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.

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.

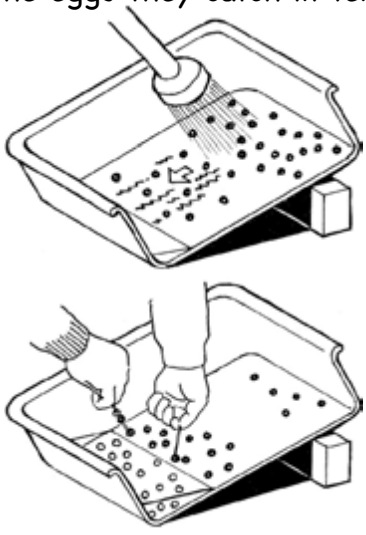


illustration: Donald Gunn

illustrations: Donald Gunn

ACTIVITY, PART TWO

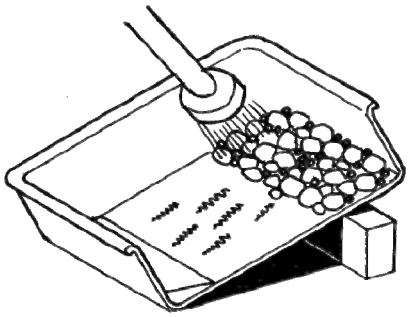
☞ Make a model redd using rocks and gravel at one end of the basin. Place the model eggs in the redd and cover them with gravel. Have students predict what might happen to them in a stream.

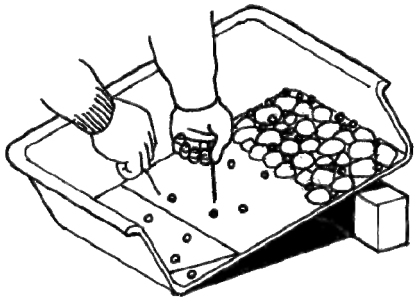
☞ Tilt the basin at the same angle as Part One. Pour water gently over the redd and have students count the eggs that are washed away.

☞ 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.

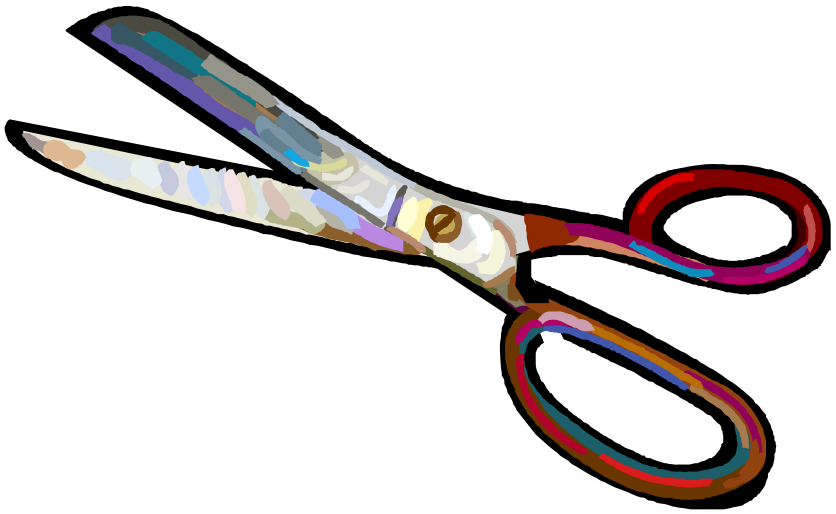
  To move, people use legs, fish use tails; to breathe, people uses noses, fish use mouth and gills, etc.

Parts Of A Salmon

Handout 2.3, (Part 1)

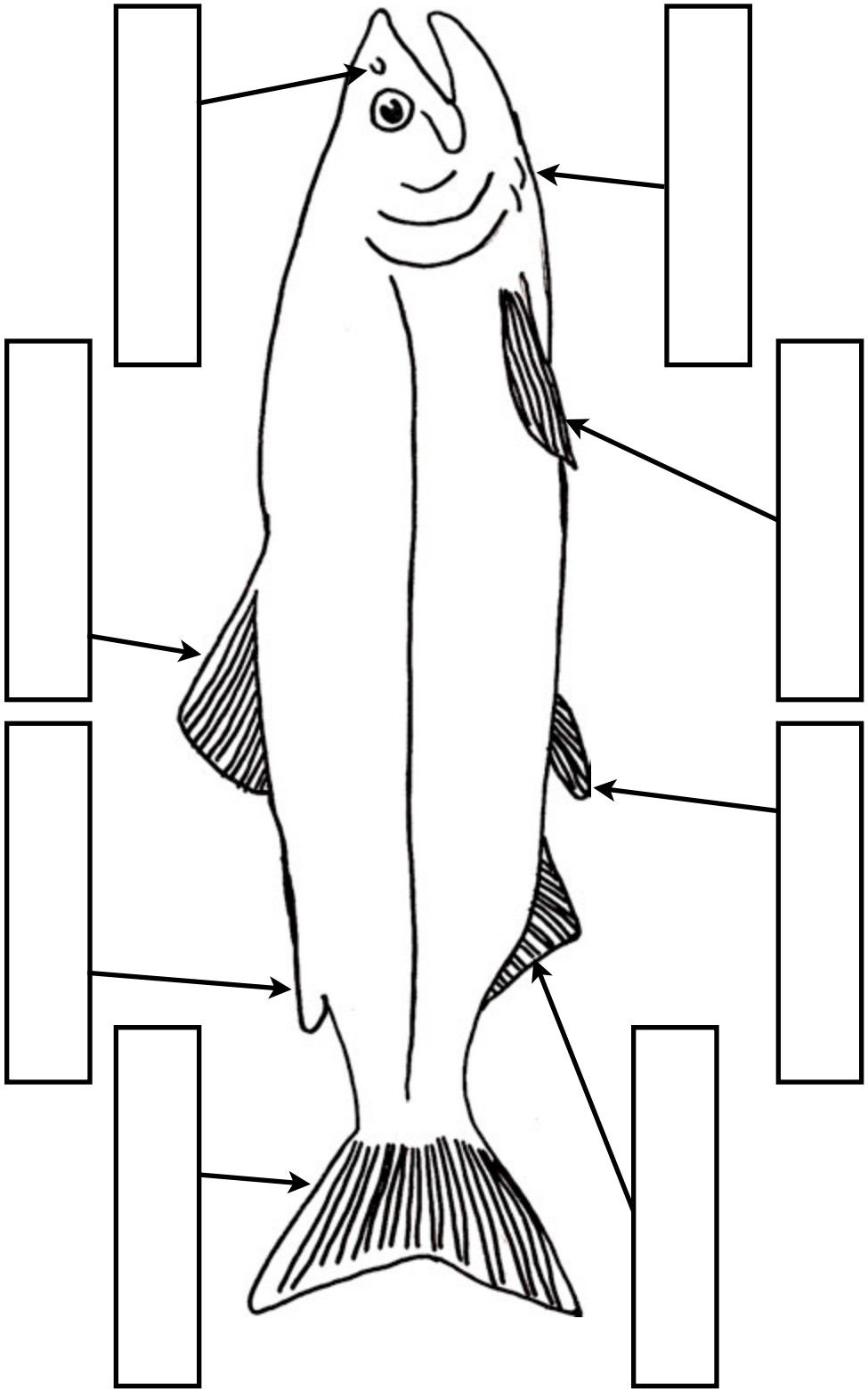
Cut out and label the salmon

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



Parts Of A Salmon

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.

- 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

Handout 2.4

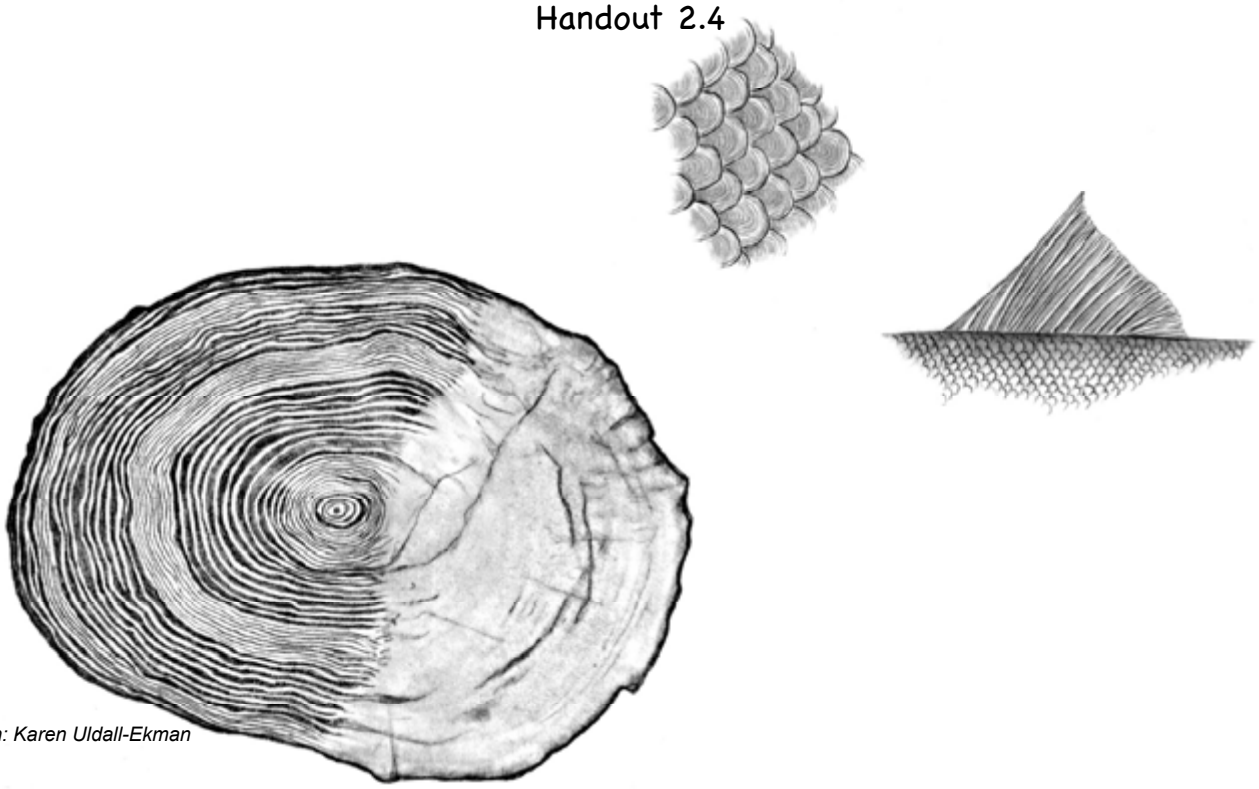


Illustration: Karen Uldall-Ekman

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?

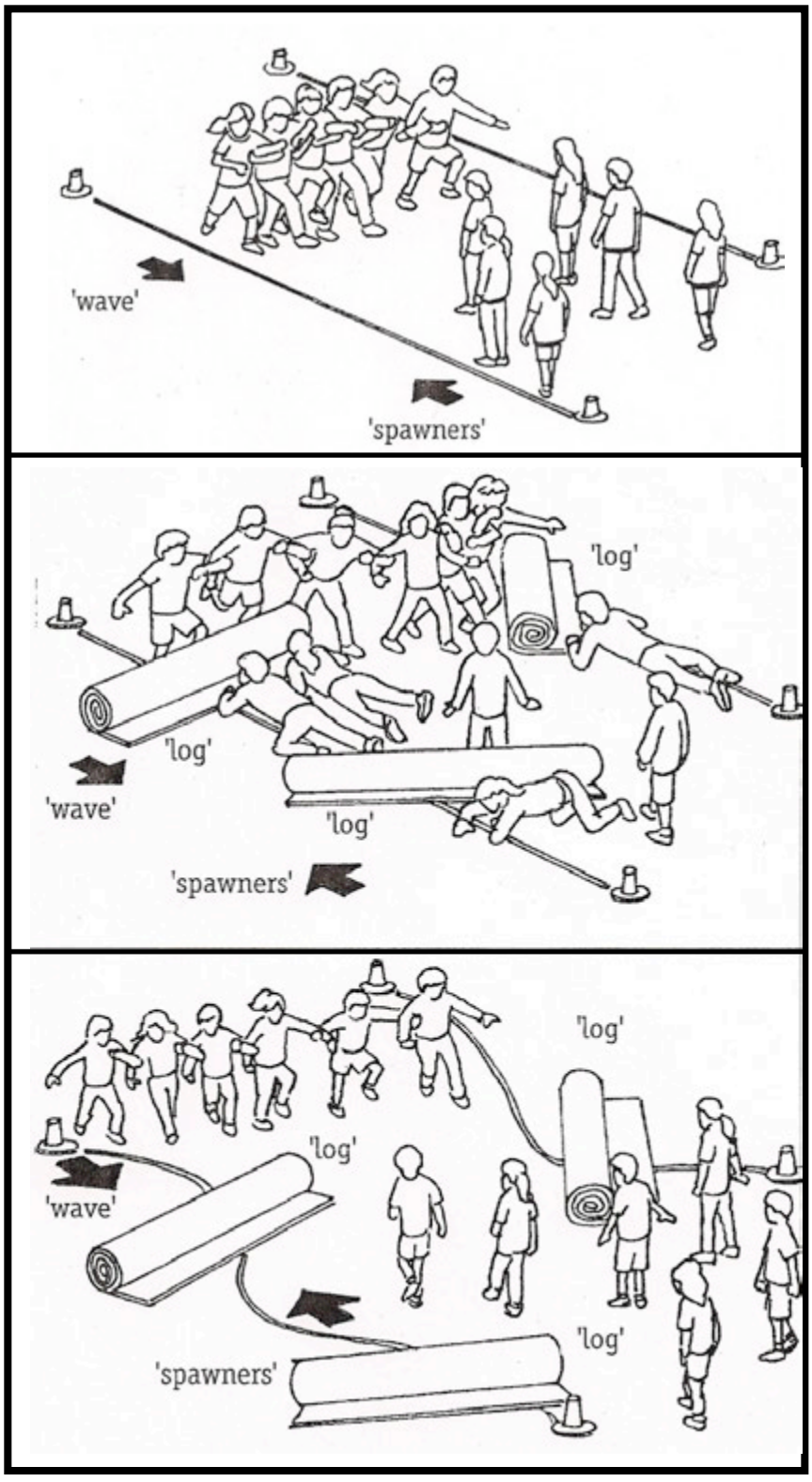
  A salmon also has to jump and slide past a variety of obstacles. It may be easier for a salmon to swim through a wave of water, but its trip is much longer, and the salmon has no hands or feet to help it.
- What kinds of obstacles does a salmon have to pass on its migration upstream?

  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. _____

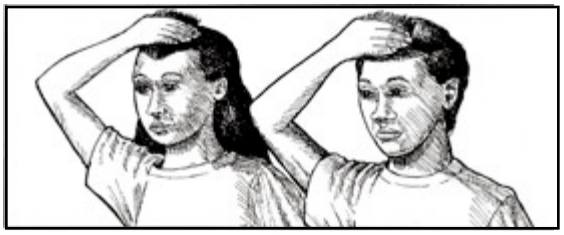
_____

_____

Genetic Diversity

Handout 2.6, (Part 2)

Widow's Peak



Tongue Roll

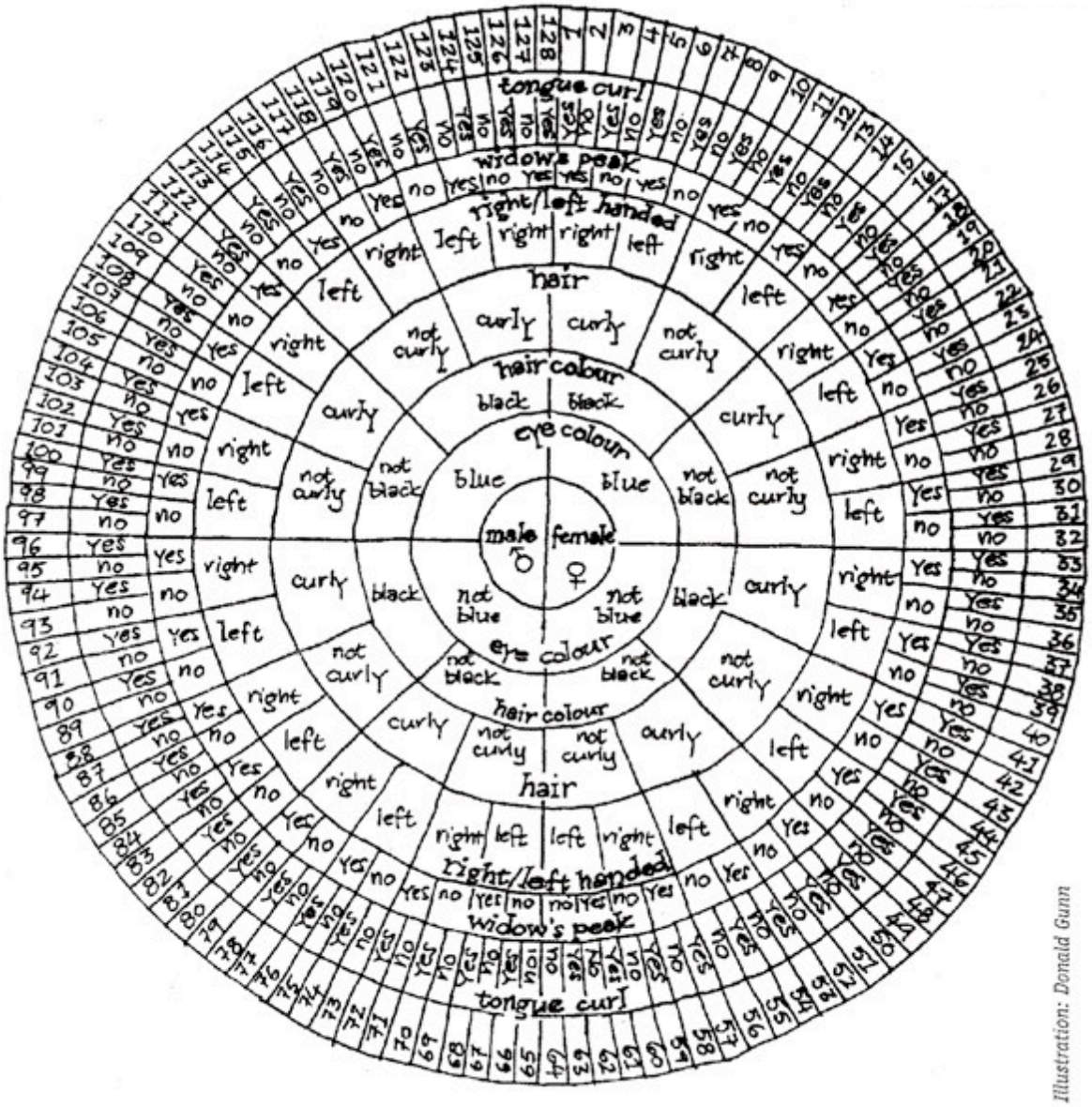


Illustration: Donald Gunn

SALMON DISSECTION

[demonstration]

MATERIALS

Each group conducting a dissection will need the following:

- A whole salmon (may require time to thaw)
- A Zak Knife (small gut hook) or a kitchen knife
- A spoon
- A plastic drinking straw
- Paper plates
- A magnifying lens
- Toothpicks or bamboo skewers (optional)
- Newspapers
- Paper towels
- A bucket of water with disinfectant for cleaning
- Heavy plastic garbage bags for waste
- One copy of "Handout 2.7: Salmon Key"
- One copy of "Handout 2.8: Dissecting a Salmon" for each student
- One copy of "Handout 2.9: Salmon External Anatomy" for each student
- One copy of "Handout 2.10: Salmon Internal Anatomy" for each student
- Writing supplies

PREPARATION

- *Before you begin - Use Handout 2.7 to determine the species of salmon you are dissecting.*
- *Option: Some independent education suppliers, education supply stores, and science education catalogues carry cloth fish, salmon anatomy puzzles, 3-D models, and posters that can help introduce this dissection activity to students. Teachers may also want to photocopy "Handout 2.9 (Part 1 & Part 2): Salmon External Anatomy" and "Handout 2.10 (Part 1 & Part 2): Salmon Internal Anatomy" onto an overhead transparency for reference.*
- Dissections may be offered as demonstrations or as a hands-on activity with pairs or groups of students dissecting salmon as teachers model the procedure. Have non-participating students use the handout for taking notes describing the procedure and their observations. If conducted as a demonstration, ask students to pass the dissected parts and magnifying lens around the observation table.
- This is an anatomy lesson, intended to provide 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 function of the various fish parts. Students are also encouraged to think about their own bodies and organs and to consider whether similarities exist.
- It is recommended that all students participate physically in the dissection. Students may need to be reminded prior to and throughout this lesson that this is science and, although science can 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.
- To obtain a salmon for dissection, contact your local fisheries biologist. Remember: It is illegal to waste sport-harvested fish or game.

SALMON DISSECTION

Time Required:
45-90 minutes

Level of Conceptual Difficulty:
Simple

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

Safety Warning:
When working with sharp instruments, safety guidelines should be discussed with all participants. This dissection is a guideline only, and individuals participate at their own risk. To reduce risk, it is recommended that a teacher or adult volunteer monitor all facets of the dissection.

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 (Part 1 & Part 2): Salmon External Anatomy" and "Handout 2.10: Salmon Internal Anatomy." Sketch an outline of a human on the chalkboard. 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 make overhead transparencies from the illustrations.)
- If possible, have teacher or adult volunteer assist with any cutting required. If students will be using knives, warn them to use caution. If students are not doing the dissection, have them their hands (or optional skewers).
- This guide will follow the standard progression of salmon dissection. Instruction will cover 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 may look away or move their chairs farther back.
- Have students in pairs or individually use "Handout 2.8: Dissecting a Salmon" to follow the dissection and record their information.

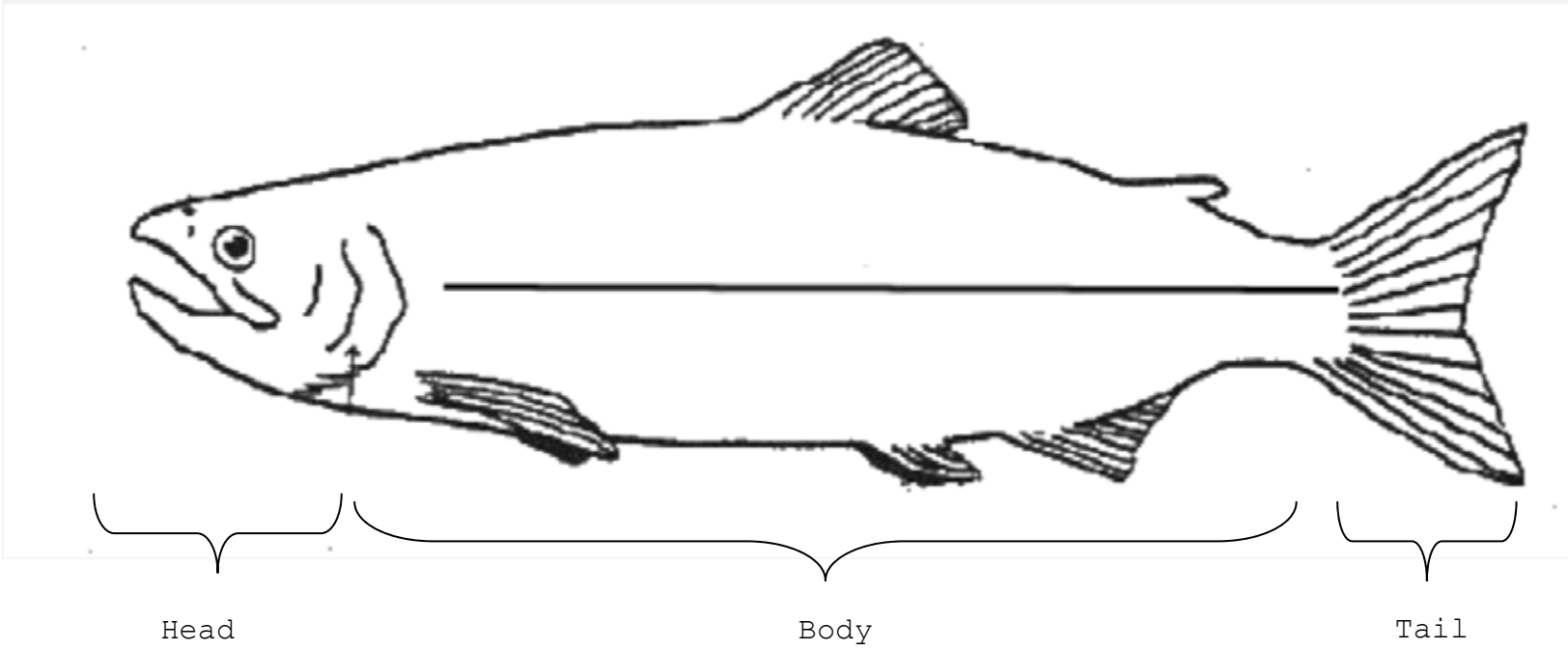
Terms and Background Information:

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.

- **Lateral Line**: 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 sacks 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. There is some evidence the fish also sense medium frequencies.

- **Mouth:** Fish use their mouths to catch food and hold food of various types, but food is not chewed before swallowing. Salmon swallow food whole and the teeth are used for primary purpose of 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.

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

    - Gills are thin-walled structures filled with blood vessels. 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 gills have many blood vessels which accounts for their red color. 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 Christmas tree.

- **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 others are used basically 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. In addition, the caudal 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 diseases, 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 predators.

Internal Anatomy Structures and Their Function:

- **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 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 throughout the body and is part of the circulatory system.
- **Esophagus**: The gullet, or esophagus, carries food from the mouth to the stomach.
- **Stomach**: A sac-like digestive organ receiving food from the esophagus and opening into the intestine.
- **Pyloric Caeca**: 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 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 organ in which white blood cells are produced and red blood cells are recycled. The spleen is also the storage location of blood for emergencies.
- **Brain:** The control center of the nervous center.
- **Otolith**: referred to as "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.

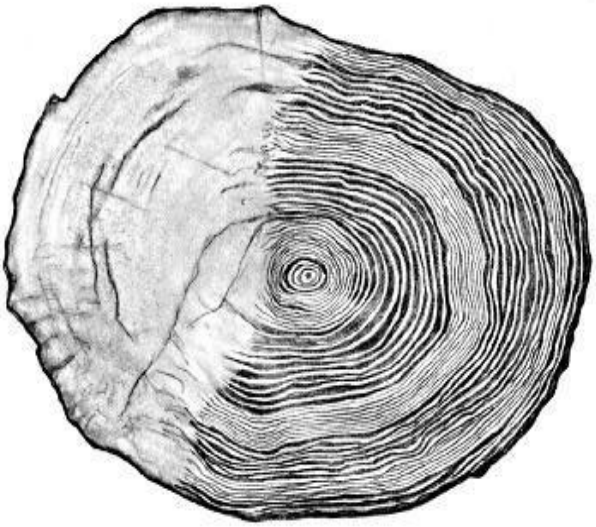
Dissection Preparation:

- 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 physically 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, but not to remove any parts until they have had a chance to discuss them.

External Anatomy Features:

- Use handout 2.7 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

Slime Layer and Scales



Fish scale

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

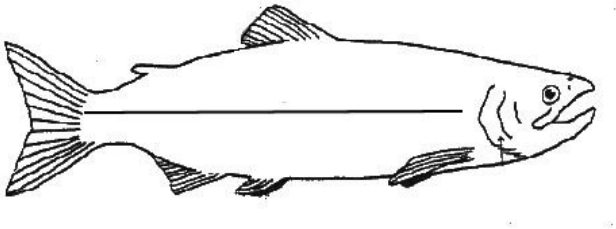
- *The fish is slippery.*
- *Many fish, including salmon, have a layer of slime covering their bodies.*
- *The slime layer helps fish to:*
  - o *Slip away from predators, such as bears;*
  - o *Slide easily through water;*
  - o *Protect it from disease, fungi, parasites and pollutants that might be in the water. (It's a living bandage that protects the salmon.)*

What should you do to protect the slime coat on a fish that is alive?

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

- *Small scales, hard plates like fingernails that cover a fish's whole body.*
- *The scales overlap to form flexible armor plating that protects fish from predators and bruising.*
- *They start to reabsorb their scales when they spawn. (Scales aren't usually completely reabsorbed at the time of death.)*
- *The way 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 fish grow, the scales grow. Along the way, 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?

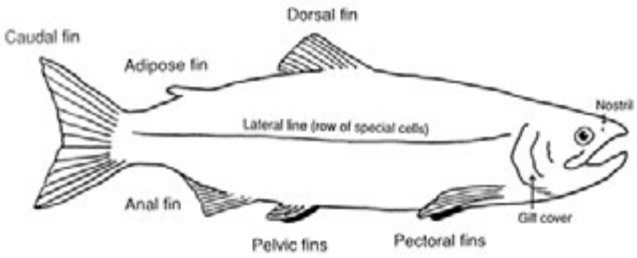
Fish come in many shapes, although torpedo shape is the most common. Salmon are torpedo shaped.

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 outside?

- *On the head, you can see the mouth, eyes, and nostrils.*
- *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.*

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.*

Should you hold a fish by the tail or fins?

- *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.*

Danielle Cyr, 10 years old, properly displays a Dolly Varden that she caught.

Photo courtesy of her father, Paul Cyr.

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, taking 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 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 breath in the water*

Lateral Line

- *Have students examine the line that goes laterally across the body of 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, and to feel movement around them or detect changes in the water.

From external features can you tell if the salmon is a Male or Female?

- *<u>Male salmon</u> will have unique identifiable characteristics:*
  - o *Hump on back*
  - o *Hooked upper jaw, referred to as kype*
  - o *Flat belly*

These features are more identifiable the closer the salmon is to their spawning grounds.

- *<u>Female salmon</u> will have unique identifiable characteristics:*
  - o *No hump on back*
  - o *Slightly rounded upper jaw*
  - o *Rounded belly due to eggs developing inside*

These features are more identifiable the closer the salmon is to their spawning grounds.

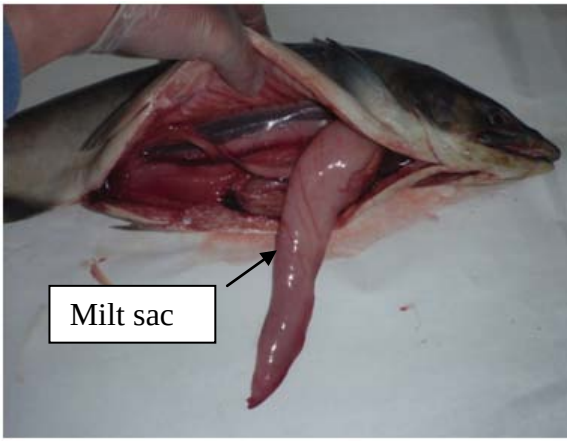
- *Remind students that as scientist we always need to be respectful of our subjects.*
- *If this is going to be table fare, remind them of that.*
- *If it is not going to be food for human consumption, let them know that these salmon are going to be food for other animals.*
- *We do not want to destroy fish in our quest to learn about them.*

Cutting the Fish Open:

Zak Knives and other 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 Zak 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?

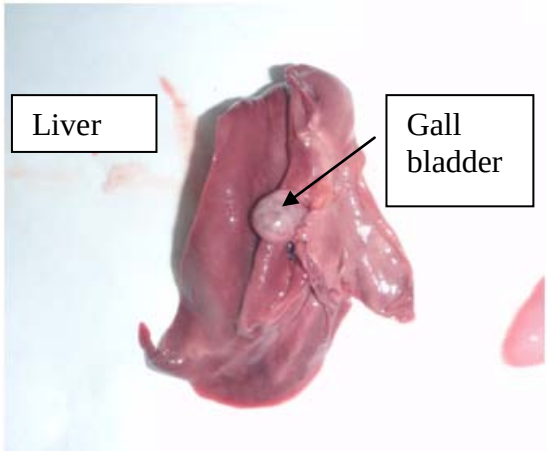
If the fish is a mature female, a large portion of the body cavity will be filled with eggs. If the fish is ripe and ready to spawn, the eggs will be loose within the body cavity; more likely, the eggs will be contained within a membrane (skein). Pull out one of the roe sacs by hand and observe the blood vessels contained within the membrane.

If the fish is a mature male, you will find two whitish-pink sacks that go the length of the body cavity. These milt sacks 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 sacks.

Why does one salmon have so many eggs?

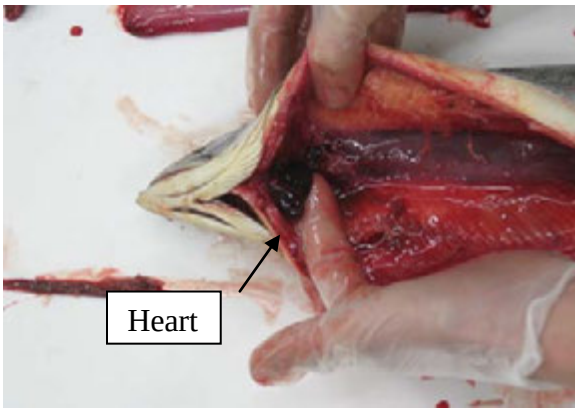
A female coho salmon has about 2,500 eggs, while other salmon species have from 2,000 to 5,000. In coho, only about 15 percent survive to hatch and only about 30 survive the first year. About four will grow to become adults, and only two will live long enough to spawn. So each female produces enough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



What is the largest organ in the fish's body (and in a person's body, too)? Before you remove this organ look to see if a sack of fluid is attached. What is this sack?

The liver is the largest organ. It is dark red and firm in texture. The liver aids the fish in digestion, storage and excretion. This sack is the gall bladder. The gall bladder is a sack in which bile is stored and used to digest fats.

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



The Heart

Where would you find the salmon heart?

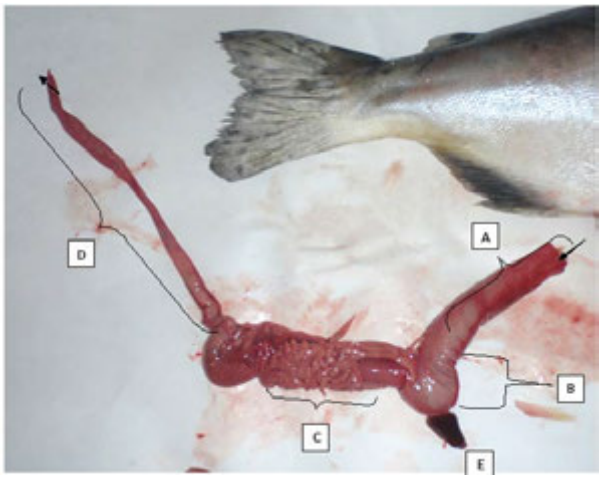
The heart is located where the gill covers fuse together high up in the throat.

Carefully remove the heart with your fingers and place it on a paper plate.

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?

Start at the mouth and feel the tongue and look down the throat follow the route that food would go through the salmon. You can use your finger or a straw to stick down the throat to see where it is on the inside of the salmon.

Mouth: food is not chewed, prey is swallowed whole and alive. Teeth are on their tongue to hold the fish from escaping. Throat/Esophagus

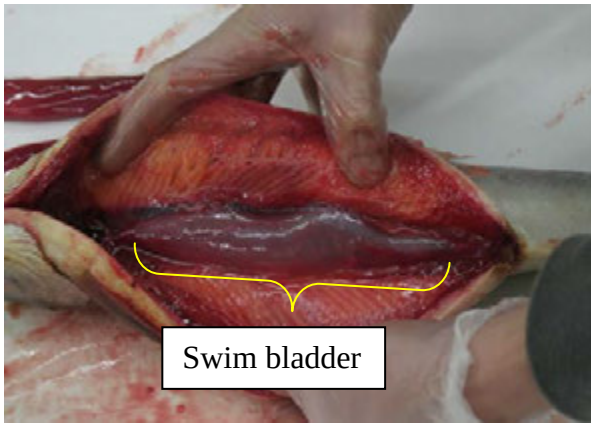
- *(A) The esophagus is tough so prey do not damage or break it.*
- *(B) The stomach is where food starts to break down nutrients.*
- *(C) Pyloric caeca aids in digestion and absorption.*
- *(D) Intestine facilitates absorption and transport of waste to the anal vent.*
- *(E) Look for bright red organ attached to stomach. This is the spleen. The spleen acts as a storehouse of blood and aids in development.*

Carefully remove the digestive system. Assistance with a Zak Knife might be needed to cut the tough tissue of the esophagus.

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

If the fish has been taken from a river, it is unlikely that that food will be found in the digestive system. Salmon do not eat once they enter freshwater. The digestive tract is short and simple, and does not feature the extensive intestine that mammals have.

The Swim Bladder



Carefully look for the swim bladder. It often looks like pink, glossy deflated balloon.

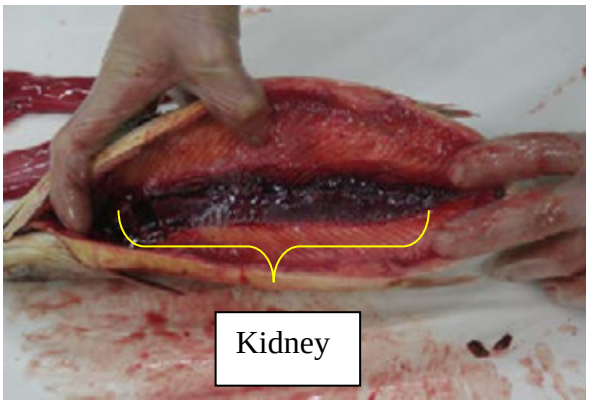
The swim bladder, also called a gas bladder or air bladder, is a whitish, thin-walled sack that may look like a deflated balloon. On salmon the swim bladder is attached to the esophagus by stripping it out from the front with your fingers. Be careful not to damage the swim bladder as you are removing it.

Would anyone care to demonstrate how the bladder can be inflated?

Most fish are able to adjust their swim bladder in order to regulate their buoyancy in the surrounding water. Notice that the swim bladder is just below the spine, which is just below the center line, or the center of balance, 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 a 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 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.

Gently detach the swim bladder, without tearing it, by stripping it out with your fingers. Cut open one end and insert a 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 ask students to examine it.



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.

Tear through the membrane holding the kidney in place and use the spoon carefully to remove it. Place it on a paper plate and ask students to examine it.

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 protect the 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.

What does the backbone look like?

Mammals and boney fish both have a flexible backbone. 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.

Muscle

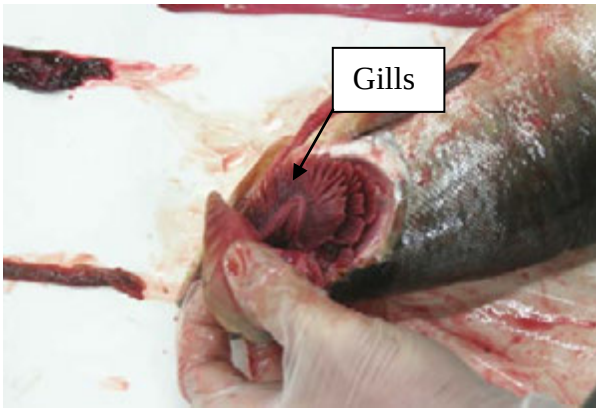
What is the tissue in between the ribs and what does it do for the fish?
Muscle is the main source of locomotion for the fish. It is also the primary part which people use for food. Salmon use their muscles to swim thousands of miles, often surviving only on the fats that have stored while out in the ocean.

- Option: <u>It is illegal to waste sport harvested fish or game!</u> If the fish is edible, have an adult 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.

The Head

The salmon head is boiled in many cultures for soups.

Gills



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

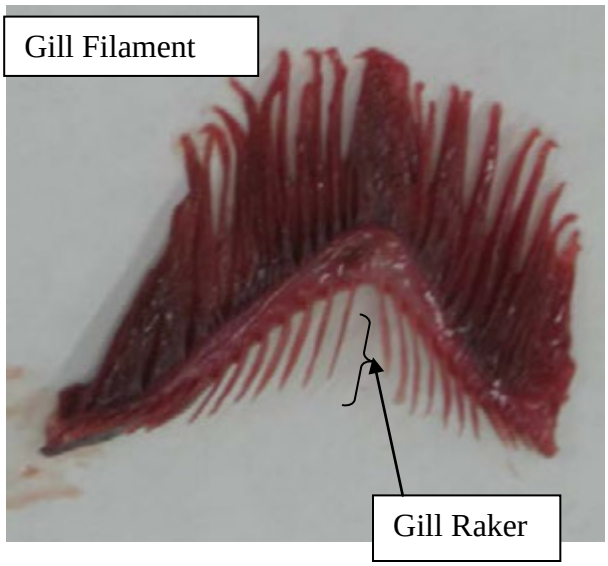
The gulping action demonstrates how water is drawn in through the open mouth. The mouth and throat close and the water is forced out past the gills. Gills extract oxygen from the water. Cold water, if saturated with oxygen and holding as much as it can, may have 13 parts of oxygen for every million parts of water.

To demonstrate what 13 parts per million (ppm) is, imagine that you have a million marbles, of which 13 are white oxygen marbles, and the rest are blue water marbles. If you were to drop one marble per second into your pocket, how long would it take you to reach a million? 12 days! Imagine how large your pocket must be.

At the end of 12 days of marble dropping, you would then drop in the 13 oxygen marbles: that shows how efficient gills must be, and how sensitive they are to material in the water. In fact, some pollutants cause problems at levels of parts per billion. Using the same analogy, it would take 38 years of marble dropping to get a billion! Fish and all living things must live within a healthy environment, which is why it must be clean.

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.



What do they look like?

They are red because you can see the blood through the thin cell walls of the gill filaments. The thin walls aid in the transfer of oxygen. Look for the gill filaments and the gill rakers (the sharp spines that guard the opening of the throat).

Remove the gills 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 gill rakers prevent food from passing through the gill passage, and instead contain, trap, and direct food into the throat.

Vision

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 mouths, but no noses. The nostrils are not connected to the mouth cavity. Their olfactory organs detect chemicals in the water in very tiny concentrations. They use this information to detect harmful pollution and avoid potential threats. They also use smells to recognize their way home.

Can salmon hear?

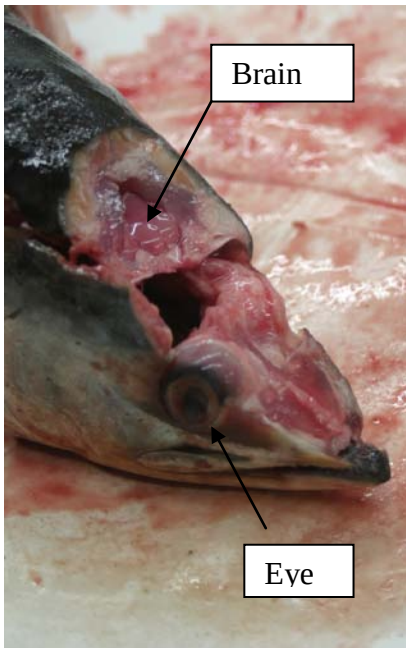
- Fish have an inner ear, but no outer ear. Sound waves travel through the water and through the fish's body to the inner ear.
- Fish may also detect sound waves through their lateral lines.
- The hearing range in fish is probably not as wide as in humans. However, fish likely use hearing to detect predators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

Do salmon have a sense of taste?

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

The Brain

- *(Adult) 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 cords 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 the 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 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 can create new 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 that are made up of specialized organs in order to live. Some of these organs have similarities to humans and other animals. Some organs 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

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
- Sliver 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

Sockeye (red)
- Green head
- No spots on tail or back
- No streak on tail
- Mouth is white with a white gum line

Salmon Key

Handout 2.7, (Optional)

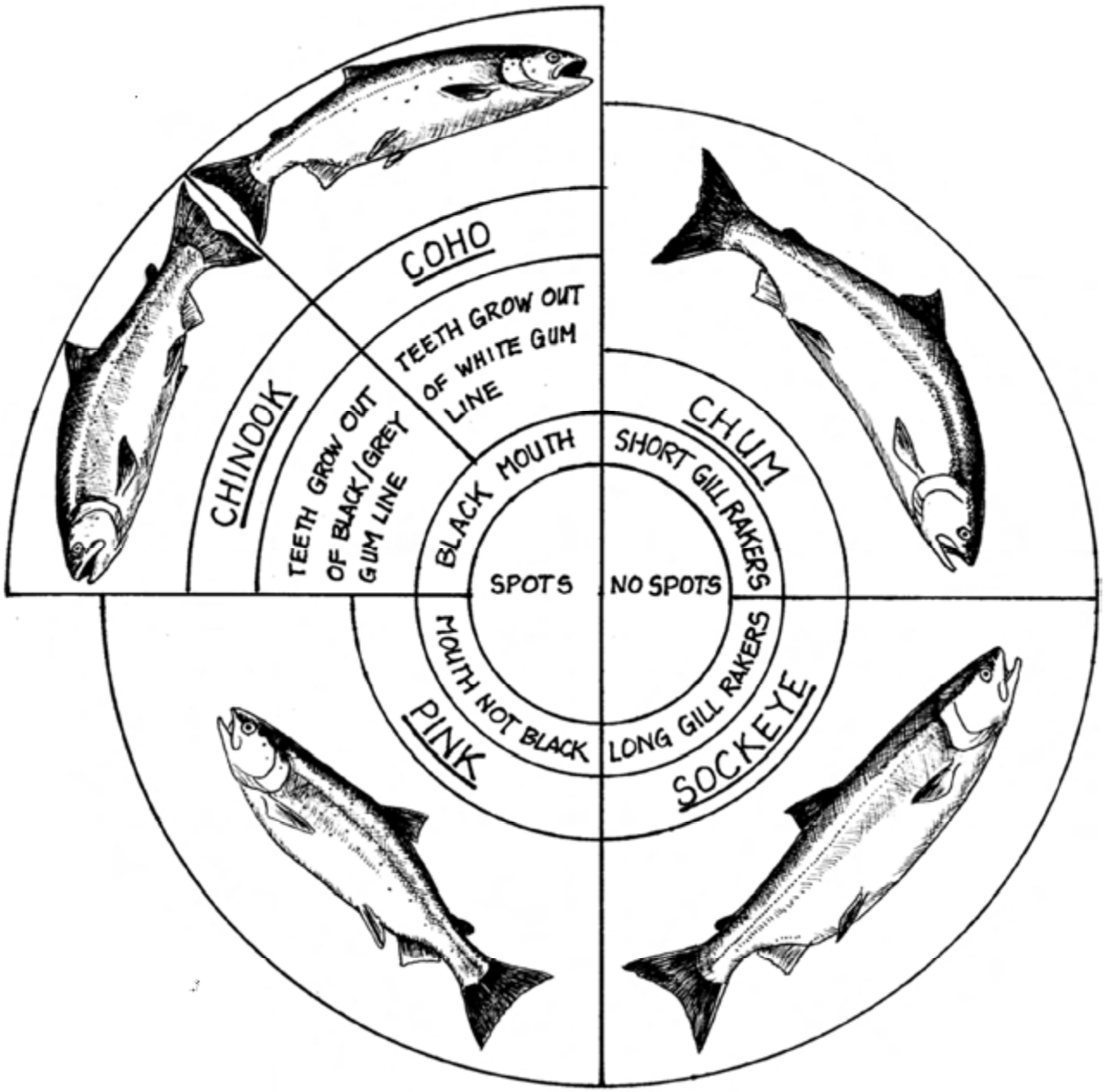


Illustration: Donald Gunn

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

Handout 2.8

Dissecting a Salmon

Name:

Mouth
Why does the salmon tongue have teeth on it?

Slime Layer and Scales
The slime layer helps salmon to:

-
-
-

Lateral Line
The lateral line 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:

Handout 2.8

Dissecting a Salmon

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.

Gills and Gill Rakers

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

Eggs or Milt

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

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

Handout 2.8

Dissecting a Salmon

The Liver

Describe the color and texture of the liver.

The Heart

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:

The Swim Bladder

Describe how the swim bladder works:

Handout 2.8

Dissecting a Salmon

The Kidney

Describe the salmon kidney and what it looks and feels like:

The Ribs and Backbone

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

Explain how you should hold a salmon you caught so you don’t hurt the fish:

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

Handout 2.8

Dissecting a Salmon

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:

Handout 2.9 (Part 1)

Salmon External Anatomy

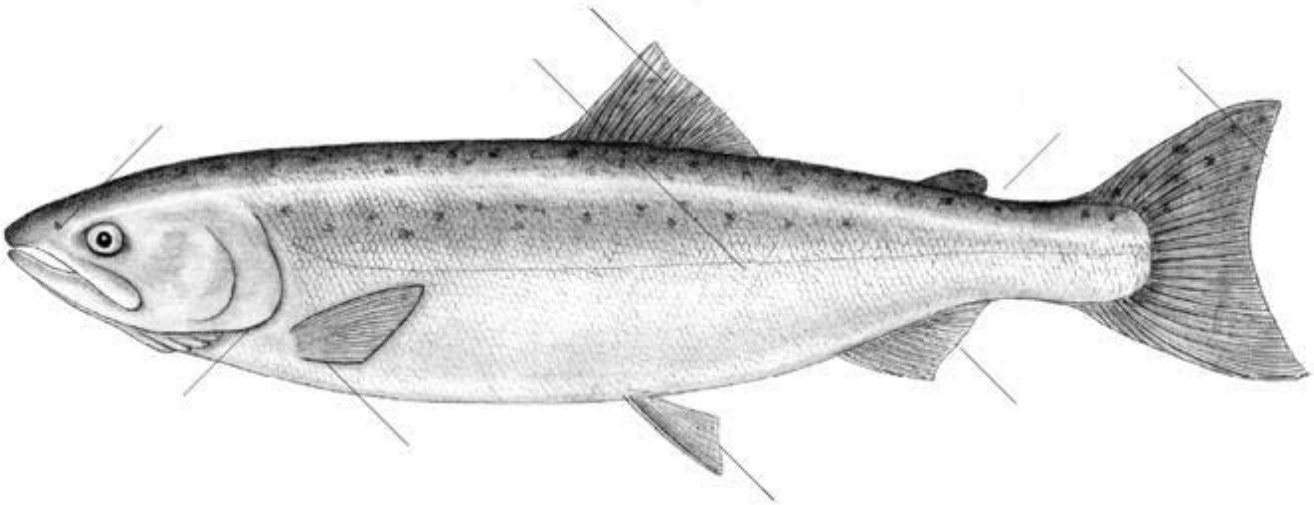
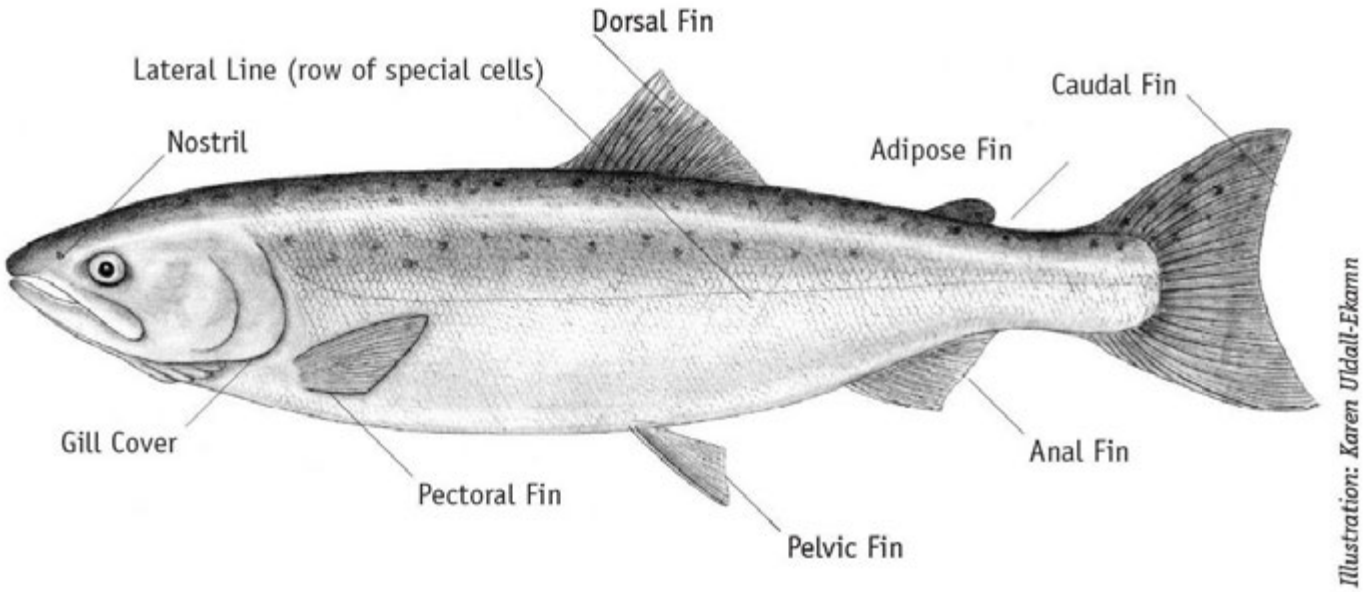


Illustration: Karen Udall-Ekamn

Handout 2.9 (Part 2)

Salmon External Anatomy



Handout 2.10 (Part 1)

Salmon Internal Anatomy

female salmon

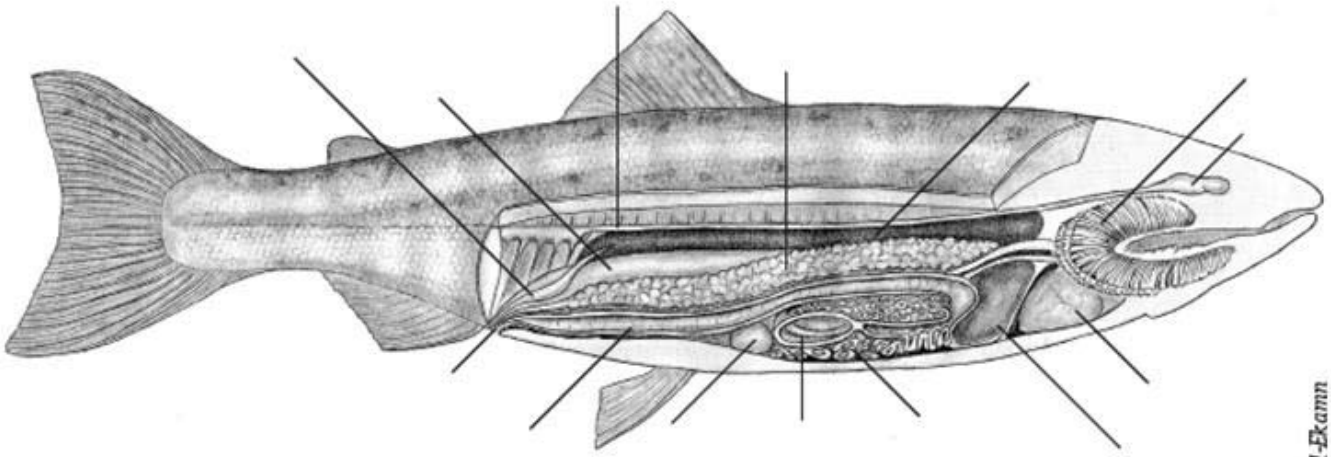
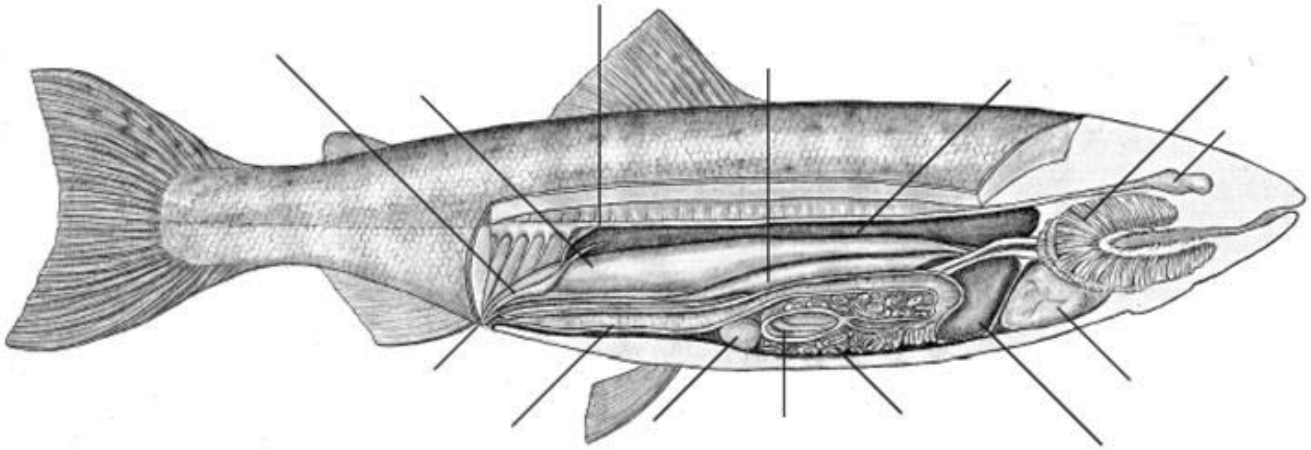


Illustration: Karen Udall-Ekamn

male salmon



Handout 2.10 (Part 2)

Salmon Internal Anatomy

female salmon

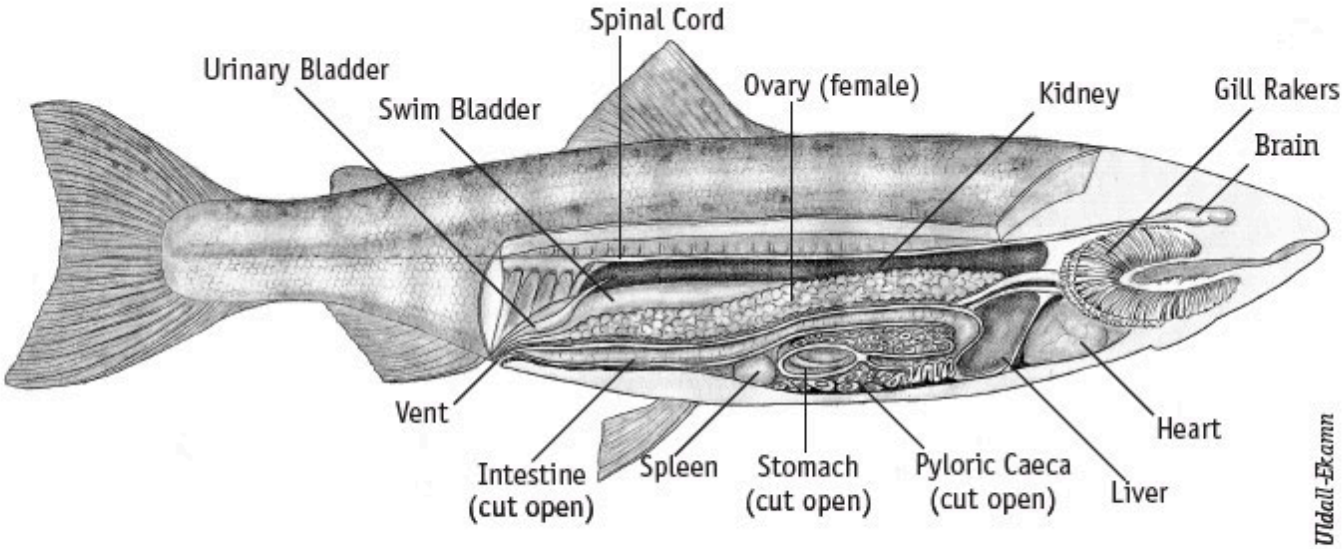
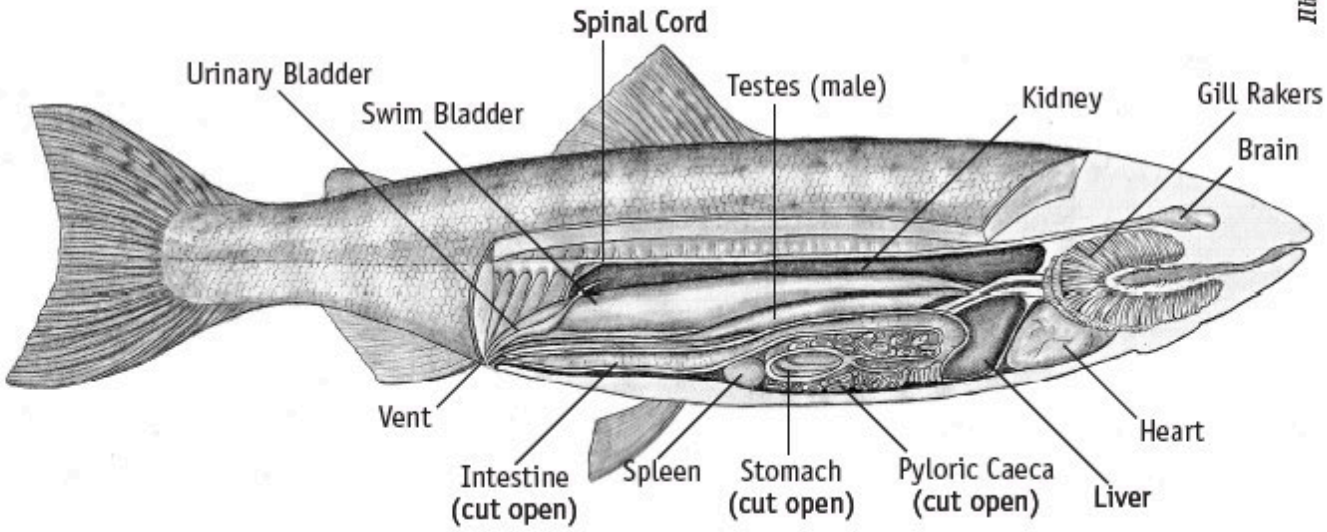


Illustration: Karen Uldall-Ekamn

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.