Alaska Salmon In The Classroom

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Salmonid In The Classroom

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Anchorage School District
Educating All Students for Success in Life

Alaska Salmon In The Classroom

***** <u>Prior to the Egg Take:</u>**

Do Skein 1, Pages 2-29 & Skein 2, Pages 1-17.

Skein 1

Overview

Building Knowledge

Overview:
This skein gives students the opportunity to:

- **P / I** Examine and discuss their pre-existing ideas about salmon.
- **P / I** Discuss and review life cycle of familiar plants and animals.
- **P** Observe how organisms relate to their environment at different stages in their lifecycle.
- **I** Discuss and Review the stages of a salmon's life cycle, and the specific needs of each stage.

Big Ideas:

- All living things have a life cycle that is related to their needs and their habitat.
- The stages in a salmon's life form a cycle, but each stage has specific needs and is vulnerable to disruption and mortality of an alevin.

Vocabulary:

salmon, life cycle, egg, alevin, fry, smolt, adult, spawner

Important Standards Netted by Teaching Skein 1

SCIENCE

Fourth Grade	Fifth Grade	Sixth Grade
SA 1.1	SA 1.1	SA 1.1
SA 3.1	SA 3.1	SA 3.1
SC 2.1	SC 2.1	SA 2.2
SC 2.2	SC 2.2	
SC 3.1	SC 3.1	

MATH 3-6	WRITING 3-6	READING 3-6
2.2.2.1	W 1.1	R 2.1
2.2.3	W 2.1	R 2.4
		R 1.5
		R 2.5

BACKGROUND INFORMATION

LIFE CYCLES

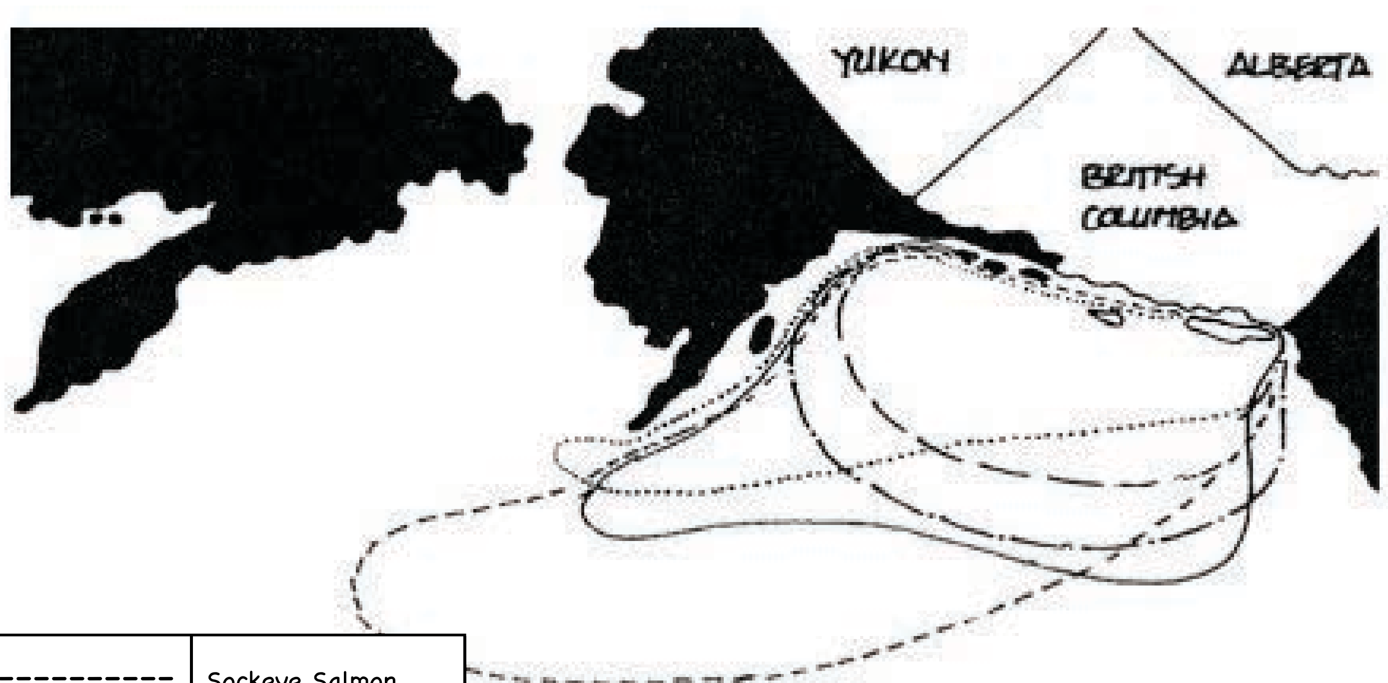
Pacific salmon move through several distinct stages in their lives, as all living things do. Each generation begins a new generation and another set of life stages. We refer to this process as a life cycle. In salmon, each stage of the life cycle takes place in a specific habitat, and has specific needs.

The stages in the life of Pacific salmon are as follows:

- ✦ **Eggs:** In late fall, adult salmon deposit thousands of eggs in a redd, a gravel depression in a flowing stream or on a lake shoreline, and cover the eggs with more gravel. The eggs, always sensitive to temperature, are particularly sensitive to movement at this stage, and need to remain undisturbed in the gravel. As cold, clean water containing oxygen flows through the gravel, an embryo develops the fertilized egg, and after about one month eyes become visible. The embryo gets the food it needs from the yolk of the egg, and oxygen from the water. Disturbances such as changing water temperature, speed of water flow and polluted water or silt deposited on the stream or lake bed can destroy the eggs. In early spring, the surviving embryos break through the membrane of the egg and hatch. They can move through the gravel, but they still face many threats: silt can still smother them, changes in water temperature or speed of water flow can be harmful, and predators catch many.
- ✦ **Alevin:** (The A is pronounced either AY as in play, or AH as in cat.) Alevin are mobile embryos. The yolk sac is still attached and provides food for the alevin for two to three months as they continue to develop hidden in the gravel. Alevin extract oxygen from the flowing water by using their gills.
- ✦ **Fry:** Once the yolk sac has been fully absorbed, the alevin leave the gravel as fry to search for food. They emerge from the stream or lake bed, usually in late spring, and swim to the surface. At the surface, they swallow air to inflate an internal swim bladder, which overcomes their natural body weight and achieves neutral buoyancy, allowing them to move easily up or down in the water. Salmon fry generally swim in a small territory and feed on whatever aquatic organisms drift through it. For protective coloring, they develop dark bars on their skin known as parr marks, which disappear in the next stage of their lives. They spend from a few months to a few years in their natal stream or lake, depending on the species. At this stage, they learn to recognize their natal environment, primarily by characteristic smells created in the water by rocks, plant life, and other aquatic organisms.
- ✦ **Smolt:** After their time in a stream or lake, salmon migrate downstream. When they reach the estuary where the river meets the ocean, they spend some time there as smolt adapting to salt water. Smolt gradually develop the ability to swallow salt water and expel the salt in their urine and through their gills. The scales that developed when they were fry turn to a silvery color. Estuary life is rich with abundant food, so smolt can grow rapidly, but estuaries are also home to many predators, such as birds, larger fish, and also to human development.
- ✦ **Adults:** Salmon migrate into the ocean, where they grow to adulthood with silvery

bellies and darker backs. Each species migrates to a particular part of the Pacific Coast from California to Northwest Alaska, sometimes ranging thousands of kilometers (km; or miles). They eat smaller ocean fish, krill (tiny crustaceans), and grow to their mature weight. Predators include large fish, fish-eating birds, marine mammals and human fishers. After a time, varying from one to eight years, they return and congregate at the mouth of their river of origin. Salmon seem to use a variety of visual and magnetic clues to navigate the ocean, then rely mainly on their sense of smell to identify their natal stream or lake.

✦ **Spawners:** When they enter their river of origin in the fall and begin to travel upstream, salmon stop eating and their bodies begin to change. Using stored energy, they travel 30 to 50 km (20-30 miles) upstream per day, often past waterfalls, and fallen obstacles. On the way, they become food for eagles, bears, wolves and people. When they reach the area where they lived as fry, the female digs a redd with her tail and fins. She deposits her eggs and a male releases his milt to fertilize them. The female then covers the eggs with fresh gravel. While a single coho salmon produces about three thousand eggs, other species can produce as many as seven thousand. Both male and female die within a few days of laying and fertilizing the eggs. Their carcasses contribute essential nutrients that fertilize the rearing area for the next generation of fry.



- - - - - - - - - -	Sockeye Salmon
___________	Chum Salmon
....	Chinook Salmon
_._._._._.	Coho Salmon
___ ___ ___	Pink Salmon

BACKGROUND INFORMATION

Salmon Life Cycle Needs and Threats

Life Cycle Stage	Needs		Threats	
	Habitat	Food	Predators	Other
EGG • Head and body formation begin • Organ formation begins • Eyes become visible	• Oxygenated water • Temperature from 5° to 9°C (42° to 50° F) • Silt-free gravel bed • Steady water flow • Stream cover	• Yolk of Egg	• Fish, such as: trout, char, grayling, burbot, whitefish, sculpin and suckers. • Birds, such as: kingfisher, gulls, terns,fish-eating ducks, shore birds, and ducks • Mammals, such as: minks and river otters.	• Gravel movement • Drastic change in water temperature • Drastic change in water level • Siltation • Fine sediment • Disease • Pollution
ALEVIN • Embryo breaks through egg membrane • Oxygen absorbed through gills • Lives in gravel spaces	• Oxygenated water • Temperature from 5° to 14°C (42° to 60° F) • Silt-free gravel • Steady water flow • Stream cover	• Yolk sac	• Fish, such as: trout, char, grayling, burbot, whitefish, sculpin and suckers. • Birds, such as: kingfisher, gulls, terns, fish-eating ducks, shore birds, and ducks. • Mammals, such as: minks and river otters.	• Gravel movement • Drastic change in water temperature • Drastic change in water level • Siltation • Fine sediment • Disease • Pollution
FRY • Inflates swim bladder • Catches food • Exhibits darting reflex • Avoids light • Guards territory • Imprints home scent • Develops scales	• Oxygenated water • Temperature from 5° to 14°C (42° to 60° F) • Even water level and flow • Stream cover	• Larval and adult terrestrial and aquatic insects, (e.g., mayfly, caddisfly, true flies) • Rotting fish carcasses • Fish eggs	• Fish, such as: trout, char, grayling, burbot, whitefish, sheefish, sculpin and northern pike. • Birds, such as: kingfisher, gulls, terns, fish-eating ducks, shore birds, ducks and eagles. • Mammals, such as: minks and river otters.	• Gravel movement • Drastic change in water temperature • Drastic change in water level • Siltation • Fine sediment • Disease • Pollution • Blockage of migration route

Life Cycle Stage	Needs		Threats	
	Habitat	Food	Predators	Other
SMOLT • Migrates to estuary • Adapts to salt water • Scales develop silver color • Increases size	• Unpolluted water in river and estuary • Estuary vegetation for shelter	• Zooplankton (copepods, amphipods, euphausids) • Insects, (e.g., beetles, ants, grasshoppers, caterpillars) • Worms • Sandfleas • Shrimp • Smaller fish	• Fish (saltwater), such as: other salmon, pollock and cod. • Birds, such as: kingfisher, gulls, terns, fish-eating ducks, sea ducks and eagles. • Mammals, such as: otters, seals and whales.	• Filling or dredging of estuary • Pollution of estuary • Diversion of river water
Ocean-Phase Salmon • Migrates into ocean • Increases size • Stocks intermingle, then return to natal river	• Ocean water	• Zooplankton (copepods, amphipods, euphausids) • Larval crustaceans, (e.g., crab, shrimp) • Smaller fish	• Fish (saltwater), such as: other salmon, pollock, cod, lingcod and sharks. • Birds, such as: gulls, terns, sea ducks and eagles • Mammals, such as: seals, whales, sea lions and people.	• Ocean pollution • Ocean temperature change • Fishing
Spawner • Eggs, milt develop • Secondary sexual characteristics develop (color, shape, teeth) • Scales absorbed • Eating stops • Organs degenerate	• Migration route free from obstruction • Oxygenated water • Cool clean water • Silt-free gravel	• None	• Fish: None • Birds, such as: Gulls and Eagles. • Mammals, such as: Seals, whales, sea lions, bears, wolves and people.	• Very high or low water levels • Warm river temperatures • Obstructions (dams, slides, log jams, etc.) • Diseases • Pollution

Building Vocabulary

Materials:

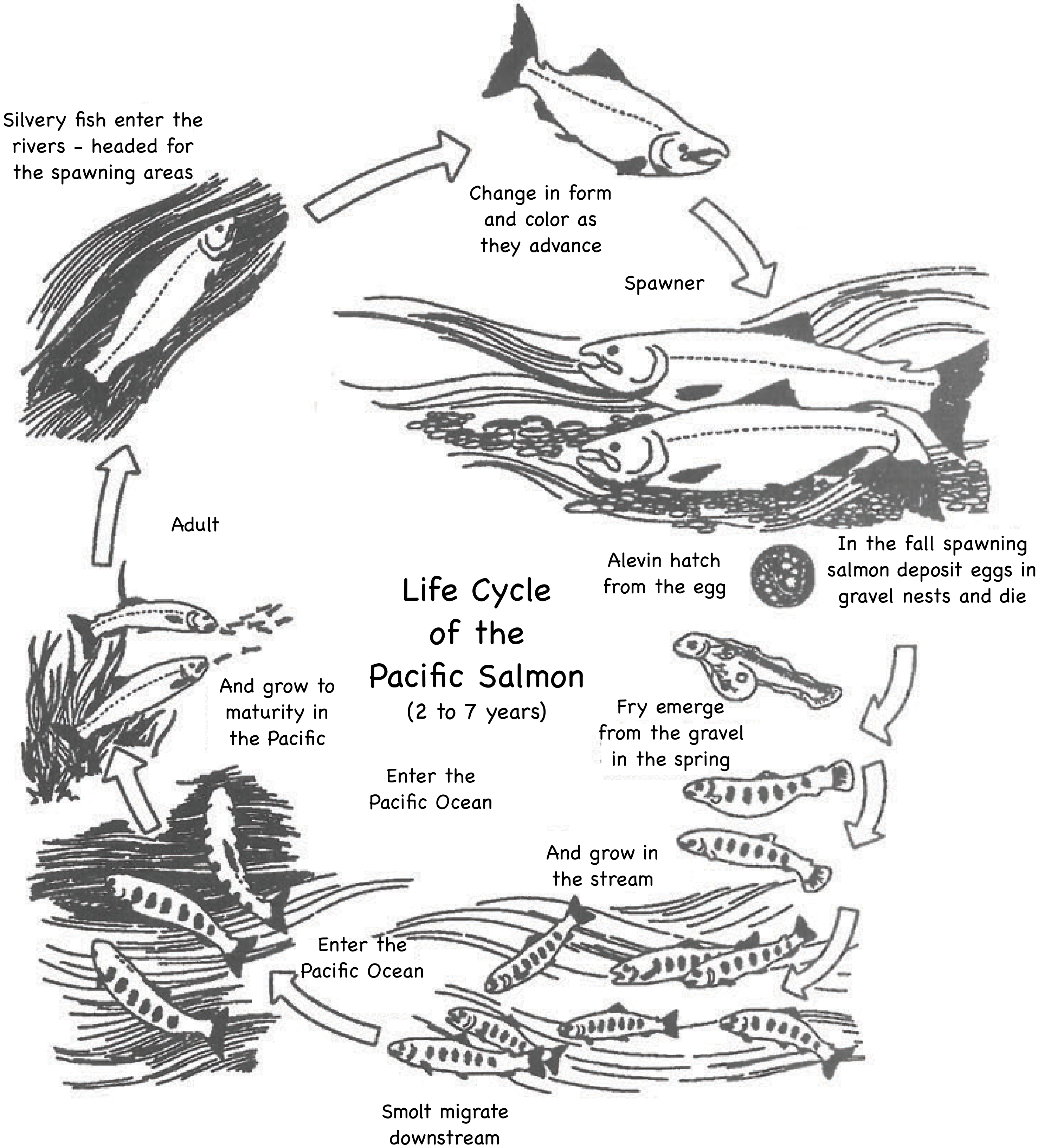
- Labeled pictures of various plants, animals and fish for each group of students
- Copies of Handout 1.1, "Salmon Stages," for each group, cut into individual illustrations
- Salmon science notebook to collect materials related to salmon

Time Required:
One lesson

Level of Conceptual Difficulty:
Simple

Evidence for Assessment:
Monitor student ideas and comments to ensure they understand the meaning of basic salmon vocabulary.

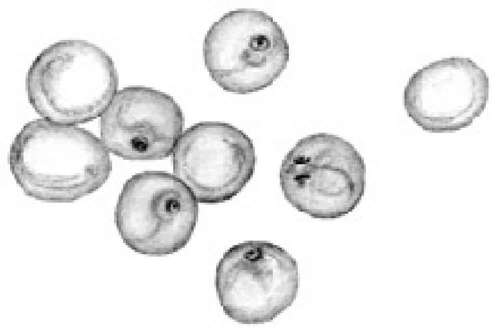
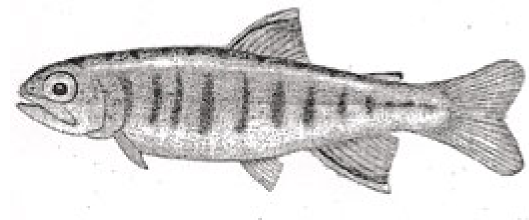
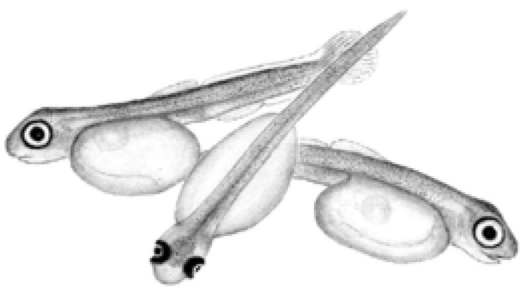
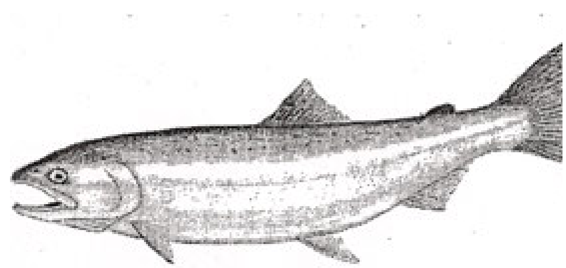
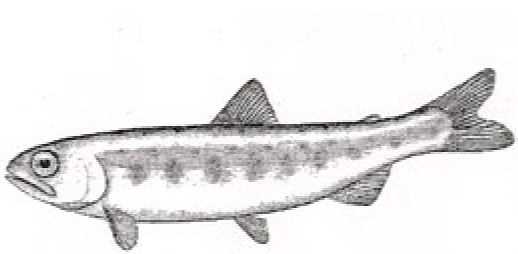
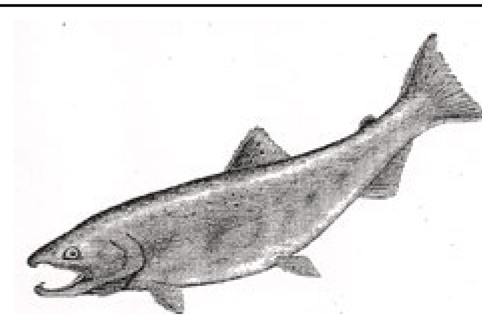
- Have groups of students sort labeled pictures into categories based on their own criteria.
- Have groups explain their categories to the class, and identify any words they do not know. Provide a definition for unknown words (see Glossary), and make a salmon dictionary on a chart posted in the classroom. Continue to add words to the dictionary from the skeins that follow.
- Have students select the pictures showing the salmon's life cycle and predict what the stage will be about.
  Salmon stages: egg, alevin, fry, smolt, adult, spawner.
- Explain that the **Alaska Salmon in the Classroom** activities will look at how salmon develop. If appropriate, outline how you plan to present **Alaska Salmon in the Classroom** throughout the year.
- Have students write their new words in their salmon science notebook.


Silvery fish enter the rivers - headed for the spawning areas
Change in form and color as they advance
Spawner
Adult
Life Cycle of the Pacific Salmon
(2 to 7 years)
Alevin hatch from the egg
In the fall spawning salmon deposit eggs in gravel nests and die
And grow to maturity in the Pacific
Fry emerge from the gravel in the spring
Enter the Pacific Ocean
And grow in the stream
Enter the Pacific Ocean
Smolt migrate downstream

Salmon Stages

Handout 1.1

Illustrations: Karen Uldall-Ekamn

 Salmon Eggs	 Fry
 Alevin	 Adults
 Smolt	 Spawners

Know, Wonder, Learn

Materials:

- Copies of Handout 1.2, "Salmon K-W-L," for each student, blown up on a photocopier to the largest size available
- Chart paper and markers
- Salmon science notebooks to collect and store materials related to salmon

Time Required:
One lesson

Level or Conceptual Difficulty:
Simple

Evidence for Assessment:
Monitor student ideas and review their "Salmon K-W-L" pages to ensure they understand the meaning of basic salmon vocabulary and facts.

- Divide a sheet of chart paper into three columns (or use three sheets) and label them "Know," "Wonder," and "Learn." Ask students to tell the class any facts they know about salmon, that is, things that they know are true. Ask the class if they agree with suggested facts. Write facts that the class agrees about in the column labeled "Know." Write statements that the class does not agree on in the column labeled "Wonder."

- Ask the class if anyone has any questions about salmon that they want to find out about, and add any statements to the column labeled "Wonder." Explain that the class will add to the "Learn" column later.

- Give students a copy of Handout 1.2, "Salmon K-W-L," and have them copy the information from the class chart to their page.

- Store the charts in a salmon science notebook, or post them in the classroom. Refer to the charts periodically as students find out more information through their salmon lessons. Ask students what they have learned to answer their questions and add their information to the column labeled "Learn." Ask if they have new questions to add.

- Have students begin gathering materials from the following skeins for their salmon science notebook, and add them as they complete further activities.

Salmon K-W-L

Handout 1.2

Use a photocopier to blow up this page to the largest format available.

LEARN	
WONDER	
KNOW	

Life Cycles

Materials:

- Large pictures of a baby, a child, a youth, an adult and an elderly person
- Copies of Handout 1.3, "Life Cycles," for each student
- Salmon Life Cycle poster
- Option: Copies of Handout 1.1, "Salmon Stages," for each group, cut into individual illustrations
- Art supplies

Time Required:
One or two lessons

Level of Conceptual Difficulty:
Simple

Evidence for Assessment:
Monitor student discussion and drawings to ensure they can show that plants and animals go through a life cycle in orderly stages.

INTRODUCTION

- With the class, sort pictures showing the stages in the life cycle of a person in chronological order.

DISCUSSION

- Discuss with the class the stages in the life cycle of a person. Draw the stages in a circular diagram as you discuss them. If necessary, prompt students with questions such as the following:

  - What happens when a baby grows older?
    He or she becomes a young child.
  - What happens when a child grows up?
    He or she becomes a teenager or an adult.
  - What happens when an adult gets old?
    He or she gets old and dies.
  - Where does a baby come from?
    From adult parents.

EXPLANATION

- Explain that salmon are a kind of fish that live in many local streams, lakes, and oceans. Use Handout 1.3, "Life Cycles," to show that salmon have a life cycle like other animals and plants.

- Explain that all living things have a life cycle, and have students compare the stages of a salmon's life cycle with the stages of a human or another familiar animal.

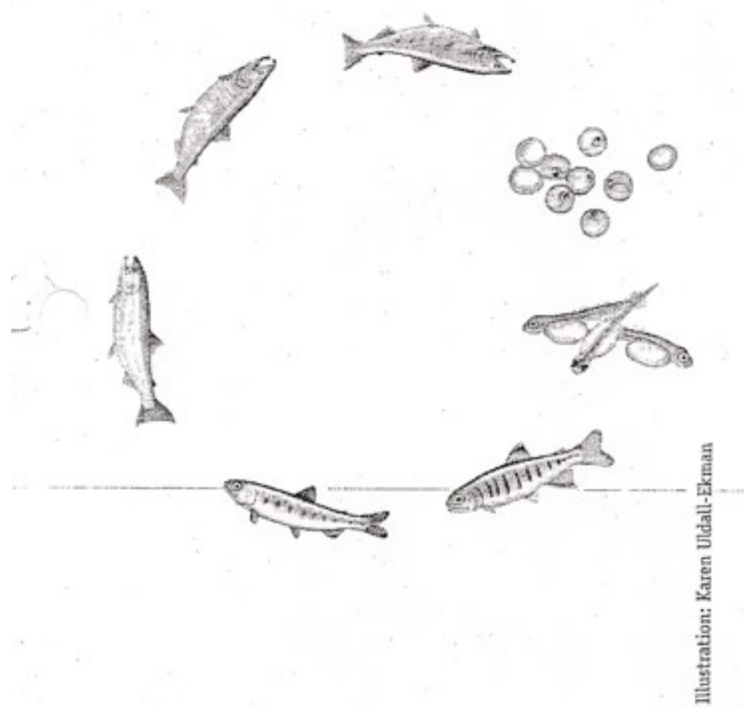
SUMMATION

- Have students draw or paint the stages in the life cycle of a familiar animal.

P

LIFE CYCLES

Handout 1.3



Most plants grow from a seed. They grow roots, a stem and leaves. When they get big, they form flowers and seeds. Seeds grow into new plants.

Salmon grow from an egg. They grow gills, fins, a head, and a tail. The salmon leaves the natal stream or lake and migrates to the ocean.

One to five years later they return to their natal stream to lay eggs and complete their cycle. More salmon grow from the eggs.

All living things have a life cycle. First they are born. Then they grow up. They have seeds or eggs or babies. Finally, they die.

Life Cycle Of A Bean

The stages of life of Pacific salmon is similar to those of other plants and animals, including humans. By studying the stages in a plant that students can grow, or stages of growth in their own family members, students can identify similarities in the life cycle of all living things and begin to understand their significances. However, the emphasis should be on drawing parallels with the salmon life cycle. Teachers who have access to a classroom salmon incubator can follow the actual development of salmon eggs in the tank.

Materials:

For each group of students:

- One or more bean seeds
- A paper towel
- A Ziploc® bag
- Water
- Rulers
- Copies of Handout 1.4, "Daily Observations," for each student
- Graph paper
- Writing supplies
- Salmon Life Cycle poster

INTRODUCTION

☞ Explain that salmon go through life cycle stages like all other animals and plants. In this activity, students will grow a bean seed, because it grows in stages like salmon and other animals.

EXPERIMENT

☞ Have students observe, measure and describe bean seeds, and record their observations.

☞ Have students predict what will happen if the beans are kept moist for several days.

☞ Have students in groups grow a bean seed between sheets of damp toweling in a Ziploc® bag (or by placing them in a clear plastic cup filled with soil, next to the side where students can watch the beans grow). Have them moisten the paper and keep it in an even-temperature location, out of direct sunlight.

☞ Have students carefully observe the bean each day, and use Handout 1.4, "Daily Observations," to describe, draw, measure, and graph the changes as the bean grows.

DISCUSSION

☞ Have students compare the growing beans with their original observations and their predictions. Ask students to suggest reasons for any differences between their observations and their predictions. Ask if anyone can describe what would happen to the bean if it were able to continue growing naturally. If necessary, prompt them with questions such as the following:

- How tall might a bean plant get if it grows in a garden?
  Up to one meter (about 3 feet).
- What are the parts of a bean plant?
  Roots, stem, leaves, flowers, pods, beans.
- What does a bean plant need to grow?
  Soil, water, light.

Time Required:
Two lessons, observation time over several weeks, and a follow-up lesson

Level of Conceptual Difficulty:
Simple; young students will need a buddy to help with measurements and recording.

Evidence for Assessment:
Review the charts the students make to ensure they can identify various stages in the life of plants and animals, including salmon.

- How does a bean plant produce new seeds?
  The grown plant makes seeds in a pod.
- What are the steps in the life cycle of a bean?
  It is a seed; it grows roots; it grows above the soil; it grows leaves and stems; it produces new seeds; etc.

SUMMATION

☞ Outline and diagram the stages of a bean seed's life.
Seed, seedling, growing plant, adult.

☞ Review and diagram the stages of a person's life.
Baby, child, youth, adult, old adult.

☞ Review and diagram the stages of a salmon's life.
Egg, alevin, fry, smolt, adult, spawner.

☞ Make a chart with the class listing the stages in the growth of a bean seed, a person, and a salmon. Have students compare the growth of a bean seed and a person with the life cycle of a salmon, as they see it in the poster. If necessary, prompt them with questions such as the following:

- Where on the poster do you see something like the bean seed?
  The egg.
- How is the egg like a bean seed?
  Something grows from it.
- What does the alevin grow into?
  Fry.
- What does the smolt grow into?
  An adult salmon.
- Where do the salmon eggs come from?
  The adult salmon spawning.

DAILY OBSERVATIONS

Handout 1.4

Name	
Title	

Date ______________

Today I Saw.....

Date ______________

Today I Saw.....

Date ______________

Today I Saw.....

Date ______________

Today I Saw.....

Date ______________

Today I Saw.....

Life Cycle Needs

Materials:

- Salmon Life Cycle poster
- Writing supplies

Time Required:

One lesson

Level of Conceptual Difficulty:

Simple to moderate

Evidence for Assessment:

Review student lists and categories to ensure they can identify the needs of various organisms, including water, food, shelter, and air.

INTRODUCTION

- Have students work in groups or as the whole class to make a list of things that a bean needs to survive. If necessary, prompt them with questions such as the following:
  - What does it need to absorb (drink)?
    Water.
  - What does it need for food?
    Nutrients from the soil, water, and sunlight for photosynthesis.
  - What does it need for respiration/transpiration (breathe)?
    Air.
  - What does it need to grow and survive (location)?
    A safe place.
- Have the groups share their lists with the class, and write their suggestions on a chart labeled "Bean Needs."
- Have the groups make a list of things that people need to survive. With older students, ask them to describe how they get the things they need. If necessary, prompt them with questions such as the following:
  - What do people need to breathe?
    Air.
  - What do people need to eat and drink?
    Food and water.
  - What do people need to stay safe?
    Shelter and clothes.
- Have the groups share their lists with the class, and write their suggestions on a chart labeled "People Needs."

RESEARCH/DISCUSSION

☞ Have the class use the Salmon Life Cycle poster to identify things that salmon need to survive. Write their suggestions on a chart labeled "Salmon Needs." If necessary, prompt them with questions such as the following:

- What do salmon need to breathe?
  Dissolved oxygen in the water.
- What do salmon need to eat and drink?
  Water and food, such as insects and tiny aquatic animals, i.e., zooplankton.
- What do salmon need to stay safe and healthy?
  Clear streams, lakes and oceans.

☞ Have the class identify similar elements from the three lists, put them in categories, such as food, shelter, etc., and give a name to each category. (With younger students, have them cut the words out of a piece of paper, then talk about and sort the words.)

SUMMATION

☞ Have students write one or more sentences (or draw a picture) describing each category.

Changing Environment

This experiment demonstrates that if the beans' needs are not met in their environment, they grow poorly or die. It leads to a discussion about meeting the basic needs of salmon.

Materials:

- Two or more bean seeds for each group
- Blotting paper
- Water
- Rulers
- Copies of Handout 1.5, "Comparison Chart," for each student
- Graph paper
- Writing supplies
- Salmon Life Cycle poster

Time Required:

Two lessons, observation time over several weeks, and a follow-up lesson

Level of Conceptual Difficulty:

Moderate; young students will need a buddy to help with measurements and recording.

INTRODUCTION

☞ Ask students what a bean needs to survive and what would happen if the bean seeds do not get enough of the things they need to survive. With older students, ask how they could test in class what would happen if a bean did not get the things it needs.

EXPERIMENT

☞ Have students suggest various environments to compare how a bean grows with and without the elements it needs to survive; e.g., with light/without light; with water/without water; with air/without air (in a sealed plastic bag).

☞ Have groups of students grow bean seeds in paired environments, one with and one without one of the elements they identified. Have them carefully observe the bean seeds each day, and describe, measure and graph what happens in each environment.

☞ Have students use their "Comparison Chart" to compare each of the pairs of growing beans. Ask older students to suggest reasons to explain any differences, or to explain why differences they predicted are not visible.

RESEARCH/DISCUSS

☞ Have students list what a salmon needs to survive, and use the Salmon Life Cycle poster to infer what they think would happen to a salmon if elements of its environment were removed (or damaged). If necessary, prompt them with questions such as the following:

- What would happen if the water in a salmon stream or lake dried up?
  Salmon and their eggs would die.
- What would happen if the water in a salmon stream or lake became very muddy?
  Salmon and their eggs would smother.

Evidence for Assessment:
Monitor class discussions and charts to ensure students can identify things that salmon need to survive, including a running stream, ocean, gravel, and food.

- What would happen if the water in a salmon stream or lake was not shaded?
  It would warm the water, and could harm salmon and their eggs.
- What would happen if stream water flowed too fast?
  Eggs, young salmon, gravel and foods might be washed away.
- What would happen if streams were straightened?
  Water velocity would increase.
- What would happen if wetlands were filled in?
  Growing salmon lose important sites that give them shelter and allow them to grow safely.

SUMMATION

☞ Have students suggest ways to protect the things salmon need to grow.
Maintain fresh water flow, avoid pollution, avoid disturbing salmon streams, protect side channels and pools of calm water.

Comparison Chart

Handout 1.5

Name	
Title	

My prediction is (write or draw your prediction)

In one example, I saw (write or draw size, color or changes)	In the other example, I saw (write or draw size, color or changes)

I think the two examples are different because

Looking Ahead At Salmon Studies [discussion]

<u>Materials:</u> One copy of Handout 1.6, "Looking Ahead at Salmon Studies," (Parts 1 & 2), for each student

- ✏ Writing supplies

<u>Time Required:</u>
One lesson

<u>Level of Conceptual Difficulty:</u>
Simple

<u>Suggestions for Assessment:</u>
Monitor the class discussion to assess student level of understanding of the language and concepts used in salmon lessons.

DISCUSSION

- ☞ Students complete Handout 1.6, "Looking Ahead at Salmon Studies," (Parts 1 & 2).
- ☞ Class Discussion

SUMMATION

- ☞ Explain that the questions reflect some of the key ideas students will investigate in the Salmon Studies activities which follow. As they do the activities, ask them to look for information that will help confirm or change what they wrote on Handout 1.6.

Looking Ahead at Salmon Studies

Handout 1.6, (Part 1)

Name ____

	What Do You Know About...	What Would You Like To Know About...
The salmon life cycle?		
Salmon needs and threats?		
The water cycle?		
Healthy salmon habitat?		
Salmon anatomy?		

Looking Ahead at Salmon Studies

Handout 1.6, (Part 2)

Name ____

	What Do You Know About...	What Would You Like To Know About...
Incubation?		
Water quality?		
Responsible fishing?		
Stewardship?		

Salmon Life Cycle Chart [build-on-what-you-know]

Materials:

- One copy of Handout 1.7, "Salmon Life Cycle," (Parts 1 & 2), for each student

Time Required:
One lesson

Level of Conceptual Difficulty:
Moderate

Suggestions for Assessment:
Review the lists the groups create and monitor the class discussion to ensure that the students can identify the key factors affecting a salmon's life during each stage.

INTRODUCTION

- Read the background information in each skein to familiarize yourself with the life cycle of the Pacific salmon. This should prepare you to answer any questions students may have as they are introduced to the salmon's life cycle.

- Watch a film of the salmon's life cycle, or read them a book that briefly summarizes the stages in the life cycle of a salmon.

- Give each student a copy of Handout 1.7, "Salmon Life Cycle," (Parts 1 & 2). Have the students fill in the information based on what they have heard or already know about salmon needs and habitat. Tell students that they will add details to the chart and refer back to it as they study other stages in the salmon's life cycle.

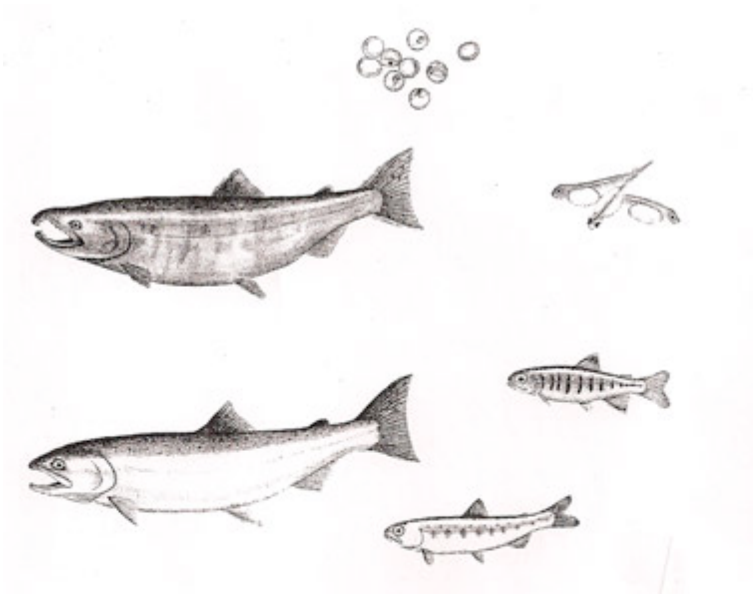


Illustration: Karen Uldall-Ekamn

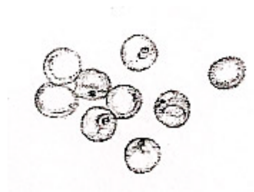
Salmon Life Cycle

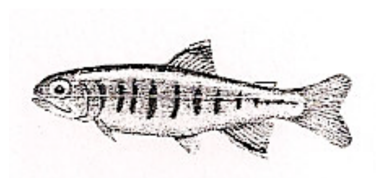
Handout 1.7, (Part 1)

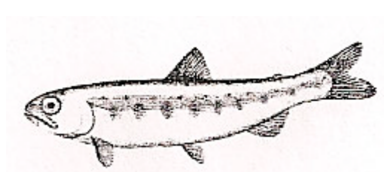
Life Cycle Stage	Needs		Threats	
	Habitat	Food	Predators	Other
Egg				
Alevin				
Fry				
Smolt				
Adult Salmon				
Spawner				

Salmon Life Cycle

Handout 1.7, (Part 2)







SALMON LIFE CYCLE

WRAP-UP

REVIEW

- ☞ Have students identify life cycle stages, e.g., birth, baby, child, adult, aged adult, death.
- ☞ Draw a large circle on the board and ask students to write or draw the stages in the life of a plant or animal.
- ☞ Point out that all living things go though a cycle of being born, growing up, having young, growing old and dying.
- ☞ Have students move in a circle, acting out the stages in the life of a plant or animal, then returning to the beginning of the circle.

EVIDENCE FOR SKEIN ASSESSMENT

- ☞ Have students draw life-sized pictures of each stage of the salmon's life cycle on chart paper and describe (or label) where the salmon live at each stage. Discuss the movement of salmon from stage to stage, to ensure that the students can describe the movement as a continuous cycle.
- ☞ Have students review their salmon science notebooks, including their initial questions about what they wanted to learn, and describe what new knowledge they acquired.
- ☞ Have students complete a stem sentence, such as, "I used to think… about salmon life cycles, but now I know that…," or, "One thing I learned about salmon life cycles is that…".
- ☞ Have students add their materials to their salmon science notebook and write a sentence explaining what they learned.
- ☞ Have students make a painting or drawing about the life cycle of a salmon and describe what it shows about what salmon need to survive.
- ☞ Have students put pictures from the life cycle of a plant, a human and a salmon in correct order, and explain why the order is correct.

LANGUAGE AND ARTS INTEGRATION

- ☞ Have students research the life cycle of the salmon, linking the seasons with what happens in a salmon's life cycle and explaining why each stage takes place when it does.

  The amount of time that it takes a salmon to develop depends on the temperature of the water. Not all salmon spawn in the fall. Each species of salmon has slightly different schedule. Coho salmon spawn in the fall. Eggs and alevin develop under the ice of winter and hatch in the spring when food is plentiful.

- ☞ Have students work with the technology lab to develop a multimedia presentation on the salmon's life cycle, and ways of protecting salmon.
- ☞ Have students cut out cards with pictures labeled with the stages of a salmon's life and play matching and memory recognition games to reinforce their vocabulary knowledge, e.g., match cards with labels to cards with illustrations, or turn over an illustration card to read the label on the reverse side.
- ☞ Have students divide a paper plate into sections and draw a stage in the life cycle of a plant or animal in each section.

HOME CONNECTIONS

- ☞ Have students describe to an adult the dangers a salmon faces throughout its life cycle and actions people can take to reduce the dangers.
- ☞ Have students describe and act out the life cycle of a plant or animal for an adult and compare it with the life cycle of their family.

SALMON LIFE CYCLE

WRAP-UP

EXTENSION ACTIVITIES

- ☞ Have students write letters to the Alaska Department of Fish and Game and U.S. Fish and Wildlife Service expressing their views on a subject that they have studied.

- ☞ Have students write a short story from the point of view of a salmon. Discuss what anthropomorphism is (viewing nonhuman events from a human perspective). Explain that anthropomorphism can be a powerful tool for understanding, and is widely used in the conventions of folk tales. However, it is important to recognize clear differences between the entities of the wild as metaphors and as beings in their own right, with their own nonhuman qualities.

- ☞ Have students create a hypertext file, multimedia presentation, puppet show or readers' theater representing the life cycle of a salmon.

SUGGESTIONS FOR ASSESSMENT

- ☞ Have students draw a food web representing the salmon's entire life cycle.

- ☞ Using information from the skeins and independent research, have students role play a scenario in which competing groups of people try to find the most appropriate way to protect a salmon spawning stream near a city. Have them compare and evaluate facts and arguments presented in a class debriefing.

- ☞ Have students use the quiz questions they prepared on index cards in previous skeins about the stages of the salmon life cycle. Have them quiz each other by asking the questions or by using a Jeopardy-style format (i.e., giving the answers and asking for a question).

- ☞ Have students draw a cartoon storyline representing the life cycle of a salmon.

- ☞ Have students review their answers and explanations from the "Looking Ahead to Salmon Studies" in Skein 1 and describe how they would answer the questions now, and how they would explain their answers.

- ☞ Have students add their notes, experiment observations, and other materials to a salmon science notebook. Have a conference with students, in which they discuss the materials in their salmon science notebook and the significance of each in understanding the life cycle of a salmon.

HOME AND COMMUNITY CONNECTIONS

- ☞ Have students ask an adult to help them set up a home waste plan, including reduction, recycling, and hazard waste management.

- ☞ Visit your local Alaska Department of Fish and Game or U.S. Fish and Wildlife office and talk to a biologist.

- ☞ Have your parents take you outside to discover some of the local resources. Ask them about what outdoor activities they like to participate in and join in those activities with them.

Skein 2

Spawners

Return From The Sea

Overview:
This skein gives students the opportunity to:

- **P / I** Discuss and simulate why salmon swim upstream in the fall.
- **P / I** Test the importance of fish carcasses to plant growth.
- **P / I** Identify body parts of a salmon and compare them to human body parts.
- **P / I** Examine and discuss the relationship between fish shape, skin, scales, and gills and the way they live.
- **I** Discuss genetics.

Big Ideas:

- Spawners travel upriver to their natal stream or lake. Females lay eggs and males fertilize eggs. Salmon die after spawning and their carcasses return essential nutrients to the water, forest, and tundra ecosystems.
- There is a relationship between fish shape, skin, scales, and gills and the way they live. Form and function are related to the journey they take.

Vocabulary:

spawn, spawning ground, redd, milt, fertilize, genetic variation, genetic diversity, lateral line, gills, pyloric caeca, operculum, otolith, pharynx, pectoral, humeral, caudal fin, dorsal fin, caudal peduncle, pollutant, chordates

Important Standards Netted by Teaching Skein 2

SCIENCE

Fourth Grade	**Fifth Grade**	**Sixth Grade**
SA 1.1	SC 1.1	SA 1.1
SA 3.1	SC 2.1	SC 2.1
SC 1.1	SC 22	SC 2.2
SC 2.1		SC 3.1
SC 2.2		SC 3.2
		SD 2.1

MATH	**Third Grade**	**Fourth Grade**	**Fifth Grade**	**Sixth Grade**
Making a Redd	M 2.1.1	M 2.2.1	M 2.2.1	M 2.2.1
	M 2.1.2	M 8.2.2	M 8.2.2	M 8.2.2
	M 8.1.3	M 6.2.1	M 6.2.1	M 6.2.1
	M 6.1.5	M 6.2.2	M 6.2.2	M 6.2.2
	M 7.1.2	M 7.2.2	M 7.2.2	M 7.2.2
Scales and Skin	M 3.1.1	M 3.2.1	M 3.2.1	M 3.2.1
Fish Fertilizer	M 2.1.1	M 3.2.1	M 3.2.1	M 3.2.1
		MEA.5	MEA.8	MEA.7
	M 7.1.2	M 7.2.2	M 7.2.2	M 7.2.2
Genetic Diversity	M 6.1.5	M 6.2.5	M 6.2.5	M 6.2.5
	M 6.1.1	M 6.2.2	M 6.2.2	M 6.2.2

READING

Where does a Spawner come from?		1.1	2.1	1.5	2.5	1.4b 2.4b	1.2.2.2
Making a Redd		1.2	2.1	1.6	2.6	1.5 2.5	
The Redd		1.1	2.1	1.5	2.5		
Parts of a Fish		1.1	2.1	1.5	2.5		
The Salmon Spawner	R[3]	1.1.1		1.1.3		1.1.4	1.1.5
	R[4-6]	2.1.1		2.1.2		2.1.3	2.1.5
If class reads aloud/small group		1.3		2.3			
Fish Fertilizer		1.6		2.6			
Genetic Diversity		1.6		2.6			

WRITING 3-6

2.1.2
2.2.4
2.4.3

BACKGROUND INFORMATION

SPAWNERS

In the final stage of a salmon's life cycle, they reenter their natal river and swim back to the stream or lakeshore in which they grew as fry. Salmon may travel hundreds or thousands of kilometers (km; or miles), swimming from 30 to 50 km (20 - 30 miles) a day against the current to get to the stream where they were born. They follow the scent of the water from their natal stream past obstacles, such as rapids, dams, rock slides, log jams, and even very low sections of river beds before reaching their destination. Fishers and predators, such as bears, otters, and eagles catch many salmon on their trip upstream.

When they enter fresh water, salmon stop eating and live only on stored body fat. Their kidneys and gills change to regulate the water and salt balance in their cells. They start to break down from lack of nutrition. They lose their slime coating, their skin becomes thick, and they start to resorb their scales.

The salmon's appearance changes dramatically, with males and females developing distinct differences (sexual dimorphism). They lose their silvery color and take on deep red, green, purple, brown, or gray colors depending on the species. The tissue around the teeth recedes, exposing more teeth, and they develop a hooked jaw. Their body shape can change, with some species developing a pronounced hump on their back. Eggs ripen in the ovaries of females, while sperm in the male changes into liquid milt.

When they reach their natal stream or lake, the female finds a spot with the right gravel size and water conditions. With strong sweeps of her tail and fins, she rearranges the stones in the gravel bed to form a redd, the nest-like depression in the stream or lake bed where she will lay her eggs. Males fight among themselves to get close to a female. The female deposits some of her eggs in the redd, and the male deposits his milt to fertilize them. Some species deposit up to 6,000 eggs, but the average is about 3,000 in coho salmon. The female covers the eggs with gravel to protect them.

Both males and females will stay near their redd and protect the eggs from other fish trying to spawn on top of their redd and from predators trying to eat their eggs. They will both eventually die near their redd. Their bodies, battered and injured by the difficult trip upstream, decompose. Valuable nutrients from the carcasses form a rich food source for other fish and wildlife by fertilizing the stream and lake. Salmon carcasses that are carried into riverbanks fertilize the forest and bushes. If most of the adult salmon are caught, the water will have few nutrients for the next generation of salmon and for the rest of the ecosystem.

BACKGROUND INFORMATION

SPAWNERS

The return of salmon to their natal streams and lakes is an essential part of the Alaska ecosystem. Not all salmon have to migrate to the sea – some landlocked populations grow and produce offspring without journeying to the ocean. Those that do migrate must return to find an environment that is suitable for their offspring to mature. Salmon eggs and fry cannot survive in the salty water and unprotected conditions of the sea.

The salmon's return provides nutrients for offspring and sustenance for other species, even after their death, by fertilizing the forest environment with their remains. Coastal watersheds, including lakes, streams and stream banks, are often low in nutrients essential for plant growth, especially nitrogen. Recent studies have shown that nutrients from the sea make an important contribution to plants and animals along salmon spawning streams. Spawners bring these nutrients from the sea and leave them in their carcasses when they die.

Some animals take up marine nutrients by eating the salmon carcasses. A single dead spawner can feed thousands of insect larvae, which in turn form the food source for fry that will spend the winter in lakes and rivers. Algae, fungi, and bacteria, which live in the water, also take up marine nutrients before dying and provide food for small invertebrates which are then eaten by salmon fry. Forest lakes and streams provide little nutrition compared with the richness of the estuary and ocean, and many species might not survive without the nutrients released by decaying spawners. After the spawners return to their spawning grounds, the increased nutrients in the water can allow fry to double their rate of growth.

When salmon cannot return to their natal lakes and rivers because of overfishing or blockages en route, or when their carcasses are removed, the lack of nutrients can mean that fewer survive in the next generation. The result can be a long-term decline in the number of survivors and a threat to already weak salmon runs.

Salmon carcasses may also form part of the forest ecosystem. Birds, bears, and smaller mammals drag some carcasses ashore, carrying marine nutrients through the forest adjacent to lakes and streams, and depositing the nutrients in their feces. The remains of the salmon fertilize the forest soil in regions where heavy rainfalls quickly leach out nutrients that are essential for strong tree growth.

The return of the salmon also ensures genetic diversity, which is important to maintain a healthy population. All living things contain codes (called genes) in their cells that give instructions for their physical development. These physical characteristics affect the way a fish interacts with its environment. Variations in these characteristics result in genetic diversity. A large amount of genetic diversity is beneficial to a salmon population since there is a better chance that a few individuals will have the favorable characteristics that will allow them to survive environmental changes. When a population is lost, the genetic diversity in that population is also lost, which weakens the chances that salmon will be able to survive changes to their environment (such as warmer temperatures).

Where Does A Spawner Come From?

Materials:

- Salmon Life Cycle poster
- Copies of Handout 2.1, "Salmon Spawners," for each student.

Time Required:
One lesson

Level of Conceptual Difficulty:
Simple

Evidence for Assessment:
Monitor student discussion of the Salmon Life Cycle poster to ensure they can describe the spawner's journey to its natal stream, building of a redd, laying and fertilizing the eggs.

INTRODUCTION

☞ Ask the class to suggest reasons why salmon return to their natal stream instead of staying in the ocean to grow old and die.
They return to their natal stream to find a safe place to lay their eggs and spawn a new generation. Salmon eggs cannot survive in the ocean.

RESEARCH/DISCUSSION

☞ Have the class look at the Salmon Life Cycle poster and draw their attention to the part about the spawner. Ask students to explain what the poster shows about where spawners come from.
When adult salmon are ready to return from the ocean, they travel to the mouth of their natal river.

☞ Have students use the poster to explain where a spawner goes and what happens to it.
Spawners swim upstream to spawn, lay and fertilize their eggs, and then die.

☞ Have students use the poster to compare conditions in the ocean with those in a spawning stream.
The ocean is large and open with salt water. A spawning stream is a small, gravel, fresh-water stream, usually the same stream the salmon was born in.

SUMMATION

☞ Read Handout 2.1, "Salmon Spawners," or have students use it to research the spawning stage. Have students in groups write three important things about an adult salmon.

Salmon Spawners

Handout 2.1

Illustration: Karen Uldall-Ekman

Salmon spawners leave the ocean to travel upstream to the stream or lake where they were born.

On the long trip upstream, spawners do not eat. Their shape and color changes. Their skin may become bright red, green, or purple. Some develop a large hump and a hooked jaw.

As they swim, they face many dangers. They must jump waterfalls and rapids. Logs and rocks block the way. Human fishers try to catch them. Eagles and bears want to eat them. Spawners smell the water to find their natal stream or lake. When they reach their natal stream or lake, the female builds a redd. She sweeps rocks and gravel with her tail and fins to make a stone nest.

She lays her eggs in the redd. The male deposits his milt so the eggs will become fertilized. The female covers the eggs.

The male and the female die after spawning. Other animals eat their bodies. Salmon bodies fertilize the stream and forest.

Appearance Changes

Materials:
- ✏ Several magazine pictures of people at a variety of ages.
- ✏ Writing materials or art supplies
- ✏ Salmon Life Cycle poster
- ✏ Painting supplies

Time Required:
One lesson

Level of Conceptual Difficulty:
Moderate

Evidence for Assessment:
Review the students' fact sheets or posters to ensure they can identify changes in the appearance of a spawner.

PREPARATION

☞ OPTION: Have students bring in pictures from magazines or photos of people at a variety of ages.

RESEARCH/DISCUSSION

☞ Give students in groups several magazine pictures of people at a variety of ages. (If appropriate, point out that magazines often rely on stereotyped images which may not accurately reflect the people in students' lives.) Have the groups sort the pictures into groups of different ages. Discuss with the class what age groups they used, and how they were able to sort the pictures. If necessary, prompt them with questions such as the following:

- What do the babies in the pictures look like? How are they different from other people?
- What do the young children look like? How are they different from other people?
- What do the older children look like? How are they different from other people?
- What do the adults look like? How are they different from other people?
- What do the elderly people look like? How are they different from other people?
- Do all people change as they get older? How do they change?
- Do other animals change as they get older? What changes have you seen in pets or other animals?

SUMMATION

☞ Have students paint a salmon spawner to show the new colors, hooked mouth, etc.

P/I

The Redd

Materials:

- ✏ Salmon Life Cycle poster

Time Required:

One lesson

Level of Conceptual Difficulty:

Easy to moderate

INTRODUCTION

☞ Have students use the Salmon Life Cycle poster to explain what a redd is, who makes it, how and why. If necessary, prompt them with questions such as the following:

- Where do you see a redd in the poster?
- Who is making the redd?
  The mother salmon.
- Where does she make the redd?
  In the bed of the stream or lake.
- How does the salmon make the redd?
  She uses her tail to push rocks aside into an oval nest.
- What is the redd made of?
  Rocks and gravel.
- Why does she make a redd?
  To protect the eggs that she lays.

Purpose Of A Redd

This activity demonstrates how a gravel redd protects salmon eggs from predators.

Materials:

- Large basin
- Water
- Modeling clay
- Toothpicks
- Rocks 5 to 10 cm (2 - 4 in) in diameter and gravel
- Copies of Handout 2.2, "Making a Redd Observation Page," for each student.

Time Required:
One or two lessons

Level of Conceptual Difficulty:
Moderate to advanced

Evidence for Assessment:
Review student discussion and observation pages to ensure they can describe how a redd protects salmon eggs from predators and strong water flow.

INTRODUCTION

☞ Discuss with the class how pets and other animals keep newly born babies safe and healthy.
They make a secure nest or den for the babies, bring them food and drink and protect them from intruders.

☞ Explain that a redd is like a nest made of gravel on the stream or lake bed, in which spawners lay their eggs.

☞ Have the class suggest reasons why spawners create a redd in which to lay their eggs, and write their ideas on Handout 2.2, "Making a Redd Observation Page."

ACTIVITY, PART ONE

☞ Have students make small eggs from modeling clay, about one half centimeter in diameter, place them at one end of a basin, and predict what might happen to them in a stream.

☞ Tilt the basin at an angle, pour water gently over the model eggs, and have students count the eggs that are washed to the bottom of the basin.

☞ Have some students in pairs act as birds, use toothpicks to peck at the eggs, and count and record the eggs they catch in ten seconds.

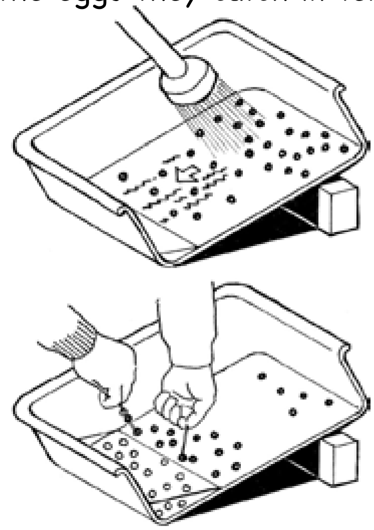
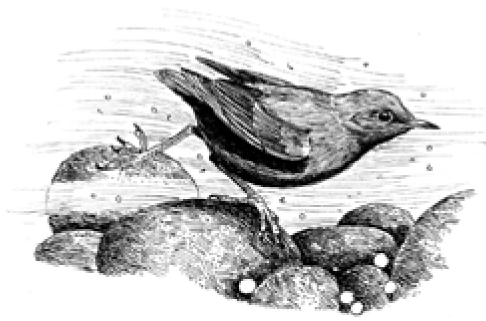


illustration: Donald Gunn



illustrations: Donald Gunn

ACTIVITY, PART TWO

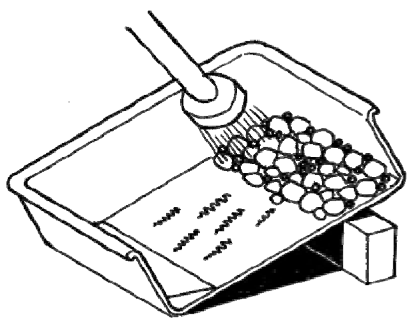
- ☞ Make a model redd using rocks and gravel at one end of the basin. Place the model eggs in the redd and cover them with gravel. Have students predict what might happen to them in a stream.

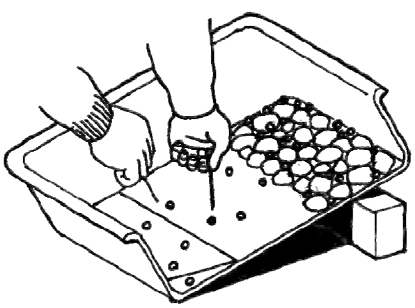
- ☞ Tilt the basin at the same angle as Part One. Pour water gently over the redd and have students count the eggs that are washed away.

- ☞ Have some students in pairs act as birds, use toothpicks to peck at the eggs, and count and record the eggs they catch in ten seconds.

ACTIVITY, PART THREE

- ☞ With the class, compare the outcomes for Activities, Part One and Part Two. Make a graph to compare the number of eggs that were washed away or caught by birds in Part One and Part Two.





DISCUSSION

- ☞ Discuss with the class what conclusions they can add to Handout 2.2, "Making a Redd Observations Page." If necessary, prompt them with questions such as the following:

  - Were more eggs washed away with the redd or without?
    Without.
  - Did the birds catch more eggs with the redd or without?
    Without.
  - How was the redd in the basin like a redd in a stream? How was it different?
    Similar materials and shape, but smaller, less water flow.
  - How would a redd help protect the eggs in a real stream?
    It would hide them from birds, and keep them from washing away. It would also help protect them from other predators, such as fish, so more would survive.

Making A Redd Observation Page

Handout 2.2

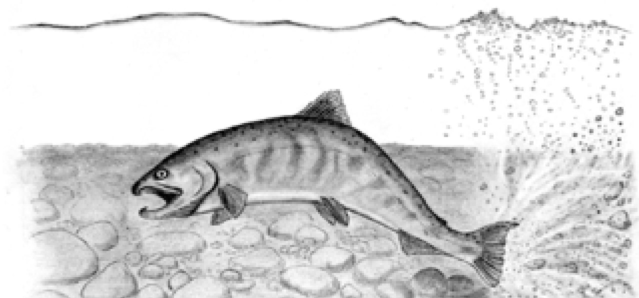


Illustration: Karen Uldall-Ekman

Prediction

I predict that water will wash away more eggs when

I predict that birds will find more eggs when

Observations

Eggs with no redd		**Eggs in redd**	
Washed Away	Found by Birds	Washed Away	Found by Birds

Conclusion

This activity shows that

Parts Of A Salmon

Materials:

- Option: a classroom plant such as a bean plant.
- Writing supplies
- Copies of Handout 2.3, "Parts of a Salmon," (Parts 1 & 2), for each student.
- Poster showing parts of a fish. See page 54.

Time Required:

One lesson

Level of Conceptual Difficulty:

Simple

Evidence for Assessment:

Monitor student discussion in making the Venn diagram to ensure they recognize that salmon have features in common with people, such as ears, eyes, noses, but that they do not share others, such as fins, tails, etc.

INTRODUCTION

- Option: Have students identify the parts of a plant and what each does.
  The stem holds it up, the leaves collect sunlight and make food, the roots hold it in t he ground and collect moisture, etc.

- Option: Have students identify the parts of a human and what each does.
  The legs hold people up and let people move, arms let people hold things, the mouth lets people eat, etc.

RESEARCH/DISCUSSION

- Have the class use a poster of a salmon to identify the external body parts, i.e., head, mouth, eyes, nostril, gills, body, lateral line, fins (pectoral, pelvic, dorsal, anal, adipose), tail, skin, scales. Have students make and label their own drawing of a fish or place labels on the outline drawing in Handout 2.3, "Parts of a Salmon," (Parts 1 & 2).

SUMMATION

- Make a list or Venn diagram of overlapping circles with the class to identify features in fish and humans that are similar and different.
  Both have ears, eyes and noses, but fish have a lateral line, fins, tails, scales and they use gills to breathe, while people have a neck, arm, legs and hair and lungs to breathe air.

- Option: Have older students make a chart comparing the functions of the fish and human body parts.
  To move, people use legs, fish use tails; to breathe, people uses noses, fish use mouth and gills, etc.

Parts Of A Salmon

Handout 2.3, (Part 1)

Cut out and label the salmon

adipose fin	dorsal fin
gill cover	anal fin
nostrils	pelvic fins
caudal fin	pectoral fins

Parts Of A Salmon

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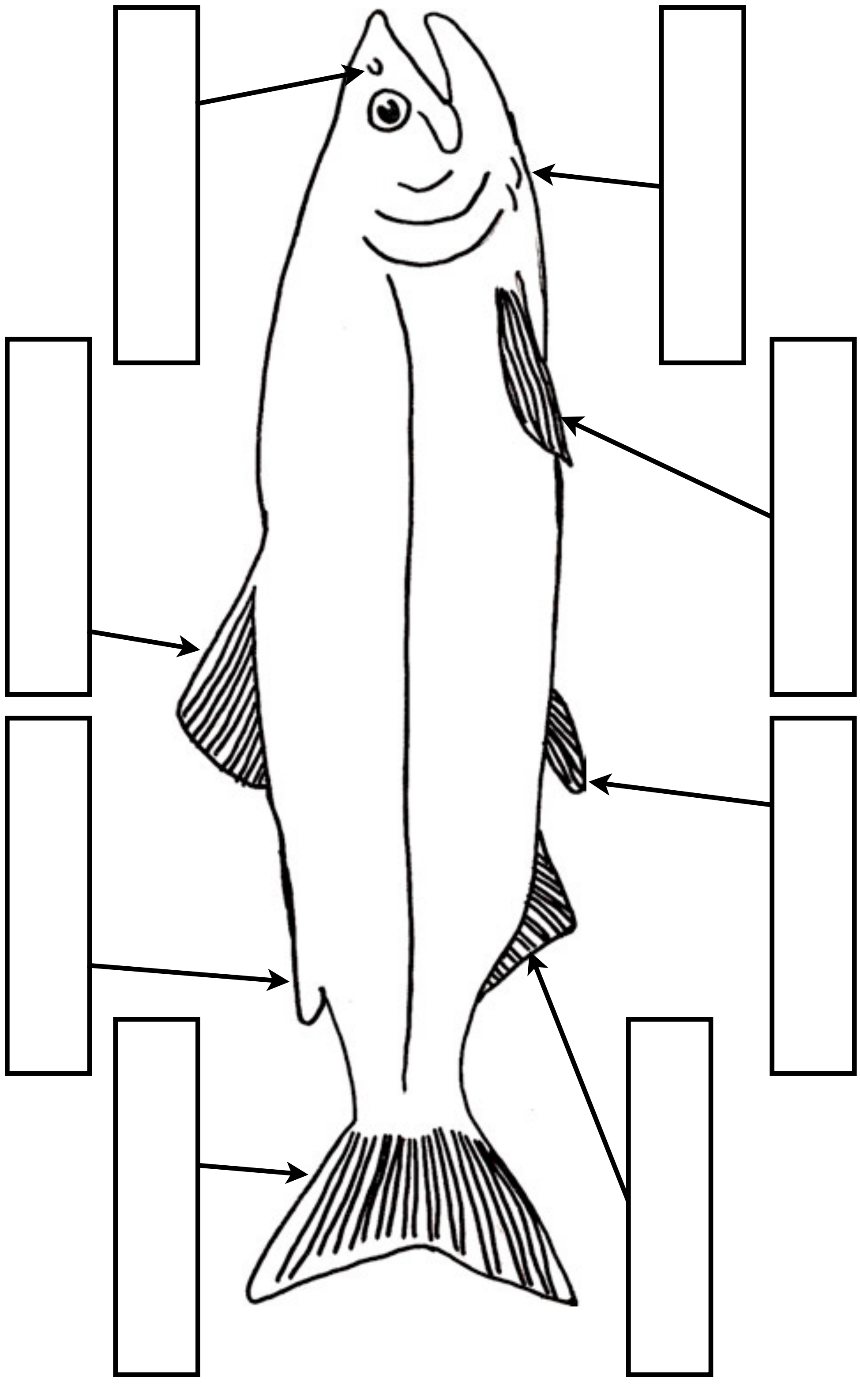
Handout 2.3, (Part 2)



Scales And Skin

Materials:

- Poster/illustration showing scales on a salmon
- Copies of Handout 2.4, "Salmon Scales," for each student
- Writing materials

Time Required:

One lesson

Level of Conceptual Difficulty:

Simple

Evidence for Assessment:

Review students' reports on scales and skin to ensure that they can identify facts about scales, such as their shape, hardness and location.

INTRODUCTION

- Ask students where on their bodies they have hard coverings that protect their skin.
  Fingernails and toenails.

- Have students list words that describe their nails.
  Hard, rounded, small, growing, smooth, multi-colored, etc.

- Have them list words that describe their skin.
  Soft, covers the whole body, has feeling, different colors, wrinkly, etc.

EXPERIMENT

- Have students use a pencil or similar object to press gently on a fingernail, and then press gently on the skin of a finger. Ask them to compare the two. If necessary, prompt them with questions such as:

  - Which surface is hardest?
    The fingernail.
  - Through which surface do you feel the most?
    The skin.
  - Which surface is the most flexible?
    The skin.
  - Which surface protects best from cuts and scrapes?
    The fingernail.
  - What would be good or bad about having a skin covered with fingernail material?
    It would be very strong, but also very stiff and hard to feel through.

DISCUSSION

- Point out the scales on the illustration of the fish and ask students to compare scales with human nails. If necessary, prompt them with questions such as:

  - Where do you see scales on the salmon?
    They cover the whole body except the eyes, fins, head, and lips.
  - What pattern do the scales form?
    They overlap in rows or curves.
  - How many scales does a salmon have?
    Hundreds or thousands.

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- What color are the scales?
  Scales are clear, but can look like they are many colors because they allow the color of the skin below to show through.
- What shape are the scales?
  They are not perfectly round (oval).
- Why don't scales make salmon very stiff?
  They have many small scales attached to their skin so the scales can all move when the salmon's body moves.

SUMMATION

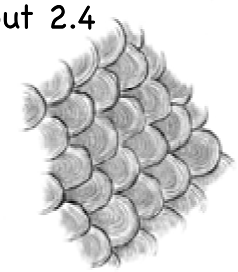
☞ Give students a copy of Handout 2.4, "Salmon Scales," and have them read it in groups or pairs.

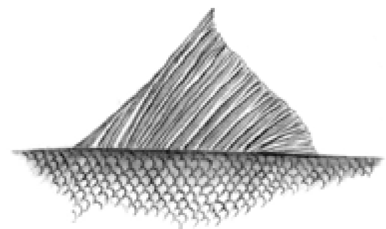
☞ Have students use the handout and the class discussion to make a simple web or write a report describing three important facts about salmon scales.

Salmon Scales

P/I

Handout 2.4





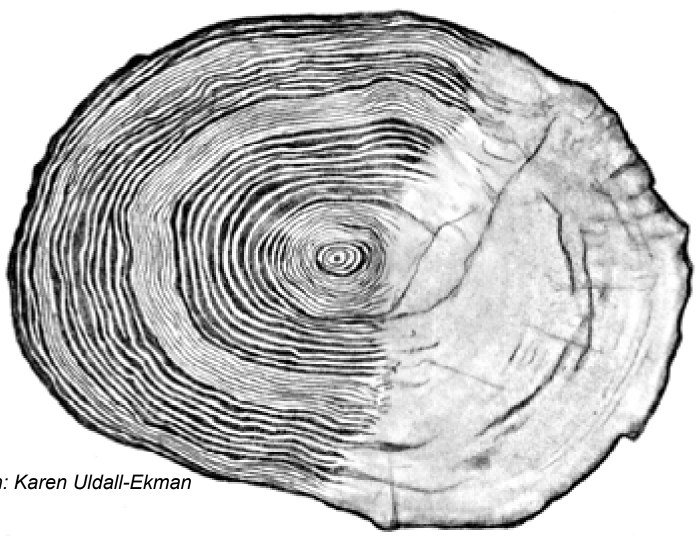


Illustration: Karen Uldall-Ekman

Scales are small plates that cover the body of salmon. The scales are attached to the skin of the salmon in many rows. They are made of hard, stiff material, like your fingernails.

Scales are oval-shaped. They overlap and partly cover each other. The part you see looks like a small fan.

Fish scales can look silver, red, green, or any color; but scales have no color. The color of the skin below shows through the scales. Scales protect the body of the fish. They let salmon slide over rocks or logs without getting hurt. They are hard for birds or animals to grab.

Scales grow throughout the life of a salmon. At different times of the year the salmon scales grow at different rates depending on water temperature and food. When the salmon is growing fast the scales grow more. Conversely, when the salmon is growing slowly the scale is growing less. This creates seasonal groupings of rings. Knowing the life cycle of the salmon, a scientist can look at these patterns and determine how old a salmon is.

Introduction

Materials:

- None

Time Required:

10 minutes

SUGGESTED ACTIVITIES

Choose activities from these suggestions that are appropriate for your class:

- Have the students describe what they have heard or read about salmon in local streams and lakes. (If you do this activity in the fall, some students will likely have heard of salmon returning to spawn. If not, introduce the subject that millions of salmon swim from the ocean and up the rivers to the small streams and lakes where they were born.)

- Ask students why salmon swim from the ocean to small lakes and streams.
  They swim upstream to lay their eggs in the cold fresh water that their eggs, alevin, and fry need to survive.

- Explain that this skein will be about the salmon's journey upstream to spawn and how that contributes to the environment.

Illustration: Karen Uldall-Ekman

The Salmon Spawner

[simulation]

Alternate Kinesthetic Activity

Adapted from Wildlife Trees in British Columbia, "Activity 12: Waterlogged."

Materials:

- Two 25-meter (Two 75 foot) lengths of rope
- Four pylons or cones
- Four to six floor mats, tied into rolls
- One copy of Handout 2.5, "The Salmon Spawner," for each student
- Writing supplies or art supplies

Time Required:

Approximately 30 minutes in the gym and 30 minutes in class

Level of Conceptual Difficulty:

Simple to moderate (if writing summation is included)

Suggestions for Assessment:

Monitor the class discussions and review student lists, written descriptions and drawings to ensure that they can identify the difficulties a salmon faces on its trip upstream.

PREPARATION

- In a gym or open area, place two ropes on the floor, parallel to each other and about four meters (12 feet) apart. Mark the ends of each rope with pylons or cones. Explain that the ropes represent the banks of a straight-sided stream.

- Have the students find a place in the gym where they can sit without being close enough to touch anyone else. Ask them to find a comfortable position and close their eyes as you read Handout 2.5, "The Salmon Spawner," to them. This should help them to relax and focus on the instructions, while minimizing any potential "rough play."

SIMULATION

- Have about six students move slowly between the ropes, as if they were spawners swimming upstream. Have another six students link arms and move rapidly (but carefully) side-by-side between the ropes in the opposite direction to the spawners. Explain that they represent a wave of water moving downstream. Have the rest of the class observe how the rapidly moving water pushes the spawners along.

- Lay some rolled-up mats across the ropes so they are partly in and partly out of the "stream." Explain that the mats represent logs, boulders, and other obstructions in the stream. Have another group of spawners move upstream, while another wave moves downstream. Have the class observe how spawners can hide behind the logs to rest and to avoid the wave.

- Explain that gravel can accumulate in slow-moving waters and change the shape of the stream bank. Move the ropes so that they curve around the logs and obstructions. Have another group of spawners move upstream, while another wave moves downstream. Have the rest of the class observe how the wave becomes slower as it moves around the curves, and how it can move the stream bank itself.

DISCUSSION

☞ Have students describe the difficulties in moving up the stream under the different conditions. If necessary, prompt them with questions, such as:

- In which stream did spawners have the most trouble? In which was it easiest to make it to the end?
- What made one part harder than another?
- In what ways is the stream similar to the streams a salmon must travel on its trip upstream? How is it different?

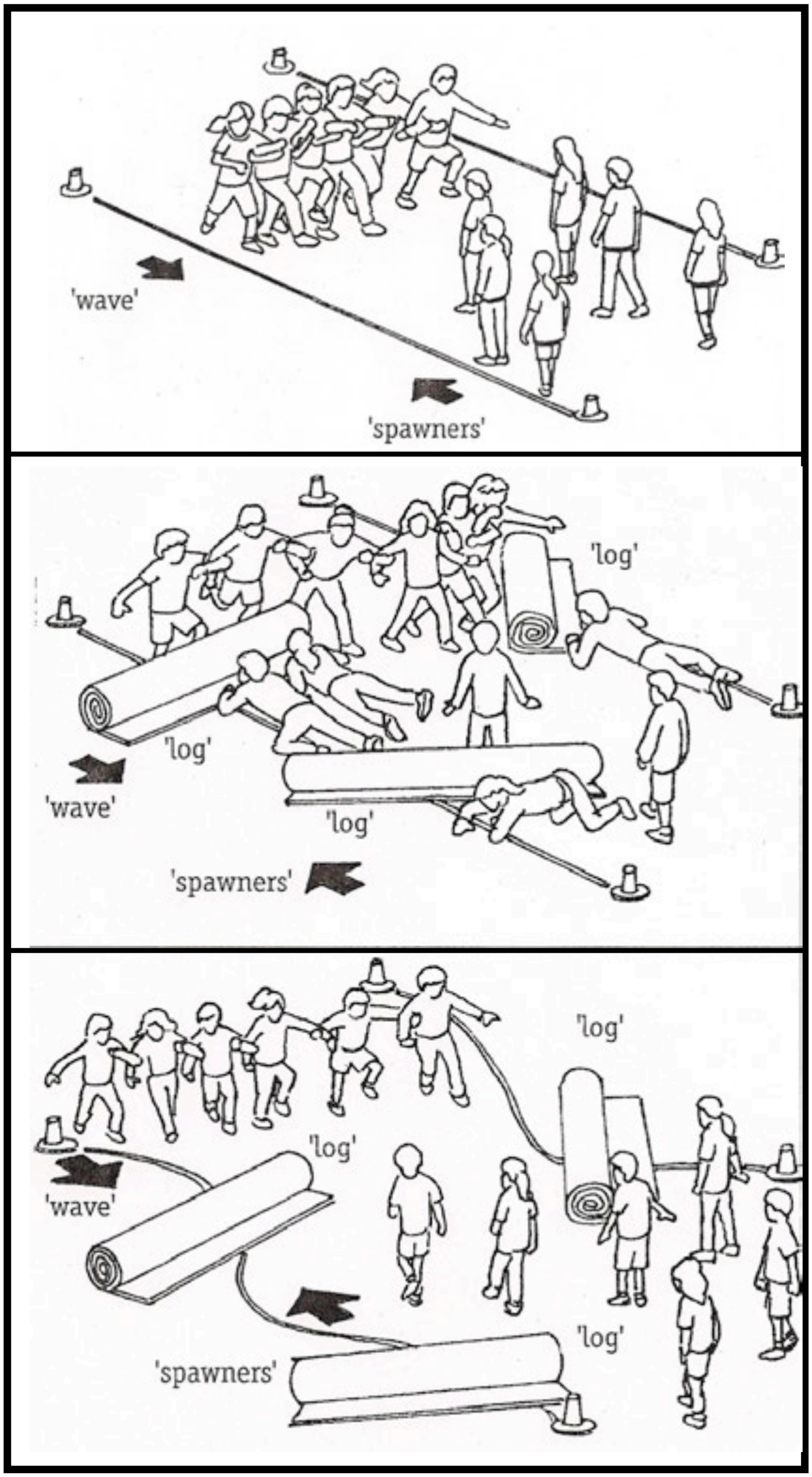
  A salmon also has to jump and slide past a variety of obstacles. It may be easier for a salmon to swim through a wave of water, but its trip is much longer, and the salmon has no hands or feet to help it.
- What kinds of obstacles does a salmon have to pass on its migration upstream?

  Rapids and waterfalls, logs, dams, dried out sections of streams, fishing nets, polluted water, predators, etc.
- What natural features help a salmon in its migration upstream?

  Salmon can find pools behind rocks and logs to rest, and slower water along the edges of a river. Also, they can jump very high, and use their strong muscles to push their way along.

SUMMATION (Adding this part changes the conceptual difficulty to moderate)

☞ Have students, in groups, review Handout 2.5, "The Salmon Spawner," and list at least four changes that salmon undergo in the last stage of their life. Have students draw or describe in writing the changes that help a salmon complete its journey upriver.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The Salmon Spawner

Handout 2.5

In the final stage of their life cycle, salmon reenter their natal river and swim back to the stream or lakeshore from which they emerged as fry. Some travel many hundreds or even thousands of kilometers (km; or miles), swimming from 30 to 50 km (20 - 30 miles) a day against the current. They follow the scent of the water to their natal stream. Fishers and predators such as bears, otters, and eagles catch many salmon on their trip upstream.

When they enter fresh water, salmon usually stop eating and live only on stored body fat. They start to resorb their scales, and some internal organs may fail on the journey.

The salmon's appearance changes dramatically, with males and females developing distinct differences. They lose their silvery color and take on deep red, green, purple, brown, or gray colors depending on their species. Their teeth become more exposed, and they develop a hooked jaw, which is particularly pronounced in males. Their body shape can change, with some species developing a distinctive hump on their back. Eggs develop in the ovaries of females, while males develop milt.

When the female salmon reaches her natal stream or lake, she finds a spot with the right gravel size and water conditions for her eggs. With her tail, she rearranges the stones in the gravel bed to form a redd, the nest-like depression in the stream or lakebed where she will lay her eggs.

The female deposits her eggs in the redd, then the male deposits his sperm to fertilize them. Some species deposit up to 6,000 eggs, but the average coho salmon lays 3,000 eggs. The female covers the eggs with gravel to protect them.

Both males and females die after spawning. The salmon's bodies decompose, releasing valuable nutrients, including minerals from the sea. The nutrients from the salmon carcasses form a rich food source for other wildlife, as well as fertilizing the stream and lake along the shore. When salmon carcasses are carried onto the riverbank, they also fertilize the forest and bushes. The ocean compounds in the salmons' bodies can be very scarce in the upstream environment. If few adult salmon return to spawn, the lack of nutrients can make the forest and the water a poor environment, with few nutrients for growing salmon fry and other species.

Genetic Diversity [investigation]

Materials:

- One copy of Handout 2.6, "Genetic Diversity," (Parts 1 & 2), for each student
- Writing supplies

Time Required:
Approximately 60 minutes

Level of Conceptual Difficulty:
Moderate to advanced

Suggestions for Assessment:
Monitor the class discussion and review students' sentences on specific genetic variations to ensure that the students can identify how genetic variation contributes to species survival.

INTRODUCTION

- Give students a copy of Handout 2.6, "Genetic Diversity," (Parts 1 & 2), and explain that they will use it when analyzing the genetic diversity of the class.

INVESTIGATION

- Have students start from the center of the wheel and work their way to the outside, coloring the segment of the circle that applies to them.

  For example, on the innermost circle, have them color the male or female side, then the eye color segment of the male or female half that applies to them, etc. Note that "widow's peak" is the tendency of the hairline to come to a V in the center of the forehead; "tongue curl" is the ability to curl the tongue to form a tube shape.

- Have students read out the number they arrived at in the outermost circle, then see if anyone shares a number with other students. If no one shares a number, the class has high genetic diversity. The more people who share numbers, the less the genetic diversity. (Most students, other than members of a family, will likely have a unique number.) Have students compare their circles with others and note where they differ.

- Option: Have students use an electronic spreadsheet program to record classroom variations at each level of the circle and graph the results. Have them calculate the probabilities that students will share characteristics at each stage.

DISCUSSION

- Point out that, with only seven variables, chances are only one in 128 that any individual will match all the characteristics on the circle. Humans and other animals have many millions of variables in their genetic make-up, so everyone on earth is unique (except identical twins).

☞ Have the class suggest ways in which genetic diversity helps a species survive. If necessary, prompt them with questions, such as:

- How might it help if some people could see in the dark better than others?
  They could hunt better at night.
- How might it help if some people could run faster than others?
  They could avoid dangerous predators.
- How might it help if some people could think more creatively than others?
  They could invent new tools.
- If everyone had exactly the same abilities and a more powerful predator came along, what danger would the community face?
  The predator might be able to destroy the whole community.
- If everyone had very different abilities and a more powerful predator came along, what advantage would the community have?
  Some members of the community might escape to create a new community.

SUMMATION

☞ Have students discuss how specific variations suggested in the handout would affect the ability of salmon to survive as a species. For example:

- ***The ability to survive warmer temperatures could help if vegetation removal contributed to an increase in stream temperature.***
- ***The ability to jump high out of the water could help when there are obstructions in a river.***
- ***The ability to lay more than one batch of eggs could help if one batch was destroyed, and could also increase species diversity, particularly if a second male fertilized the eggs.***
- ***Smaller size might help if it allowed more salmon to slip through fishing nets. Larger fish size might give the fish the ability to swim faster or longer distances.***

Genetic Diversity

Handout 2.6, (Part 1)

Find your own number on the genetics wheel. Color the side of the center circle that represents your sex. On the next circle, color the segment that represents your eye color. Continue until you reach the outside circle.

This wheel represents only seven possible differences, but it produces 128 possible results. Humans, and many other species, have millions of possible differences. The number of possible results is uncountable. No one on earth is genetically the same as anyone else – except identical twins.

Species that have many differences among their members can adapt to many different conditions.

Genes for muscular bodies, for example, allow people to survive when they have to work hard to raise food. Genes for quick thinking allow people to survive when they must respond quickly to dangers in the environment.

Genetic variations are important in other species, too. Among salmon, some may be better able to survive if the water becomes warmer or becomes polluted. If herring become scarce in the ocean, some salmon may be able to catch other species. If all the salmon were identical, a change in the environment could be devastating to them as a species.

Write a sentence describing how each of these variations might help salmon survive.

The ability to survive warmer temperatures. ______________________________

____

____

The ability to jump high out of the water.______________________________

____

____

The ability to lay more than one batch of eggs. ______________________________

____

____

The ability to grow larger or smaller than other salmon. ______________________________

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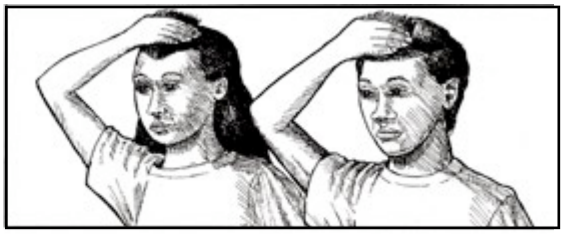
Genetic Diversity

Handout 2.6, (Part 2)

Widow's Peak



Tongue Roll

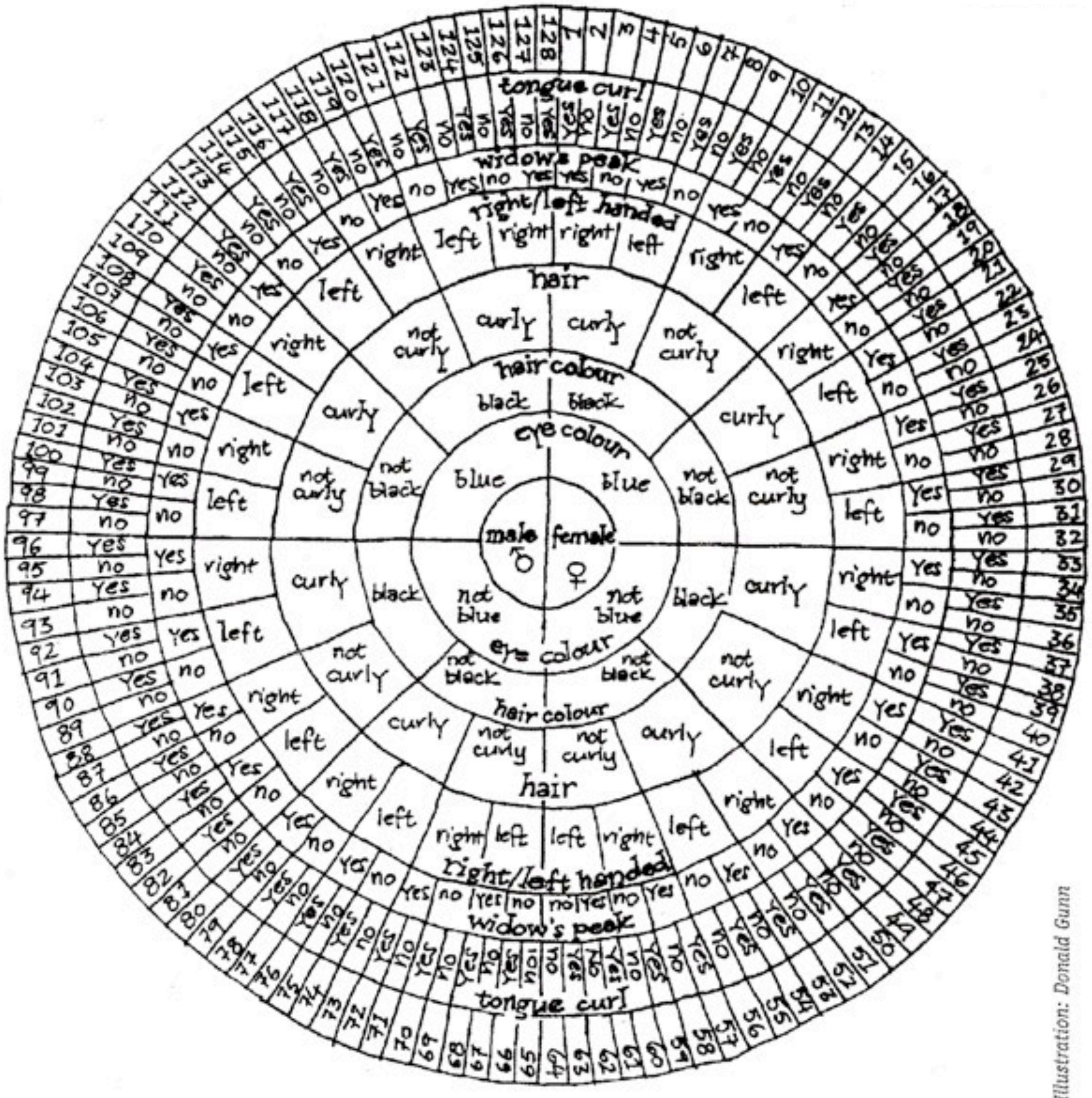


Illustration: Donald Gunn

Dissecting A Salmon [demonstration]

Materials:

For each group conducting a dissection:

- A whole salmon (may require time to thaw)
- Safety knife
- Spoons
- A plastic drinking straw
- Paper plates
- Magnifying lenses
- Toothpicks or bamboo skewers (optional)
- Newspapers
- Paper towels
- Thin latex-free gloves
- A bucket of water with disinfectant for cleaning
- Heavy plastic garbage bags for waste
- One copy of Handout 2.7, "Pacific Salmon ID Marine Phase," for each student
- One copy of Handout 2.7, "Salmon Key," (Optional), for each student
- One copy of Handout 2.8, "Dissecting a Salmon," for each student
- One copy of Handout 2.9, "Salmon External Anatomy," (Parts 1 & 2), for each student
- One copy of Handout 2.10, "Salmon Internal Anatomy," (Parts 1 & 2), for each student
- Writing supplies

PREPARATION

✓*Before you begin, use Handout 2.7, "Pacific Salmon ID Marine Phase," or Handout 2.7, "Salmon Key," (Optional) to determine the species of salmon you are dissecting.*

Option: Some independent education suppliers, education supply stores and science education catalogues carry cloth fish, 3-D models and posters that can help introduce this dissection activity to your students. You may also want to display Handout 2.9, "Salmon External Anatomy," (Parts 1 & 2), and Handout 2.10, "Salmon Internal Anatomy," (Parts 1 & 2), on a projector for reference.

☞ Depending on your students and the availability of salmon for dissection, you may prefer to do this activity as a demonstration or as a hands-on activity with pairs or groups of students dissecting a salmon as you model the procedure. If you do it as a hands-on activity, have pairs or groups of students take turns carrying out the steps as you model them. Have the non-participating students write notes describing the procedure and their observations on Handout 2.8, "Dissecting a Salmon." If you do the activity as a demonstration, have students pass the dissected parts and the magnifying lens around the observation table.

☞ This is an anatomy lesson, intended to teach elements of form and function, basic comparative physiology, and proper catch handling. It is recommended prior to removing any part of the fish that it be examined and discussed. Encourage students to identify, name, and determine the function of the fish parts. Students are encouraged to think about their own physiology and to identify similarities.

☞ It is recommended that all students participate in the dissection. Students may need to be reminded prior to and throughout this lesson that this is science and, although science can

Time Required:
45-90 minutes

Level of Conceptual Difficulty:
Simple

Suggestions for Assessment:
Monitor student responses during the dissection and review their dissection observations and comparisons to ensure that the students can identify and describe the parts of a fish, their functions and their relationships to human physiology.

be fun, fish must be respected and not destroyed. Students are encouraged to participate at their individual comfort levels.

☞ Obtain a whole salmon for each group of students, plus one for modeling correct dissection.

☞ Advise students in advance to wear clothes that can get messy.

☞ To obtain a salmon for dissection, contact your local fisheries biologist. **Remember: It is illegal to waste sport-harvested fish or game.**

INTRODUCTION

☞ Have a discussion with students about showing respect for all species. This should serve as a guiding principle for the students' behavior during the following activity.

☞ Provide each student with a copy of Handout 2.9, "Salmon External Anatomy," (Parts 1 & 2), and Handout 2.10, "Salmon Internal Anatomy," (Parts 1 & 2). Sketch an outline of a human on the board. Refer to the salmon handouts, as needed, to explain the dissection. Refer to the human sketch to compare human physiology with fish physiology. (If convenient, you may prefer to project the illustrations.)

☞ Warn students to use caution when using the knife, as it is very sharp. If the students are not doing the dissection, have them use toothpicks or bamboo skewers as probes when you ask them to feel the samples.

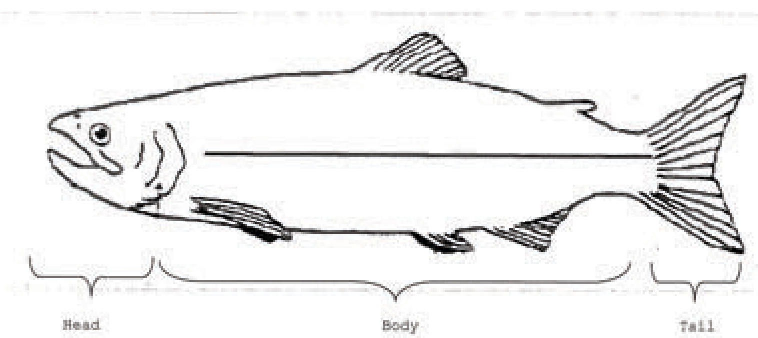
☞ This guide will follow the standard progression of salmon dissection; first the external (outside) features and then progress to the internal (inside) organs. Instructors may choose to omit some dissection aspects depending on students' ages and scholastic levels.

- ☞ Advise students that, if they feel uncomfortable during the dissection, they can look away or move farther back.

- ☞ Have students use Handout 2.8, "Dissecting a Salmon," to follow the dissection and record their information.

BACKGROUND INFORMATION

External Anatomy of the Fish



- ☞ **Head**: A salmon's head includes the eyes, nostrils, mouth, and gills. The area in front of the eyes above the mouth is often referred to as the snout. The position of the mouth varies among species. Fish absorb oxygen from the water. The water is taken through the mouth, flows over the gills, and then exits through the gill openings. The gills are protected by a cover, called the operculum. Fish have teeth in the jaws, mouth and pharynx.

- ☞ **Body**: The area immediately behind the operculum is called the pectoral or chest region. The humeral area, or shoulders, lies above the base of the pectoral fins. The belly extends from the pectoral fins to the anus.

- ☞ **Tail**: The tail is the part of the fish behind the anus. The slender section between the base of the caudal fin and the anal or dorsal fin is called the caudal peduncle.

External Anatomy Structures and Their Functions

- ☞ **Eyes**: As with humans, fish depend upon eyesight to see food, avoid predators, and to navigate. Because their eyes are bathed in water constantly, fish do not have eyelids and do not need tears.

- ☞ **Nostrils**: Salmon have a well-developed sense of smell and use this ability to seek out their natal streams. (The term "natal stream" refers to a salmon's water of origin.) Scent can also aid in avoiding predators and finding food. Fish breathe through their gills, not their nostrils.

☞ **<u>Lateral Line</u>**: Fish do not have ears, as such. In part, low-frequency sounds are detected in the water through the lateral line, a system of fluid-filled sacs with hair-like sensory apparatus that are open to the water through a series of pores along each side of a fish. The lateral line allows fish to detect movement of other fish and predators in the water. The full spectrum of frequencies fish can sense is not completely understood.

☞ **<u>Mouth</u>**: Fish use their mouths to catch food and hold food. Salmon do not chew their food, but swallow it whole. The teeth are used primarily for holding prey that is struggling to escape. In addition, the mouth is a very important part of the breathing process. Water is constantly taken in through the mouth and forced over the gills.

☞ **<u>Gills</u>**: The gills are delicate, but effective breathing mechanisms, and are one of the most important organs of a fish's body. Fish gills are composed of two basic parts, the gill covers and the gills. The gill covers protect the gill respiratory apparatus and , together with the mouth, force water containing oxygen over the gills.

- Gills are thin-walled structures filled with blood vessels; which accounts for their red color. The fish takes in water through its mouth, and oxygen dissolved in the water is absorbed through the thin membranes into the fish's blood. Carbon dioxide is simultaneously released from the blood into the water across the same membrane. This exchange is essential to the normal functions of the fish and contact with the gills on a live fish should be avoided.

- The lamellae, or branches of the gills, perform the same function as the small sacs (alveoli) within human lungs. They act to transfer carbon dioxide from the body of the fish and absorb the oxygen from the water. The lamellae are only two cells thick and present maximum surface area to permit the most efficient transmission of gases. Under a lens, the lamellae look like a spruce tree. Gills are far more efficient than human lungs, because they can extract up to 80 percent of the oxygen dissolved in water, while human lungs only extract up to 25 percent of the oxygen in the air.

☞ **Fins**: Salmon have two sets of paired fins (pelvic and pectoral) and four single fins (dorsal, caudal, anal, and adipose). Except for the adipose and caudal fins, the fins are basically used to maneuver and balance the fish in the water. The adipose is a small fleshy fin which serves no known purpose. The most important fin is the caudal, more commonly called the tail. The caudal functions as a means of propulsion, and acts as a rudder. The caudal fin is also used by female salmon to dig the redd, in which eggs are deposited.

☞ **Scales**: The bodies of salmon are protected by scales, which grow in regular concentric patterns and can be used to determine the age and life history of the fish. Covering the scales is a layer of mucous (slime) which further protects the fish from disease, fungi and viruses. The slime also helps fish slide through the water more easily, a term called hydrodynamics. Slime also aids the fish in escaping from the predators.

Internal Anatomy Structures and Their Functions

- ☞ **Ovaries**: The female reproductive organ, ovaries produce eggs. A group of eggs is often referred to as a skein. Eggs are often used for bait when sport fishing.

- ☞ **Testis**: The male reproductive organ, testis produce milt which contains salmon sperm.

- ☞ **Liver**: The liver stores, synthesizes and secretes essential nutrients that are contained in food. It destroys old blood cells and maintains proper levels of blood chemicals and sugars. The liver assists in digestion by secreting enzymes that break down fats.

- ☞ **Gall Bladder**: The gall bladder is a sac attached to the liver in which bile is stored and used to digest fats.

- ☞ **Heart**: Bony fish, like salmon, have a two-chambered heart. This muscular organ circulates blood through the body and is part of the circulatory system.

- ☞ **Esophagus**: The gullet, or esophagus, carries food from the mouth to the stomach.

- ☞ **Stomach**: The stomach is a sac-like digestive organ receiving food from the esophagus and opening into the intestine.

- ☞ **Pyloric Caeca**: The pyloric caeca is an appendage in the form of a blind sac, connected with the alimentary canal, in which digestion takes place. It also absorbs nutrients into the blood.

- ☞ **Intestine**: The intestine extends from the pyloric caeca to the anal vent.

- ☞ **Anal Vent**: Anal vent is also referred to as the anus. This is where urine, feces, eggs and milt exit the digestive system.

- ☞ **Air Bladder**: Air bladder is also called the gas or swim bladder. The air bladder is a membranous sac that is filled with gas, situated in the body cavity of fish, ventral to the vertebral column, which is used to control buoyancy.

- ☞ **Kidney**: These organs have multiple functions. They remove waste from the blood and produce urine. Kidneys also aid in osmoregulation and production of red blood cells. Osmoregulation is the ability to control the concentration of substances in body fluids compared to the liquid outside of the fish.

- ☞ **Spleen**: The spleen produces white blood cells and recycles red blood cells. The spleen is also the storage location of blood for emergencies.

- ☞ **Brain**: The brain is the control center of the nervous center.

- ☞ **Otolith**: Otolith refers to as the "ear bone" or "ear stone." These mostly calcium carbonate ($CaCo_3$) structures help keep fish upright in the water column. Growth rings formed in otoliths allow biologists to determine the age of a fish.

DISSECTION PREPARATION

- ☞ Before the dissection begins, prepare all materials in a convenient area.
- ☞ Cover the dissection surface with newspapers, and then butcher paper on top of the newspaper.
- ☞ Take time to consider the physical arrangement of the room.
- ☞ Keep in mind that some students may not want to participate, but make it easy for them to participate at their own comfort level.

☞ Make sure that you have adequate volunteer support for the number of participants.

☞ Talk to the volunteers and ask them to encourage their students to discover the different parts until they have had a chance to discuss them.

☞ Use Handout 2.7, "Pacific Salmon ID Marine Phase," or Handout 2.7, "Salmon Key," (Optional), to identify the type of Pacific salmon you have:

- King, or Chinook salmon
- Coho, or Silver salmon
- Pink, or Humpy salmon
- Chum, or Dog salmon
- Sockeye, or Red salmon

DEMONSTRATION

☞ Have students observe the salmon as you dissect it, and compare the salmon's anatomy with the anatomy of other animals or other organisms they know. Prompt them with questions, such as:

Slime Layer and Scales

- What is the first thing you notice when you hold a fish?

The fish is slippery. Many fish, including salmon, have a layer of slime covering their body. The slime layer helps the fish to:

- ***slip away from predators, such as bears;***
- ***slide easily through water when swimming;***
- ***protect it from disease, fungi, parasites, and pollutants that might be in the water. (It's sort of a living plastic bag that protects the salmon.)***

- What covers the fish's body under the slime layer?

Scales are small, hard plates like fingernails that cover a fish's whole body.
The scales overlap to form a flexible armor plating that protects fish from predators and bruising.
Salmon start to resorb their scales when they spawn. (Scales aren't usually completely resorbed at the time of death.)
The way the scales are arranged in rows or patterns is different for each species of fish. You can tell one species from another by the size of the scales and the way they are arranged.
Fish have the same number of scales all their lives. As the fish grows, the scales grow. They form lines, like the rings in a tree. Biologists can tell the age of a fish and how many years it spent in freshwater or

saltwater from the lines on its scales. If a fish loses a scale, it can grow another to replace it. New scales have a clear focus, because they do not have the growth lines.

☞ Remove a scale and have students examine it later under a hand lens or microscope.

Fish Shape and Features

- What shape is a fish? What shape is a salmon? Why are fish shaped this way?
  Fish come in many shapes, although torpedo shape is the most common. Salmon are torpedo shaped.
  However, some fish, like flounder and halibut, are flat. Some are almost string-like and a few are round, like a balloon.
  The streamlined shape of a fish lets it move easily through water. Water has much more resistance to movement than air does, so it takes much more energy to move through water. A streamlined shape saves energy.

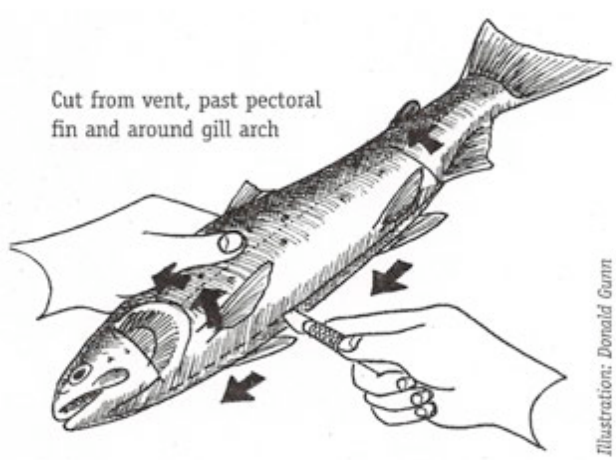
- What are the main parts of a salmon that you can see?
  On the head, you can see the mouth, eyes, nostrils and gills.
  On the body, you can see the fins and tail, the vent and the lateral line.

Fins and Tail

- How many fins can you see? How are they arranged?
  Salmon have eight fins, including the tail.
  Some fins are arranged in pairs, one on each side of the salmon's body.
  The pectoral fins are in the front, below the shoulder.
  The pelvic, or ventral, fins are on the belly, farther back from the head
  The others, known as median fins, are arranged in a line on the salmon's belly and back.
  The dorsal fin is in the center of the back.
  The anal fin is in the center of the belly, just in front of the tail.
  The adipose fin is on the back, in front of the tail. (The adipose fin is sometimes clipped off in hatchery fish to help identify the fish when they return or are caught.) The tail is a special fin at the back of the body, called the caudal fin. It includes the end of the backbone.

- What do the fins do?
  The fins have different functions.
  The caudal fin, or tail, is the largest and most powerful. It pushes from side to side and moves the fish forward in a wavy path.
  The dorsal fin acts like a keel on a ship. It keeps the fish upright and it also controls the direction in which the fish moves.
  The anal fin also helps keep the fish stable and upright. The pectoral and pelvic fins are used for

steering and for balance. They can also move the fish up and down in the water.
The adipose fin has no known function. It does not seem to harm salmon if it is cut off from nursery fish.
Note that a fish uses its whole body to move through water, but the fins give it much more control. Even without fins, however, a fish would be able to swim, but it would not be able to right itself easily.



☞ Hold the salmon by the tail, with the belly facing away from you. Without cutting deeply into the belly, cut open the salmon from the vent to the pelvic fins. Cut through the pelvic fins and remove them.

☞ Place the pelvic fins on a paper plate and have students examine them.

- What do all the fins have in common (except the adipose fin)?
The fins are made up of a fan of bone-like spines with a thin skin stretched between them.
The fins are embedded in the salmon's muscle, not linked to other bones, as limbs are in people. This gives them a great deal of flexibility and maneuverability.

Proper Fish Handling

☞ Handling and care for your catch is very important for the health of fish you intend to release, and for those you choose to retain as table fare. It is good to discuss and practice proper fish handling skills.

☞ Live fish that you intend to release should be kept in the water.

☞ Before touching the fish, remove any gloves and wet your hands. Wetting your hands will protect the fish's slime layer.
  - Slime aids fish in swimming and moving through water.
  - Slime helps fish escape predators.
  - Slime protects fish from bacteria and infection.

☞ Handle fish with care.

☞ If you are going to hold a fish up for a picture or to show to a friend or family member, support the fish's entire weight with your hands. Return fish back to the water as soon as possible. As an exercise, try holding your breath when you pull the fish out of the water - this is what the fish is having to do - and then take a breath when you return the fish to the water. This way you realize what the fish is going through.

☞ If you are considering releasing your fish, carefully remove the hook, take care not to damage the fish's mouth.

☞ Fish retained to be eaten should be cooled as soon as possible. This will keep the meat from spoiling.

☞ **Do Not**:
- Do not hold the fish by the tail!
  - This can cause damage to the fish and meat.
- If releasing the fish do not hold the fish by its fins.
  - Fins help the fish maneuver in the water.
- If releasing a fish, do not touch the gills or hold the fish by the gill plates.
  - Gills are what allow the fish to breathe in the water.

Cutting the Fish Open

☞ Knives are not to be left out for participants to use and should only be handled by a responsible adult. A safe cut is always away from your body and not toward participants.

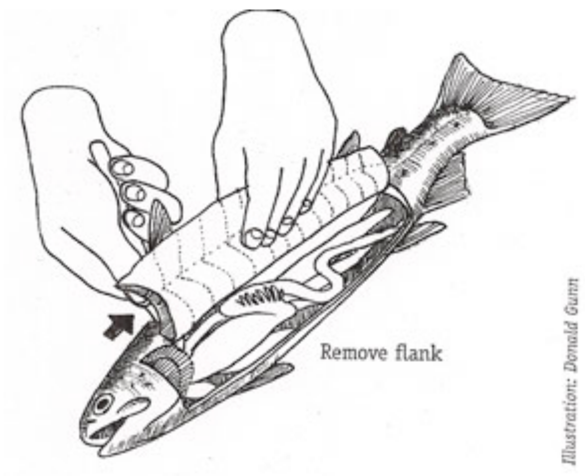
☞ Before making a cut, be sure that no hands or participants are in the way of the incision.

☞ It is recommended that a safety knife is used by an adult to make one incision from the anal vent toward the head until immediately past the pectoral fins. Additional cuts may be required if you are unable to cut through the belly meat in between the pectoral and pelvic fins.

Eggs or Milt

○ What hypothesis would you make about whether the fish is male or female?

If the fish is a mature female, a large portion of the body cavity will be filled with eggs.
If it is ready to spawn, the eggs will be loose within the body cavity; more likely, they will be contained within a membrane (skein).
If the fish is a mature male, you will find two whitish-pink sacs that go the length of the body cavity. These milt sacs are where millions of sperm are made. Milt provides half the genetic information needed for fertilization to occur.



☞ Using your hands, carefully remove the two skeins of eggs or the milt sacs. Place it on a paper plate. If you have roe sacs, examine the blood vessels contained within the membrane prior to cutting it open and have students examine it.

○ Why does one salmon have so many eggs?

A female coho salmon has about 2,500 eggs, while other salmon species have from 2,000 to 5,000.
In coho, only about 15 percent of the eggs survive to hatch and only about 30 survive the first year. About four will grow to become adults, and only two will live long enough to spawn. So each female produces enough eggs to replace only one pair of fish.

The Liver

○ What is the largest organ in the fish's body (and in a person's body, too)?

The liver is the largest organ.
It is dark red and firm in texture.
The liver aids the fish in digestion, storage and excretion.
The liver is essential for maintaining the proper level of blood chemicals and sugars.

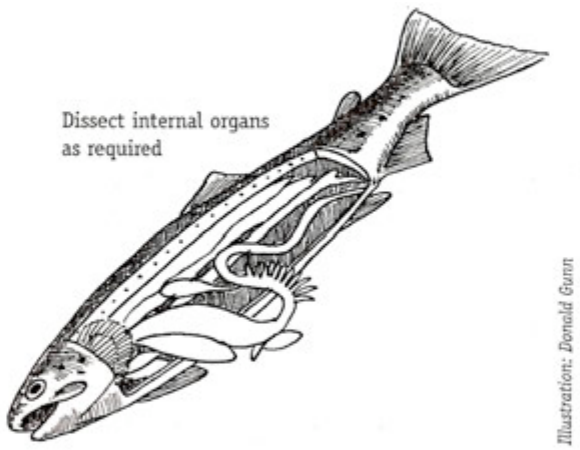
The Gall Bladder

☞ Before you remove this organ, look to see if a sac of fluid is attached.

○ What is this sac?

This sac is the gall bladder. The gall bladder is attached to the liver. It contains green bile, which is used in the digestion process.

☞ Carefully remove the liver and gall bladder. Place it on a paper plate, cut it open and have students examine it.



The Heart

- Where would you find the salmon heart?
  It is very close to the gills, high up in the throat, where the blood is refreshed; just as the heart is close to the lungs in humans.

☞ Locate the heart in the cavity in the throat area near the gills. Carefully remove the heart. Place it on a paper plate, cut it open and have students examine it.

- What does the heart feel like? Why?
  The heart feels tough, but flexible. It is a strong muscle. It is triangular in shape, and consists of two chambers. The white tube is the ventral aorta, which leads to the gills and gill capillaries.

The Digestive System

- How would you find the digestive system?
  The digestive system consists of several pieces, attached to the mouth at one end and the vent, or anus, at the other end.

☞ Carefully push the straw through the mouth of the salmon, down the throat and into the digestive system.

☞ **Mouth:** Food is not chewed, prey is swallowed whole and alive.

☞ **Teeth:** There are teeth on a salmon's tongue to keep the prey from escaping.

☞ Detach the system at the throat and vent. Place it on a paper plate and have students examine it. Assistance with a safety knife might be needed to cut the tough tissue of the esophagus.

☞ **Throat/esophagus**: The esophagus is tough so prey do not damage or break it.

☞ **Stomach**: The stomach extrudes digestive juices that break down food and absorb nutrients into the blood.

☞ **Pyloric Caeca**: The pyloric caeca aids in digestion and absorption.

☞ **Intestine:** Food absorption occurs mainly in the intestine, the tube-like section at the end of the system. It facilitates absorption and transport of waste to the anal vent.

☞ A bright red organ, **spleen,** is attached to the digestive system (stomach). It acts as a storehouse of blood for emergencies and it recycles worn-out red blood cells.

- Does your salmon have any partially digested food in its stomach?

  If the fish has been taken from a river, it is unlikely that food will be found in the digestive system. Salmon do not eat once the enter freshwater.

☞ The digestive system of a fish is much shorter and simpler than the digestive system of mammals. Because fish are cold-blooded, they do not use as much energy as a warm-blooded animal of the same size. They do not need to extract as much energy from their food when they digest it, so they can expel it more quickly.

The Swim Bladder

- Most fish swallow air into their swim bladder to counteract the weight of their bodies. Where would you look for the swim bladder?

  The swim bladder is attached to the throat, along the top of the abdominal cavity. It often looks like a pink, glossy deflated balloon.

☞ Carefully detach the swim bladder, without tearing it, by stripping it out with your fingers. The swim bladder, also called a gas bladder or air bladder, is a whitish, thin-walled sack that may look like a deflated balloon. Cut open one end and insert the straw. Have a student gently inflate the bladder by blowing through the straw, then twist the end and float it in the bucket of water. Place the bladder on a paper plate and have students examine it. Salmon can adjust the air in their swim bladder so they can hover comfortably at different levels in the water without sinking or rising.

☞ Salmon can adjust the air in their swim bladder in order to regulate their buoyancy in the surrounding water. Notice that the swim bladder is located just below the spine, found just below the center line of a fish. This is why fish float upside-down when they die.

☞ When a fish, such as a salmon, is deep in the ocean, it adjusts the amount of air in its swim bladder so that it can hover comfortably without sinking or rising in the water. This enables the fish to conserve energy. Some bottom fish, such as rockfish, are unable to adjust their swim bladders by burping, and can only adjust their swim bladder slowly to different levels. This is why when a rockfish is caught and quickly brought to the surface its swim bladder protrudes from its mouth; the swim bladder has expanded due to the rapid decrease in pressure and is forcing the internal organs out through their throat; this is a severe sign of barotrauma (trauma due to change of pressure).

The Kidney

- What color should the kidney be? What is the purpose of the kidney?

  The kidney looks like a dark red line along the backbone. The kidney cleans the blood and produces red blood cells. It is also critical in the salmon's smolting process (going from fresh to salt water) in a process called osmoregulation.

☞ Slice through the membrane holding the kidney in place and use the spoon carefully to remove it. Place it on a paper plate and have students examine it. The front part of the salmon's kidney replaces red blood cells and the back part filters waste products out of the blood.

The Ribs and Backbone

- What are the bones that surround the abdominal cavity?

  The ribs are lightweight, curved bones that give the fish its shape, just as ribs create the barrel-like shape of a human torso. The ribs serve to protect that salmon's internal organs.

☞ Slice through the membrane on either side of a rib and pull it up toward the backbone. Pull to disconnect it, place it on a paper plate and have students examine it.

- Fish share a very important characteristic with mammals: their flexible backbone. What does the backbone look like?

  The backbone is made up of a series of interlocked disks. They can move from side to side, but fish can only bend up and down a small amount.
  The backbone protects the spinal cord that runs through the body to the brain and gives structure to the fish's body.

☞ Cut off the tail, and expose a segment of backbone. Place the tail on a paper plate.

- What is the tissue in between the ribs and what is its purpose?

  Muscle is the main source of locomotion for the fish. It is also the primary part which people use for food. Salmon use their muscles to swim thousands of miles, often surviving only on the fats that they have stored while out in the ocean.

Lateral Line

☞ Have students examine the cross-section of the body and note the indentation where the lateral line runs along the fish.

- What is the lateral line for?

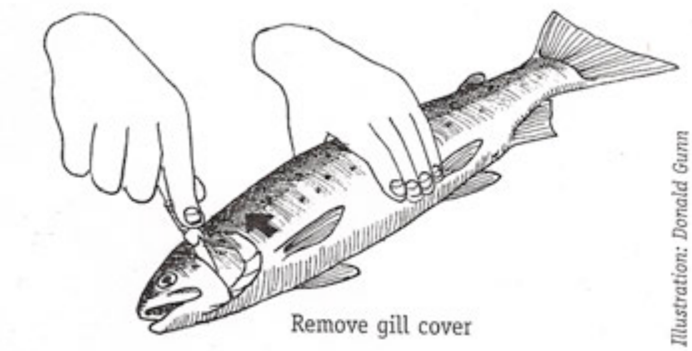
  The lateral line is a specialized organ which all fish have, and which functions like an ear. It detects vibrations and pressure waves in the water, just as an ear does in air.
  The lateral line is a series of liquid-filled canals below the skin along the side of the fish.
  It combines aspects of an organ of touch, an organ of hearing and an organ of seeing.
  Fish use the lateral line mainly to tell distance and water flow, and to detect disturbances in the water. Some fish can use the lateral line to find their way when it is too dark or muddy to see, feel movement around them and detect changes in the water.

- Option: It is illegal to waste sport harvested fish or game! If the fish is edible, filet the fish by slicing the flesh away from the ribs and backbone, first on one side, then on the other, exposing the ribs and backbone. Refrigerate the filets.

Gills and Gill Rakers

- How do fish breathe? Can someone demonstrate the motions for the class?

Fish gulp water through their mouth, then close their mouth and throat.
They force the water out through an opening in the back of the their throat. Gills line the opening.
Gills are very thin membranes (two cells wide) that line the gill passage. Oxygen dissolved in the water diffuses through the membrane into the fish's blood. (This is similar to the way oxygen in the air diffuses through the membranes in an animal's lungs.)
Carbon dioxide in the fish's blood diffuses out through the gills.
Salmon also secrete excess salt through their gills when they are in salt water.
Gills are much more efficient at extracting oxygen than lungs are. They can extract oxygen if there are as few as five molecules of dissolved oxygen for every million parts of water. Animals with lungs are used to one part oxygen to five parts of air (200,000 parts per million).



Remove gill cover

- What protects the outside of the gills?

The operculum, or gill cover, is a hard outer lining like a flexible plate that the fish opens and closes to let water through.

☞ Remove both sets of gill covers. Cut through the bone from the apex near the throat, then pare away upward toward the spine on both sides. Cut only as far as necessary. Once the gills are freed, pull them out with the fingers. Place them on a paper plate and have students examine them with a magnifying lens.

- What color are the gills? Why? What do they look like?

The gills are red because they are filled with blood. They look like fine, branched structures, like a spruce tree. The branching structure gives the greatest possible surface area to absorb oxygen from the water.

☞ Cut the gill rakers from the opening of the throat. Place them on a paper plate and have students examine them.

- Why does a fish need spines lining the gill opening on the inside of the throat?

  The spines prevent food from entering the gill passages and guide it into the throat.

The Head

☞ Reach under the gill with a finger and push up to loosen the muscles around the eye. Then cut the muscles attaching the eye to the eye socket and pull it out. Place the eye on a paper plate and have students examine it.

- How are fish eyes similar to and different from people's eyes?

  Salmon have two eyes but, unlike people, salmon do not have binocular vision, which would give them depth perception. However, the salmon can swivel each eye independently forward and backward, to cover a much wider field of vision than people have.
  Fish have very sharp vision under water. Some can see five meters or more.
  Fish have no eyelids. Their eyes are continuously washed in water.

- How do salmon smell?

  Fish have nostrils above their mouth, but no noses. The nostrils are a small indentation that is not connected to the mouth cavity.
  Their scent (olfactory) organs detect chemicals in the water in very tiny concentrations. They use this information to detect harmful pollution and avoid potential threats, if possible. They also use smells to recognize their way to their natal lake or stream.

- Can salmon hear?

  Fish have an inner ear, but no outer ear. Sound waves travel through the water and through their body to the inner ear.
  Fish may also detect sound waves through their lateral line.
  The hearing range in fish is probably not as wide as in humans. However, fish probably use hearing to detect predators and other threats.

- Do salmon have a sense of taste?

  Salmon have taste buds inside their mouth, like people do. They probably taste salt, sweet, bitter and acid, but their sense of taste has not been studied in detail.

The Brain

- ☞ Split the head open by placing the fish on its back, pressing the knife vertically into the backbone at the base of the head, and levering forward into the mouth. The brain will be visible in the split.

  - ○ What organ do salmon use to process all the information their senses gather and to respond to stimuli in their environment?

    Like all chordates, salmon have a brain at the end of their spinal cord where the nervous system transmits the information they receive about their environment. Salmon brains have three pea-shaped sections. The forebrain controls the salmon's sense of smell. The midbrain controls vision, learning and responses to stimuli. The hindbrain coordinates movement, muscles and balance.

Clean-up and Conclusion

- ☞ If students are conducting a dissection, have them gather all scraps, rubber gloves, newspaper, paper towels, paper plates, etc. in garbage bags (unless you have made provisions for returning or disposing of the waste).

- ☞ Have students use buckets of clean water with disinfectant and paper towels to thoroughly clean the knife, tables, chairs, sink, etc.

- ☞ Have students draw a stick figure on a sheet of paper, with a large thought bubble on one side and a speech balloon on the other. Have them write in the thought bubble words that describe how they felt during the dissection. Have them write in the speech balloon words that describe what a scientist would conclude following the dissection.

- ☞ Invite students to share their thought bubbles and speech balloons with the class and discuss their reactions. If necessary, prompt them with questions, such as:

  - ○ What would make people feel uncomfortable during a dissection?

    Cutting open a body, unusual sights and smells, etc.

- How do scientists react if they feel uncomfortable?
  They talk about their concerns, discuss why they feel uncomfortable, and why they want to continue or stop the investigation.

- What would a scientist conclude from the observations?
  Salmon have many complex biological systems in order to live. Some systems have similarities to humans and other animals. Some systems are unique to fish.

☞ Have students refer to their notes and information sheets and compare the structural and internal anatomy of a fish with that of a human, including the muscular, skeletal, respiratory, digestive, and reproductive systems.

Pacific Salmon ID Marine Phase

Handout 2.7

Chinook (king)
* Spots on both lobes of tail
* Large spots on back
* Mouth is dark with a black gum line

Coho (silver)
* Black spots on back
* Black spots on upper lobe of tail
* Silver streaks on tail
* Wide caudal peduncle
* Mouth is light with a white gum line

Pink (humpy)
* Large oval spots on both lobes of tail
* Large oval on back above lateral line
* Very small scales
* No silver on tail
* Mouth is white with a black gum line

Chum (dog)
* Calico markings (vertical bars) faint on bright fish
* No spots on tail or back
* Grey streaks on tail
* Mouth is white with a white gum line

Sockey (red)
* Green head
* No spots on tail or back
* No streaks on tail
* Mouth is white with a white gum line

Salmon Key

Handout 2.7, (Optional)

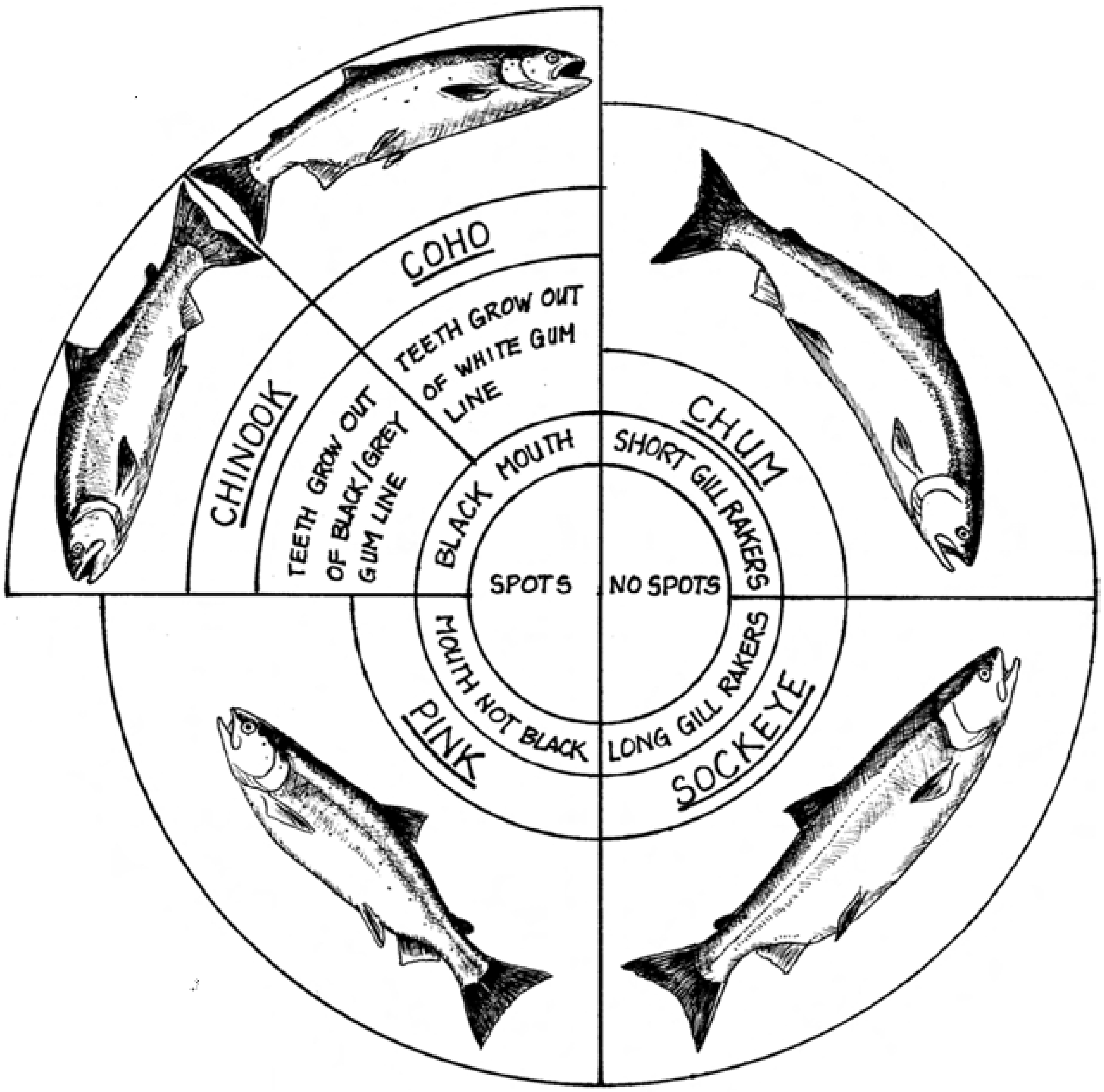


Illustration: Donald Gunn

Use this key to decide what kind of salmon you have.

Dissecting A Salmon

Handout 2.8

Name____

Mouth

Why does the salmon tongue have teeth on it? ______________________________

____

____

Slime Layer and Scales

The slime layer helps salmon to ____

____

____

____

Draw a salmon scale, showing its growth lines.

Fish Shape and Features

Draw the main external features you can see on a salmon.

Dissecting A Salmon

Handout 2.8

Fins and Tail

On your diagram, label four median fins and two sets of paired fins you see on a salmon.

Draw one of the salmon's bony fins, showing its parts.

Proper Fish Handling

Explain how you should hold a salmon you've caught so you don't hurt the fish. ______________

____

____

____

What part of the fish could you damage by improperly holding a fish?____________________________

____

____

Eggs or Milt

State whether your fish is male or female and explain how you know. _______________________

____

____

____

Dissecting A Salmon

Handout 2.8

The Heart

Describe the egg or milt sac from the dissection (e.g., its shape, texture, any features, number of eggs)

____

____

____

The Liver

Describe the color and texture of the liver. ______________________________________

____

____

____

Describe where the heart is located and explain why it is located there.__________________

____

____

____

____

The Digestive System

Draw and label the main parts of the digestive system.

Dissecting A Salmon

Handout 2.8

The Swim Bladder

Describe how the swim bladder works. ____

____

____

____

____

The Kidney

Describe the salmon kidney, then describe what it looks and feels like.____________________

____

____

____

The Ribs and Backbone

Sketch the skeleton of a salmon, showing the ribs and backbone.

Lateral Line

The lateral line helps salmon to ____

____

____

____

Dissecting A Salmon

Handout 2.8

Draw a cross-section of the salmon, near the tail.

Gills and Gill Rakers

Write three or more observations about the gills and gill rakers.

-
-
-

The Head

What sense organs are located in the head of a salmon? ________________________________

____

____

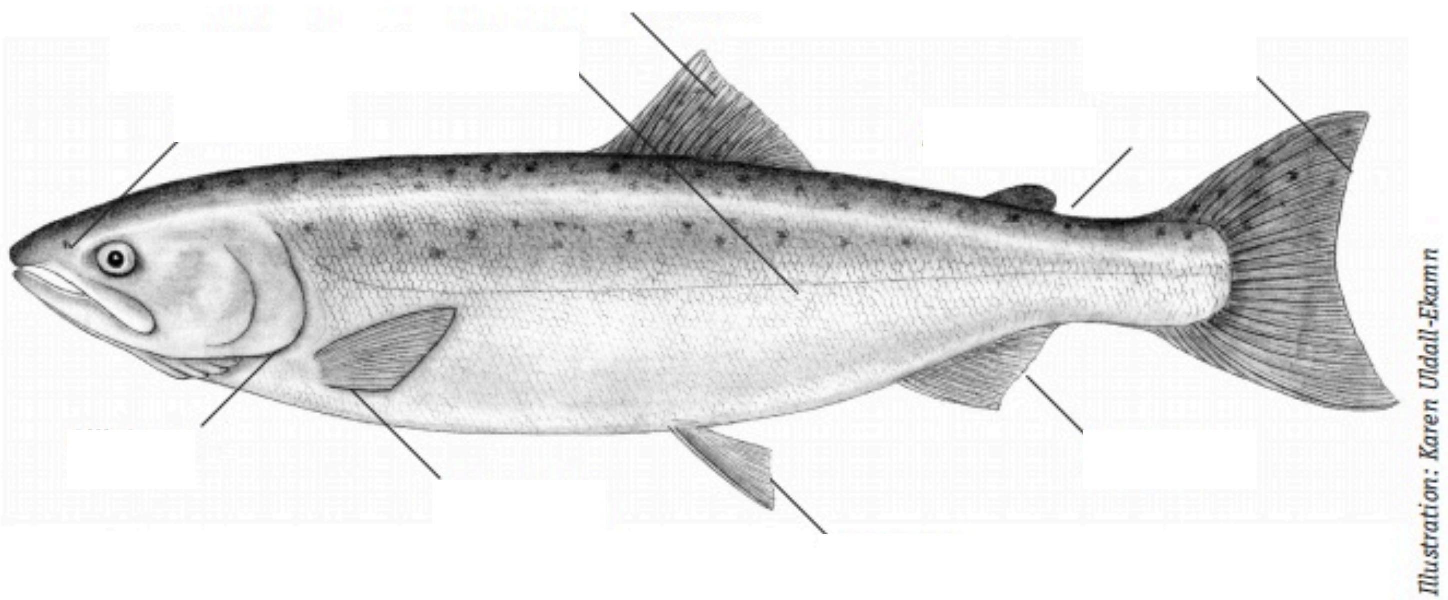
____

The Brain

Draw the location of the brain on your sketch of the salmon's skeleton.

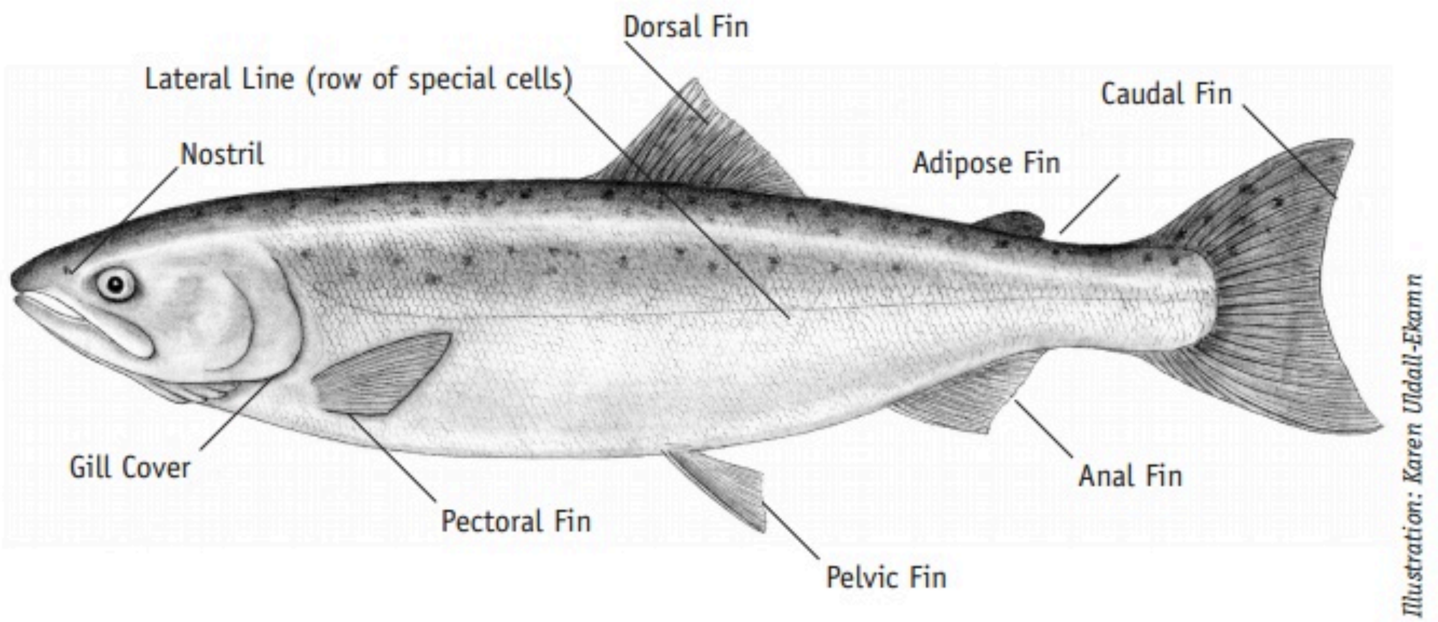
Dissecting A Salmon

Handout 2.9, (Part 1)



Dissecting A Salmon

Handout 2.9, (Part 2)



Dissecting A Salmon

Handout 2.10, (Part 1)

female salmon

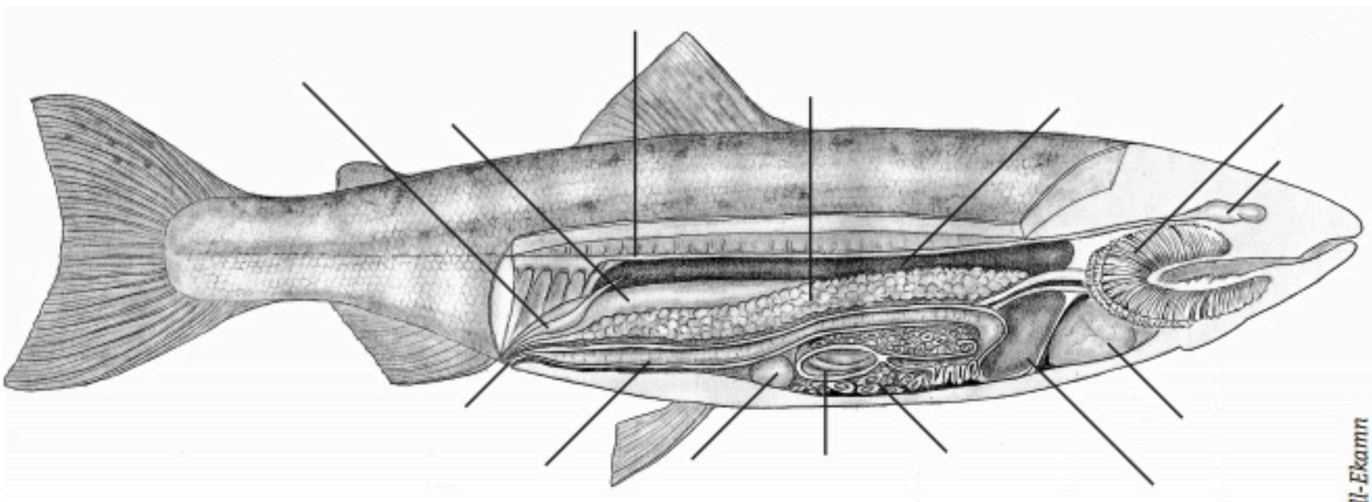
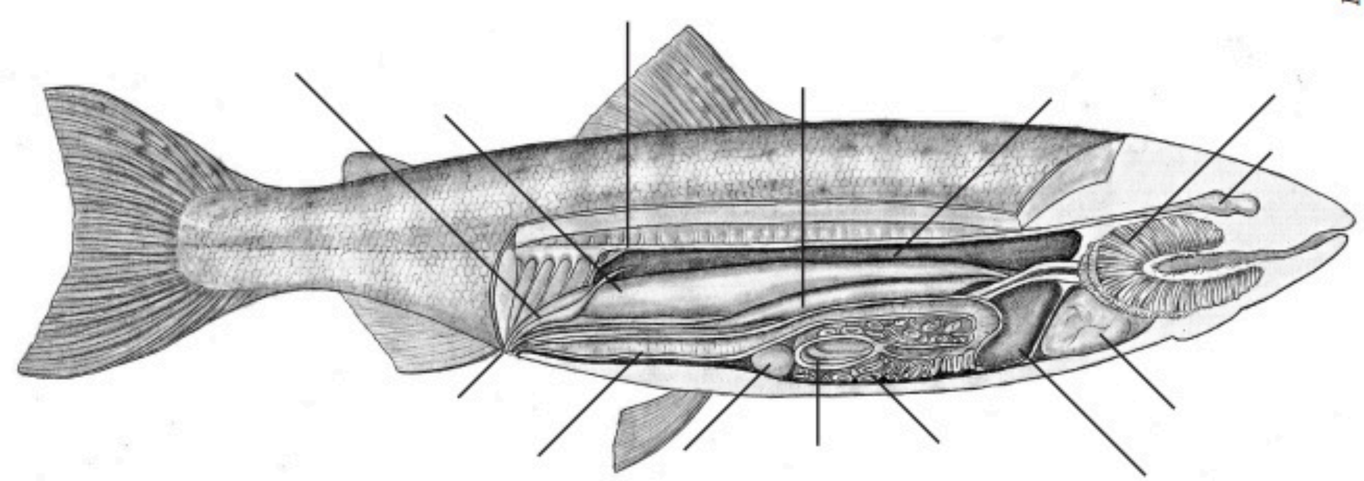


Illustration: Karen Uldall-Ekamn

male salmon



Dissecting A Salmon

Handout 2.10, (Part 2)

female salmon

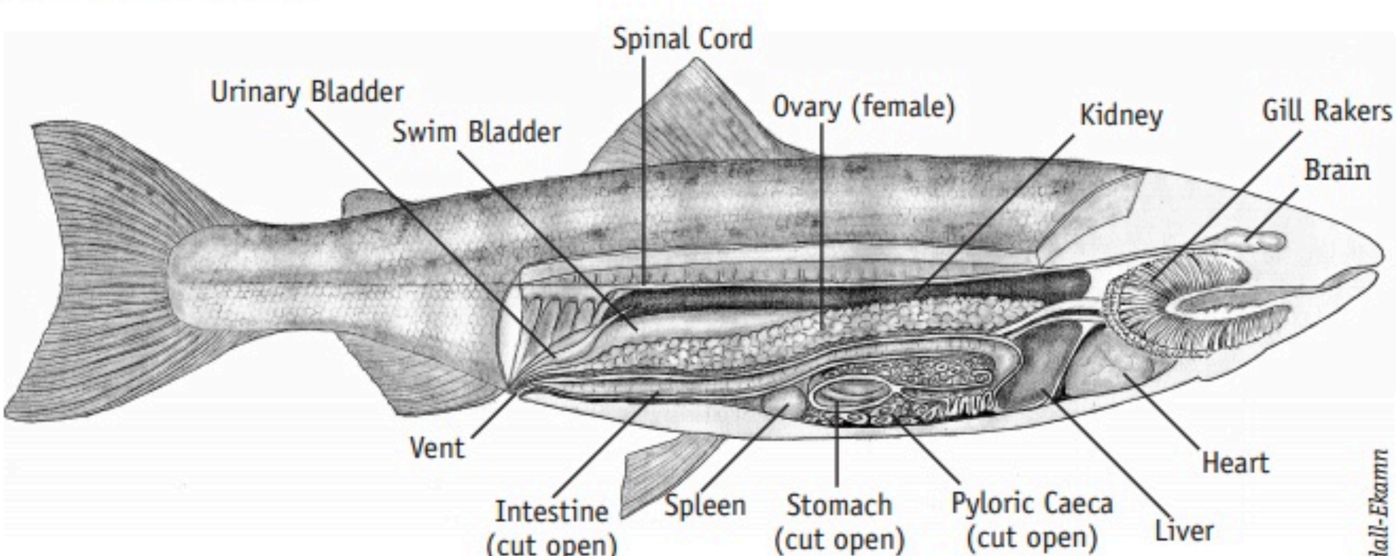
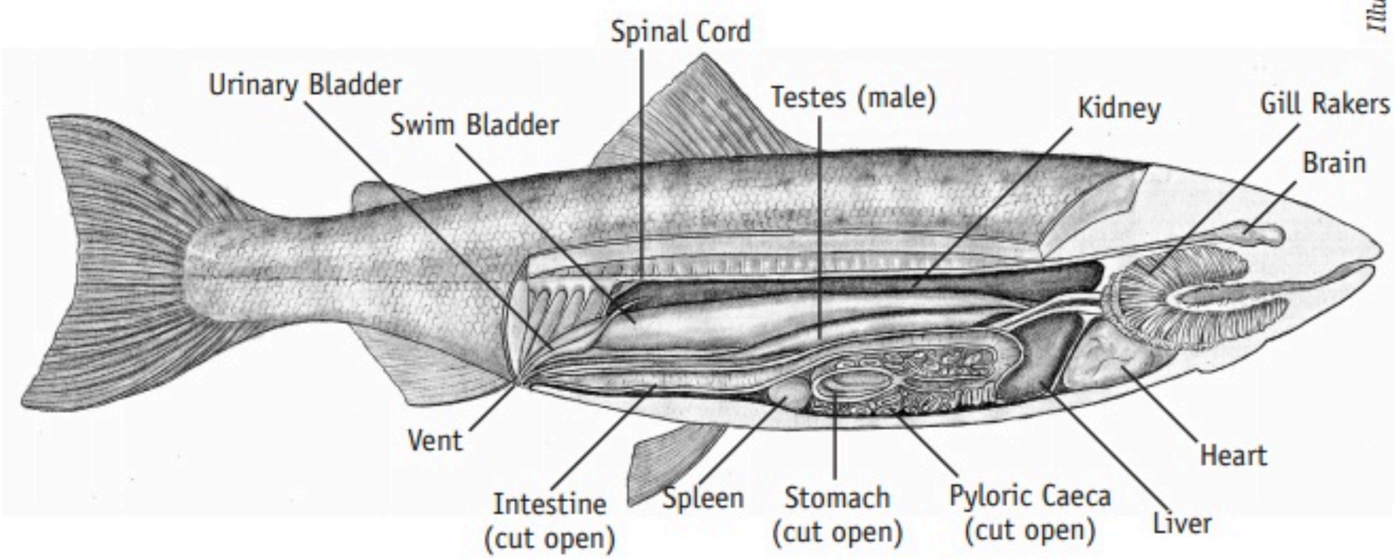


Illustration: Karen Uldall-Ekamn

male salmon



SALMON SPAWNERS

WRAP-UP

REVIEW

- ☞ Materials: chart paper and markers
- ☞ Have students draw and label the closing of a salmon's life cycle as it swims upriver, spawns and dies.
  It fights its way upstream, builds its redd, chooses a mate, lays and fertilizes the eggs, dies, and its body returns to the environment.
- ☞ Explain that these elements ensure that the salmon egg is born in a safe place so that the next generation will begin the cycle again.

EVIDENCE FOR SKEIN ASSESSMENT

- ☞ Have students use stick puppets to demonstrate and explain, in a play, how spawners complete their life cycle by swimming upstream, laying eggs and leaving their bodies to feed other animals in the environment.
- ☞ Have students use a reflection sheet to write or draw their thoughts about the salmon's trip upstream.
- ☞ Have students make a web or write a sentence listing ways that a salmon spawner is different from an adult salmon.
- ☞ Have students complete a stem sentence, such as, "I used to think… about salmon spawners but now I know that…," or, "One thing I learned about salmon spawners is that…".
- ☞ Have students add their materials to their salmon science notebooks and write a sentence explaining what they learned.

LANGUAGE AND ARTS INTEGRATION

- ☞ If your school is near a salmon spawning stream or lake, arrange a field trip to observe the spawning salmon in the fall. (Contact Community Resources or your local Fish and Game for assistance, if necessary.)
- ☞ Have students run a spawner obstacle course consisting of various challenges along a pathway in a gym or open area. Discuss how running the obstacle course is similar to a salmon swimming upstream.
- ☞ Have students dry an apple or a grape and describe how it changes as it ages. Discuss whether or not these changes are similar to the changes of a salmon as it returns to its natal stream or lake.
- ☞ Have students write a poem or paint a picture describing how someone they know or how a pet grew old or died.

HOME CONNECTIONS

- ☞ Have students enact for an adult the salmon's swim upstream, and explain how they find their natal stream.

SALMON SPAWNERS

WRAP-UP

EXTENSION ACTIVITIES

- ☞ Have students look for newspaper and magazine articles or record television news programs discussing the return of salmon to local waterways, then report their findings to the class.
- ☞ Have students take a field trip to a stream or fish ladder through which spawning salmon pass, or to a local fish hatchery. Examine and record features of a stream or lake that relate to the spawning stage of a salmon's life cycle.
- ☞ Have students research the effect on salmon spawners of hydroelectric development or other blockages on rivers and streams. Have them research any species of landlocked salmon found in their areas.
- ☞ Have students write a letter to the editor presenting evidence to support an argument for or against a development that would affect a hypothetical salmon stream.

SUGGESTIONS FOR ASSESSMENT

- ☞ Have students identify environmental changes caused by humans that help salmon spawn (e.g., culverts, fish ladders, spawning beds) and those that interfere with salmon (e.g., dams, fisheries, roads). Have students present arguments, orally or in writing, for or against the expanded use of each.
- ☞ Monitor the discussion as students make and present their lists in the review activity to ensure that the students can use factual information from the activities to support opinions about the life of salmon spawners.
- ☞ Monitor student discussions of the class' habitat mural and life cycle chart to ensure that the students can identify the needs of salmon spawners, as well as their habitat and threats to it.
- ☞ Have students write quiz questions about salmon spawners on one side of an index card and answers on the other. Have them quiz each other by asking the questions or using a Jeopardy-style format by giving the answers and asking for a question.
- ☞ Have students add their notes, experiment observations and other materials to a salmon science notebook.

HOME AND COMMUNITY CONNECTIONS

- ☞ Have students ask an adult to take them to visit a local salmon spawning area, where they describe to an adult what is happening.
- ☞ Suggest that the class begin a project to identify and protect any waterways in the community used by spawning salmon or to restore damaged spawning habitat.

Skein 3

Salmon Eggs

Overview:
This skein gives students the opportunity to:

- **P / I** Hatch salmon from eggs.
- **P / I** Study the role of temperature in egg development.

Big Ideas:
The egg contains a developing salmon.

- **P** It needs certain elements in a protected environment to survive.
- **I** It is highly sensitive to disturbances in water quality, variation in temperature, and pollution in its habitat.

Vocabulary:

redd, yolk, hatch, gravel, shell, oxygen parts per million (ppm), concentration, molecule, oxygen, dissolved, impurities, pollutant, silt, embryo, alevin, Accumulated Thermal Units (ATU)

Important Standards Netted by Teaching Skein 3

SCIENCE

	Fourth Grade	**Fifth Grade**	**Sixth Grade**
Classroom Incubation of Eggs	SA 1.1 SA 1.2 SC 2.2	SA 1.1 SC 1.2 SC 1.1 SC 2.1 SC 2.2	SA 1.1 SA 1.2 SA 3.1 SC 1.1 SC 2.3

MATH	**Fourth Grade**	**Fifth Grade**	**Sixth Grade**
Eggs: Salmon and ATUs	M 6.2.1 M 2.2.1 M 4.2.5 M 4.2.1 M 7.2.2	M 6.2.1 M 2.2.1 M 4.2.5 M 4.2.1 M 7.2.2	M 6.2.1 M 2.2.1 M 4.2.5 M 4.2.1 M 7.2.2

READING

Salmon Eggs	R1.1	R2.1	

WRITING 3-6

None

BACKGROUND INFORMATION

EGG DEVELOPMENT

When adult salmon return upstream to spawn, each female lays from 2,000 to 6,000 spherical, pinkish-orange eggs, which are about 6 to 9 mm (1/4 in) in diameter. Instead of a hard shell like a chicken, each egg has a soft, transparent membrane for its outside surface. This surface offers little protection against predators or other disturbances, so the female covers the eggs with gravel in a rocky stream or lakebed nest called a redd.

The redd is a shallow depression in the gravel, about one to three meters (3-9 ft) long and one to two meters (3-6 ft) wide. The female chooses a site in a stream with a high flow of fresh water or near a lakeshore where waves keep the water fresh. Different sized gravel is used for redds by each species. The larger salmon, chinook, spawn in coarser gravel and the smallest salmon, pink, spawn in the finest gravel of the river bottom. The other species spawn in gravel and locations between these two.

Salmon eggs are very sensitive - only one in 10 survives to hatch. In the first days, even a slight disturbance of the stream or lakebed can be fatal.

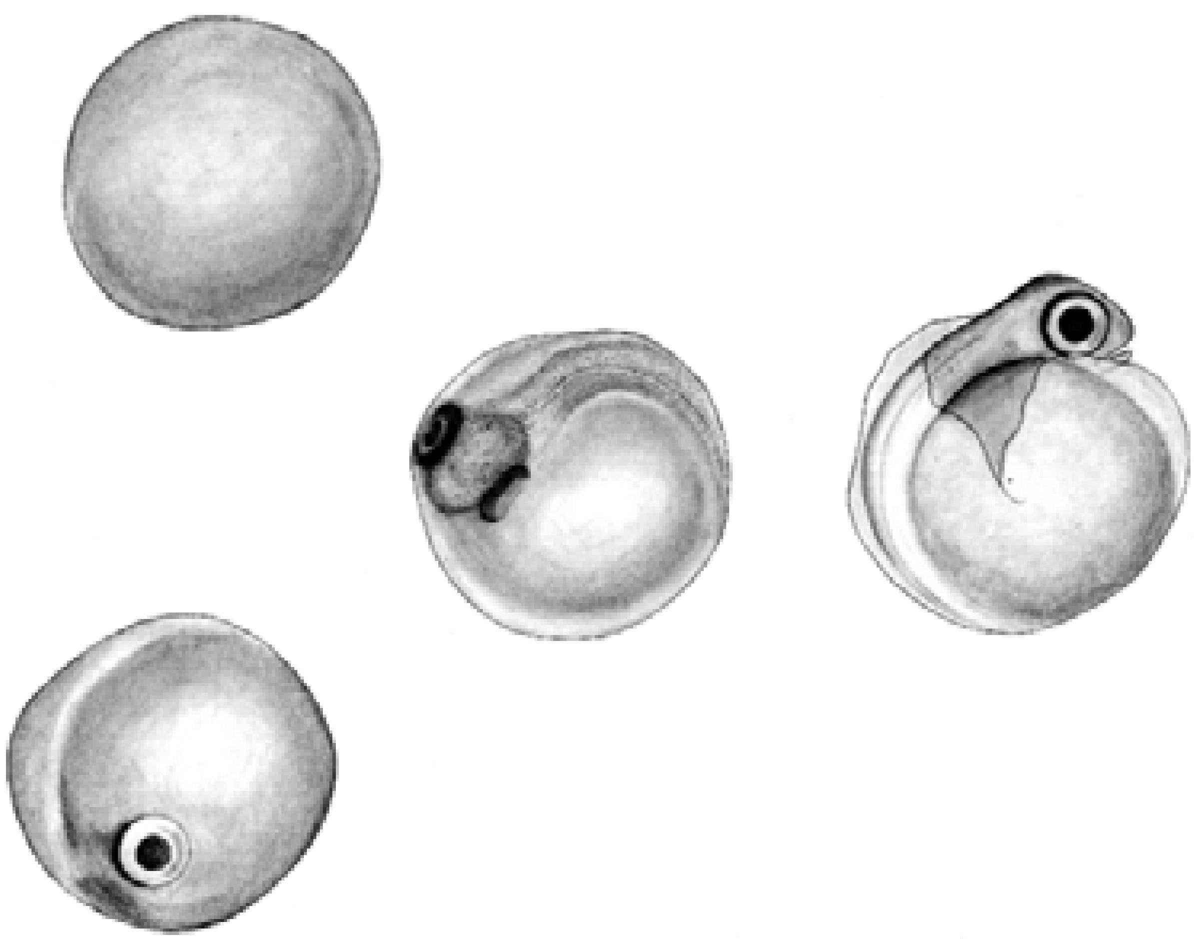


Illustration: Karen Uldall-Ekman

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Changes in water level or temperature can kill the eggs. Predators such as birds, bears and trout feed on the eggs, if they can find them, and flooding, pollution, and disease also destroy eggs.

The salmon embryo begins to develop inside the egg, growing cells and gradually forming distinct organs. Because they are cold-blooded, the rate at which fish develop depends on the outside temperature. The ideal water temperature for salmon eggs is from 5-10°C (42-50°F). Eggs develop more slowly at lower temperatures. In average temperatures, the embryonic development takes place at the following rate:

After 7 to 10 days	head and body begin to form
After about 1 month	eyes begin to appear
After about 2 months	embryo begins to move inside the egg
After about 3 months	embryo hatches from the shell

Inside the egg, the developing embryo feeds from its yolk sac and obtains oxygen through the egg membrane, through which the oxygen passes from the running water flowing through the gravel of the stream or lakebed. The eggs can smother if the gravel is covered with silt or if the water flows too slowly and stagnates.

As development progresses, the embryo begins to move and wiggle around. Scientists believe that, when the embryo can no longer get enough oxygen through the egg wall, it releases an enzyme that weakens the membrane. The embryo then breaks through the membrane and wiggles out. It lives the next stage of its life in the gravel as an alevin.

BACKGROUND INFORMATION

EGG DEVELOPMENT

The development of salmon eggs, like the early development of most organisms, is a process of cell formation, division, and differentiation.

An egg is fertilized when one sperm from the milt of the male salmon finds and enters a narrow canal in the egg. Sperm must enter the canal soon after the eggs are laid because the egg membrane reacts to the water and closes off the canal. After fertilization, the clear egg fluids concentrate over the surface of the yolk, forming a dome that becomes the blastodisc of cells after many cell divisions. The blastodisc eventually becomes the embryo.

After fertilization, egg development goes through three main phases:

- Cleavage or cell division. The first cell forms inside the fertilized egg on the cytoplasmic dome, and within 10 to 25 hours, depending on the water temperature, it divides to form two cells. The cells continue to divide and begin to show some differentiation into tissues within four to eight days.
- Epiboly or embryo development. After four to eight days, the first bud of the tail begins to form and, a few days later the shape of the embryo becomes distinct, attached to the yolk within the egg.
- Organogenesis or organ formation. After a period varying from 12 to 30 days, the individual organs and body parts of the embryo become distinct, beginning with the tail. The heart begins to beat and blood vessels form over the yolk. After 22 to 50 days, the dark eyes are visible through the egg membrane and, after 60 to 120 days, the embryo has developed a backbone, fins and gills. It is ready to hatch from the egg.

As the embryo starts to grow, it moves within the egg. First the heart sac begins to contract, then the body begins to twitch. The developing pelvic and pectoral fins begin to twitch. Their fanning motion is essential to move oxygen, enzymes and fluids through the egg. The twitching movements also build up the muscles the embryo will use when it hatches.

As the embryo grows and becomes more active, it needs more oxygen. The oxygen that transfuses through the egg membrane becomes insufficient for the growing embryo. Scientists believe this insufficiency may trigger the embryo to release a chemical called a hatching enzyme, which digests the egg membrane. The movement of the embryo spreads the enzyme through the egg, further weakening the membrane. By stretching and pushing, the embryo breaks through the cell membrane, then slowly wiggles out of the egg, dragging the yolk sac with it.

Virtually all organisms, except one-celled ones, develop through a process of cell division and differentiation.

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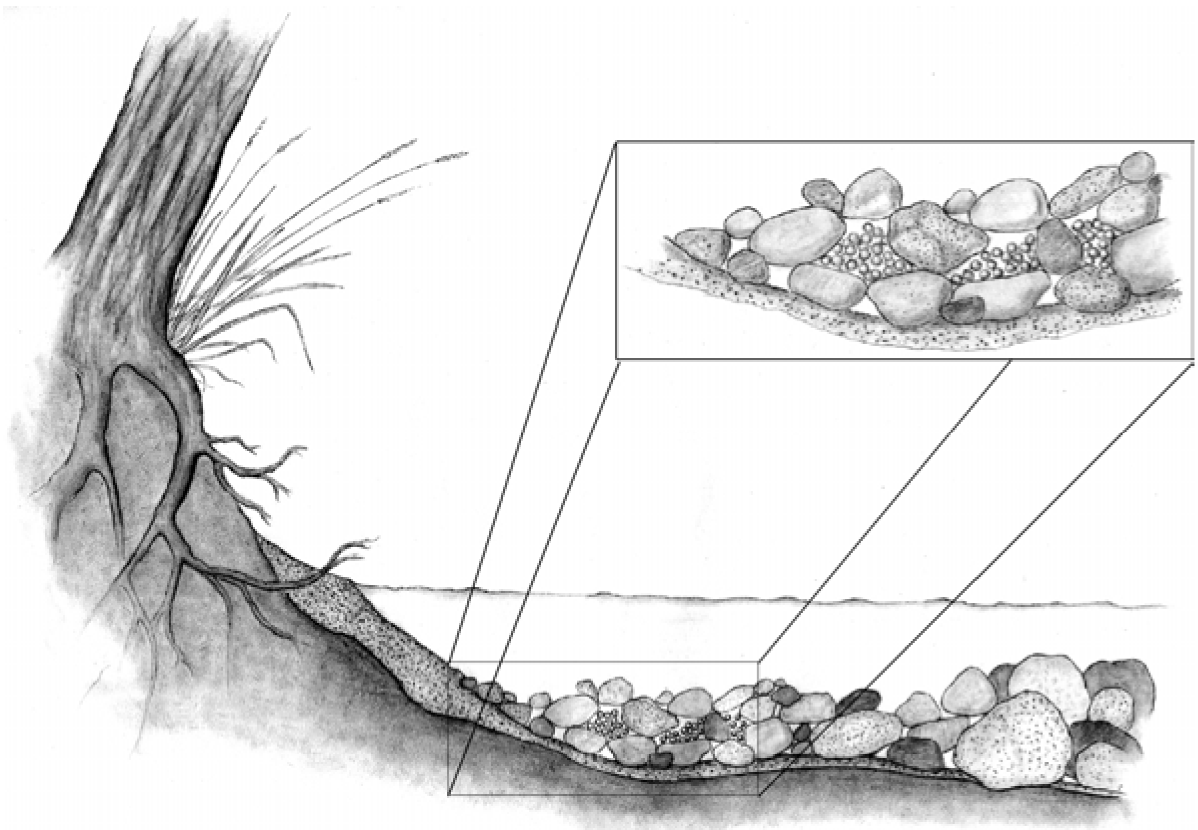
Salmon Eggs

Illustration: Karen Uldall-Ekman



Salmon lay eggs in a stream or lake. They lay their eggs in a nest made of small, rounded rocks called gravel. The nest is called a redd. The salmon cover their eggs with gravel to keep them safe.

Salmon eggs are like small orange balls. They have a soft shell. Inside is a yolk and egg white.

Salmon eggs need cold water to live. If the water is too cold or too hot, the eggs will die. A salmon begins to grow inside the egg. The yolk gives it food. The salmon gets air through the egg wall from the stream or lake water. If the water stops running, the growing salmon inside the egg will die. Dirt in the water can bury the egg and smother the salmon that is growing inside.

Salmon grow eyes, tails, and other parts inside the egg. You can see a salmon's dark eye through the egg wall. After spending the winter in the water, salmon hatch from the eggs.

Salmon Eggs

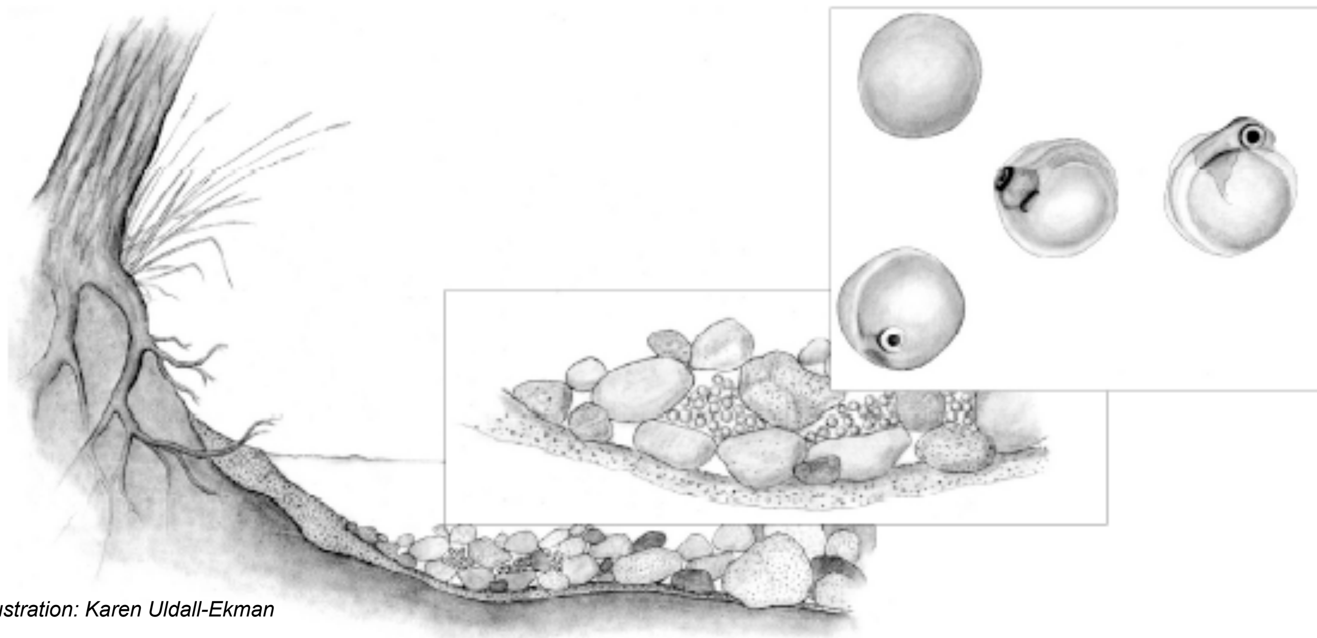


Illustration: Karen Uldall-Ekman

When adult salmon swim upstream to spawn in the fall, the female chooses a site in a stream with a gravel bed and plenty of flowing, fresh water. With her body, she digs a shallow depression called a redd, like a nest in the gravel.

Depending on the species and size, each female lays from 2,000 to 6,000 round, pinky-orange eggs, about 6 to 9 mm (1/4 inch) in diameter. Instead of a hard shell like a chicken egg, each salmon egg has a soft, transparent wall. This wall, or membrane offers little protection against predators or other disturbances, so after the male fertilizes them the female covers the eggs with gravel. Birds, bears, and trout eat the eggs if they can find them, and flooding, pollution, and disease also destroy eggs.

Salmon eggs are very sensitive—only one in 10 survives to hatch. In the first days, even a slight disturbance of the stream bed can be fatal. Changes in water level or temperature can kill many eggs; they are also very sensitive to pollution in the water. The eggs need pure, clean water, with dissolved oxygen and little silt in the water.

Salmon begin to develop inside the egg. Because they are cold-blooded, the water temperature controls the rate at which the salmon develop. The ideal water temperature for salmon eggs is from 5° to 9°C (41°-48°F). The eggs will die above 20°C (68°F) or below freezing. Eggs develop more slowly at lower temperatures. (See the box on ATUs.)

Salmon Eggs

Salmon biologists use accumulated thermal units (ATUs) to measure the heat an egg receives. ATU is the total heat an egg receives over a period of time. To calculate ATUs, you add the water temperature each day to the total for the previous days. For example, if the water temperature is 8°C (46°F) on the first day, the ATUs are 8. If the temperature is 8°C again on the second day, the ATUs are 16. If the temperature falls to 6°C (43°F) on the third day, the ATUs are 22.

The ATUs control the time a salmon takes to develop. Coho salmon, for example, develop as outlined below. (Other salmon species have a slightly different schedule.)

Head and body 50 ATUs (About 7 to 10 days)
Eyes begin to appear 220 ATUs (About one month)
The salmon begins to move inside the egg 400 to 500 ATUs (About two months)
The salmon hatches 700 to 800 ATUs (About three months)

Inside the egg, the developing salmon feeds from a yolk sac. However, the embryo still needs to get oxygen from air dissolved in the water that flows through the gravel. Some oxygen can pass through the wall of the egg. However, if silt covers the gravel under which the egg is buried, oxygen cannot transfer through the egg membrane and the embryo can smother. The embryo can also die if the water flows too slowly and the dissolved oxygen cannot reach the egg.

As development progresses, the embryo begins to move and wiggle around. At a certain point, it releases a chemical that weakens the wall. The embryo breaks through and wiggles out. It will live the next stage of its life in the gravel as an alevin.

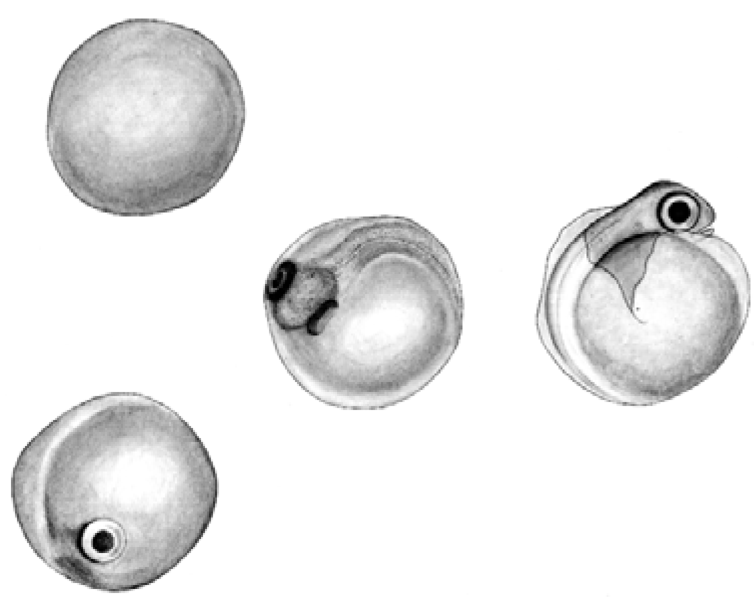


Illustration: Karen Uldall-Ekman

Salmon and ATUs
[math/simulation]

Materials:
- Math blocks or pennies (optional)
- Handouts

Time Required:
Approximately 60 minutes

Level of Conceptual Difficulty:
Simple to moderate

Evidence for Assessment:
Review the charts the students make to ensure that the students can identify various stages in the life of plants and animals, including salmon.

INTRODUCTION

- Ask students to suggest reasons for birds sitting on their eggs before they hatch. Explain that a bird's body provides heat, which eggs need to develop. In many species, including birds and fish, the amount of heat that eggs receive is the most important factor in determining when the eggs will hatch. The amount of heat is measured in units called accumulated thermal units (ATUs). Each species needs a different number of ATUs (about 450 ATU's for coho salmon; about 777 for chicken eggs at 70% relative humidity). While birds get most of the ATUs they need from their mother's body, salmon get the ATUs they need from the water that flows past them.

SIMULATION

- Explain that, in the simulation which follows, each student represents a redd with 2,500 coho salmon eggs in a stream. The eggs must receive 450 ATUs to hatch, but if they receive more than 18 or less than 2 ATUs in a day, they will die. Events taking place around them in their environment may also cause the eggs to die. Using the table on page 12, have the class calculate the ATUs received by their salmon eggs.

  Note: You may wish to calculate a few examples with the class. With younger students, you may prefer to have them manipulate tokens such as math blocks or pennies representing the ATUs the eggs receive. Ensure that the students understand that the ATUs suggested below are examples for the purpose of the simulation only, although they represent what could happen in an actual setting.

- Read the daily temperature from the chart (page 10) to the class. Have each student note the temperature in a notebook, then calculate the ATUs the eggs in the redd receive.

☞ Periodically ask the class to calculate the number of days until the eggs hatch if the temperature continues at that day's temperature. Students can use the formula:

$$\frac{450 - \text{ATUs to date}}{\text{current day's temperature}}$$

☞ Ask the class to predict when eyes will appear in the egg if they normally appear at 220 ATUs.
Prediction-Day 30

☞ Randomly add some events that affect the survival of the redds. Ensure that about 10 percent survive to hatch.

Events could include:

- ✓ ***Rainbow trout discover redds and eat some eggs. One of every 10 redds is lost.***
- ✓ ***Disease hits some redds and kills some eggs. Two of every 10 redds are lost.***
- ✓ ***Off-road vehicles drive through the stream, crushing some eggs. One of every 20 redds is lost.***
- ✓ ***Construction or logging upstream releases silt into the stream, preventing oxygen from reaching the eggs. Two of every 10 redds are lost.***
- ✓ ***Small streams freeze solid, which destroys eggs. One of every 10 redds is lost.***
- ✓ ***High rainfall floods the stream and washes away the gravel and some eggs. One of every 10 redds is lost.***
- ✓ ***Car oil seeps into the stream and poisons the water. One of every 20 redds is lost.***
- ✓ ***People remove stream-side vegetation, raising the temperature to 20ºC and killing juvenile salmon in the stream. Three of every 10 redds are lost.***
- ✓ ***Dogs playing in the stream dig up redds. One of every 20 redds is lost.***

☞ Option: Have students determine scientific ways of maximizing the eggs' chances of hatching on a given date.
Control the temperature to a level between 2°C and 14°C (36°F and 57°F) so the eggs receive 450 ATUs on the given date.

☞ Option: Have students calculate the average ATUs the eggs received per day (9) and use graph paper to graph the daily variations.

DISCUSSION

☞ Discuss with the class the observations they drew from the data. If necessary, prompt them with questions, such as:

- How consistent was the temperature?
  It varied from 4ºC to 14ºC (39º-57ºF), changing 0ºC to 3ºC per day.
- When the temperature changed, what happened to the projected hatch out day?
  Higher temperatures made it sooner; lower temperatures made it later.
- What events had the most impact on salmon survival?
  Logging, construction and disease

☞ Option: Have students use data such as those in the table to create a computer simulation game or a desktop game that represents the development of an egg and its chances of survival.

RESEARCH

☞ Have students measure the water temperature of a nearby salmon stream daily or weekly. A chart like the one on page 12 can help students estimate when eyes will appear in the eggs, when the eggs will hatch, etc.

☞ Conduct the research until the fry emerge from the gravel. Observe to see if fry have emerged. How accurate were the students' estimates of the emergence date? Ask the students what factors other than temperature may affect emergence.

Day	Temp C°	ATUs	Days to hatch*	Notes
Day 1	8	8	55	Eggs laid, very sensitive.
Day 2	8	16	54	
Day 3	8	24	53	
Day 4	9	33	46	
Day 5	9	42	45	
Day 6	10	52	40	
Day 7	9	61	43	
Day 8	8	69	48	
Day 9	8	77	47	
Day 10	9	86	40	
Day 11	8	94	45	
Day 12	7	101	50	
Day 13	6	107	57	
Day 14	5	112	68	
Day 15	6	118	55	
Day 16	5	123	65	
Day 17	4	127	81	Low temperature warning.
Day 18	4	131	80	
Day 19	5	136	63	
Day 20	5	141	62	
Day 21	6	147	51	
Day 22	7	154	42	
Day 23	8	162	36	
Day 24	8	170	35	
Day 25	9	179	30	
Day 26	9	188	29	
Day 27	9	197	28	
Day 28	9	206	27	
Day 29	10	216	23	
Day 30	10	226	22	Eyes become visible.
Day 31	11	237	19	
Day 32	11	248	18	
Day 33	12	260	16	
Day 34	12	272	15	
Day 35	13	285	13	
Day 36	13	298	12	
Day 37	14	312	10	
Day 38	13	325	10	
Day 39	14	339	8	
Day 40	13	352	8	
Day 41	12	364	7	
Day 42	12	376	6	
Day 43	11	387	6	
Day 44	10	397	5	
Day 45	11	408	4	
Day 46	10	418	3	
Day 47	8	426	3	
Day 48	7	433	2	
Day 49	7	440	1	
Day 50	10	450	0	Hatch out.

* If current day's temperature continues until hatch out.

SALMON EGGS

WRAP-UP

REVIEW

- ☞ Materials: chart paper and markers.
- ☞ Have students draw and label the things a salmon egg needs for a healthy environment.
  A redd made of rocks and gravel; cold, clean water; air in the stream or lake water; vegetation on the stream bank.
- ☞ Explain that these elements make a safe home for a salmon egg, and that a baby salmon will hatch when it has finished growing inside the egg.

EVIDENCE FOR SKEIN ASSESSMENT

- ☞ Have students make a list or Venn diagram of overlapping circles (model the procedure, if necessary) comparing the size, shape, color, and parts of a chicken egg and a salmon egg.
- ☞ Have students make a model or picture of a redd in a stream, and use it to explain in a conference or using an audio recording how a redd protects salmon eggs.
- ☞ Have students make a web or write a sentence listing ways that a salmon egg is different from a chicken egg.
- ☞ Have students complete a stem sentence such as "I used to think … about salmon eggs but now I know that …" or "One thing I learned about salmon eggs is that …"
- ☞ Have students add their materials to their salmon science notebook and write a sentence explaining what they learned.

LANGUAGE AND ARTS INTEGRATION

- ☞ Have students bring in small rocks that they can place in the salmon incubation tank, and demonstrate how they are cleaned and boiled to prevent them from contaminating the tank.
- ☞ Have students research the temperature needs of developing salmon eggs by interviewing students in an older class who are raising eggs in an incubation tank.
- ☞ Have students incubate frog, snail, butterfly, or chicken eggs and compare their development with that of salmon eggs.
- ☞ Have students construct large hollow eggs by covering balloons with papier mâché, then make a hole in the egg, and make sock puppets of growing salmon or other animals to place inside the eggs.

HOME CONNECTIONS

- ☞ Have students describe a redd to their parents or caregiver and compare it to their own home.

SALMON EGGS

WRAP-UP

EXTENSION ACTIVITIES

- ☞ If your school has a classroom incubation tank, have students observe the eggs from the spawner when they are placed in the tank.
- ☞ If students are raising salmon in an incubation tank, have them calculate the number of ATUs the eggs receive daily and project the hatching date.
- ☞ Have students test and compare the physical and chemical characteristics of water from salmon streams in their local watershed and discuss its suitability for salmon eggs.
- ☞ Have students research what happens to wastes that enter the local sewage and stormwater drainage systems.
- ☞ Have students collect information on water quality in the following skeins to defend a position in favor of or against a project, such as a water diversion or sewage outflow, that would affect water conditions in a salmon spawning stream.

SUGGESTIONS FOR ASSESSMENT

- ☞ Have students write a letter to governmental or nongovernmental organizations describing the impact of pollutants on salmon and other organisms, and recommending steps the organization could take to protect salmon and their habitat.
- ☞ Monitor student discussions of the class' habitat mural and life cycle chart to ensure that the students can identify the needs of salmon eggs, their habitat and threats.
- ☞ Monitor the discussion as students make and present their lists in the review activity to ensure that they can use factual information from the activities to support an opinion about salmon eggs.
- ☞ Have students write quiz questions about salmon eggs on one side of an index card and answers on the other. Have them quiz each other by asking the questions or using a Jeopardy-style format by giving the answers and asking for a question.
- ☞ Have students add their notes, experiment observations, and other materials to a salmon science notebook.

HOME AND COMMUNITY CONNECTIONS

- ☞ Have students describe to an adult practical steps they could take at home to reduce liquid pollutants and explain why the steps are useful.
- ☞ Suggest that the class begin a project to improve damaged salmon streams by arranging to place suitable gravel in appropriate locations where salmon can use it to bury their eggs.

Skein 4

Water Cycle

Watershed

Overview:
This skein gives students the opportunity to:

- **I** Discuss what the water cycle is.
- **I** Observe water cycling in a glass container.
- **I** Construct and discuss a model of a water shed.
- **I** Begin to construct a watershed wall mural or display linked to the stages of the salmon's life cycle.

Big Ideas:

- The water cycle, the watershed, and ocean conditions form the broad context in which salmon ecology and human ecology take place.
- Each stage of the salmon's life cycle relies on parts of the aquatic ecosystem in which they live.

Vocabulary:

water cycle, hydrologic cycle, life cycle, habitat, watershed, transpiration, evaporation, ecology, atmosphere, deforestation, runoff, lake, pond, stream, creek, river, solar energy

Important Standards Netted by Teaching Skein 4

SCIENCE

	Fourth Grade	Fifth Grade	Sixth Grade
Classroom Incubation of Eggs	SA 1.1	SA 1.1	SA 1.1
	SA 1.2	SA 1.2	SA 3.1
	SA 3.1	SA 3.1	SD 1.3
	SB 1.1	SB 1.1	SB 3.1
	SB 3.1	SB 3.2	
	SD 1.2	SD 2.1	
	SD 2.1	SE 1.1	
	SE 3.1	SE 3.1	

READING

	Fourth Grade	Fifth Grade	Sixth Grade
Water Cycle	R 1.6	R 2.6	
	R 1.5	R 2.5	
	R 1.4	R 2.4	
Runoff Pollution	R 1.1	R 21.1	
	R 3.1	R 4.1	
	R 1.2	R 2.2	

WRITING	Fourth Grade	Fifth Grade	Sixth Grade
	W 2.1.2	W 2.1.3	W 2.1.3
	W 2.2.2	W 2.2.2	W 2.2.2
			W 2.2.4

BACKGROUND INFORMATION
WATER CYCLE

The information below supplements the information in Handout 4.2, "The Water Cycle and the Watershed," (Parts 1 & 2), and Handout 4.3, "An Overview of the Salmon Life Cycle," (Parts 1 & 2).

WATER STEWARDSHIP

All living things need water. People need about 80 liters a day for domestic, agricultural and industrial uses (although North Americans use an average of 500 liters a day).

British Columbia, the Yukon, and Alaska contain some of the world's richest aquatic systems, with thousands of kilometers (km; or miles) of coastline and some of the biggest rivers and watersheds in the world. Many areas on the Pacific Coast receive over 1,000 millimeters (approximately 40 inches) of precipitation every year. The interior regions receive enough rainfall for extensive forests and grasslands to thrive, and most of the southern drylands can be irrigated by large lake and river systems.

These waterways are habitats for a great diversity of plants and animals, including Pacific salmon which migrate, sometimes thousands of kilometers (km; or miles), from small, clear lakes and streams to the ocean and then back again. To understand the life of the Pacific salmon, students need to start with the salmon's aquatic habitat.

Understanding water systems involves several key concepts (Adapted from McLaren et al., Water Stewardship, pages 19 to 21):

- Water is essential for life and all living things depend on water.
- All water is part of the hydrologic or water cycle.
- Streams, lakes, rivers, and other water bodies are part of larger systems known as watersheds.
- Watersheds are dynamic; they change over time as a result of geological and biological processes, as well as human activities.
- Humans are major users of water.
- Although part of an ongoing cycle, water is finite, and clean water is very limited.
- Aquatic habitats are essential elements of the biosphere.
- Contaminants and toxins can move within water and can have harmful effects on life.
- Different human cultures have different values about water and different patterns of use.
- Human activities that are harmful to water supplies and aquatic environments can be reduced. People can practice water stewardship to protect water resources for the future.

When students learn how their own activities, and the activities of their communities, affect the aquatic habitat of salmon and other species, they can begin to practice water stewardship in their own lives.

The Water Cycle [demonstration]

Materials:

- ✏ One heat-proof glass container containing approximately one liter of water (The container should have a small opening, but should not close completely.)
- ✏ One heat source for a demonstration
- ✏ One copy of Handout 4.1, "Water Cycle Procedure," for each student
- ✏ One copy of Handout 4.2, "The Water Cycle and Watersheds," (Parts 1 & 2), for each student
- ✏ Writing supplies

Time Required:
Approximately 60 minutes in two periods

Level of Conceptual Difficulty:
Moderate

LESSON

☞ Give students a copy of Handout 4.1, "Water Cycle Procedure," and have them complete the steps listed. Alternatively, lead the class in a demonstration of the activity.

DISCUSSION

☞ Use the board to diagram the activity in the form of a cycle. Have students identify what drives and what limits the cycling.

The energy from the heat source drives the cycle. The container walls and the cool outside air limit it by condensing the vapor, which precipitates completing the cycle.

☞ Have students use their own knowledge or Handout 4.2, "The Water Cycle and Watersheds," (Parts 1 & 2), to compare the water cycle in the activity with the atmospheric water cycle. If necessary, prompt them with questions, such as:

- Where do we see water that is part of the atmospheric water cycle?
  In the form of rain, snow, lakes, ponds, streams, oceans, etc.
- What is the energy source that drives the atmospheric water cycle?
  Solar energy, i.e., the sun.
- What causes water vapor to condense and fall back to earth?
  Cool upper elevation atmosphere.
- How does condensed water return to the oceans?
  Through precipitation falling on the ocean, or falling on land and flowing through streams and rivers or underground to the sea.
- How long will the water continue to cycle through the oceans and the sky?
  Forever, or at least as long as the water and the sun exist.

☞ Have students describe what would happen to the water cycle in the container if the cycle were disrupted. If necessary, prompt them with questions, such as:

Evidence for Assessment:

Review the students' written observations and conclusions to ensure that the students can trace the cycling of water in the container. Monitor their discussion and atmospheric diagrams to ensure that they can trace the cycling of water in the environment and identify potential human impacts.

- What would happen if the heat source were hotter?
  The water would boil and it might destroy the container.
- What would happen if the heat source were removed?
  The water would not evaporate and the cycle would end.
- What would happen if the container were open?
  The vapor would escape, the water would dry up and the cycle would end.
- How are interruptions to the water cycle in the container similar to or different from interruptions to the water cycle on earth?
  The water and energy on earth are not likely to end, but small changes could still have major effects.

☞ Have students describe what might happen if the water cycle on earth were disrupted. If necessary, prompt them with questions, such as:

- If atmospheric change were to increase the solar energy that drives the water cycle, what might happen?
  The atmosphere might get warmer and more humid, possibly causing storms and changing climate and weather patterns. This is similar to global warming, in which the sun's energy builds up in the earth's atmosphere and the climate becomes warmer.
- If atmospheric change were to decrease the solar energy that drives the water cycle, what might happen?
  The atmosphere and ocean might get cooler, possibly changing the climate and weather patterns responsible for plant and animal growth.
- If atmospheric pollution were to contaminate moisture in the air, what might happen?
  Pollution might reduce the solar energy that drives the water cycle and change climate patterns, or it might dissolve in the water that falls as precipitation and pollute land and water.

SUMMATION

☞ Have students create parallel diagrams, comparing the cycling of water in the container with the cycling of water in the environment. Have them describe the cycle in a paragraph.

☞ Option: Have students use maps of the local area (lakes, stream, mountains, etc.) to diagram local aspects of the water cycle, including sources of atmospheric moisture, locations where it falls to earth, and ways in which it returns to the sea.

Water Cycle Procedure

Handout 4.1

Name ____

Hypothesis

When water is heated in a closed container, what is going to happen?

____

____

____

Teacher Demonstration

1. Place approximately one liter of water in a large heat-proof glass container. Place a top on the container loosely enough to allow any steam that forms to escape.
2. Place the container over a heat source. USE CAUTION AROUND HEAT SOURCES.

Student Observation

3. Describe any changes that you see in the glass container:

____

____

____

____

Teacher Demonstration

4. When vapor begins to form, reduce heat while maintaining the water vapor production.

Student Observation

5. Describe what happens to the vapor inside the container.
   (Where does it come from? Where does it go?)

____

____

____

____

Conclusion

6. What do your observations tell you about the hypothesis?

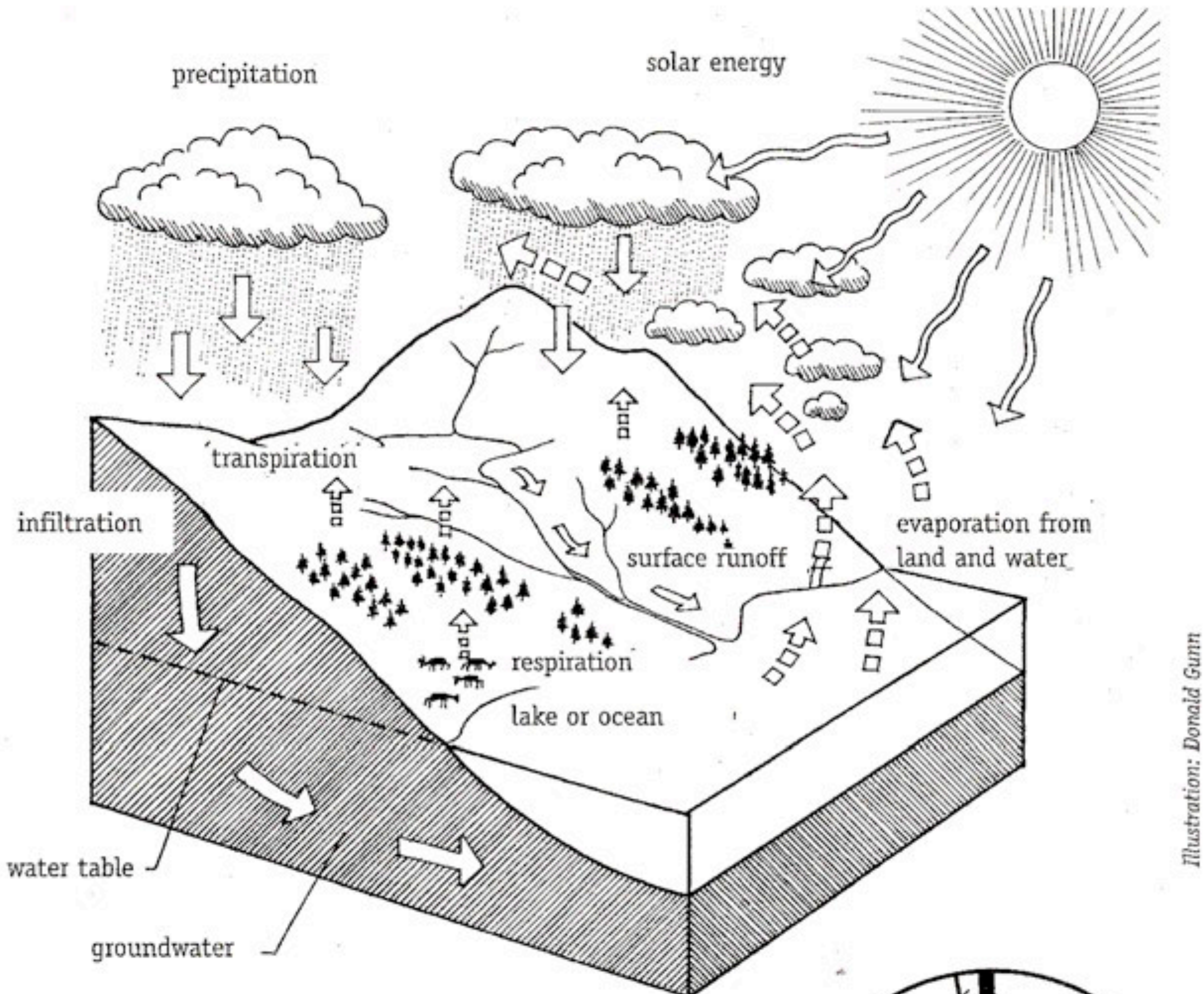
____

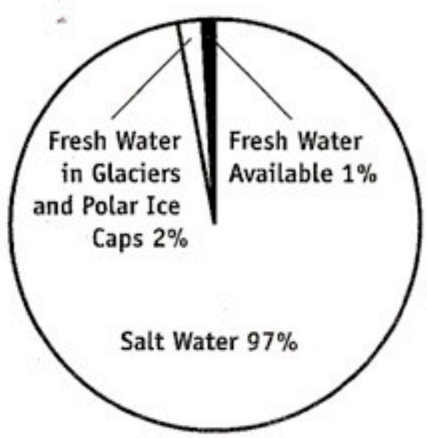
____

____

The Water Cycle And The Watershed

Handout 4.2, (Part 1)





Earth's Water supply

Water covers 72 per cent of the earth's surface. Only three per cent of this is fresh water; the rest is salt water. Two-thirds of the fresh water is frozen in glaciers and the polar ice caps.

The Water Cycle And The Watershed

Handout 4.2, (Part 2)

The water is constantly in motion. The water cycle, or hydrologic cycle, transports water from water bodies into the atmosphere and back again.

Energy from the sun, or solar energy, powers the cycle. It:

- evaporates water from the seas, fresh water lakes, rivers and streams, and the surface of the soil
- gives plants energy to take up moisture and give off water vapor from their leaves in a process called transpiration
- creates wind, which blows vapor through the atmosphere until cool air causes the vapor to condense

Water in the atmosphere falls to the ground as rain, snow, or other forms of precipitation. The moisture in the atmosphere falls to earth every 9 to 12 days, and it is replaced just as quickly.

When rain falls on land, it flows through streams and rivers until it rejoins the sea. Some water trickles into the soil, forming part of an underground, or groundwater, water system.

An area that drains into one river or stream is known as a watershed. The land, plants, and animals form part of the watershed. The watershed is where plants and animals live. Animals, like salmon, rely on a watershed to meet their needs. Animals also affect how water moves back into the atmosphere and to the sea. Plant roots can draw water out of the soil, creating pockets where water gathers temporarily. The roots can slow or stop erosion by slowing water as it moves in the soil. Beavers build dams that divert the water, and microorganisms can slowly break down rocks in the water.

The water cycle renews and cleans the water flowing in watersheds. Humans rely on water from local watersheds for drinking water, for cleaning, for recreation, and for industry. But our actions can divert, dry up, or even poison local watersheds. When we cover even part of a watershed with concrete or asphalt (like parking lots), it can change the water flow, sometimes even causing floods.

A Watershed Mural or Display

Materials:

- Copies of Handout 4.3, "An Overview of the Salmon Life Cycle," (Parts 1 & 2), for each student
- Art supplies

Time Required:
Two 40-minute lessons, plus ongoing time in future lessons

Level of Conceptual Difficulty:
Simple

Evidence for Assessment:
Review the students' displays and monitor class discussions to ensure that the students can describe environmental and human factors that influence the watershed.

INTRODUCTION

- Point out that cycles are one of the important themes in science, and ask students to identify a number of cycles they have studied (e.g., the water cycle, the nitrogen cycle, the carbon cycle, plant and animal life cycles).

DISCUSSION

- Have students identify activities in their own or their family's lives that illustrate one phase of a cycle.

- Point out that all living things go through a cycle of growing up, growing old, having offspring and dying, and the life cycle of the salmon will be one illustration of that cycle.

SUMMATION

- Have students review the life cycle of a salmon from previous knowledge or from Handout 4.3, "An Overview of the Salmon Life Cycle," (Parts 1 & 2), and predict where salmon live in the watershed at each stage of the salmon's life cycle.

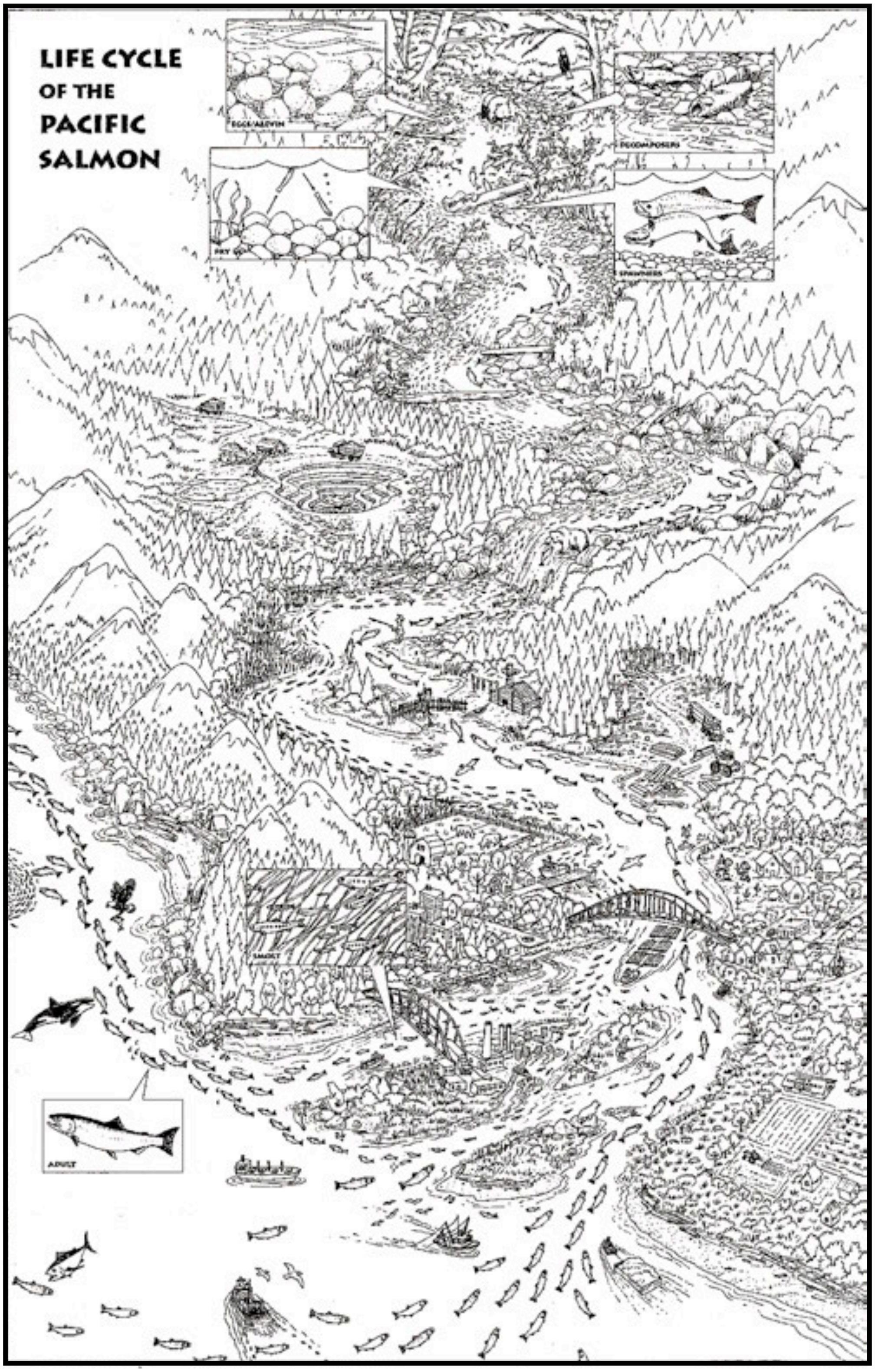
- Have the class create a large poster or bulletin board display to which they can refer and add in the following skeins. Have them show small streams draining into larger ones, then into a river, an estuary and the ocean, leaving enough space at each area to show life cycle stages of a salmon.

- In future lessons, have the class look for information they can add to the display to make a mural showing the complete life cycle of the salmon and the habitat at each stage.

An Overview Of The Salmon Cycle

Handout 4.3, (Part 1)

Illustration: Robert Browne



An Overview Of The Salmon Cycle

Handout 4.3, (Part 2)

Salmon begin their life in freshwater streams, rivers, and lakes. Their life begins in the gravel of streams or lakebeds. Mature females dig a nest, called a redd, in the gravel. Here, they lay as many as 6,000 eggs. The average is between 2,500 and 3,000. The male salmon fertilizes the eggs, and the female covers them with gravel for protection.

The eggs slowly develop under the gravel over the winter months. When the eggs hatch they are called alevin. Alevin continue to live in the gravel and take nourishment from a yolk sac attached to the underside of their bodies. By the spring, they finish the yolk sac, and miniature salmon called fry come out from the gravel.

Coho, chinook, and sockeye salmon remain in fresh water for a time. Chum and pink salmon travel downstream to the sea soon after they come out from the gravel.

Salmon fry eat constantly and grow quickly. When they reach what is called the smolt stage, they move downstream to the estuary, where the river meets the sea. They stay in the estuary for a time while their bodies adapt to being in salt water. Once the smolt can survive easily in salt water, they travel into the ocean.

Some types of salmon wander as far as 3,200 kilometers (approximately 2,000 miles) from their natal stream. Others stay closer to home. As they grow to adulthood, the salmon eat small fish and tiny animals that live in the sea.

When they are ready to spawn, or lay their eggs, the salmon return to the stream or lake where they hatched. During the difficult journey to the spawning grounds, their bodies change color and shape. Once they lay and fertilize their eggs, their life cycle is complete and the salmon die.

Runoff Pollution

Materials:

- One copy of Handout 4.4, "Runoff Pollution," (Parts 1 & 2), for each student
- Writing supplies

Time Required:
Approximately 60 minutes in two periods

Level of Conceptual Difficulty:
Moderate

Evidence for Assessment:
Monitor class discussion

DISCUSSION

- Have students read Handout 4.4, "Runoff Pollution," (Parts 1 & 2), and discuss. If necessary, prompt them with questions, such as:

  - How did the runoff water sample differ from the pond water?
    More or less silt, smell of water, oil on the surface, etc.
  - Which sample had a greater number of organisms? Which had a greater variety?
  - In which sample would salmon fry or other aquatic organisms prefer to live? Why?
    Ponds and streams have greater numbers and varieties of plant and animal life that fry can use for food and shelter. In addition, the supply and quality of water is more reliable and less polluted.
  - Where does the runoff water go?
    It soaks into nearby soil and flows into creeks, streams and drains, which sometimes flow into rivers, streams or seas.
  - What problems might be caused by runoff water from paved land?
    Instead of percolating into the ground, it tends to flow quickly, often flooding ditches and creeks with contaminated rainwater.
  - How does human development, especially in cities, affect aquatic life and the aquatic environment?
    It reduces the space for natural water, creates floods of polluted runoff, and reduces the variety and number of organisms.
  - What steps might people take to reduce the impact of urban runoff?
    Reduce the need for roads, reduce car pollution, reduce runoff floods by building porous pavement that allows water to percolate into the soil, surround pavement with natural vegetation to absorb runoff, divert polluted water into ponds or wetlands where it can be treated, etc.

- Option: Have students build small-scale models demonstrating how urban runoff water can be diverted or treated to reduce its impact.

Runoff Pollution

Handout 4.4, (Part 1)

Water pollution comes from many sources. Transportation, farms, forest activities, and boating activities can leave waste in the water that is used by salmon.

People have changed their activities to reduce pollution, but some kinds of pollution are hard to stop. Runoff is an example.

In nature, when rain falls, most trickles into the soil and gradually moves toward lakes and streams. However, cities and buildings change that flow. Roads, sidewalks, and parking lots do not absorb rainwater, nor can rain soak easily into hard-packed soil. Instead, rainwater flows across the surface to drains or puddles.

As rain flows across the surface, it can pick up dirt, chemicals and microorganisms that are harmful to salmon. Harmful pollutants include:

- oil that drips from cars onto the street;
- air pollutants that settle on the ground;
- fertilizers and herbicides sprayed near the street;
- dirt kicked from a playground;
- paints and cleaners used on a parking lot; and
- waste that people dump onto the street.

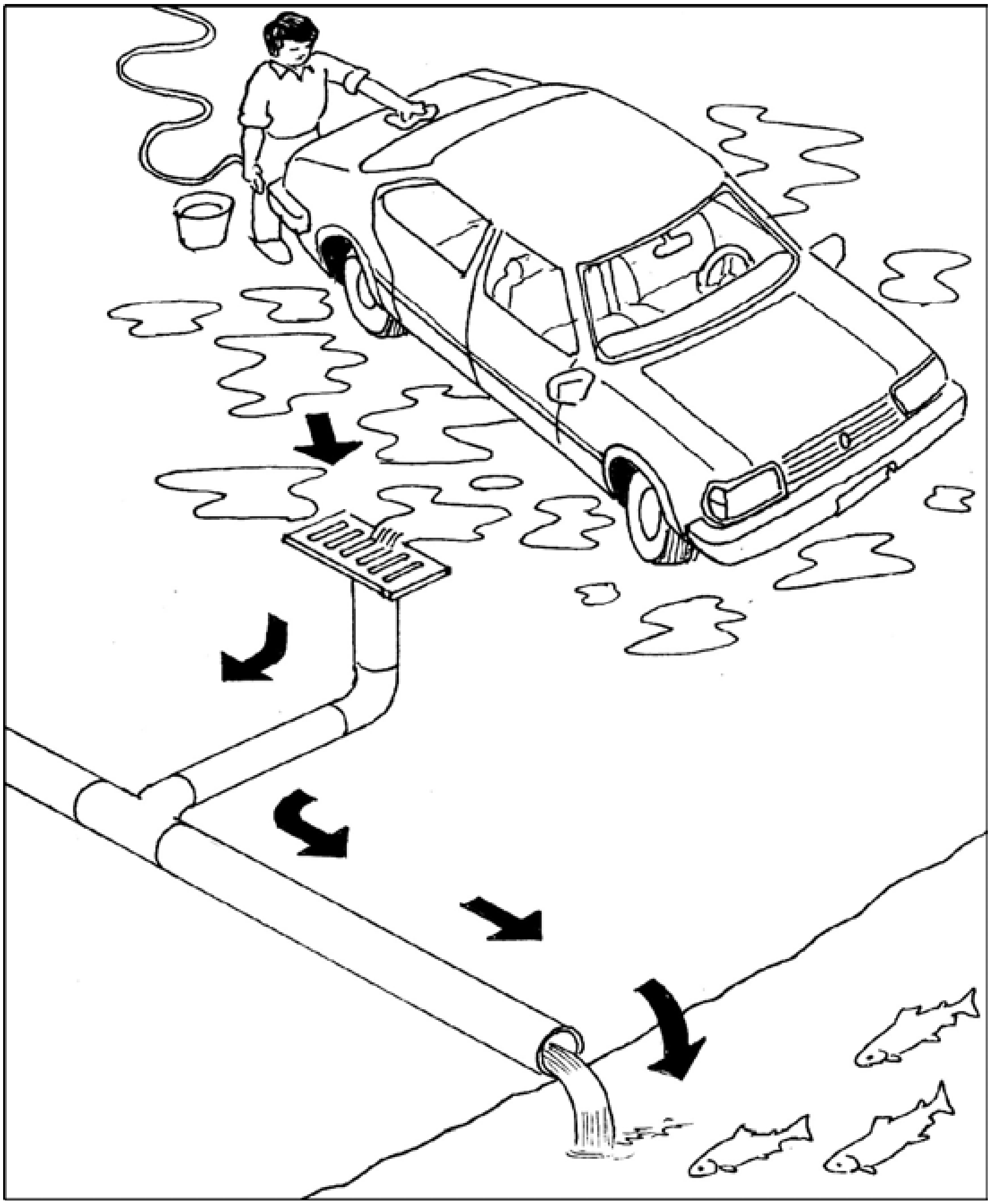
When rain carries these pollutants into a drain, it often flows to nearby streams. The pollutants then flood into a water body, where they can harm salmon and other organisms. The dirt can harm their delicate gills. The chemicals can be poisonous. Chemicals also kill insects and microorganisms that salmon need for food.

However, people can make a difference. Many schools mark road drains to remind people that waste in the drain can harm nearby streams. Some people are planting vegetation to support loose soil that will absorb rainwater. New types of pavement allow water to drain through the surface into the soil below.

Runoff Pollution

Handout 4.4, (Part 2)

Illustration: Donald Gunn



SALMON LIFE CYCLE

WRAP-UP

EXTENSION ACTIVITIES

- ☞ Have students view a video on a watershed and discuss how it relates to the life cycle stages of a salmon.
- ☞ In the schoolyard or on a nearby property, create a "natural" watershed that is exposed to the weather.
- ☞ Have students create a public announcement using posters, video, hypertext or other media to inform others of the importance of protecting watersheds.
- ☞ Have students take a field trip to a local stream and identify physical and biological factors in the local environment that form part of a watershed. Have them use the on-site studies guide in Skein Five: Salmon Habitat: On-Site Studies to examine and record features of the watershed that relate to the water cycle and the salmon life cycle.
- ☞ During the activities, have students gather information about ways in which different users use a watershed, e.g., fish, animals, a forest company, a utility company, a farmer, recreationists. Have students prepare for a city council meeting in which the different users debate, from their perspectives, for balanced use of the watershed.
- ☞ Contact your local water supplier (usually a municipal or regional government) and invite a representative to talk to your class about the water supply in your community.
- ☞ To demonstrate the slow and not so noticeable processes of evaporation, condensation, precipitation and climate change, have your students build a biosphere model.
- ☞ Have students prepare a map showing the path water takes from a source to their home, including any purification or contamination sites along the route.

SUGGESTIONS FOR ASSESSMENT

- ☞ Have students place pictures of the salmon life cycle stages in the correct order and position on a watershed diagram, then write an explanation of how each stage relates to the water cycle in a watershed.
- ☞ Monitor student discussions of the life cycle handout and mural to ensure that the students can identify the stages of the salmon's life cycle.
- ☞ Have students write quiz questions about salmon and the water cycle on one side of an index card and answers on the other. Have them quiz each other by asking the questions or using a Jeopardy-style format by giving the answers and asking for a question.
- ☞ Have students add their notes, observations, and other materials to a salmon science notebook.

SALMON LIFE CYCLE

WRAP-UP

HOME AND COMMUNITY CONNECTIONS

☞ Have students ask an adult to help them identify the source of the water they use in their home, the means by which it arrives at their home, and the destination of waste water and storm water runoff.

☞ Have students paint road drains with a salmon stencil as a reminder that waste in drains can harm streams.

☞ Suggest that the class begin a project to identify and protect any streams, drainage ditches, or storm drains that carry rainwater from built-up areas in the community to waterways inhabited by fish and other aquatic life.

SALMON INCUBATOR

If you have a classroom salmon egg incubator, have students learn the names of its components, examine how it works, and set it up for receiving salmon eggs.

☞ Have students create a chart (such as the one below) comparing the parts of the incubator and the functions they fill with the way the functions are filled in nature.

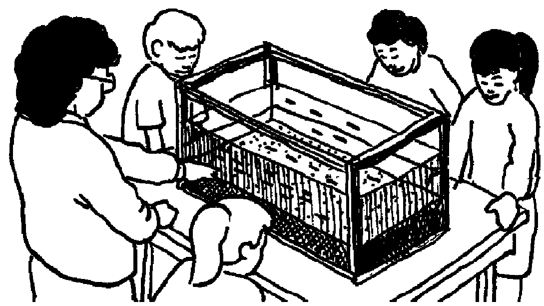


Illustration: Donald Gunn

In the tank	In nature
• Water supply provides fresh water	• Water sources (lakes, streams, rain, etc.)
• Pump/hose keeps water circulating	• Water moved downstream by gravity
• Riser tubes oxygenate and circulate water	• Riffles oxygenate moving water
• Foam cover provides darkness, and keeps water cool	• Darkness comes from gravel cover
• Dechlorinator removes chlorine	• Water does not contain chlorine
• Gravel filter changes ammonia to nitrates	• Microorganisms in water convert ammonia
• Gravel cleaner removes food and waste	• Water organisms eat and convert wastes
	• Water is chilled by cold atmosphere

Skein 5

Salmon Habitat

Overview:
This skein gives students the opportunity to:

- **P / I** Select, discuss, and review rules a site for on-site stream studies
- **I** Conduct and then discuss the stream studies

Big Ideas:

- A stream or lake may be a salmon's home for part of its life cycle. Streams and lakes with certain features will be attractive to salmon.

Vocabulary:

streambed, stream bank, lake, gravel, riffle, pool, habitat, polluted, garbage

Important Standards Netted by Teaching Skein 5

SCIENCE

	Fourth Grade	Fifth Grade	Sixth Grade
Rules for Salmon Habitat Study	SA 1.1 SA 1.2 SA 2.1 SA 3.1 SC 2.2 SC 3.1 SD 1.1	SA 1.1 SA 1.2 SA 2.1 SA 3.1 SD 1.1	SA 1.1 SA 1.2 SA 3.1 SC 3.1

MATH	Third Grade	Fourth Grade	Fifth Grade	Sixth Grade
Field Trip	M 2.1.1 M 2.1.3	M 2.1.1 M 2.2.3	M 2.1.1 M 2.2.3	M 2.1.1 M 2.2.3
Habitat Survey Data	M 1.3.4	M 3.2.1	M 3.2.1	M 3.2.1

READING		
Field Trip	R 1.1 R 1.5 R 1.4	R 2.1 R 2.5 R 2.4

WRITING	Fourth Grade	Fifth Grade	Sixth Grade
	W 2.1.2 W 2.2.2	W 2.1.3 W 2.2.2	W 2.1.3 W 2.2.2 W 2.2.4

BACKGROUND INFORMATION

WATER CYCLE

Alaska's salmon spawn in streams and lakes, and many species spend a year or more in the stream or lake after they hatch. Salmon habitat is easily damaged by logging and mining activities, by urban and industrial construction, and by pollution. Many of these practices are changing to protect streams and revitalize streams that have been damaged in the past.

Water. At every stage in their life, salmon need clean water that is approximately between 40°F and 50°F and which contains oxygen. A healthy salmon stream has a mix of fast running water and deep pools. Fast running water washes over rocks in riffles and picks up oxygen. Deep pools that form at the edge of a stream and in the water behind rocks, logs, or other debris allow salmon to rest from the current and hide from predators. Cloudy water contains silt and mud that can smother eggs and irritate the gills of young salmon. Cloudy water also makes it harder for salmon fry to find and catch food.

Young salmon are very sensitive to pollutants in the water. Household chemicals like bleach, soap, oil, or paint can be fatal if people dump them into a stream. Many pollutants enter streams through storm drains, which carry rainwater from paved streets to nearby streams. Pollutants dumped down storm drains can kill salmon and wildlife in nearby streams.

Stream banks and lake shores. The gravel bottom of a salmon stream or lake contains a mix of rock sizes. Salmon need gravel to spawn, but once the alevin emerge, the presence of pools and riffles are more important. The slope and curves in the streambed are important to control the flow of water and reduce flooding during storms.

Stream banks lined with plants soak up water during heavy rain and release it slowly into the stream. Marshes and similar wetlands also absorb rainfall to prevent flooding and reduce the chance of streams and lakes drying out in hot weather. Bushes and trees growing along the banks of a stream create shade, keep the water cool in the summer, keep the banks stable, and allow salmon to hide in the shadows. Insects live in the vegetation along the banks and fall into the water as food for salmon. To protect the stream banks, laws prohibit construction or logging near the streams.

Food. Salmon fry catch tiny insects that float past them. As they grow, the salmon can catch larger insects and caterpillars that fall into the stream or lake, as well as mayflies and stoneflies that land on the water to lay their eggs. When they are large enough, the salmon can eat smaller fish in the stream or lake.

People. People disturb streams and lake shores and their natural residents when they remove the vegetation, divert the water flow, pollute the water, or build docks. People can erode the banks by playing or driving along the edges of a stream or lake. They can crush salmon eggs in the gravel or expose them at this very sensitive stage. People and pets sometimes harass spawning salmon in shallow streams or leave garbage at the site.

But people can also protect and restore streams and lakes. Many groups and individuals act as streamkeepers, conducting stream inventories, monitoring environmental health, working for the streams' protection, and replanting and restoring streams that have been damaged or buried in culverts. People should be conscious that they share the stream with others and that every organism contributes to the health of the ecosystem.

P/I

If I Were A Salmon

Materials:

- Copies of Handout 5.1, "Rules for Salmonid Habitat Study," for each student
- Copies of Handout 5.2, "A Healthy Salmon Habitat," for each student

Time Required:

One lesson, plus follow-up time after the field trip

Level of Conceptual Difficulty:

Simple to moderate

Evidence for Assessment:

Monitor class discussion to ensure that student can identify features of a healthy salmon habitat.

ADVANCE PREPARATION

- Review any rules your school has regarding student safety around water and ensure that adequate precautions are in place. Some streams and lakes may be hazardous for young children, particularly if there are strong currents, slippery rocks, or unstable banks.

- If possible, tell the students that you have selected a variety of sites for a salmon habitat study and ask them to choose the site they would prefer to visit.

- Arrange adequate supervision from parent helpers or other volunteers. Most sites cannot provide supervision, although those with school programs can provide information and activities when informed in advance. If there is an on-site program, check what it offers and how to prepare the class.

- Walk the site before the class visit to check for appropriateness, safety, and educational opportunities.

- Prepare the handouts and other materials students will need. Arrange permission, as required by your school. Advise students to bring warm clothing, waterproof boots, a snack, and a backpack.

- These activities make a valuable extension to the skeins on the egg, alevin, and fry, especially if your school has a classroom egg incubator tank and will be releasing fry.

INTRODUCTION

- Have the class brainstorm answers to the question, "If I were a salmon, what kind of habitat would I want?" If necessary, prompt them with questions, such as:

  - What kind of water would you want?
    Cold, clean, fresh-running, with riffles and still ponds.

- What would you want at the bottom of the stream or lake?
  Clean gravel and rocks.
- What would you want on stream banks?
  Shady, overhanging vegetation.
- What would you want to eat?
  Insects, smaller fish, bits of plant and animal debris.

RESEARCH/DISCUSSION

☞ Have students, in small groups, use Handout 5.2, "A Healthy Salmon Habitat," to research and list items they would find in good salmon habitat.

SUMMATION

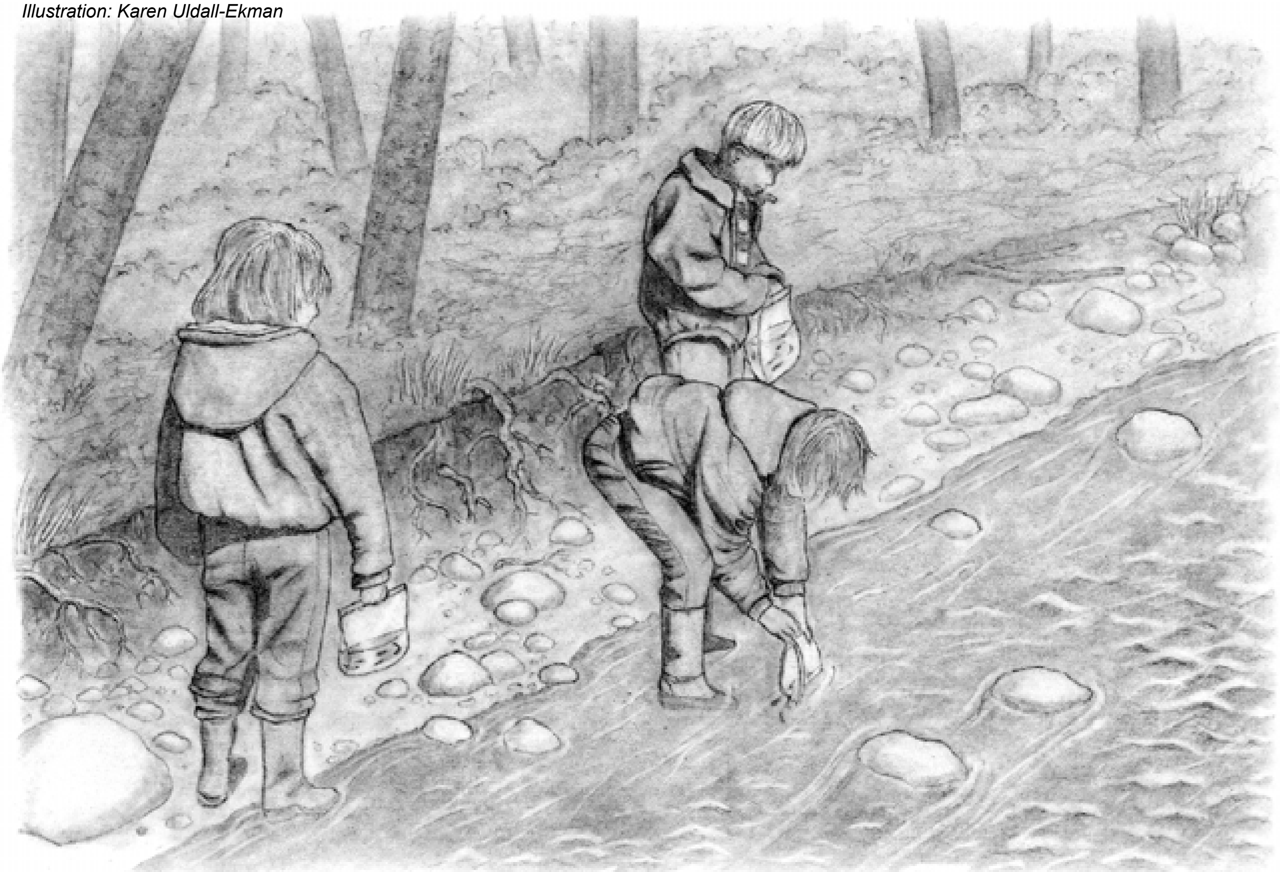
☞ Help the class make a list of plants, animals, and other objects to look for when they are at a stream or lake and to decide whether or not each item is good for salmon. Discuss how students will make and record their observations on the salmon habitat study: taking notes, drawing, taking photos, video and/or audio recordings, etc.

Rules For Salmonid

P/I

Handout 5.1

Illustration: Karen Uldall-Ekman



1 Follow directions.
2 Stay in your groups.
3 Walk only. Do not run.
4 Play only where allowed.
5 Stay on the paths.
6 Do not pick plants.
7 Do not disturb fish or other animals.
8 Take your things with you when you leave.

A Healthy Salmon Habitat

Handout 5.2

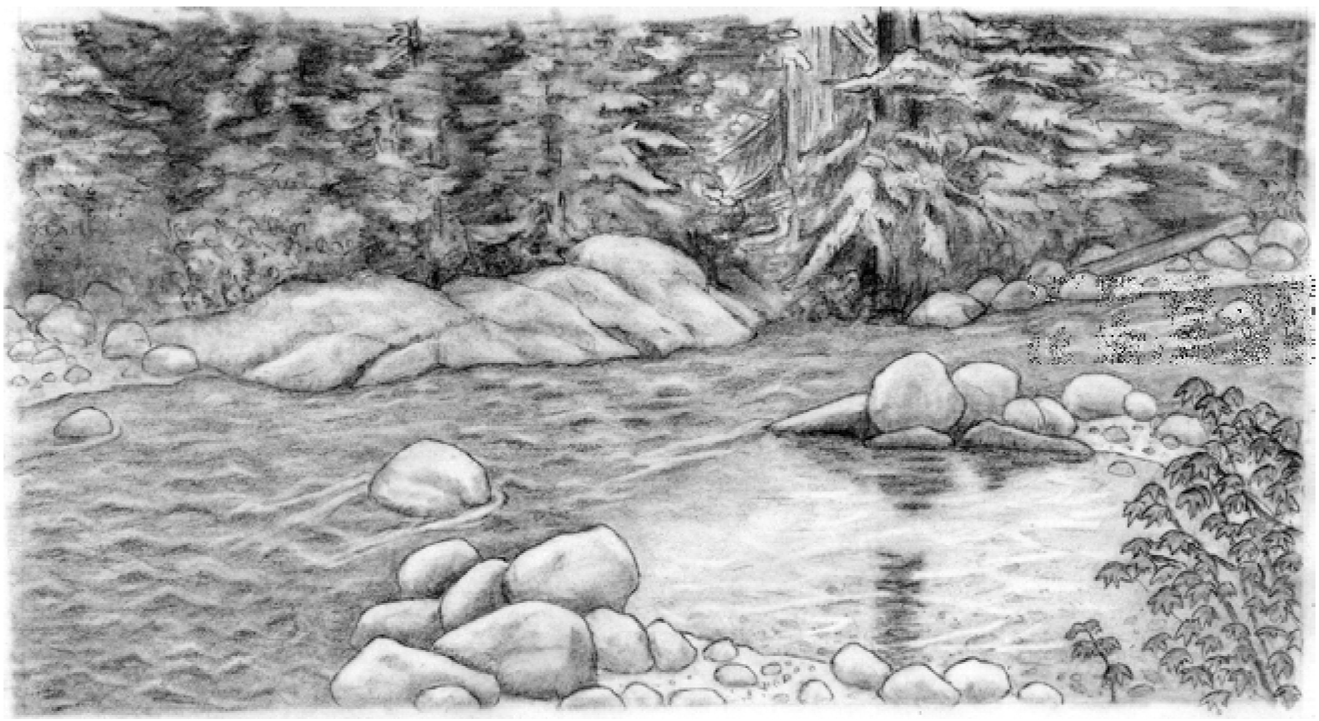


Illustration: Karen Uldall-Ekman

Salmon need many things to make a home.

Salmon live in streams and lakes. They like cold water. The water must run fast. It must be clean. Salmon also like to rest in still pools.

The lakebed or streambed must have clean rocks and gravel. Gravel is a mix of small stones and sand. Salmon do not like mud or dirt.

Salmon need bushes and branches to shade the water. The shade keeps the water cool. Salmon can hide in the shade.

If a lake or stream has all these things, it is a good home for salmon.

Do not play in a salmon stream. Salmon do not like to be disturbed.

What To Look For

Materials:
- Copies of Handout 5.3, "Salmon Habitat Study No. 1," for each student
- Copies of Handout 5.4, "Salmon Habitat Study No. 2," for each student
- Writing supplies
- Chart paper

Time Required:
One lesson, plus follow-up time after the field trip

Level of Conceptual Difficulty:
Simple

Evidence for Assessment:
Review student handouts and monitor in-class discussion to ensure that the students can observe and describe a variety of phenomena from nature.

INTRODUCTION

- Shortly before the field trip (earlier in the day if feasible), have small groups of students use Handout 5.3, "Salmon Habitat Study No. 1," to list things they think they will see.
- Have the groups report their lists to the class and make a class list on a chart.
- Have the class divide the list into items from nature and items from humans.

RESEARCH/DISCUSSION

- Give the students copies of Handout 5.4, "Salmon Habitat Study No. 2," and have them use it on the field trip to write or draw their observations. Stop several times during the field trip and have students record their observations on the handout.
- Following the field trip, have students read their notes or describe their observations to the class.

SUMMATION

- Discuss with the class similarities and differences between their observations and the list of what they expected to see. If necessary, prompt them with questions, such as:
  - What did you observe that you did not think of before the field trip?
  - What were you expecting that you did not observe?
  - What did you think would be most interesting and what turned out to be most interesting?
  - Did you see more or less items from humans than you expected?
  - Why were there differences between what you expected and what you observed?

NOTE

- These handouts would be good accompaniment to your egg-take field trip.

On The Salmon Habitat Study, No. 1

Handout 5.3

Name ____

On the salmon habitat study, I think

I Will See

I Will Hear

I Will Touch

I Will Smell

P

On The Salmon Habitat Study, No. 2

Handout 5.4

Name ____

On the salmon habitat study,

I See

I Hear

I Touch

I Smell

Field Trip

This activity will be most meaningful when repeated over time (e.g., visit the chosen stream in both the fall and spring). Teachers could research the historical characteristics of the stream or arrange for a guest speaker to share his or her knowledge.

Materials:

- Copies of Handout 5.5, "Salmon Habitat Survey and Data Sheet," for each student
- Thermometer
- Meter stick

Time Required:
Several hours for field trip

Level of Conceptual Difficulty:
Moderate

Evidence for Assessment:
Monitor student discussions and notes to ensure that the students can describe the site and identify features about the habitat that make it suitable for salmon.

INTRODUCTION

- Assemble the class in groups of four or five, each with an adult supervisor. Remind the class of the class rules for habitat study.

INVESTIGATIONS

- Option: Have different groups of students take a five-minute walk, each focusing on one specific thing.
  List all the colors you can identify; List all the sounds you hear; List all the smells you can; List all the trees or leaves you can find; List all the things you can see on the ground; List all the things less than one centimeter in size; etc.

- Have the groups reassemble and compare the results of their walks on-site or in class.

- Have the class walk to the stream or lakeshore. Have students identify features that would identify the site as good or bad for salmon.
  Clean, cold running water, gravel stream bottom, vegetation on stream banks, insects for food.

- Have them carefully look for signs of salmon or other fish in the water. Have them record their observations.

- Have students in pairs or small groups use Handout 5.5, "Salmon Habitat Survey and Data Sheet," to record information about the stream. If necessary, have the adult supervisor lead students through the survey.

- Have the class look for evidence of people near the stream or lake.
  Signs, construction, trails, pipes, waste, etc.

- Have the students record their observations.

- Have the class look for things they could do to make the site better for salmon and other animals.
  Remove waste, restore minor damage, etc.

P

Salmon Habitat Survey & Data Sheet

Handout 5.5

Name________________________________ Date__________________________________

Materials:

4 Thermometers

4 Meter sticks

1. How cold is the water?
   Use a thermometer. Hold it in the water for one minute.

   The water is ____________ degrees Celsius.

2. How deep is the water?
   Use a meter stick. Do not go more than 50 cm deep.

   The water is ____________ centimeters deep.

3. How clear is the water?

   The water is: clear / muddy

4. Look at the stream or lake bottom. What kind of rocks does it have?

   mud / gravel / boulders

5. Look at the stream or lake sides. What kind of plants does it have?

   none / low bushes / trees

Salmon Habitat Study Field Trip

[research/discussion]

Materials:

- Copies of Handout 5.6, "Habitat Survey and Data Sheet," (Parts 1 & 2), for each student
- HACH field testing kits to measure dissolved oxygen
- pH testing kit
- Thermometers for measuring air and water temperature
- Meter sticks or other measuring tools
- Stopwatch or other watch with a second hand
- Writing and drawing supplies

Time Required:
Several hours for field trip

Level of Conceptual Difficulty:
Simple to moderate

Evidence for Assessment:

Monitor student discussions and review their written observations to ensure that the students can describe the site and identify features that make the habitat suitable for salmon.

ADVANCE PREPARATION

- Review your school's field trip guidelines. Then review Advance Preparation (Page 4) and contact State Fish and Game for additional resources.

FIELD RESEARCH

- Assemble the class into five groups, with an adult supervisor for each group. (Adult supervisors can also rotate between groups if fewer than five are available). Remind the class of the class rules for habitat study.

- Option: Have the class walk the banks of the stream or lake, either together or in their groups. Every two to three minutes stop and have students describe the general sights, sounds, smells, and other characteristics of the site. Have students write or draw their observations in the salmon science notebook. Have students sketch a map of the site.

- Have students, in their groups, use Handout 5.6, "Habitat Survey and Data Sheet," (Part 1), and/or Handout 5.6, "Advanced Habitat Survey and Data Sheet," (Part 2), to record information about the stream. Have the class walk to the stream or lakeshore. Have students identify features that would identify the site as good or bad for salmon.

- Note: you may wish to laminate the handout sheets for future reuse, in which case overhead pens may be required for recording information.

- Have the class look for evidence of people near the stream or lake.
  Signs, construction, trails, pipes, waste, etc.

- Have the students record their observations.

☞ Have the class look for things they could do to make the site better for salmon and other animals.

Remove waste, restore minor damage, replant shoreline vegetation, etc.

Illustration: Donald Gunn

Habitat Survey and Data Sheet[I]

Handout 5.6, (Part 1)

Name ____

Name of stream or lake____

Habitat checklist

Check the box if you see any evidence that the stream or lake meets these conditions.

- ☐ The stream or lake bed has clean gravel.
- ☐ The stream or lake has clean flowing water
- ☐ The stream or lake does not dry up.
- ☐ The stream or lake floods easily.
- ☐ The stream or lake is not blocked by waterfalls.
- ☐ The stream or lake has vegetation on its banks.
- ☐ There are signs of animals near the stream or lake.
- ☐ The stream or lake is not damaged by people.
- ☐ The stream or lake is cared for by people.

Does the stream or lake appear to be a good salmon habitat? What makes it look like a good or poor habitat?____

____

____

____

What could be done to make the stream or lake a better habitat for salmon?______________________

____

____

____

Who could do something to make the stream or lake a better habitat for salmon?____________________

____

____

____

Other evidence you observe ____

____

____

Habitat Survey and Data Sheet I

Handout 5.6, (Part 2)

Physical characteristics of the stream or lake banks and bottom					
1. Stream or lake bank Estimate the portion of the bank that is made up of:	N/A	25%	50%	75%	ALL
Bedrock (solid rock):					
Boulders (rock pieces of 30 cm across or larger)					
Cobble (rock pieces of 10 to 30 cm across)					
Gravel (rock pieces 1 to 10 cm across)					
2. Stream or lake bottom Estimate how much of the bottom is made up of:	N/A	25%	50%	75%	ALL
Bedrock (solid rock):					
Boulders (rock pieces of 30 cm across or larger)					
Cobble (rock pieces of 10 to 30 cm across)					
Gravel (rock pieces 1 to 10 cm across)					
Sand					
Mud					
3. Plant life along the stream or lake banks Estimate the portion of the bank with the following types of vegetation:	N/A	25%	50%	75%	ALL
Tall trees					
Low bushes					
Overhanging bushes					
Ferns					
Grass					

SALMON HABITAT STUDIES

WRAP-UP

EVIDENCE FOR SKEIN ASSESSMENT

- ☞ Have students describe in writing or draw one or more things they did not know before the field trip or one thing they found interesting on the field trip.
- ☞ Have students complete a stem sentence, such as, "I used to think… about salmon habitat but now I know that…," or, "One thing I learned about salmon habitat is…".
- ☞ Have students add their materials to their salmon science notebook and write a sentence explaining what they learned.

LANGUAGE AND ARTS INTEGRATION

- ☞ Invite a local naturalist or other resource person to the class to prepare students or to lead the visit. For information, contact local organizations, such as the Alaska Department of Fish and Game.
- ☞ Arrange a visit to another type of salmon resource, such as a local hatchery or salmon enhancement project, a local spawning stream or lake, a salmon processing facility, or a commercial fishing boat. Discuss the kinds of jobs people hold that involve working with salmon.
- ☞ Have students imagine the site from a bird's-eye view. Have them identify the main visible features, such as the road, parking lot, stream, clearings, trees, and buildings. Have students draw the site as they would see it if they were a bird flying overhead.
- ☞ Arrange for the class, or for a group of students, to view the site at different seasons and to compare their observations using notes, illustrations, photos, or other media.
- ☞ Have students make a map of a local stream or lake, showing its main features and ways to protect these features from damage.
- ☞ Have the class paint a mural showing the site and labeling features that salmon would like.

HOME CONNECTIONS

- ☞ Have students guide an adult around a stream or lake and identify features about the stream or lake that salmon would like.

SALMON HABITAT: ON-SITE STUDIES

WRAP-UP

EXTENSION AND INTEGRATION

☞ Invite a local naturalist or other resource person to the class to prepare students or to lead the visit.

☞ Arrange a visit to another type of salmon resource, such as a local hatchery or salmon enhancement project, a local spawning stream or lake, an estuary, a salmon-processing facility, or a commercial fishing boat. Discuss the kinds of jobs people have working with salmon.

☞ Have students imagine the site from a bird's-eye view. Have them identify the main visible features, such as the road, parking lot, stream, clearings, trees, and buildings. Have students draw the site as they would see it if they were a bird flying overhead. Obtain an aerial photograph of the site from the local planning office and have them compare their views with the photograph.

☞ Arrange for the class, or for a group of students, to view the site at different seasons and to compare their observations using notes, illustrations, photos, or other media.

☞ Have students make a map of a local stream or lake, showing its main features and ways of protecting them from damage. Alternatively, have students add the features they observed to a topographical map of the site.

☞ Have the class paint a mural showing the site and labeling features that salmon would like.

☞ Build a mock stream. Have the water flow across the mock stream and discuss the anatomy of the stream. Modify the stream and see how it impacts the water. Predict what will happen to the salmon habitat with the changes.

EVIDENCE FOR SKEIN ASSESSMENT

☞ Have students make notes listing at least six important ideas or facts about the stream they studied.

☞ Have students share their lists in pairs and negotiate an agreement on the four most important ideas about the stream they studied.

☞ Have the pairs share their ideas with the class and discuss any differences between the lists the different pairs negotiated.

Skein 6

Salmon Alevin

Overview:
This skein gives students the opportunity to:

- **P** Compare a bean seed and a bag lunch to an alevin's yolk sac
- **P / I** Discuss survival needs of newborns
- **I** Review and discuss how temperature affects rate of growth
- **I** Review and discuss how people affect the temperature of the water and ways of minimizing human impacts

Big Ideas:

- Alevin hatch from an egg and continue to grow by using food from the egg yolk.

Vocabulary:

alevin, yolk sac, hatch, egg wall, embryo

Important Standards Netted by Teaching Skein 6

SCIENCE

	Fourth Grade	Fifth Grade	Sixth Grade
Energy and Growth	SA 1.1	SA 1.1	SA 1.1
	SA 1.2	SA 1.2	SA 1.2
	SA 3.1	SA 3.1	SA 3.1
	SC 3.1	SB 3.1	SC 3.1
	SC 3.4	SC 3.2	
	SE 3.1		

MATH	Third Grade	Fourth Grade	Fifth Grade	Sixth Grade
Energy and Growth	M 2.1.1	M 2.2.1	M 2.2.1	M 2.2.1
	M 2.1.3	M 2.2.3	M 2.2.3	M 2.2.3
	M 2.1.4	M 2.2.5	M 2.2.5	M 2.2.5
	M 7.1.2	M 7.2.2	M 7.2.2	M 7.2.2

READING

Bag Lunch	R 1.1	R 1.2
	R 1.4b	R 2.4b
	R 3.3	R 4.2
Energy and Growth	R 1.6	R 2.6
	R 1.4b	R 2.4b

WRITING	Fourth Grade	Fifth Grade	Sixth Grade
	W 2.1.2	W 2.1.1	W 2.1.1
		W 2.1.2	W 2.1.2

BACKGROUND INFORMATION

Alevin

The salmon embryo inside an egg hatches out to become an alevin (the A is pronounced AY as in play or AH as in cat). Wiggling energetically and releasing a little enzyme from its head, the embryo breaks through the egg membrane. For the next month or two, it hides in the dark spaces in the gravel of its natal stream or lake.

The yolk sac from the embryo remains attached to the alevin's belly and provides the food it needs. The sac shrinks as the alevin develops its teeth, eyes, and digestive system. It begins to eat some external food that floats through the water in the gravel. The alevin's respiratory system also develops, allowing it to breathe through its gills.

Alevin cannot swim very well, so they are an easy target for predators. To hide from predators, they avoid light and live as much as 30 cm (about 1 foot) down in the gravel. As they grow stronger and their yolk sac shrinks, alevin move up to the surface of the gravel. They lose their bright orange color, and begin to develop a fish shape.

Alevin need cold running water that is rich in oxygen and clean gravel with spaces it can hide in. Threats include predators in the water, siltation, pollution, and floods or other activity that can disturb the gravel. Human activity that disturbs the gravel can be very harmful, so people can protect the alevin by keeping dirt or other pollutants out of the water and by staying out of the gravel.

When the yolk sac is completely absorbed, or "buttoned up," alevin grow to about 2.5 cm (approximately 1 inch). Then, they must emerge from the gravel and begin to search for food. Alevin emerge in the spring when the water begins to warm and plankton grow in lakes and rivers.

BACKGROUND INFORMATION

Alevin

In addition to the information in Handout 6.2, "Salmon Alevin," the following information may be useful.

Alevin can move about and swim, but their yolk sac makes them awkward and slow-moving. Since the bright color of the yolk sac makes them very visible, they avoid light and live in spaces between the gravel. However, they are mobile, and they can move large distances through gravel if necessary.

As long as there is water and enough space between the gravel pieces, they can avoid silt or find more oxygen-rich water.

Alevin begin to breathe through their gills when they hatch from the egg. Their rate of respiration can be estimated by observing the number of gill movements. As cold-blooded animals, their metabolic rate depends on the temperature of their environment, which also controls the rate of their respiration. As a result, they breathe more slowly, and grow more slowly, in colder water. At higher temperatures, they grow more rapidly, but their overall body growth is reduced because metabolic processes such as digestion and respiration are less efficient.

Alevin can flush small amounts of silt out of their gills, but their gills are very sensitive and their breathing is easily clogged.

Alevin depend entirely on their yolk sac for nourishment, except in the final days before the yolk sac becomes "buttoned up," when the alevin begin to catch bits of organic debris that float through the water. The yolk sac, containing a mixture of water, fats, protein and salts, contains enough nourishment for the alevin to live in the gravel for two to three months. As the yolk sac is absorbed, the alevin become more active and move up through the gravel. When the sac is absorbed, they emerge from the gravel and migrate toward food sources. This usually coincides with the spring bloom of plankton and aquatic insects.

Bag Lunch

Materials:
- Option: Student's bag lunch
- Option: Growing bean seed
- Illustration of salmon alevin (from Life Cycle poster or Handout 6.1, "Salmon Alevin,")

Time Required:
One lesson

Level of Conceptual Difficulty:
Simple

Evidence for Assessment:
Monitor student discussion of bag lunches to ensure they know that the yolk sac provides nutrition to alevin, just as a bag lunch does for people.

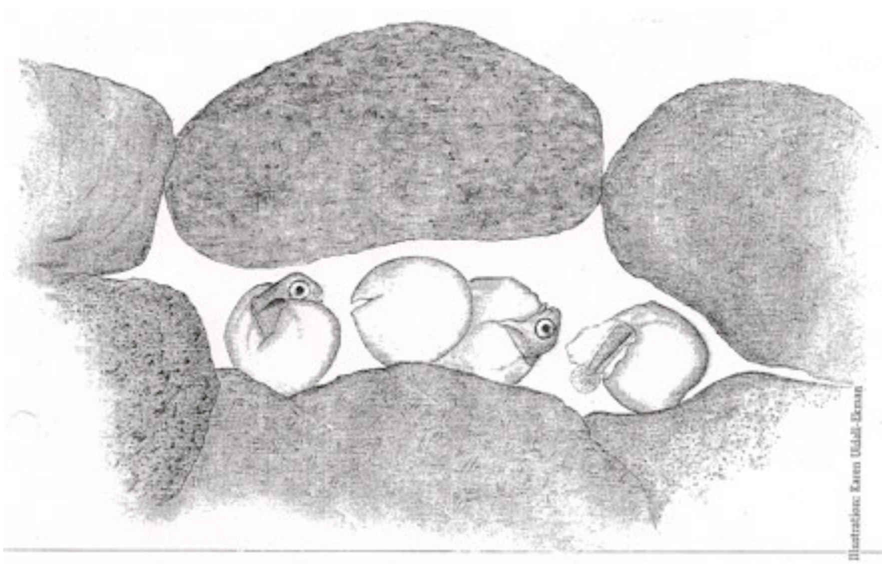
INTRODUCTION
- Ask students to volunteer to show what they bring to school for lunch, or to describe what they would like to bring.
- With the class, list the kinds of food people bring in bag lunches, and form the foods into categories such as grains, fruits, vegetables, dairy, etc.
- Have students explain what happens when they eat the food in the bags.
  The bag empties and the students get nutrients to grow.
- Option: Have students describe what happened to the bean seed as the bean plant grew. The food segments shrank as the bean grew. Have students explain how a bean is similar to a bag lunch.
  Both provide food for growing.

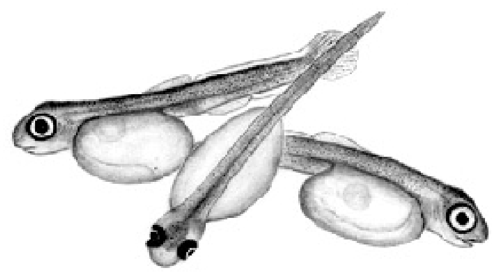
EXPLANATION
- Show student an illustration of a salmon alevin. Explain that an egg yolk provides food for a chicken or a salmon in its egg, like a bag lunch or a bean seed. A baby salmon takes its lunch with it when it hatches.

P

Salmon Alevin

Handout 6.1





Alevin hatch from salmon eggs. The salmon growing inside the egg gets too big for the egg. The salmon emit an enzyme from its head that makes the egg wall break.

The alevin pushes its head through the egg wall. It wiggles more and more. The hole gets bigger. The alevin pushes its whole body out.

The alevin has a bag on its stomach. This is the yolk sac. It is left from the yolk inside the egg.

The alevin still feeds on the yolk. The yolk is like a bag lunch. It goes where the alevin goes. Alevin start to eat bits of other food as they get older. When the yolk sac is used up, they will have to feed themselves.

The alevin is orange, like the egg. It has to hide from other animals. It lives in spaces in the gravel. It breathes oxygen dissolved in the water.

Protecting Alevin

Materials:
- ✏ Writing or drawing supplies

Time Required:
Two or three lessons

Level of Conceptual Difficulty:
Moderate

Evidence for Assessment:
Monitor student discussion and review their list to ensure they can recognize ways people can protect alevin.

INTRODUCTION

☞ Have the class describe things people do that could harm the things alevin need to live. If necessary, prompt them with questions such as the following:

- What would happen if people walked or drove machines through the gravel that alevin live in?
  Alevin or their homes could be crushed.
- What would happen if someone dug the gravel out of the stream or lake?
  The alevin would have nowhere to live.
- What would happen if sand or dirt got into the stream or lake water?
  Alevin can clear a small amount of silt from their gills, but silt can smother alevin, or fill the spaces between the gravel.
- What would happen if people dammed the stream or diverted the water somewhere else?
  The alevin would have no water to live in.
- What would happen if people cut all the plants down around the stream or lake?
  Sunlight might make the water too warm or remove possible food sources for older alevin. When it rains, the water might get silty from the runoff.
- What happens when people empty drains and sewers into streams?
  They can pollute the water the alevin live in.

Energy and Growth

[demonstration]

Materials:

- 5 mL dry yeast
- 5 mL sugar
- 750 mL water
- Three small containers (test tubes or 500-mL clear plastic pop bottles)
- Funnel (optional)
- Measuring cup
- Measuring spoon
- Stirring sticks
- Three balloons (try to find Latex Free balloons that blow up easily)
- Thermometer (optional)
- One copy of Handout 6.2, "Salmon Alevin," for each student
- One copy of Handout 6.3, "Energy and Growth," for each student
- Writing supplies

Time Required:

60 to 90 minutes

Level of Conceptual Difficulty:

Simple to moderate

INTRODUCTION

☞ Temperature affects the rate at which plants and animals grow. Cold-blooded animals, such as fish and reptiles, and microorganisms cannot control their body temperature by themselves. Instead, the surrounding environment controls their temperature and the temperature controls the amount of energy they use. This experiment shows how temperature affects yeast, a microorganism that uses sugar for food.

☞ Ask the class to compare the way their body feels when they are sitting quietly and the way it feels when they are being physically active. Ask if they can explain the difference.

When they are more active, their body gets warm, they breathe harder, and their heart pumps more. This happens because they are turning more of the food stored in their body into energy and producing more carbon dioxide, which they must expel by breathing harder.

☞ Explain that all animals turn food into energy and produce more carbon dioxide when they work harder. Salmon alevin and other cold-blooded animals convert food to energy at a rate determined mainly by water temperature. Although yeast is a different type of organism, it shows the effect of temperature on growth.

PROCEDURE

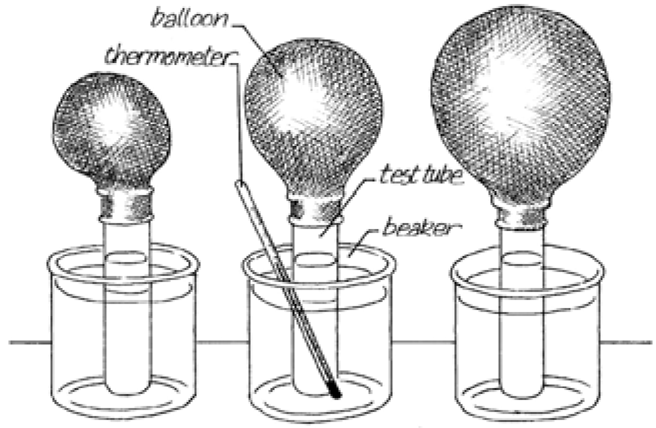
☞ 1. Use a thermometer or your hand to find three places in the classroom with different temperatures, one warm, one room temperature and one cool.

☞ 2. Mix 5 mL of dry yeast, 5 mL of sugar and 500 mL of water in the measuring cup. Stir them together until they are dissolved.

☞ 3. Carefully pour an equal amount of the mixture into the three containers. Label the containers with your name and a number. Fit a balloon tightly over the opening of the container.

Evidence for Assessment:
Review student's written observation sheets and class discussion to ensure that the students describe the effect of external temperature on the rate of growth in salmon alevin and yeast.

☞ 4. Place one container in each of the locations you have chosen, and label them "Warm", "Cool" and "Control".



lustration: Donald Gunn

1 Yeast, sugar in cold water 2 Yeast, sugar in tepid water 3 Yeast, sugar in warm water

EXPERIMENT

☞ Thirty minutes after setting up and starting the demonstration, give students a copy of Handout 6.3, "Energy and Growth," and have them individually complete it. Repeat the observations after an hour, if necessary, to see a visible difference.

DISCUSSION

☞ With the class, discuss the observations and conclusions the students recorded. If necessary, prompt them with questions, such as:

- What happened inside the containers?
  The yeast consumed the sugar and produced carbon dioxide, which caused the bubbles and expanded the balloon.
- What was the difference between the three bottles?
  The warm mixture produced more bubbles and a larger balloon than the control, while the cool mixture produced fewer bubbles and a smaller balloon.
- What conclusions did you draw?
  The yeast grows faster and produces more carbon dioxide in the warm location.

RESEARCH/DISCUSSION

☞ Have students, in small groups, read Handout 6.2, "Salmon Alevin," then list ways in which salmon alevin are similar to the yeast in the experiment and ways in which they are different. Have the groups report their conclusions to the class and discuss their observations. If necessary, prompt them with questions, such as:

- How is the alevin habitat similar to or different from the habitat in the bottle?
  Both are watery, but the bottle is enclosed, while alevin live in gravel in free-running streams or along lake shores.
- How are the food sources similar or different?
  The alevin carries its food in its yolk sac, while the yeast consumes sugar dissolved in the water.
- How is their respiration similar or different?
  Both take oxygen from the water and produce carbon dioxide.
- How is their rate of growth similar or different?
  Both are affected by the temperature of the environment.

SUMMATION

☞ Have students add information on salmon alevin to the chart of the salmon life cycle, which they began in Skein Three: Salmon Eggs.

Salmon Alevin

Handout 6.2

Wiggling energetically, the salmon embryo in an egg breaks through the egg lining and makes its way out of its egg and into the gravel. For the next 30 to 50 days, it lives as an alevin (A-le-vin – the A can be pronounced as in play or as in cat) in the dark spaces between the stones in the gravel of its natal stream. As with the egg, the rate of alevin development depends mainly on the water temperature, which should range from 4°C to 14°C (40°-57°F).

The yolk sac, which remains attached to the alevin belly, provides the food it needs. The sac shrinks as the alevin develops, gradually allowing it to move about more easily.

The alevin respiratory, or breathing system, also develops, allowing it to breathe through its gills. Clear, flowing water is still important, but an alevin can swim through spaces in the gravel away from gravel that is too silty.

Alevin need cold running water that is rich in oxygen and they need clean gravel with spaces in which they can hide. Threats include predators in the water, heavy siltation, pollution, floods, and other activities that can disturb the gravel. People can protect the alevin by keeping dirt or other pollutants out of the water and by staying out of stream gravel.

Because alevin keep the orange color of the salmon egg and their yolk sac slows their movements, they are an easy target for predators. Alevin avoid light and live as much as 30 cm (1 foot) down in the gravel. However, as they grow stronger and their yolk sac grows smaller, they begin to move up to the surface of the gravel.

When the yolk sac is completely absorbed, or "buttoned up", alevin are about 2.5 cm (approximately 1 inch) long. In spring, when the water begins to warm and insects and plankton grow in lakes and rivers, alevin emerge as fry to begin the next stage of their life.

Adapted from Jim Wiese,
Salmon Below the Surface, pp 35-36

I

Energy And Growth

Handout 6.3

Name ____

Observations

After about 30 minutes, check the containers and compare what you see happening in them. Write or draw your observations in the table below.

Warm	Cool	Control

Hypothesis

What do you think is happening in the bottle?____

____

____

____

____

Conclusions

What conclusions can you make from your observations?_____________________________________

____

____

____

SALMON ALEVIN

WRAP-UP

REVIEW

- ☞ Materials: chart paper and markers
- ☞ Have students draw and label on the paper the things a salmon alevin needs for a healthy environment.

  Rocks and gravel; cold, clean water; air in the stream or lake water; vegetation on the stream bank.

- ☞ Explain that the alevin does not have to hunt for food because it carries its food in its yolk sac, but once the yolk sac is gone, the alevin will have to find its own food.

EVIDENCE FOR SKEIN ASSESSMENT

- ☞ List the key words about salmon alevin on sheets of paper and have pairs of students tell each other everything they know about the word.
- ☞ Have students make a cardboard puppet on a straw and use it in a puppet play to describe how people affect alevin homes and to identify ways of protecting them.
- ☞ Have students make a web or write a sentence listing ways that a salmon alevin is different from a salmon egg.
- ☞ Have students complete a stem sentence, such as, "I used to think… about salmon alevin but now I know that…" or, "One thing I learned about salmon alevin is that…"
- ☞ Have students add their materials to their salmon science notebook and write a sentence explaining what they learned.

LANGUAGE AND ARTS INTEGRATION

- ☞ Use food pictures or displays to have students analyze their own food sources and the types of food they need for healthy eating, then compare how they obtain food with how alevin obtain food.
- ☞ Have students bring in pictures of themselves as small children learning to move and walk, then write webs or poems comparing very young children with alevin that are beginning to move about.
- ☞ Have students demonstrate active games they can play to grow strong, healthy bodies, and compare their movements with the movements of salmon alevin.

HOME CONNECTIONS

- ☞ Have students show an adult how alevin wiggle out of an egg, and explain how an alevin yolk sac is like a lunch bag.

SALMON ALEVIN
WRAP-UP

EXTENSION ACTIVITIES

- ☞ Have students discuss the ethics of experiments involving live animals.
- ☞ If your class has access to a salmon incubator, have the students observe the alevin when they hatch and count the number of mouth and gill openings. Have them calculate the ATUs the alevin receive and project when the alevin will swim to the surface as fry.
- ☞ Have students research and compare the basic nutritional needs of humans and alevin.
- ☞ Have students research the difference between modern and old landfills.
- ☞ Have students research where landfills are located in their community or where their community's garbage goes, and identify any known impacts on the environment.
- ☞ Contact your local fly shop or fly tying club and get assistance tying a fishing fly that imitates an egg, eyed egg, alevin, and a fry. Discuss which predators would be looking for these.

EVIDENCE FOR ASSESSMENT

- ☞ Have students prepare a presentation, using appropriate graphics, to explain to a younger class how alevin live, the kind of environment they need, reasons young people should not harm the alevin environment, and ways of avoiding damage to spawning streams.
- ☞ Monitor the discussion as the students make and present their lists in the review activity to ensure that they can use factual information from the activities to support an opinion about the life of salmon alevin.
- ☞ Monitor student discussions of the class' habitat mural and life cycle chart to ensure that the students can identify the needs of salmon alevin, as well as their habitat and threats to it.
- ☞ Have students write quiz questions about salmon alevin on one side of an index card and answers on the other. Have them quiz each other by asking the questions or by using a Jeopardy-style format, by giving the answers and asking for a question.
- ☞ Have students add their notes, experiment observations and other materials to a salmon science notebook.
- ☞ Have students review their own learning in their salmon science notebook.

HOME AND COMMUNITY CONNECTIONS

- ☞ Have students ask an adult to visit the classroom to see the landfill demonstration or to take them to a local landfill and observe how waste is managed.
- ☞ Suggest that the class begin a project to identify and remove any unnatural threats to salmon alevin in waterways in the community (e.g., silt or pollution entering salmon streams, people interfering with growing alevin).

Skein 7

Salmon Fry

Overview:
This skein gives students the opportunity to:
- **P / I** Read and discuss information on salmon fry
- **P / I** Test how air helps fry float/ buoyancy
- **I** Investigate the classification of animals as fish

Big Ideas:
- Fry swim and search for food in their habitat. Fry exhibit characteristics that classify them as fish.

Vocabulary:
fry (singular and plural), parr marks, camouflage, swim bladder, predator, buoyant, buoyancy, species, cold-blooded

Important Standards Netted by Teaching Skein 7

SCIENCE

	Fourth Grade	Fifth Grade	Sixth Grade
Buoyancy and Swim Bladder	SA 1.1 SA 1.2 SA 2.1 SB 1.1 SB 4.1	SA 1.1 SA 1.2 SA 2.1 SC 2.2	SA 1.1 SA 1.2

MATH	Third Grade	Fourth Grade	Fifth Grade	Sixth Grade
Swim Bladder	M 2.1.1 M 2.1.3 M 7.1.2	M 2.2.1 M 2.2.3 M 7.2.2	M 2.2.1 M 2.2.3 M 7.2.2	M 2.2.1 M 2.2.3 M 7.2.2

READING		
The Swim Bladder	R 1.6 R 1.4b	R 2.6 R 2.4b
Buoyancy	R 1.6 R 1.4b	R 2.6 R 2.4b

WRITING	Fourth Grade	Fifth Grade	Sixth Grade
	W 2.1.2	W 2.1.1 W 2.1.2	W 2.1.1 W 2.1.2

BACKGROUND INFORMATION

THE FRY

Alevin emerge from the gravel as "swim-up" fry. Rapidly vibrating their tails, they emerge from the gravel, then push themselves vertically up to the surface of the water, usually taking several hours, right after nightfall, when they will be less visible to predators. They snap their mouths into the air, hold their gills closed, and force a mouthful of air into a swim bladder, a balloon-like organ in their abdomen. They may have to repeat this motion several times to initially fill their swim bladder. The air in the bladder is only for buoyancy, not for breathing. After the fry's swim bladder is initially filled it can increase the amount of air in the swim bladder by gulping more air from the surface or converting dissolved oxygen into gas form. It counters their body weight, giving them neutral buoyancy in water. Now, they are known as "free-swimming fry."

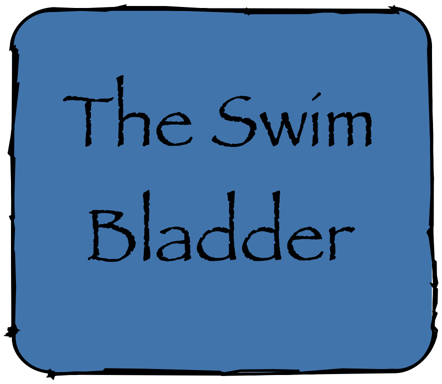
Fry are not strong enough to swim upstream, so they drift downstream until they find calm pools where they can feed. There, they defend a small feeding territory from other fry. They catch land insects that fly close to the water or fall from plants hanging over the water. They also catch food in the water, mainly insect nymphs and larvae, as well as plankton. They grow from about 2.5 cm (approximately 1 inch) to between 4.5 and 5.5 cm (approximately 2 inches).

Because they are out in open water searching for food, many salmon fry are eaten by predators, including birds and larger fish. To hide, salmon fry change their skin color. They develop camouflage markings known as parr marks, which are dark bars across their bodies. The mixture of light and dark helps them blend into the shadows on the stream or lakebed so they are less visible to predators. They also dart very quickly from spot to spot.

A crucial part of the salmon's life cycle occurs at the fry stage — imprinting. Salmon fry memorize their natal stream or lake through factors such as the type of rock and soil in the bed, plant life, and other aquatic organisms, all of which contribute to the quality and the unique scent of the water. Salmon learn to recognize this scent as very young fry and can identify it in the water when they return from the ocean. Changes in the stream's environment that occur after the fry leave can confuse the returning salmon, preventing them from finding their natal stream and spawning. Imprinting continues as the fry grow and become smolt.

Almost 90 percent of all fry die from predators, disease, or lack of food. People can help increase fry survival by protecting their environment from pollution, flooding, or blockages. Fry need fresh, flowing, cold water with plenty of oxygen and shade to keep the water from getting too warm. They also need places to hide, such as large boulders, overhanging bushes, tree stumps, or fallen logs.

Depending on the species, salmon spend from a few days to three years in their natal stream or lake. Then, they begin to migrate downstream to the estuary where the river meets the ocean.



This activity demonstrates that air can float objects that sink in the water. It leads to a discussion of how salmon use a swim bladder to achieve neutral buoyancy.

Materials:

- One copy of Handout 7.1, "Salmon Fry," or Handout 7.2, "Salmon Fry," for each student
- Writing supplies
- Carbonated water
- Small raisins
- Clear container
- Clay-Primary Activity
- Film canisters or other similar containers (2 per group)
- Basins of water
- Option: Illustration of Salmon internal anatomy, Salmon Skein 2, Page 57

Time Required:
Two to three lessons

Level of Conceptual Difficulty:
Moderate to advanced

INTRODUCTION

☞ Ask students to predict what will happen when raisins are placed in a glass of carbonated water.

EXPERIMENT

☞ Demonstrate or have students test their prediction by pouring 200 to 300 mL (approximately 1 cup) of carbonated water into a clear container with 5 or 6 raisins.
The raisins float as bubbles form on them, sink as the bubbles pop at the surface, and continue to rise and sink until all the air bubbles out of the water. The bubbles are most easily visible against a dark background.

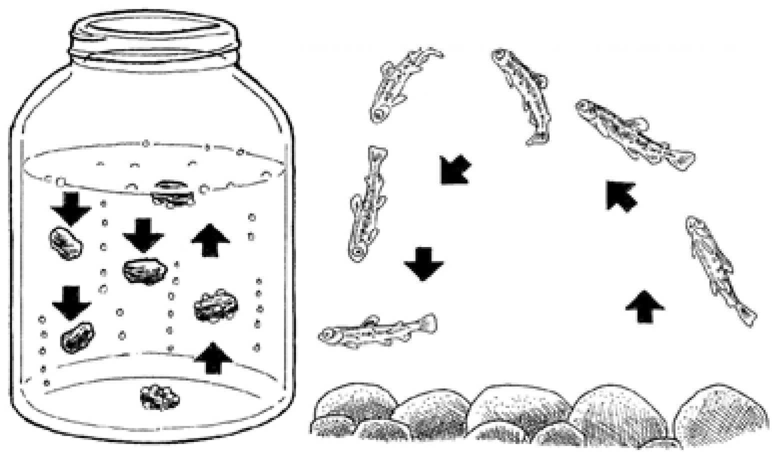


Illustration: Donald Gunn

DISCUSSION

☞ Ask students to suggest reasons for the raisins rising and falling.
Air clinging to the raisins makes them more buoyant, so they float to the surface. When the air bubbles pop, the raisins loose buoyancy.

☞ Explain that fish, like raisins, are heavier than water, and that they would sink to the bottom of the water if they did not have an easy way to rise and fall. Ask the class to suggest ways that fry can float in water.

Evidence for Assessment
Monitor the students' buoyancy experiments and review their charts to ensure that they can describe how air helps fry achieve neutral buoyancy.

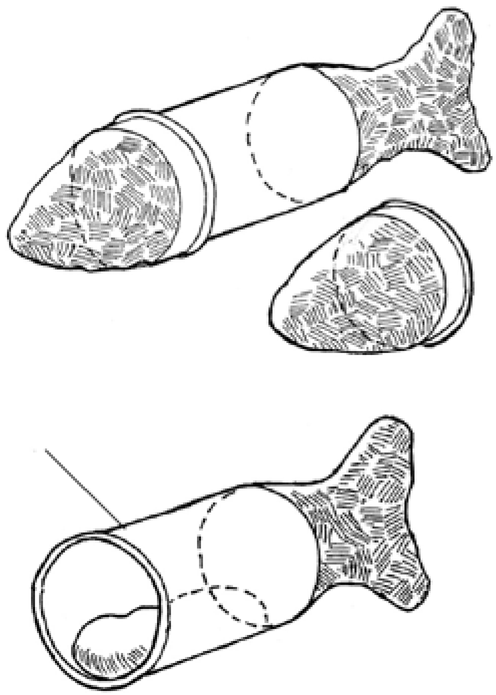


Illustration: Donald Gunn

☞ Ask students to suggest how humans can float without using any flotation items.
By taking in a large breath of air to fill the lungs, humans have better floating ability.

☞ Ask students to suggest ways that fry can float in water.
To help them float, fry fill their swim bladders by swallowing air from the surface of the water. (See next activity.)

ACTIVITY

☞ Have groups of students use clay and film canisters or other similar containers to make two model fry with hollow abdomens (see illustration). Have them add bits of clay into one of the film canister models until it neither rises nor falls in a basin of water. Have them compare the action of the two models in a basin of water.

DISCUSSION

☞ Have students describe what happened to their two models in the basin of water. Ask them to suggest reasons for one model sinking and the other not. Have students record their observations and conclusion.

☞ Have students explain how fry use a swim bladder to float in water.
Fry have a small sac, a swim bladder, that acts like a balloon inside of their bodies. The fry will swim to a desired depth and then adjust the amount of air in that sac to keep them at that depth.

☞ Ask students to suggest ways in which raisins floating in water is different from fry floating in water.
Air bubbles that cling to the outside of the raisins help them to float. Fry swallow air from the surface of the water, filling their swim bladder to help them float.
(Note: You may wish to use the salmon internal anatomy illustration on page 57 of Skein 2 to show students where the swim bladder is located.)

P

Salmon Fry

Handout 7.1

Illustration: Karen Uldall-Ekman

When alevin finish the food in their yolk sacs, they have developed into fry. Fry catch their own food.

At first, fry cannot float in water. Fry sink in water. To float they must swallow air. They flutter their tail very hard to swim up. When they reach the air, they swallow large gulps. They keep air in a swim bladder, like a balloon in their stomach. Then they can swim up and down easily by moving their fins.

Once fry swim, they can chase food. They catch small insects. They also eat bits of animals that drift downstream.

Plants beside the stream or lake keep the water cool and shady. Fry can hide in the shadows. Their skin changes color to help them hide. Dark lines called parr marks also help them hide.

Birds and bigger fish try to eat fry. Fry dart about very quickly to avoid predators.

Salmon fry remember where they grew up. When they are adults, they will find their way back to the same stream or lake.

Salmon Fry

Handout 7.2

Alevin emerge from the gravel to begin the next stage of their life as "swim-up" fry and then "free-swimming" fry.

Rapidly vibrating their tail, they push themselves up to the surface of the water and swallow a mouthful of air. The air is not for breathing, but to balance the weight of their body and allow them to float in water. It goes into a swim bladder, an organ like a balloon in their abdomen. They may have to take several gulps until they have enough air.

Fry are not strong enough to swim upstream, so they drift downstream until they find calm pools where they can feed. There, they defend a small feeding territory from other fry. Salmon fry eat the nymphs and larvae of insects such as stonefly, mayfly, caddisfly, and black fly. They also eat plankton and some land insects that fall into the water. They grow from about 2.5 cm (1") to between 4.5 and 5.5 cm (approximately 2") during the summer.

Many salmon fry are eaten by predators, including birds and larger fish. To hide, salmon fry change their skin color. They develop camouflage markings known as parr marks, dark bars across their bodies. The mixture of light and dark helps them blend into the shadows on the streambed so they are harder to see. They also dart very quickly from spot to spot.

Almost 90 percent of all fry die from predators, disease or lack of food. They still need fresh flowing, cold water, with plenty of oxygen and shade to keep the water from getting too warm. People can help increase their survival by protecting their environment from pollution, flooding, or blockages.

A crucial part of the salmon life cycle begins at the fry stage—imprinting. Salmon fry remember the smell of the water they grew up in. When they return as adults, they try to find the same spot. The rocks and soil in the streambed, plant life, and other aquatic organisms all create the scent that salmon return to. Changes in the environment of the stream can confuse the returning salmon, and prevent them from spawning.

Some salmon species spend just a few days in their natal stream, but most spend one to three years.

- Pink and chum spend one to three months in fresh water.
- Chinook, coho and sockeye spend about one year.

Then, they begin to migrate downstream to the estuary where the river meets the ocean. Sometimes, dams or other blockages prevent salmon from traveling to the sea. They remain in lakes and rivers through their entire life cycle, but can continue to produce land-locked offspring.

Buoyancy
[optional experiment]

Materials:
For each group of students:
- Plastic drinking straw
- A small container
- A balloon
- Waterproof tape
- A basin of water
- Scissors
- One copy of Handout 7.3, "Buoyancy," (Parts 1 & 2), for each student
- Writing supplies

Time Required:
Approximately 60 minutes

Level of Conceptual Difficulty:
Simple

Evidence for Assessment
Review the students' written observations and class discussion to ensure that the students can describe how a balloon can help fish achieve buoyancy in water.

INTRODUCTION
- ☞ Ask the class to predict what will happen if a container filled with water is placed in another container of water.
 It will sink.

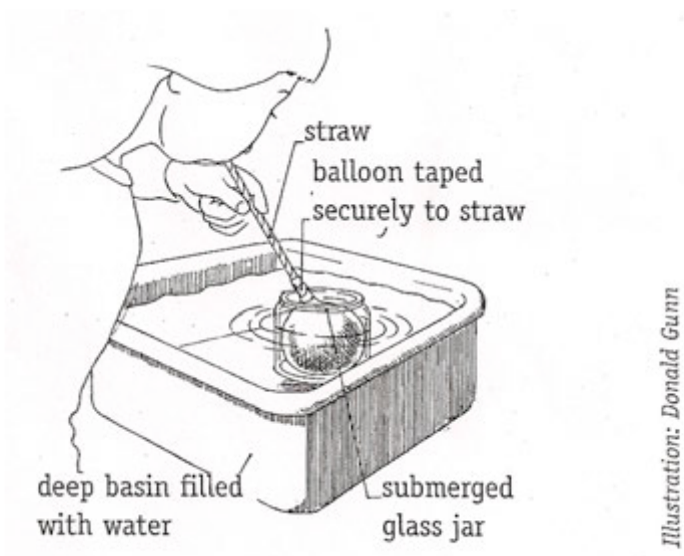
- ☞ Ask the students to suggest ways to make the container float.

EXPERIMENT
- ☞ Have students, in groups, use Handout 7.3, "Buoyancy," (Parts 1 & 2), to conduct a test for buoyancy.

- ☞ Option: Have students invent and test other ways in which a heavier-than-water object can achieve neutral buoyancy in water.

DISCUSSION
- ☞ Have students discuss ways in which a submarine, a scuba diver, a fish and an amphibian could use the balloon method or another method to move in water. If necessary, prompt them with questions, such as:

  - Does the balloon help or prevent easy movement?
  - Does the balloon take up a practical amount of space?
  - Can the balloon be inflated, as needed, or must it remain inflated?
  - Where would the balloon fit?



Buoyancy

Handout 7.3, (Part 1)

Name ____

Heavy objects sink when you put them in water. To float, they need buoyancy (pronounced BOY- an-cy). Buoyancy is the ability to float. The bodies of fish (and other animals) do not sink to the bottom of the water. They are buoyant. This experiment shows how heavy objects can be buoyant.

Materials

- Plastic drinking straw
- A small bottle with a narrow mouth
- A balloon
- Waterproof tape
- A basin of water

Hypothesis

A balloon can help an object float in water.

1. Tape balloon onto a drinking straw

2. Insert straw/ balloon through seal on small water-filled bottle.

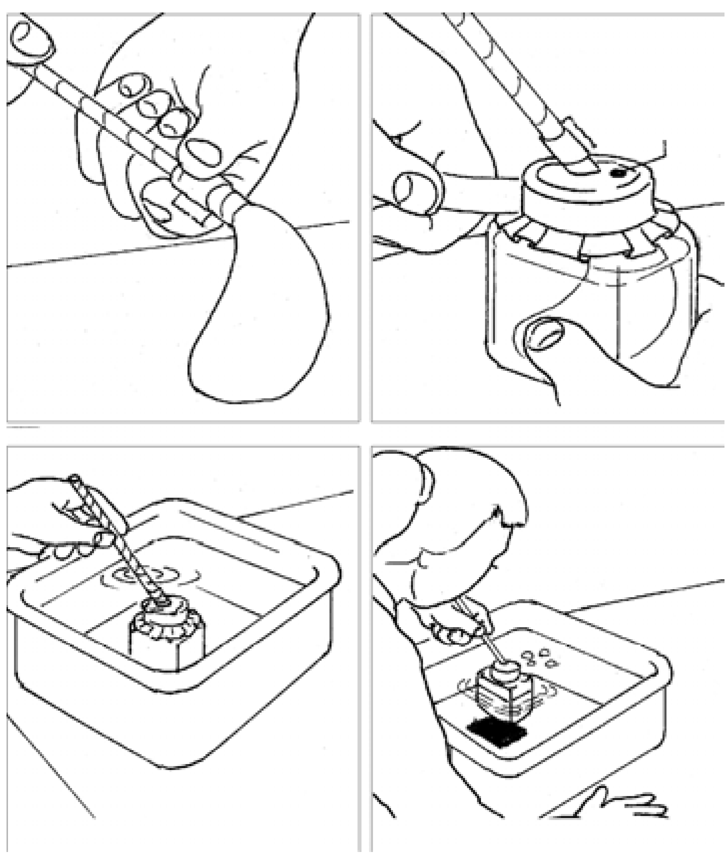


Illustration: Donald Gunn

3. Immerse bottle in a basin of water.

4. Blow gently through straw to inflate balloon.

Buoyancy

Handout 7.5, (Part 2)

Procedure

1. Tightly tie a balloon around the end of a drinking straw (but do not crush the straw).
2. Tape the straw to the mouth of the bottle so the balloon is inside.
3. Submerge the container in the basin of water.
4. Observations: Describe what happens to the container.

____

____

5. Blow through the long straw into the container.
6. Observations: Describe what happens to the container.

____

____

____

7. Suck the air out of the balloon.
8. Observations: Describe what happens to the container.

____

____

____

9. See if you can keep enough air in the balloon so that it floats just below the surface of the water.
10. Observations: Describe what happens when you try to float the balloon just below the surface.

____

____

____

Conclusion

How do your observations support or question the hypothesis?______________________

____

What conclusion can you make from your observations?__________________________

____

How could salmon and other fish make use of buoyancy? ________________________

____

SALMON FRY

WRAP-UP

REVIEW

- ☞ Materials: chart paper and markers. Have students draw and label three ways by which a salmon fry survives in its environment.

  It swallows air and then uses its swim bladder to make its buoyancy neutral in the water. It catches food and relies on camouflage to hide from predators.

- ☞ Explain that these elements make a safe home for a salmon fry and that if it gets enough food and avoids predators, the fry will grow into a smolt.

EVIDENCE FOR SKEIN ASSESSMENT

- ☞ Have students make a fry habitat in an aquarium or basin, using rocks, sand, water, plants, and modeling clay. Use it to explain how fry live in the environment.

- ☞ Have students make a pop-up book with a mouth that opens and draw food that salmon fry would eat.

- ☞ Have students make a web linking a fry's needs with its environment, then use it to explain how a fry lives in its environment.

- ☞ Have students make a web or write a sentence listing ways in which a salmon fry is different from a salmon alevin.

- ☞ Have students complete a stem sentence, such as, "I used to think… about salmon fry but now I know that…" or "One thing I learned about salmon fry is that…".

- ☞ Have students add their materials to their salmon science notebook and write a sentence explaining what they learned.

LANGUAGE AND ARTS INTEGRATION

- ☞ If your school is near a salmon stream or lake, arrange a field trip to identify the plant and animal life living there. This activity is particularly meaningful if done when incubated fry are released into the stream or lake.

- ☞ Have students use a heavy paper clip to seal the end of a balloon and find out how much the balloon has to be inflated so it neither rises nor falls in a basin of water. Discuss how the balloon is like a salmon's swim bladder.

HOME CONNECTIONS

- ☞ Have students demonstrate to an adult how a salmon fry swallows air and catches food.

SALMON FRY

WRAP-UP

EXTENSION ACTIVITIES

- ☞ Arrange a field trip to conduct a systematic stream survey and identify plants, animals, and environmental factors that make the site a good (or poor) habitat for salmon (e.g., running water, gravel, shade, food sources).

- ☞ Have students conduct a stream mapping or clean-up activity on a local stream. (Contact a local naturalist or Alaska Department of Fish and Game to find out about local projects and procedures to use.)

- ☞ Have students use a dichotomous key of salmon fry species to identify different types of salmon fry.

- ☞ Have students paint a picture of an underwater stream environment, then paint fry in different colors and patterns to identify the camouflage patterns that best allow fry to avoid detection by predators.

SUGGESTIONS FOR ASSESSMENT

- ☞ Have students draw a Venn diagram comparing fish with other species, then explain what distinguishes fish from other species.

- ☞ Monitor the discussion as students make and present their lists in the review activity to ensure that the students can use factual information from the activities to support an opinion about the life of salmon fry.

- ☞ Monitor student discussions of the to ensure that the students can identify the needs of salmon fry, as well as their habitat and threats to it.

- ☞ Have students write quiz questions about salmon fry on one side of an index card and answers on the other. Have them quiz each other by asking the questions or by using a Jeopardy-style format (giving the answers and asking for a question).

- ☞ Have students add their notes, experiment observations and other materials to a salmon science notebook or portfolio.

- ☞ Have students reflect on what they learned about salmon fry independently in their salmon science notebook.

HOME AND COMMUNITY CONNECTIONS

- ☞ Have students visit a nearby stream or lake with an adult, identify a variety of aquatic organisms, and explain how the organisms contribute to salmon habitat.

- ☞ Suggest that the class begin a project to identify and remove any obstructions that make it difficult for migrating smolt to travel to the estuary, or suggest the class identify damaged estuary habitat and investigate how to restore it.

Skein 8

Salmon Smolt

Overview:
This skein gives students the opportunity to:

- **P / I** Identify where salmon smolt come from and how they live in an estuary
- **P / I** Test how salt water affects cells
- **I** Discuss how salt water and fresh water mix in an estuary
- **I** Play a simulation game representing salmon predators

Big Ideas:

- Smolt migrate to the estuary before leaving to swim in the ocean.

Vocabulary:

smolt, salt water, fresh water, smoltification, hazard, polluted, estuary, adapt, excrete, membranes, cells, nutrient

Important Standards Netted by Teaching Skein 8

SCIENCE

	Fourth Grade	**Fifth Grade**	**Sixth Grade**
Salt and Fresh Water-Predator Game	SA 1.1	SA 1.1	SA 1.1
	SA 1.2	SA 1.2	SA 1.2
	SB 2.1	SB 3.1	SB 3.1
		SC 2.2	SC 2.2
			SC 3.1

MATH	**Third Grade**	**Fourth Grade**	**Fifth Grade**	**Sixth Grade**
Salt and Fresh Water	M 2.1.1	M 2.2.1	M 2.2.1	M 2.2.1
Predator Game	M 1.1.5	M 1.2.4	M 1.2.4	M 1.2.4
	M 6.1.1	M 6.2.1	M 6.2.1	M 6.2.1
	M 6.1.5	M 6.2.5	M 6.2.5	M 6.2.5
	M 6.1.4	M 6.2.4	M 6.2.4	M 6.2.4
	M 7.1.2	M 7.2.2.	M 7.2.2.	M 7.2.2.

READING		
Salmon Smolt	R 1.1	R 1.2
Predator Game	R 1.1	R 1.1

WRITING	**Fourth Grade**	**Fifth Grade**	**Sixth Grade**

BACKGROUND INFORMATION
THE SMOLT

As salmon begin to mature, they adapt for life in salt water in an intermediary stage known as smolt. This process marks the beginning of their first migration from their natal stream to the ocean.

Fish, like salmon, that move from fresh to salt water and back again over the course of their lives, must be able to change their physiology, the way their bodies work. Most salmon species spend some time in the estuary of a river, where the fresh water mixes with the salt water. Here, they gradually get used to life in salty water in preparation for the time they will spend at sea. Very few fish have the ability to adapt from living in fresh water to salt water, and then return back to fresh water.

In a process called smoltification, salmon adapt to the changes salt water causes to their bodies. In fresh water, the salmon's body is saltier than the water in which it swims. To work properly, the body needs salt so it tries to keep the salt in. Some escapes, but the salmon gets enough from the food it eats to make up for the loss.

In the ocean, the water is saltier than the salmon's body needs to be, so it must try to keep the salt out and the water in. When salmon swim in the ocean, the salt water draws water out of the fish's cells. Salmon adapt by drinking sea water to replace the water their cells lose. They excrete the excess salt through their gills and urine. Freshwater fish would die in salt water because they cannot replace the water in their cells.

As the smolt prepare for ocean life, their appearance also changes, from the dark colors of the fry to the silvery color of adult salmon. This helps them hide in the light conditions of the surface waters of the open ocean where there is no dark shade from overhanging trees.

In estuaries, the mineral and organic elements of a river mix with ocean nutrients brought in by tides, creating a nutrient-rich environment that supports diverse plant and animal growth. Estuaries provide salmon with a good supply of insects and crustaceans, such as tiny shrimp, for food. While in the estuary, smolt can grow from 4 or 5 cm (approximately 2 inches) in length to as much as 9 cm (approximately 3 1/2 inches).

However, estuaries are home to many fish predators, including larger fish, birds, seals, and even orcas. People build cities and industries on estuaries, as well as diking and dredging them, or extending landfills into them for development projects. The loss of estuary habitat means that there is less room for salmon and other estuary animals to mature, feed, and adapt. If smolt cannot live in an estuary, it is a sign that other plants and animals are at risk, also.

Different species of salmon spend different amounts of time in estuaries. Some leave almost immediately, while others spend several months there. While approximately 30 fry from a redd of 2000 to 2500 eggs grow into smolt, fewer than four survive to become adults.

Salmon Smolt

Handout 8.1

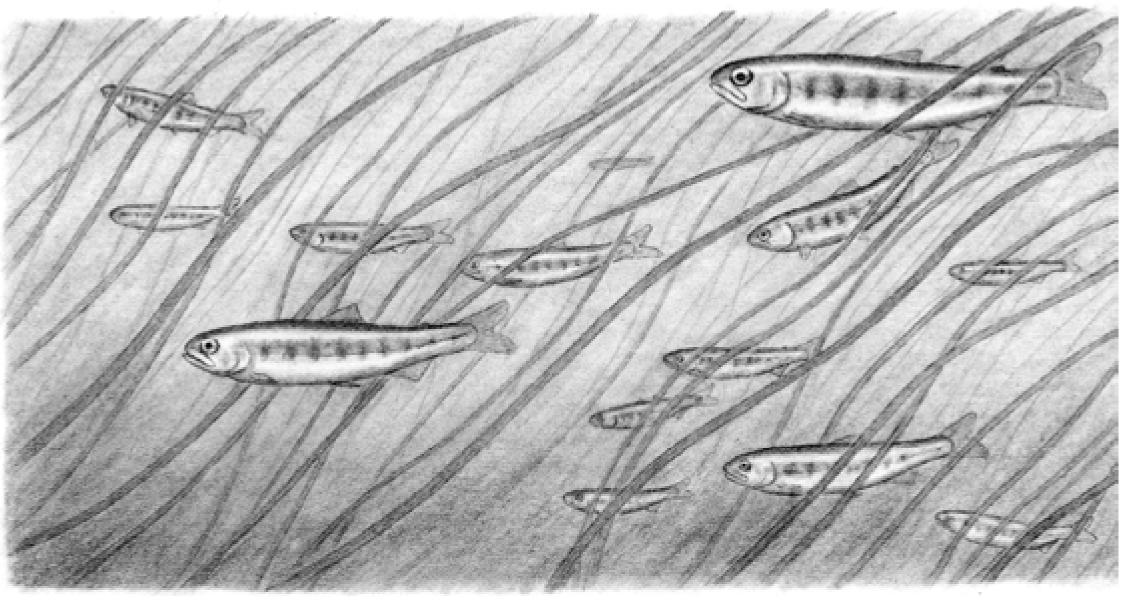


Illustration: Karen Uldall-Ekman

Salmon fry grow into smolt. They swim downstream to the ocean. Sometimes the journey takes many months.

On the way, smolt face many hazards. Predators try to catch the smolt and eat them. Logs or dams may block the way. Sometimes the water is polluted.

The end of the smolt's trip is the estuary. An estuary is a place where a river meets the sea. The fresh river water and the salty ocean water mix together. The water is salty, but not as salty as the sea. Smolt get used to the salt water in the estuary.

Smolt find a lot of food in the estuary. Smolt can eat other fish, tiny shrimp, insects, and other animals. There are also many predators. Larger fish, birds, seals, and whales eat smolt.

People also use estuaries. People build cities, farms, factories, and roads near estuaries. They fill in parts of the estuary with dirt. Development leaves little space for smolt.

People can save some of the estuary for smolt. They can build away from the estuary. They can keep polluted water out of the estuary.

BACKGROUND INFORMATION
SALMON SMOLT

The information which follows can be used to supplement Handout 8.1, "Salmon Smolt," (P) and 8.2. "Salmon Smolt" (I).

Smoltification

Salmon fry become smolt when they begin the process of adapting to salt water, a process called smoltification. The process begins in fresh water and continues in the estuary and the ocean.

Osmotic pressure forces fresh water into areas with a higher concentration of salt or other minerals. In fresh water, cells have a higher concentration of minerals and water moves from the environment into the cells. Salmon do not drink in fresh water. They get rid of excess water in their cells by excreting large amounts of weak urine.

In salty water, osmotic pressure draws water out of the cells and would lead to dehydration if the salmon did not compensate for the change in its environment. The salmon copes by drinking large amounts of salt water and excreting a concentrated urine. It also excretes excess salt in solution through the cell walls of its gills.

Smolt also develop silvery scales, which provide them with protective coloration in the bright waters of the estuary and the ocean.

Different species of salmon smoltify at different times.

- Chum and pink migrate within a few weeks of their emergence from the gravel. Chum fry are already prepared for salt water.
- Most sockeye spend one year in freshwater before smoltifying and migrating to the ocean.
- Coho and some chinook stocks spend about one year in their natal stream before migrating and smoltifying. Other chinook stocks spend 60-90 days in fresh water.

Estuaries

An estuary is the mouth of a river, where fresh water meets salt water and the river's current mixes with ocean tides. Material is deposited both by the rivers and tides, so estuaries provide a rich source of natural nutrients and are concentrated zones of food production. Most of the food production peaks in late spring, when the salmon are migrating to the sea.

Most salmon species spend several months in an estuary, although scientists have only limited knowledge about this phase of salmon life. Here, salmon adapt to the saltwater environment and make large increases in their body weight. In the estuarine area, many animals (e.g., birds and larger fish) prey on salmon. However, the thick beds of vegetation (e.g., eelgrass and sedge) provide cover in which smolt can hide. Many other marine fish species grow through their juvenile stages in estuaries, while ocean species, such as herring, migrate to the estuary to spawn among the eelgrass beds. The shallow, protected environment of estuaries makes good harbors and many large ports are located in estuaries. The urbanization of these high-density population centers can destroy the ecological properties of the estuary. Developments include landfilling and dredging; pollution from urban sewage, solid waste, agricultural and industrial effluent, and hot water; and alteration of the salinity by changing the volume and the timing of the flow of fresh water.

Salmon Smolt

Handout 8.2

As salmon begin to mature, they leave their natal stream to head to the ocean.

Most salmon species spend some time in the estuary of a river, where the fresh water mixes with the salt water. Here, they gradually get used to life in salty water, preparing for the time they will spend at sea. Some species spend up to a year in estuaries, while others leave almost immediately.

Salmon must adapt to the changes that salt water causes to their bodies. Salt water draws fresh water out of an organism's body. Saltwater fish, like salmon, survive by drinking salt water to replace the fresh water that is lost. However, too much salt is harmful. Saltwater animals develop a way to get rid of salt from their bodies before it harms them. Salmon excrete water and salt in their urine and they excrete excess salt through the fine membranes in their gills.

The appearance of smolt also changes as they prepare for ocean life. They lose the dark colors of the fry, which helped them hide in the shady water of a forest stream, and begin to take on the silvery color of adult salmon. In an estuary, and in the open ocean, there is no shade – only the bright color of sunlight reflecting on the waves. The smolt's silvery color helps them hide in the silvery light at the surface of the ocean.

In an estuary, the mix of river and sea creates a nutrient-rich environment that supports plant and animal growth. Thick beds of eelgrass and sedge provide a home for insects and crustaceans, such as shrimp. Salmon smolt feast on these microscopic animals and on smaller fish that also live among the estuary plants. While in the estuary, smolt can grow from 4 or 5 cm (approximately 2 inches) in length to as much as 9 cm (approximately 3 1/2 inches). They also add to the imprinted memories that help them find their way home after they migrate to the ocean.

Estuaries are also home to many fish predators. Fish-eating birds, such as herons, ducks, and sea birds, stalk fish in the marshes, while gulls and eagles watch for them in the sky. Larger fish, seals, and even whales also prey on smolt.

In addition, people build cities and industries in estuaries. In some areas, less than 10% of the original estuary remains. With less room to mature, feed, and adapt, fewer salmon survive to grow into adults in the ocean.

Salt Water and Fresh Water

This activity demonstrates that salt water makes cucumber slices wilt. It leads to a discussion of how salmon must adapt to salt water when they migrate to the ocean.
To leave time for the cucumber to soak, you may wish to begin the experiment the night before and have students observe the change the following day.

Materials:
For each group of students:
- Two containers with approximately 250 mL (approximately 1 cup) of water in each
- Approximately 15 mL of salt
- Two fresh slices of cucumber

Time Required:
Two lessons

INTRODUCTION

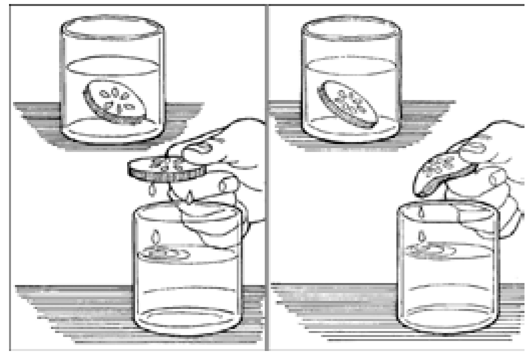
- Have the class explain the difference between fresh water and salt water. If necessary, prompt them with questions, such as:
  - What is salt water?
    Water with salt and other minerals dissolved in it.
  - What happens if people drink a lot of salt water?
    They get sick.
  - Do objects float in both salt and fresh water?
    Yes, but they float better in salt water.
  - Do fish live in both salt and fresh water?
    Yes, but most freshwater fish have low tolerance for salt water. Salmon and a few other species are an exception.

ACTIVITY

- Divide the class into small groups. Give each group two containers with approximately 250 mL of water in each, and approximately 15 mL of salt.
- Have the groups prepare a saltwater solution by dissolving the salt in one container of water.
- Give each group two fresh slices of cucumber. Ask the groups to predict what will happen if they soak the cucumber in salt water and write their prediction in their salmon science notebook.
- Have the groups place one cucumber slice in each container of water.
- After two hours or more, have the groups compare the cucumber slices in the two containers. Discuss their observations.
  The cucumber in the salt water will be soft and wilted, but the cucumber in the fresh water will remain crisp. The salt water draws water out of the cells of the cucumber, making them less stiff.

Level of Conceptual Difficulty:
Moderate

Evidence for Assessment:
Review students' observation pages and classroom discussion to ensure that they can describe how salt water makes plants wilt.



DISCUSSION

☞ Explain that the cucumber slices are like a fish in water. In fresh water, the fish is normal, but salt water would make the fish lose its shape as water is drawn from its body. Ask the class to hypothesize what might happen to a salmon as it moves from fresh water to salt water. Explain that salmon smolt drink salt water from the ocean to keep from shriveling up. They get rid of the extra salt through their gills and urine. (See Background Information on Skein 8, pages 3-6.)

SUMMATION

☞ Have students write or draw their observations and conclusions in their salmon science notebook.

Predator Game

Materials:

For each group of students:

- Chart paper
- Writing supplies
- Colored sashes/belts
- Option: Gym supplies
- One copy of Handout 8.3, "The Predator/Prey Game.," (Parts 1 & 2), for each student

Time Required:

One lesson

Level of Conceptual Difficulty:

Simple

Evidence for Assessment:

Monitor student discussions and review their reflections on the predator game to ensure that they can identify how predators reduce the number of smolt.

INTRODUCTION

- Have students use the poster or Handout 8.1 and/or 8.2, "Salmon Smolt," to list animals that prey on smolt and other dangers smolt face.

  Larger fish, birds, seals, whales, construction of buildings and roads, and pollution..

- Option: Have students make large name tags for all of the predators they identify. These can be used in the simulation.

SIMULATION

- Give students Handout 8.3, "The Predator/Prey Game.," (Parts 1 & 2).

- Divide the class into two teams, with four-fifths of the students as smolt and one-fifth as various predators (e.g., predatory fish, birds). Give each group a different color of sash.

- Label one side of a gym or open area "Natal Stream" and the other side "Ocean." Label the area in between "Estuary."

- Have the predators take various places in the estuary, in the middle of the gym floor. Explain that predators can catch smolt by tagging them as they cross the floor from the natal stream to the ocean.

- Have the smolt try to move from the natal stream to the ocean without being caught by the predators. Once students have been tagged, have them move to the outside of the play area so as not to become a danger to the other students. Have students count and record the number that make it safely to the ocean. Have students change roles and play the game again. Have students vary the number of players on each team and record the number of smolt who make it to the ocean.

-

☞ With the class, use the game counts to graph the results. Have older students calculate the rate of smolt survival (e.g., one out of five).

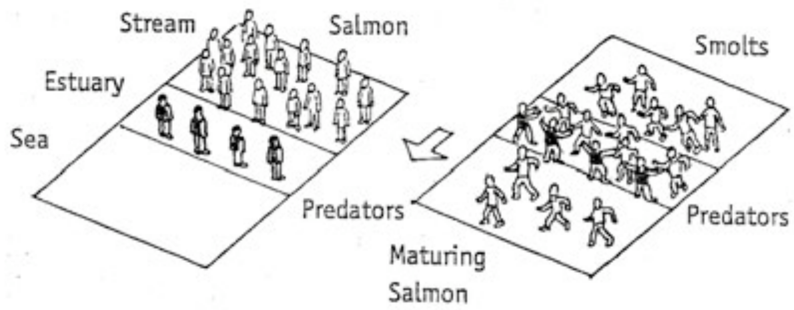


Illustration: David Gunn

DISCUSSION

☞ Have students discuss how the game compares with the hazards smolt face as they travel to the ocean. If necessary, prompt them with questions, such as:

- What are the similarities between the game and a real smolt's trip to the ocean?
  It is a hazardous trip and many smolt do not survive.
- What are the differences between the game and a real smolt's trip to the ocean?
  The real route is much longer. Smolt can hide under the water.
- What happens when the number of predators increases?
  Fewer smolt survive.
- What happens when dams or other obstacles block the way?
  Fewer smolt survive.
- What does the game show about the smolt's trip?
  Predators and obstacles prevent many smolt from reaching the ocean.

SUMMATION

☞ Have students write a reflective sentence or paragraph about the predator game.
Use the sentence stem, "When playing the game, I thought…."

☞ Have students draw and label the hazards a smolt faces on its trip to the ocean.
Pollution, obstacles en route; adaptation to salt water; loss of estuary habitat; predators in the estuary.

P/I

- ☞ Explain that many smolt do not survive the trip to the ocean, but that the estuary is a rich environment for smolt to grow and prepare for life in the open ocean.

- ☞ Discuss what the consequence of losing or gaining a link in the food chain.

P/I

The Predator/Prey Game

Handout 8.3, (Part 1)

Salmon face many new predators in an estuary, including ducks and other sea birds, mammals, such as otters and seals, and predatory fish. If they can avoid the predators, salmon smolt can triple their weight by feeding on the abundant food sources in the estuary.

Work in small groups to devise the rules for a game that your class can play to model the life of a salmon smolt in an estuary. For example, mark an area of the floor as the estuary. Have students pass through the estuary on their way to the ocean. Have some students act as different predators that hunt for salmon smolt. Create some safe places where smolt can hide and grow in the estuary.

When you have worked out the rules, test them with your class in the gym or an open area. If you have time, try to modify your rules after you test the game to make it work better.

Your game must meet these conditions:

1. The whole class must be able to participate safely. (For example, predators catch smolt by tapping them on the shoulder.)
2. In the game, smolt must start at the river's mouth, spend time in an estuary, then swim to the ocean.
3. Predators in the estuary will try to catch smolt. Smolt will try to avoid predators.
4. Smolt will try to eat enough food to gain strength to begin their life in the ocean.

To make the game more interesting, try this:

1. Give smolt more "power" to survive if they have been feeding. (For example, smolt gain power by picking up paper shrimp from a container. A predator has to tag a smolt twice if the smolt has eaten a shrimp.)
2. Give different predators different "powers", that is, different ways to catch smolt. (For example, bird predators might tag a smolt above the waist, but fish predators tag a smolt below the knee.)
3. Imagine that, as the game goes on, construction makes the estuary smaller. (For example, the passage from the river to the ocean becomes one meter narrower with every passing minute.)

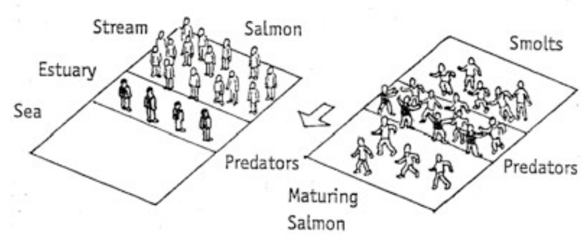


Illustration: David Gunn

P/I

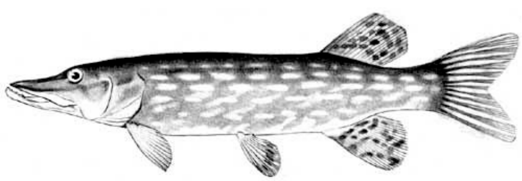
The Predator/Prey Game

Handout 8.3, (Part 2)

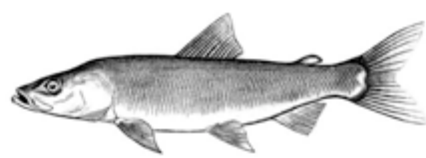
Orca

Trout

Red-brested Merganser



Northern Pike



Sheefish

Subsistence Fishing

Belted Kingfisher

SALMON SMOLT

WRAP-UP

EVIDENCE FOR SKEIN ASSESSMENT

- ☞ Have students use a poster or picture to describe the hazards a smolt must overcome to reach the ocean and ways in which the smolt survives.

- ☞ Have students write or draw their thoughts in a reflection.

- ☞ Have students make a web or write a sentence listing ways in which a salmon smolt is different from a salmon fry.

- ☞ Have students complete a stem sentence, such as, "I used to think… about salmon smolt, but now I know that…," or, "One thing I learned about salmon smolt is that…".

- ☞ Have students add their materials to their salmon science notebooks and write a sentence explaining what they learned.

LANGUAGE AND ARTS INTEGRATION

- ☞ If your school is near an estuary, arrange a field trip to identify the diversity of plant and animal life living there.

- ☞ Have students construct a model estuary in a tank and use colored water to observe how fresh water mixes with sea water.

- ☞ Have students paint a picture of an estuary from a smolt's point of view, then from an eagle's or duck's point of view.

HOME CONNECTIONS

- ☞ Have students describe to an adult the ways in which people affect estuaries where smolt live, and ways in which people can reduce their impact.

SALMON SMOLT

WRAP-UP

EXTENSION ACTIVITIES

- ☞ Invite a retired municipal engineer or someone from a local historical society, drainage district or naturalist organization to describe to the class local rivers that have been diverted or buried in culverts to protect human development in the local area, and to discuss the new interest in restoring lost waterways.
- ☞ Have students prepare presentations on the best locations for humans to build settlements. Discuss the criteria that should be used to decide what "best" means.
- ☞ Have students take the role of contemporary planners and developers and work in small groups to develop a procedure for presenting, reviewing and approving development plans for natural areas.

SUGGESTIONS FOR ASSESSMENT

- ☞ Have students draw an estuarine food web showing relationships between salmon predators and prey.
- ☞ Have students develop a dialogue expressing different points of view on estuarine development and backing up their points of view with evidence.
- ☞ Monitor the discussion as students make and present their lists in the review activity to ensure that they can use factual information from the activities to support an opinion about the life of salmon smolt.
- ☞ Have students write quiz questions about salmon smolt on one side of an index card and answers on the other. Have them quiz each other by asking the questions or by using a Jeopardy-style format (i.e., giving the answers and asking for a question).
- ☞ Monitor student discussions of the class' habitat mural and life cycle chart to ensure that the students can identify the needs of salmon smolt, as well as their habitat and threats to it.
- ☞ Have students add their notes, observations, and other materials to a salmon science notebook.
- ☞ Have students review their group work and their own learning using their salmon science notebook.

HOME AND COMMUNITY CONNECTIONS

- ☞ Have students ask an adult to take them to visit a local estuary if there is one in the region.
- ☞ Suggest that the class begin a project to identify and remove any unnatural threats to salmon smolt in waterways in the community (e.g., silt or pollution entering salmon streams or people interfering with growing smolt).

Skein 9

Adult Salmon

Overview:
This skein gives students the opportunity to:

- **P / I** Identify where salmon smolt come from and how they live in an estuary
- **P / I** Test how salt water affects cells
- **I** Discuss how salt water and fresh water mix in an estuary
- **I** Play a simulation game representing salmon predators

Big Ideas:

- Adult salmon travel long distances to the ocean. They migrate through the ocean and return to their natal rivers. People fish for salmon in different ways and for different reasons [sport, personal, commercial, subsistence (AS 16.05.940)].

Vocabulary:

adult, ocean, school, natal stream, scent, salinity, magnetic direction, thermal, navigation, principles, by-catch, dichotomous key

Important Standards Netted by Teaching Skein 9

SCIENCE

	Fourth Grade	Fifth Grade	Sixth Grade
	SA 1.1	SA 1.1	SA 1.1
	SA 1.2	SA 1.2	SA 1.2
	SA 3.1	SA 3.1	SB 2.1
	SE 1.1	SC 2.1	SC 2.1
	SE 3.1	SE 1.1	SC 2.2
		SE 3.1	SE 1.1
			SE 3.1

MATH	Third Grade	Fourth Grade	Fifth Grade	Sixth Grade
Fishing	M 2.1.1	M 2.2.1	M 2.2.1	M 2.2.1
	M 7.1.1	M 7.2.2	M 7.2.2	M 7.2.2
	M 6.1.1	M 6.2.1	M 6.2.1	M 6.2.1
	M 6.1.5	M 6.2.5	M 6.2.5	M 6.2.5
	M 6.1.4	M 6.2.4	M 6.2.4	M 6.2.4
Navigating without	M 7.1.2	M 7.2.2	M 7.2.2	M 7.2.2
Landmarks	M 5.1.6	M 5.2.6	M 5.2.6	M 5.2.6
Salmon Survival	M 7.1.3	M 7.1.2	M 7.1.2	M 7.1.2
		M 7.2.3	M 7.2.3	M 7.2.3
	M 1.1.5	M 1.2.4	M 1.2.4	M 1.2.4
	M 6.1.4	M 6.2.4	M 6.2.4	M 6.2.4

READING		
Fishing	R 1.1	R 2.1
	R 1.4b	R 2.4b
Pacific Salmon	R 1.1	R 1.2
	R 1.4b	R 2.4b
Navigations without Landmarks	R 1.1	R 1.2

WRITING	Fourth Grade	Fifth Grade	Sixth Grade

BACKGROUND INFORMATION

THE ADULT SALMON

After gaining weight in the estuary and adapting to the salt water, salmon travel along the coastline and then to the open ocean. Here they gain the full size, shape and color of one of the species of mature salmon: coho, sockeye, pink, chum, and chinook. Because scientists cannot easily observe salmon in the ocean, knowledge of this part of the salmon's life cycle is limited. Scientists do know that most salmon spend the first part of their life in coastal waters, then migrate farther out to sea. Each species of Pacific salmon has a characteristic migration route and spends a different length of time in the ocean before returning home.

Young salmon can travel up to 20 km (approximately 12 miles) a day, while mature salmon can travel as much as 50 km (approximately 30 miles) a day. Salmon usually travel north in summer, as far as Northwest Alaska, and south in winter, possibly following ocean temperature changes while searching for food.

While at sea, salmon feed on a variety of smaller fish and plankton, often following schools of herring or krill. They can gain many kilograms, with mature adults reaching weights ranging from a few kilograms to 20 kilograms (approximately 40 pounds) or more, depending on the species. Salmon are also prey for larger salmon species, seals, orcas, and other fish, such as sharks and cod.

Alaska divides the allotment of salmon catch between sport/personal use fisheries, commercial fisheries and subsistence use after estimating how many salmon must return to their natal streams and lakes to conserve the species.

The largest number of adult salmon are probably taken by human fishers. People catch salmon mainly in coastal waters as large schools return from their ocean travels, although some are also caught in rivers and huge ocean drift nets. Commercial fishers use three main kinds of gear to catch salmon:

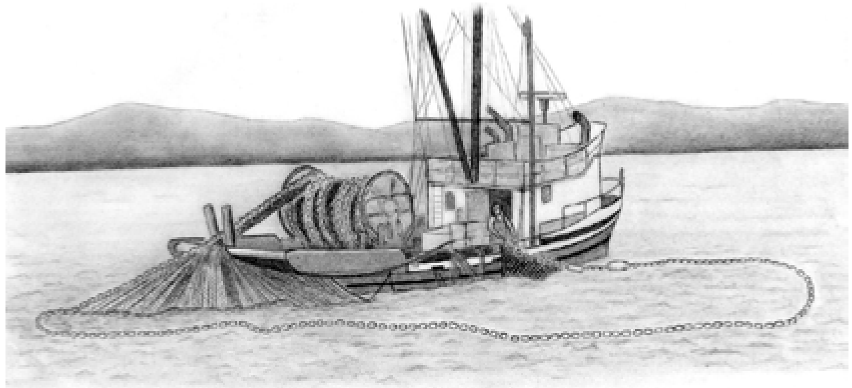
- gill nets: nets that hang like a curtain from the water's surface and entangle salmon by their gills;
- purse seine nets: nets that fishers first drag to form a circle around a school of fish, then pull in the bottom to form an enclosure from which fish cannot escape; and
- troll lines: long steel fishing lines, each with several lures and hooks to catch salmon by the mouth.

After spending from one to seven years at sea, depending on the species, salmon return to their natal stream or lake to spawn a new generation. No one knows how, but mature salmon form large schools and find their way to the mouth of their home stream. Scientists think salmon use ocean currents, the earth's magnetic field, and even the North Star to find their way back. When they get near their natal river, the scent of its water helps them identify the right river. The salmon congregate at the mouth of their natal river before starting the difficult journey upstream.

Adult Salmon

P

Handout 9.1



Salmon swim to the ocean to grow into adults. Some live in the ocean for only one year. Others live in the ocean for many years.

Salmon find many smaller fish to eat in the ocean. They grow very large.

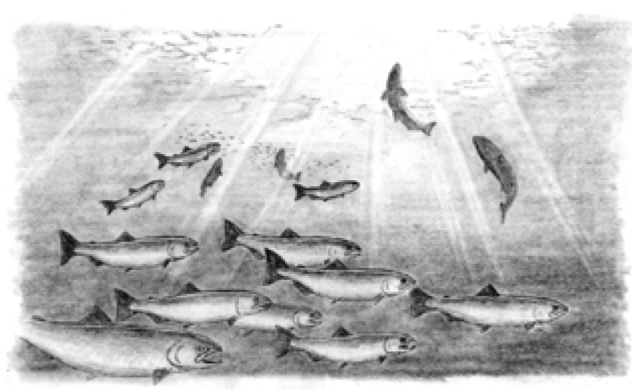
Their bodies become silver and gray. They are hard to see in the ocean.

Seals, whales, and large fish catch salmon and eat them. Human fishers in fishing boats catch many salmon.

Like many birds, salmon can travel a very long way. Often they swim in big groups called schools. But they come back when their travel is finished.

No one knows how salmon find their way home. Scientists think they use all their senses to find the way.

Salmon remember the scent of the water where they were born. The scent of their home river in the ocean tells them they are almost home.



Illustrations: Karen Uldall-Ekman

Adult Salmon

Handout 9.2

After gaining weight in the estuary and adapting to the salt water, salmon travel along the coastline and then to the open ocean. Here they gain the full size, shape, and color of a mature salmon.

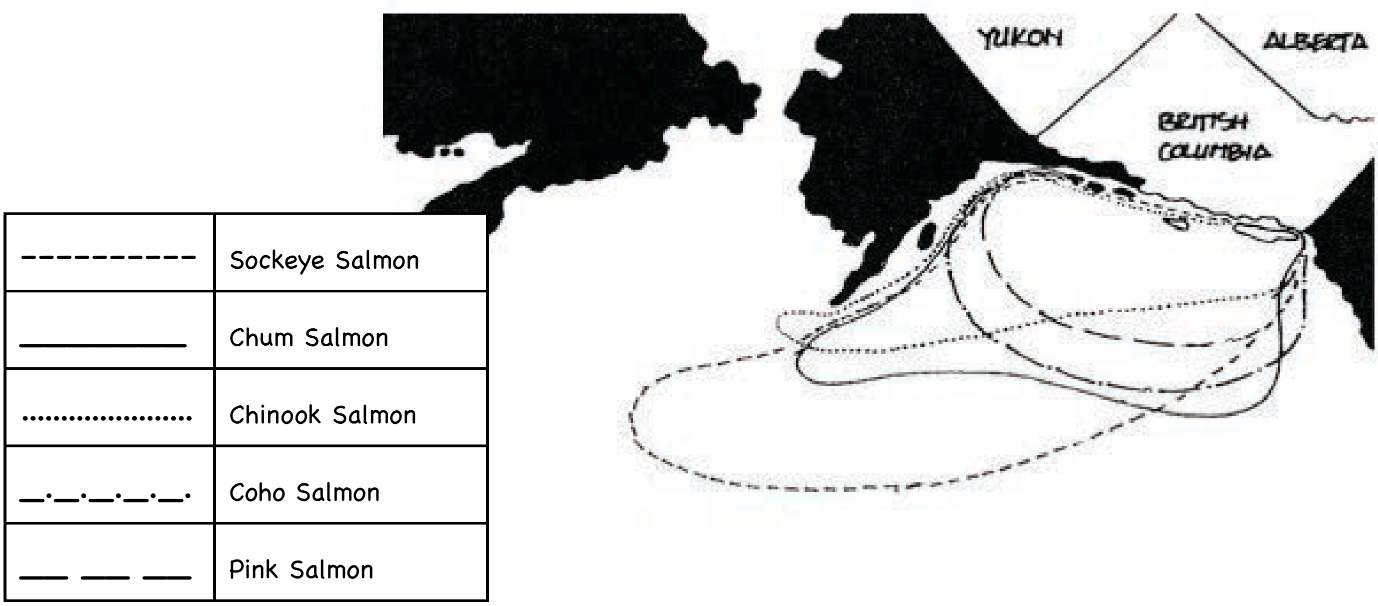
Most salmon spend the first part of their life in coastal waters, then migrate further out to sea. Each of the species of Pacific salmon has its own migration route and spends a different length of time in the ocean before returning home.

Young salmon can travel up to 20 km (approximately 12 miles) a day, while mature salmon can travel as much as 50 km a day. Salmon usually travel north in summer, often swimming as far as Northwest Alaska, and south in winter.

While at sea, salmon feed on a variety of smaller fish and zooplankton. The salmon can gain many kilograms (kg), with mature adults reaching a few kilograms to 20 kg (7 to 45 pounds) or more, depending on the species. Salmon are prey for seals and orcas, as well as for fish, such as cod.

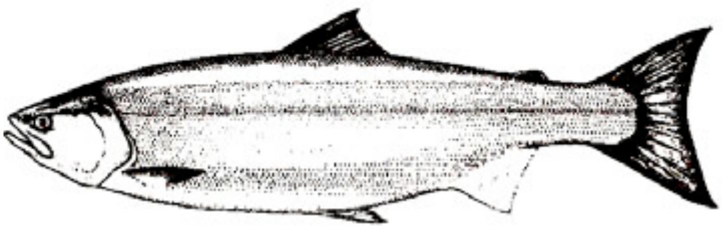
The largest number of salmon is probably taken by human fishers. People catch salmon mainly in coastal waters as large schools return from their ocean travels, although some are also caught in rivers and huge ocean drift nets. Millions of salmon are caught each year.

After spending from one to seven years at sea, depending on the species, salmon return to their natal stream or lake. Mature salmon form large schools and find their way to the mouth of their natal stream. They gather at the mouth of their natal river before starting the difficult journey upstream.

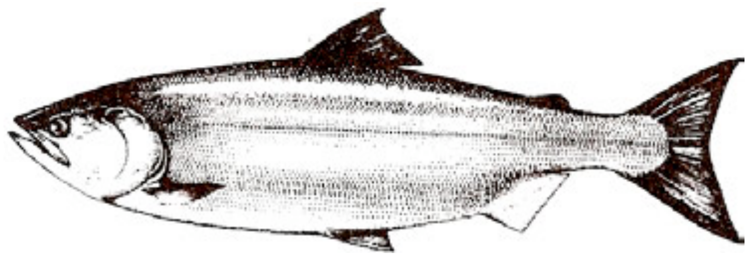


Species of Pacific Salmonids

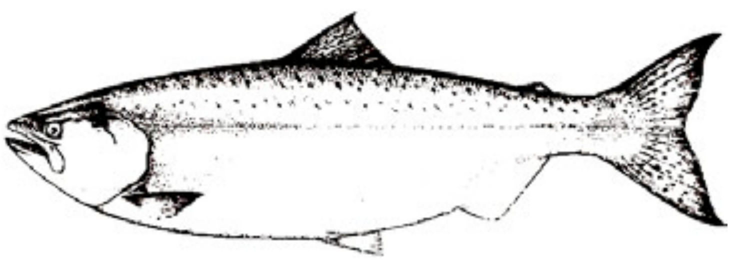
Handout 9.3



A. Sockeye

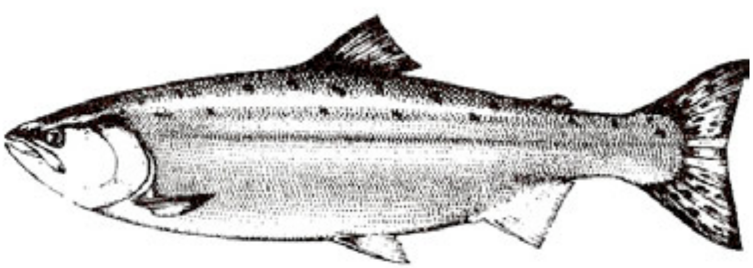


B. Chum



C. Chinook

D. Coho



E. Pink

Smelling The Way Home

This activity demonstrates how a scent can be used to identify a location. It leads to a discussion of how salmon identify their natal stream or lake by the scent of the water.

Materials:

For each group of students:

- Variety of strongly scented substances that students will recognize (preferably not artificial or allergenic scents)
- Opaque containers with perforated lids (e.g., plastic film canister)
- Option: Cotton balls
- Writing supplies

Time Required:

Two or three lessons

Level of Conceptual Difficulty:

Simple to moderate

PREPARATION

- ☞ Place a variety of strongly scented substances, such as orange, banana, mint, toothpaste, maple syrup and chocolate, in plastic film canisters (or other opaque containers) with holes in the top. (You may prefer to place the scents on cotton balls in the containers. Avoid perfume or artificial scents that might cause allergic reactions.) Test the scents with the students so that they can recognize them prior to taking part in the activity.

INTRODUCTION

- ☞ Make sure your students have read Handout 9.1, "Adult Salmon."

- ☞ Discuss with the class how people find their way on a trip. If necessary, prompt them with questions, such as:

  - How do you know when you are going in the right direction?
    By using memories and familiar sights as landmarks.
  - How do you know when to turn?
    By using memories and landmarks.
  - How do you know when you have arrived at your destination?
    By using memories and landmarks.
  - What do you do if the road is blocked?
    Look for another way until you find a familiar landmark.

- ☞ Have students, in pairs, describe to each other or map a trip they know how to take, e.g., from school, swimming pool, or a friend's house to home. Have the pairs list any landmarks or memories that help them find their way and know when they have reached their destination. Model this activity for students, if necessary.

- ☞ Explain that one way salmon find their way home is by the scent of their natal stream. They also use other factors, such ocean current. This activity tests how to use scents to identify a home.

Evidence for Assessment:

Review student discussion and observation pages to ensure that the students recognize that scents can be used to find a home area.

- ☞ Ask the class to name any smells that identify a place they know: a bakery, swimming pool, laundry, garbage, garden, etc.
- ☞ Ask the class to predict whether students could use scents to find a home area of the classroom.

EXPERIMENT

- ☞ Divide the class into groups and assign each group a home smell. Have the groups sniff and describe their scent sample.
- ☞ Place the samples in different parts of the room and have students try to find their home by sniffing each sample to identify their home area.

DISCUSSION

- ☞ With the class, discuss whether or not the test supports the predictions. Have students record their predictions.
- ☞ Option: With older students, reassign the samples, repeat the activity, and compare the time needed to identify different home locations by their scent.
- ☞ Option: Use masking tape to mark a path on the floor representing a river system with tributary streams, and place a different home scent at each stream. Have students follow the river system to their home stream.

SUMMATION

- ☞ With the class, compare a salmon's sense of smell with a human's sense of smell.
  Salmon can smell under water, while people cannot. Salmon remember smells longer than people do. A salmon's sense of smell is more acute than a human's.

Navigating Without Landmark

Materials:

- One copy of Handout 9.4, "Salmon Navigation," for each student
- Writing supplies

Time Required:
Approximately 60 minutes in two periods

Level of Conceptual Difficulty:
Moderate to advanced

Evidence for Assessment:
Monitor the class discussion of navigation using the senses and how salmon navigate, and review their imaginary instructions for a salmon to ensure the students can describe how salmon navigate the ocean and return to their natal river.

INTRODUCTION

- Make sure your students have read Handout 9.2, "Adult Salmon," and Handout 9.3, "Species of Pacific Salmonids."

- Discuss with the class how students find their way from one place to another without using a map. If necessary, prompt them with questions, such as:

  - How do you find your way home after school?
    By following a familiar route.
  - How do you know you are going in the right direction?
    By heading toward familiar landmarks, such as intersections, buildings, signs, etc.
  - How do you know when to turn?
    Watch for familiar landmarks, etc.
  - How do you know when you are there?
    By recognizing the destination.
  - Do you rely on any senses besides your vision?
    Humans rely mainly on vision.
  - How is this different from finding your way to a new place, like a new shop?
    In traveling somewhere new, you need a map or familiar landmark to which to relate.

DISCUSSION

- Explain that salmon navigate through the ocean, without maps or familiar routes, by using all their senses. This activity demonstrates how to use a variety of senses to find an unfamiliar destination.

- Have the class suggest ways to navigate through an unfamiliar neighborhood without using a map, using their senses of vision, hearing, smell and touch. If necessary, prompt them with questions, such as:

  - What kinds of things could you watch for?
    Vegetation, buildings, roads, sun and stars, etc.
  - What kinds of things could you smell?
    A bakery, a garbage container, a candy shop, a flower bed, etc.
  - What kinds of things could you listen for?
    A playground, a radio, a speaker system, a dog, etc.
  - What kinds of things could you feel?
    Carpet on the floor, grass, gravel, a hill, a rough wall, etc.

- ☞ Option: Have groups of students navigate blindfolded, if it can be done safely in the school.

ACTIVITY

- ☞ Note: It is strongly suggested that you try this activity in a nearby natural environment if time permits.

- ☞ Have students write instructions for getting from one place to another in the school without naming the destination, and without using a map or names of rooms, teachers, etc. Have students use each of their senses (except taste) at least once in their instructions. (For example, go down the hall toward the clock until you smell something cooking.) Have other students attempt to follow the instructions and discuss their success with the class. If necessary, prompt them with questions, such as:

    - Who was able to follow the instructions to the destination?
    - Which directions were easy to follow? Which were difficult?
    - Which of your senses were easiest to use?
    - What was difficult about writing clear instructions?

RESEARCH/DISCUSSION

- ☞ Have students, in groups, read Handout 9.4, "Salmon Navigation," and help each other clarify any parts they do not understand. Discuss with the class various hypotheses in the handout on how salmon navigate through the ocean. If necessary, prompt them with questions, such as:

    - Which salmon senses are most like human ones?
      Smell, touch (temperature).
    - Which salmon landmarks are like those humans use?
      Sun, stars, scents.
    - Would other human senses help salmon find their way in the ocean?
      Not much since visibility is limited and sounds do not seem very distinct.
    - If salmon could draw a map, what would they put on it?

Salmon Navigation

Handout 9.4

Sockeye and chum salmon travel as far as the Aleutian Islands, Northwest Alaska, and the middle of the Pacific Ocean.

Salmon from different lakes and rivers mingle together in the ocean. They follow schools of plankton and smaller fish, such as herring. Although they follow a general pattern, their position can vary greatly from one year to the next.

Migrating salmon seem to know where their natal stream is and how to return to it. When they are mature, all those that hatched at the same time in one stream or lake return together to the mouth of their natal river. Then they begin their journey back upstream.

No one knows how salmon navigate through the ocean and find their way back. Scientists believe that salmon use a variety of ways to tell where they are and where they are going.

Possible navigational aids for salmon

Possibly salmon use different senses at different times, or rely on all of them together.

- **Scents in the water.** Scientists know that salmon use their sense of smell to recognize their natal river and to find their natal stream or lake when they travel upstream. They may use similar scents to tell where they are in the ocean.
- **Water pressure and salinity**. The amount of salt in the ocean varies slightly in different places, and pressure can vary, too. Salmon are very sensitive to these changes and may use them to tell one place from another.
- **Magnetic direction.** Salmon seem to be sensitive to the earth's magnetic poles. They may use the poles to help in getting their direction.
- **The sun and the North Star**. Salmon seem to have more trouble finding their way on overcast days. Some scientists think this is because they use the North Star or the sun to navigate.

ADULT SALMON

WRAP-UP

REVIEW

- ☞ Materials: chart paper and markers.
- ☞ Have students draw and label or list the benefits and dangers in a salmon's ocean environment.
  Lots of small fish to eat, clean water, many predators, fishers, etc.
- ☞ Explain that adult salmon grow large in this environment, then find their way back to their natal stream or lake.

EVIDENCE FOR UNIT ASSESSMENT

- ☞ Have students make stick puppets of an adult fish and use them to explain, in a play, how an adult salmon swims through the ocean and then finds its way home.
- ☞ Have students make a web or write a sentence listing ways in which an adult salmon is different from a salmon smolt.
- ☞ Have students complete a stem sentence, such as, "I used to think… about adult salmon, but now I know that…", or, "One thing I learned about adult salmon is that…".
- ☞ Have students add their materials to their salmon science notebook and write a sentence explaining what they learned.

LANGUAGE AND ARTS INTEGRATION

- ☞ If there are fishers in your community, invite one to tell the class how they catch and process fish.
- ☞ If there is a fish cannery, native fishery, or fish market in your area, arrange a tour to show students how fish get from the fishers to the home.
- ☞ Make canned salmon sandwiches, arrange a salmon barbecue for the class, or discuss how students enjoy eating salmon.
- ☞ Have students compare the migration of salmon with the annual migration of birds. If there is a migratory bird flyway in your area, arrange a field trip when the birds are migrating.
- ☞ Make fish prints by painting colors on a whole fish and gently pressing a page of paper against the paint.
- ☞ Make mobiles of salmon to represent a school of fish.

HOME CONNECTIONS

- ☞ Have students describe the fishing activity to an adult and explain how a larger number of fishers increases the catch.

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ADULT SALMON

WRAP-UP

EXTENSION ACTIVITIES

- ☞ Have students glue the illustrations of Pacific salmon species to cards and challenge each other to recognize them by playing a game of Snap with the cards.
- ☞ Have students describe their own experiences in the sport, commercial or native fishery, or recount stories or "tall tales" they have heard from other fishers.
- ☞ Have students prepare a variety of salmon recipes and hold a class party in which they describe their favorite way to eat salmon.
- ☞ Have students arrange a field trip to a nearby salmon or trout fishing stream or commercial fishing operation, or have someone from the industry come to the class to talk about their work.
- ☞ Have students visit a cultural center, or Native fishing site to discuss traditional and modern methods of salmon harvesting and the role of salmon in the culture of Natives.
- ☞ Have students describe what a fisheries conservation officer does to manage the population and catch of Pacific salmon.
- ☞ Have students present information on the 1985 fisheries treaty between the United States and Canada or treaties with other countries and report to the class on the main issues.
- ☞ Have students research methods of aquaculture and identify the pros and cons of each.
- ☞ Have students research the effect of introducing non-native species into an environment. Have them evaluate the potential effect of introducing Atlantic salmon into Pacific waters.
- ☞ Have students research the extent of ocean pollution or climate change.
- ☞ Have students write imaginary instructions for a salmon to return from the Aleutian Islands to a local river mouth, using only senses that a salmon could detect.

SUGGESTIONS FOR ASSESSMENT

- ☞ Have students label a black outline drawing of an adult salmon.
- ☞ Have students describe at least three ways by which salmon are thought to navigate through the ocean and back to their natal stream or lake.
- ☞ Have students write quiz questions about adult salmon on one side of an index card and answers on the other. Have them quiz each other by asking the questions or by using a Jeopardy-style format (i.e., giving the answers and asking for a question).

- ☞ Monitor student discussions of the class' habitat mural and Life Cycle poster to ensure that the students can identify the needs of adult salmon, as well as their habitat and threats to it.

- ☞ Have students add their notes, experiment observations, and other materials to a salmon science notebook.

HOME AND COMMUNITY CONNECTIONS

- ☞ Have students ask an adult to take them fishing, and discuss how to catch fish responsibly.

- ☞ Suggest that the class implement a project encouraging sport fishers to follow fishing regulations and to explain why it is important to do so.

GLOSSARY

For primary grades (K to 3)

Note: These definitions refer to words in the context in which they are used in the Alaska Salmon in the Classroom Curriculum materials. They may have other meanings in other contexts.

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adipose fin — a small boneless fin on a salmon's back, near the tail

adult — fully grown; a salmon ready to return to its natal stream

air — the invisible substance people and animals breathe

alevin — a salmon that has just hatched from the egg, with the yolk still attached

anal fin — a fin on a fish's belly near the tail

bean seed — a small living object from which a bean plant can grow

body — the main part of a person or animal

camouflage — colors that make an animal hard to see

city — a place where many people live

dam — a wall that holds back water in a stream or lake

dorsal fin — a fin on a fish's back

egg — a rounded object, laid by fish and some other animals, in which the young begin to grow

egg wall — the outer part of an egg

egg white — the clear liquid inside an egg

embryo — a very young salmon in the egg

estuary — a place where a river joins the sea

eyes — the part of the body used for seeing

factory — a building where people use machines to make things

female — a salmon that produces eggs

fertilize — to make eggs ready to grow

fin — the part of a fish's body which it moves to balance and move around

fish — an animal with bones and fins that lives in water

fisher — someone who catches fish

fishing boat — a boat used to catch fish

food — what a fish eats to live and grow

fresh water — water with no salt in it

fry (plural: fry) — a young salmon that can swim freely in a stream or lake

garbage — something that someone has thrown away

gill — the part of a fish's body which it uses to breathe under water

gravel — a mixture of pebbles and rocks

hatch — when a salmon wiggles out of the egg

hazard — a danger

head — the front part of a fish's body, with the mouth, eyes and gills

krill — tiny animals that live in the sea

lateral line — the part of a fish's body in a line along its side that it uses to feel

leaf — the flat green part that grows on a plant

life cycle — all the stages in a plant or animal's life

log — the trunk of a tree that has been cut down

male — a salmon that produces milt to fertilize eggs

mouth — the part of a fish's body which it uses to take in food and water

natal stream — the stream where a salmon was born

nostril — the part of a fish's body which it uses to smell the water

ocean — the body of salt water that covers most of the earth

oxygen — a gas which plants and animals need to breathe

parr marks — dark up-and-down bars on the sides of salmon fry

pectoral fins — fins on a fish's side, behind the gills

pelvic fins — fins on a fish's belly in front of the anal fin

polluted — air or water with waste in it

pool — a small area of still water

predator — an animal that catches and eats other animals

redd — a stone nest in the gravel of a lake or stream for protecting eggs

riffle — an uneven area in a stream that makes the water form small waves or ripples

root — the part of a plant that grows down into the ground

salmon — a type of fish that hatches in fresh water, swims to the ocean, then returns to its home stream or lake

salt water — water that has salt in it, such as the sea

scales — small, hard, flat pieces that cover a fish's body like armor

scent — a smell

school — a large group of fish

shell — a hard casing that covers some animals, such as clams and snails

skin — the soft layer that covers the bodies of animals

smolt — a young salmon that is getting ready to enter salt water

spawn — to produce, deposit and fertilize eggs

spawner — a salmon that is getting ready to lay or fertilize eggs

spawning ground — a stream or lake where salmon deposit eggs

stage — one part of a salmon's life cycle

stem — the part of a plant that holds the branches and leaves

stream — water flowing in a narrow path

stream bank — the sides of a stream

streambed — the bottom of a stream

sustainability — meeting the needs of the present without compromising the ability of future generations to meet their own needs

sustainable development — development that meets the needs of the present without compromising the ability of future generations to meet their own needs

swim bladder — the part of a salmon's body which it can fill with air, like a balloon

tail — the part of a fish's body which it moves from side to side to move forward

water — the liquid that falls as rain and fills rivers and lakes

wiggle — to move and twist from side to side

yolk — the thick yellow part of an egg

yolk sac — a thin bag which contains egg yolk and grows on the belly of an alevin

GLOSSARY

For intermediate grades (4 to 6)

Note: These definitions refer to words in the context in which they are used in the Alaska Salmon in the Classroom Curriculum materials. They may have other meanings in other contexts.

ATU	— a measure of the total heat received over a period of time (**accumulated thermal unit**)
angling	— the practice of catching fish with a hook and line
anadromous	— a fish migrating from salt water to spawn in fresh water
anthropomorphism	— viewing non-human events from a human perspective
adapt	— to become suited for changed conditions
alevin	— a fish, especially a salmon, that has hatched and has a visible yolk sac.
aquatic organism	— a plant or animal that lives in water
amphipods	— small crustaceans that are often food for salmon
atmosphere	— the air that surrounds the earth
back-eddy	— a water current that flows backward against the main current
bedrock	— solid rock that lies below loose surface rocks and soil
bladder	— a thin bag in the body that holds fluids or air
boulder	— rock pieces 30 cm or more cm across
built environment	— the parts of the surroundings that are built by people
buoyancy	— the ability to float or rise in water
buoyant	— tendency to float or rise in water
by-catch	— fish caught that are not the species that fishers intended to catch
carcass	— the body of a dead animal
caudal fin	— the tail fin
caudal peduncle	— slender section between the base of the caudal fin and the anal or dorsal fin
cell	— tiny building blocks that make up the bodies of all living things
chinook	— a species of Pacific salmon, also known as king
chordate	—any animal of the phylum *Chordata* having a spinal column
chum	— a species of Pacific salmon, also known as dog salmon
classification	— arranging things into similar groups

cobble	— loose stones 10 to 30 cm across
coho	— a species of Pacific salmon, also known as silver salmon
cold-blooded	— animals whose body temperature changes according with the temperature of the surroundings
compost	— a mixture of decaying plant and animal material
concentration	— the amount of a substance in a solution
conservation	— the prudent management of natural resources
copepods	— small crustaceans that are often used by salmon for food
creek	— water flowing in a narrow path, a small stream
cutthroat trout	— a trout species having a reddish streak on each side of the throat
deforestation	— clearing land of trees
dichotomous key	— a chart that subdivides items of the natural world by two, through a series of choices that lead the user to the correct name of the given item
dissolved	— mixed into a liquid such as water
dissolved oxygen	— the concentration of oxygen in water. It is used as a measure of the water's ability to support aquatic life. Low concentrations do not support fish or similar organisms.
d**orsal fin**	— the fin on the middle of a fish's back
ecology	— the science that studies how organisms relate to the environment in which they live
eelgrass	— a plant with long, thin leaves that grows in salty water
embryo	— any multicellular animal in a developmental stage preceding birth or hatching
energy	— the strength to live and be active
estuary	— the mouth of a river where it mixes with the sea
euphausids	— small crustaceans that become food for salmon in their fry, smolt and adult life cycle stages
evaporation	— changing from a liquid to a vapor
excrete	— to get rid of waste from the body
fertilize	— to make eggs ready to grow by uniting egg and sperm
fishing ethics	— a set of moral principles regarding appropriate fishing practices, including the duty and obligation to follow regulations and safe practices
fisheries biologist	— a person who specializes in the study of fisheries
fry (plural: fry)	— a young salmon that can swim freely in a stream or lake

genetic diversity — the variability in the genetic make-up among a group of individuals in a population. Also called genetic variability.

genetic variation — change from one generation to the next; differences between organisms of one species that are inherited from the parents

gill rakers — a bony finger-like projection of the gill that diverts food away from the gills

gill — the part of a fish's body (an organ) that it uses to breathe under water

gravel — loose stones from 1-10 cm across

guideline — an ideal that is written down to guide others

habitat — the natural environment of an organism

herring — a small, silvery ocean fish which is prey for salmon

humeral — the area directly above the pectoral fins on a fish; "shoulder" area

hydrologic cycle — a process in which water evaporates from the ocean, falls to earth as rain or snow and returns to the ocean in rivers and streams; the water cycle

imprinting — the way that salmon fry remember the scent of their natal stream or lake

impurity — something that pollutes something else

insect — small animals with three pairs of legs and, usually, one or two pairs of wings

isotherm — a line on a map connecting places that have the same temperature

kidney — the part of an animal that separates waste and water from the blood

lake — a large body of fresh water

landfill — waste buried in the ground

larva — a stage of insect life, after it hatches but before it becomes a pupa (plural: larvae)

lateral line — a series of nerves along the side of fish that it uses for sensing

leachate — liquid that flows through solid material and carries some of the material with it

life cycle — all the stages in a plant or animal's life

liver — the part of a fish's body that removes toxins and secretes substances that help absorb food

mackerel — a predatory ocean fish

magnetic direction	— direction following the earth's magnetic poles, as on a compass
membrane	— a layer of tissue that covers a part of the body
microorganism	— living organisms too small to see without a microscope
migration	— movement from one place to another
milt	— the sperm-containing fluid of a male fish
molecule	— the smallest particle into which a substance can be divided and still keep the properties of the original substance; made up of two or more atoms
natural	— the parts of the surroundings that are not built or modified by people
navigation	— finding a position or a direction of travel
nutrient	— food that allows a plant or animal to live and grow
nymph	— a stage of an insect that is between a larva and an adult
orca	— a marine mammal; a killer whale
operculum	— a cover over the gills
otolith	— a calcium carbonate ($CaCo_3$) structure that helps keep fish upright in the water column; "ear bone"; "ear stone"
oxygen	— a gas which plants and animals need to breathe
organism	— a living thing
parr marks	— dark vertical bars on the sides of salmon fry
part per million (PPM)	— for every particle of one substance there are one million particles of another substance
pectoral	— region on a fish's side, behind the gills
pH	— a measure of the concentration of hydrogen ions in a solution, indicating neutrality (pH 7), acidity (less than pH 7), or alkalinity (greater than pH 7)
pharynx	— tube or cavity, with its surrounding membrane and muscles, that connects the mouth and nasal passages with the esophagus
pink	— a species of Pacific salmon, also known as a humpy salmon
plankton	— a group of microscopic organisms that live in water
pollutant	— a byproduct of human activity which may cause harm to humans or other species
pond	— a small body of still water
precautionary approach	— recognizes that the absence of full scientific certainty

shall not be used as a reason to postpone decisions where there is a risk of serious or irreversible harm

predator — an animal that catches and eats other animals

principle — a rule, especially a basic rule on which other rules are based

pyloric caeca — a tubular sac that is connected to both the stomach and alimentary canal, where digestive enzymes are secreted and nutrients are absorbed.

rainbow trout — a species of salmonid that spends all its life in fresh water. The anadromous variant of this species is called steelhead trout.

redd — a nest mad out of stones in the gravel of a lake or stream where salmonids lay their eggs

respiration — breathing

riffle — an uneven area in a stream that makes the water form small waves or ripples; a ripple is on the surface of the water

river — a large channel of water flowing to a sea or lake

runoff — water that drains away after a heavy rain or a spring thaw

salinity — saltiness

salmon — a fish that hatches in fresh water, swims to the ocean, then returns to its natal stream or lake; it is also an important sport, commercial, and subsistence fish

salmonid — a family of fish including all the species of salmon, all the species of trout, and all the species of white fish

scales — small, hard, flat pieces that cover a fish's body like armor

sensitive — easily affected by external influences

silt — very fine earth carried in water

slime — a slippery layer that covers and protects the fish

smolt — a juvenile salmon that is getting ready to enter salt water

sockeye — a species of Pacific salmon, also known as a red salmon

solar energy — energy that radiates from the sun

spawn — to produce, deposit and fertilize eggs

spawner — a salmon that is getting ready to lay or fertilize eggs

spawning ground — a stream or lake where salmon deposit eggs

species — a grouping of plants or animals; a group of plants or animals that can breed together and produce fertile offspring

sport fishing — recreational fishing for pleasure

steelhead trout — anadromous rainbow trout

stream — water flowing in a narrow channel

sustainability — meeting the needs of the present without compromising the ability of future generations to meet their own needs

sustainable development — development that meets the needs of the present without compromising the ability of future generations to meet their own needs

swim bladder — the part of a fish's body where a fish stores air to maintain buoyancy in water

temperature — the amount of heat or cold

thermal — something that has to do with heat (or cold)

transpiration — the process whereby plants give off moisture through the pores in their leaves

turbidity — a measure of water clarity; cloudiness or muddiness

velocity — speed

warm-blooded — animals that can maintain their own body temperature

waste — garbage; something that is thrown away or left over

water cycle — a process whereby water evaporates from the ocean, falls to earth as rain or snow and returns to the ocean in rivers and streams; the hydrologic cycle

water pressure — the weight of water on an object

watershed — the area that drains into one system of rivers and streams, including all the living things in it

yeast — a microorganism that grows in liquids containing sugar

yolk sac — a thin bag containing egg yolk that is the nutrients for the alevin stage of the juvenile salmon

zooplankton — an animal species of plankton

Activity Appendix

Important Standards Netted by Teaching These Activities

SCIENCE

	Fourth Grade	Fifth Grade	Sixth Grade
	SA 1.1	SA 1.1	SA 1.1
	SA 1.2	SA 1.2	SA 1.2
	SA 3.1	SA 3.1	SB 2.1
	SE 1.1	SC 2.1	SC 2.1
	SE 3.1	SE 1.1	SC 2.2
		SE 3.1	SE 1.1
			SE 3.1

MATH	Third Grade	Fourth Grade	Fifth Grade	Sixth Grade
Thermal Map	M 7.1.2	M7 .2.2	M 7.2.2	M 7.2.2
	M 5.1.6	M 5.2.6	M 5.2.6	M 5.2.6
	M 2.1.1	M 2.2.1	M 2.2.1	M 2.2.1
		M 2.2.3	M 2.2.3	M 2.2.3

READING		
A Thermal Map	R 1.1	R 1.2
	R 1.6	R 2.6

WRITING	Fourth Grade	Fifth Grade	Sixth Grade

A Thermal Map [demonstration]

Adapted from Jim Wiese, Salmon Below the Surface, pages 67-74

Materials:

- One copy of a weather map showing isotherms

For each student or pair of students:

- One thermometer
- One ruler
- Tape
- Blank paper or three copies of an outline map of the classroom
- Colored pencils or felt tip markers
- One copy of Handout A (Parts 1, 2 & 3), "A Classroom Thermal Map," for each student
- Writing supplies

Time Required:
60 to 90 Minutes

Level of Conceptual Difficulty:
Challenging

PREPARATION

- To save time and ensure consistency, you may wish to draw an outline map of the classroom and make three copies for each student or pair of students.

INTRODUCTION

Although Scientists do not believe salmon use water temperature to help them navigate, water temperature affects their food source.

Explain that special maps show other information that is important for other purposes.

- Ask the class what an ocean map for salmon would show.

  Locations, food sources, temperature, etc.

- Have students look at a weather map showing isotherms and discuss how they link areas of similar temperatures. Ask the class to suggest ways that scientists create the weather maps.

  They take temperature readings from various locations over land and water using weather balloons, ground stations, weather ships, etc., then plot them on maps and link places with similar values.

- Ask the class to suggest a way to make a temperature map of the classroom. Use thermometers to take temperature readings at fixed locations in the room and at different levels above the floor. (Hint: This may be easiest in winter when the heat is on or with an open window.)

EXPERIMENT

- Divide the students into six groups and have them follow the procedure in Handout A, "A Classroom Thermal Map," to create an isotherm map of the classroom (i.e., readings at each level will be done by two groups). Model each step of the procedure as the class does it.

Evidence for Assessment:
Monitor the class discussion and review the students' maps and conclusions to ensure that the students can make an isotherm map from data, draw conclusions based on the map, and recognize ways in which salmon respond to temperature in the ocean.

☞ Note: Depending on the time you have available, and the ability of your students, you may prefer to skip steps 6 and 7 in the procedure and make a single map instead of three maps.

☞ Option: Have students use a computer-graphing program to create a 3-D graph representing the room's isotherms.

☞ Option: If the school has a classroom salmon incubation tank, have students create isotherm maps of the incubation tank.

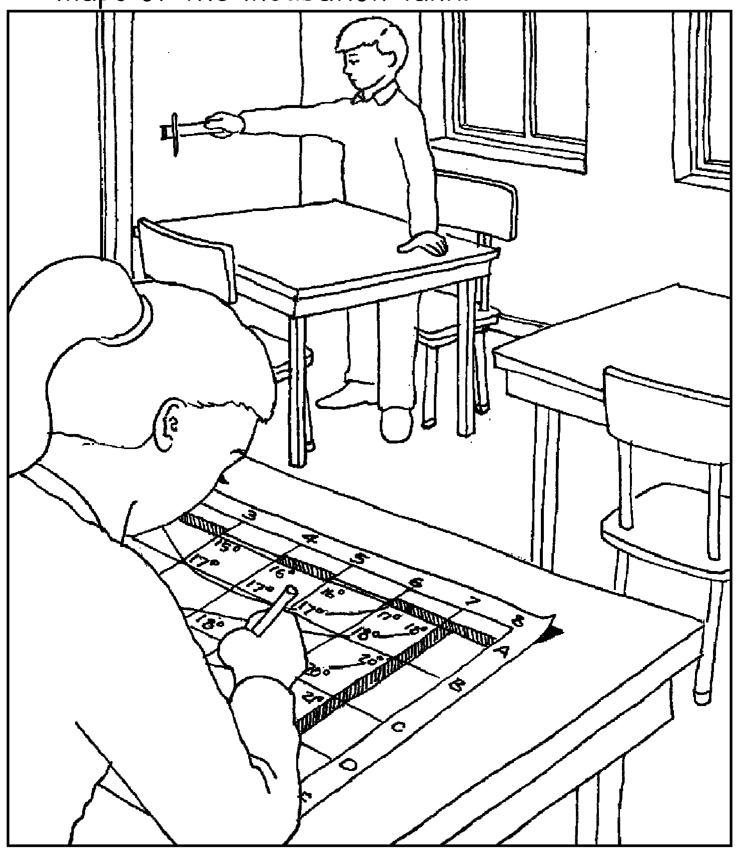

Illustration: Donald Gunn

DISCUSSION

☞ Discuss with the class whether or not their data supported their hypothesis, and any other observations they draw from their data. If necessary, prompt them with questions, such as:

I

- What did the maps or the data show you that you did not know before the investigation?
  Temperature variations at different levels, sources of heat or cold drafts, the most comfortable place to sit, etc.
- What differences did you observe between the ceiling, middle and floor maps?
  Usually the temperatures will be warmer at the ceiling and cooler near the floor.
- How did the data compare with what your senses told you about the room?
- If you knew that animals preferred cool temperatures, how could you use isotherm maps to help locate them?

☞ Discuss with the class how to make an isotherm map of the ocean, and what it might indicate about salmon. If necessary, prompt them with questions, such as:

- How could you adapt the procedure to make an isotherm map of the ocean?
  Take temperature measurements at various depths and locations to plot a 3-D ocean isotherm map.
- How would an ocean isotherm map differ from the classroom map or an atmospheric map?
  Water temperature changes less frequently and by smaller amounts, so the maps use smaller differences and do not change so quickly.
- How could people use ocean isotherm maps?
  To track ocean currents, and changes such as El Nino/ La Nina; to predict climate changes that are affected by ocean temperature; to track fish populations that prefer certain temperatures, etc.
- How could you use an ocean isotherm map to keep track of salmon?
  Look for the temperatures they prefer to predict where they will be, where they will go, or where their food species will be, etc.
- Salmon do not use isothermal maps. How do temperature differences in the ocean affect them?
  They are very sensitive to temperature changes. Temperature differences affect how fast they grow and the availability of food species.

A Classroom Thermal Map

Handout A (Part 1)

The temperature varies from place to place. Some areas are warm, while others are cold. Temperature differences can be very important. Salmon bodies develop faster in warmer water. They "live faster", but they may gain less weight and die sooner.

Also, salmon predators, like tuna and mackerel, follow warm currents and kill more salmon when warm currents move north.

Even within a room you can record differences in temperature. If you take careful measurements and plot them on a map, you can make a thermal map showing the temperature in each area.

When you draw a line connecting the points with the same temperature, the line is called an isotherm. ("Iso" means equal; "therm" means temperature.) You can use the procedure below to make an isothermal map of your classroom. During the investigation, move as little as you can. Movement will create air currents that make it difficult to get accurate temperature readings.

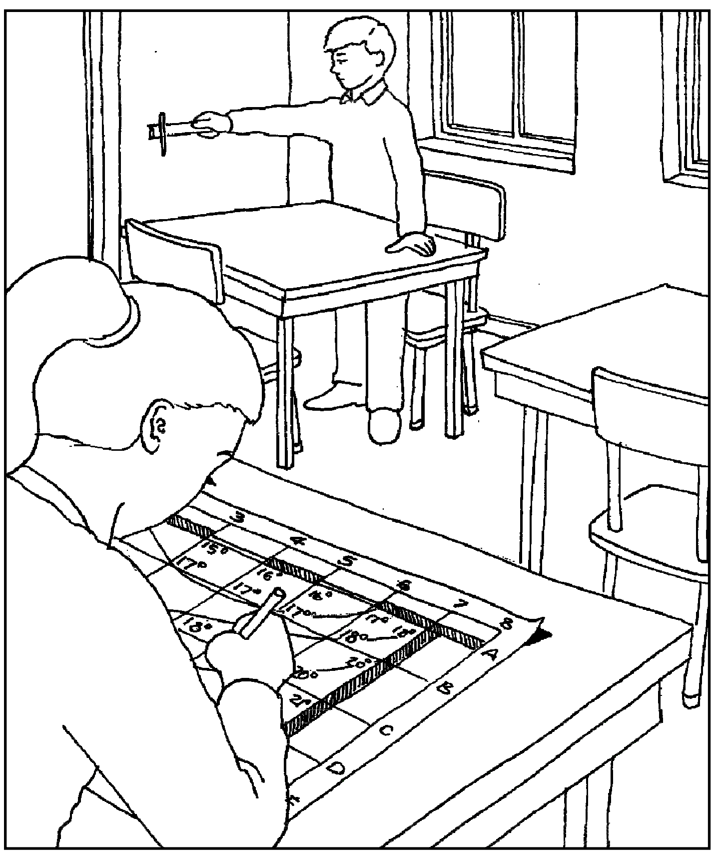

Illustration: Donald Gunn

A Classroom Thermal Map

Handout A (Part 2)

1. Tape a thermometer to a ruler. Use the ruler as a handle so that your hand does not affect the temperature reading.

2. Make a map of the room, including walls, windows, doors, heating vents, desks, etc. (Your teacher may have a map you can use.)

3. Use your knowledge of the room to make a hypothesis about where the warmest and coolest parts of the room will be. Write your hypothesis on the next page.

4. Position yourself through the room in rows, giving each position a row number and letter. (For example, in the first row, the first position is A1, the one beside it is A2, the next is A3. In the second row, the first position is B1, the one beside it is B2, etc.) Draw each position on the map of the room.

5. Hold a thermometer above your head for two minutes. On the data form, record the temperature for each position in the classroom under the title "Ceiling Reading."

6. Hold a thermometer at waist level for two minutes. On the data form, record the temperature for each position in the classroom under the title "Waist Reading."

7. Hold a thermometer about one centimeter from the floor for two minutes. On the data form, record the temperature for each position in the classroom under the title "Floor Reading."

8. Transfer the data from the ceiling readings to the appropriate position on the classroom map. Then transfer the data from the waist readings and the floor readings onto separate maps.

9. Use colored markers to connect the positions with similar temperature readings. The result will be an isothermal map of your classroom. With the three maps, you can compare the temperatures near the ceiling, middle and floor of the room.

A Classroom Thermal Map

Handout A (Part 3)

Name ____

Hypothesis

My hypothesis is that the warmest area of the classroom will be: ____________________

And the coolest areas of the classroom will be: _________________________________

Data Form

Ceiling Reading

Position	1	2	3	4	5
A					
B					
C					

Waist Reading

Position	1	2	3	4	5
A					
B					
C					

Floor Reading

Position	1	2	3	4	5
A					
B					
C					

Conclusions

State whether or not the data support your hypothesis, and any other conclusions you can draw from the data. ____

____

____

____