

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 1.2 SB 2.1	SA 1.1 SA 1.2 SB 3.1 SC 2.2	SA 1.1 SA 1.2 SB 3.1 SC 2.2 SC 3.1

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

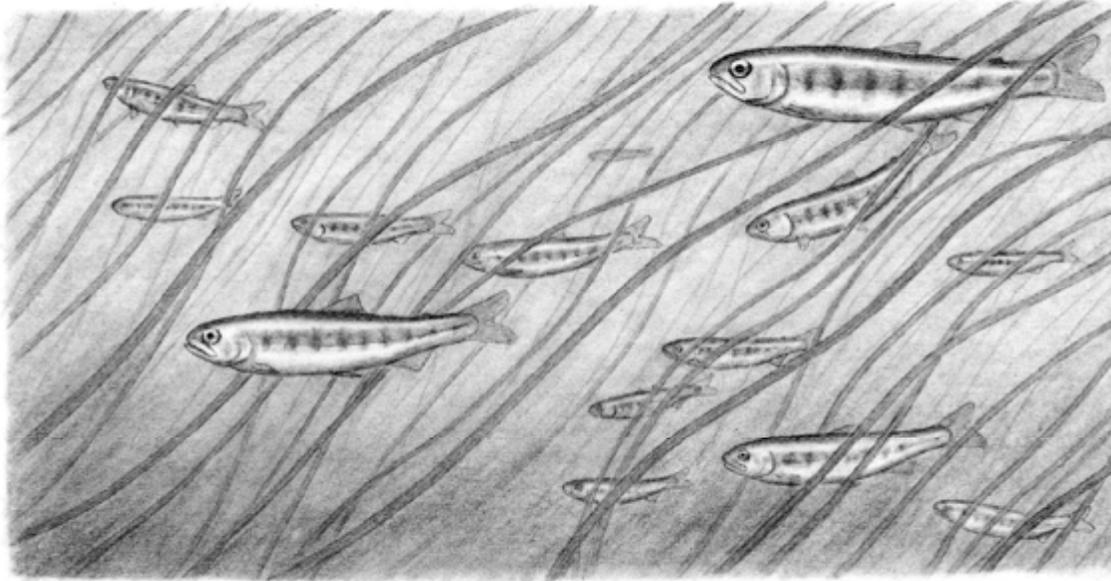


Illustration: Karen Uldall-Ekman

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

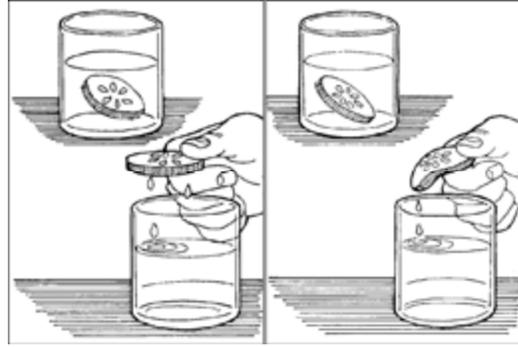
- ☞ Divide the class into small groups. Give each group two containers with approximately 250 mL of water in each, and approximately 15 mL of salt.
- ☞ Have the groups prepare a saltwater solution by dissolving the salt in one container of water.
- ☞ Give each group two fresh slices of cucumber. Ask 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.



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.

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.

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).

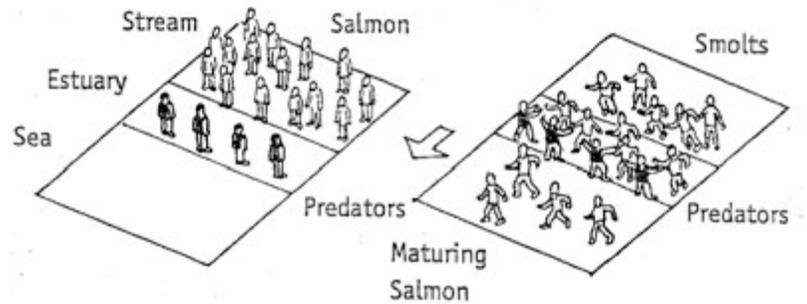


Illustration: David Gunn

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.

- ☞ 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.

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.
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.)

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.)

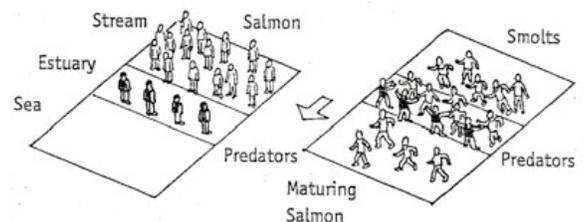


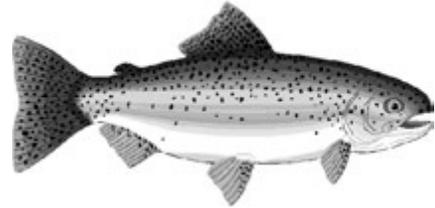
Illustration: David Gunn

The Predator/Prey Game

Handout 8.3, (Part 2)



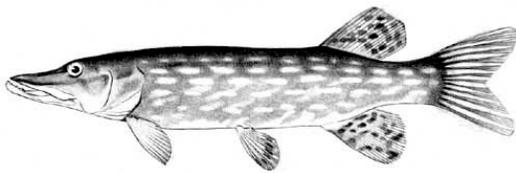
Orca



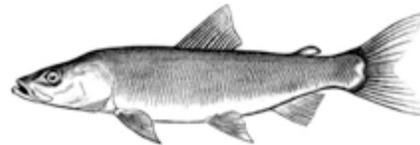
Trout



Red-breasted 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).