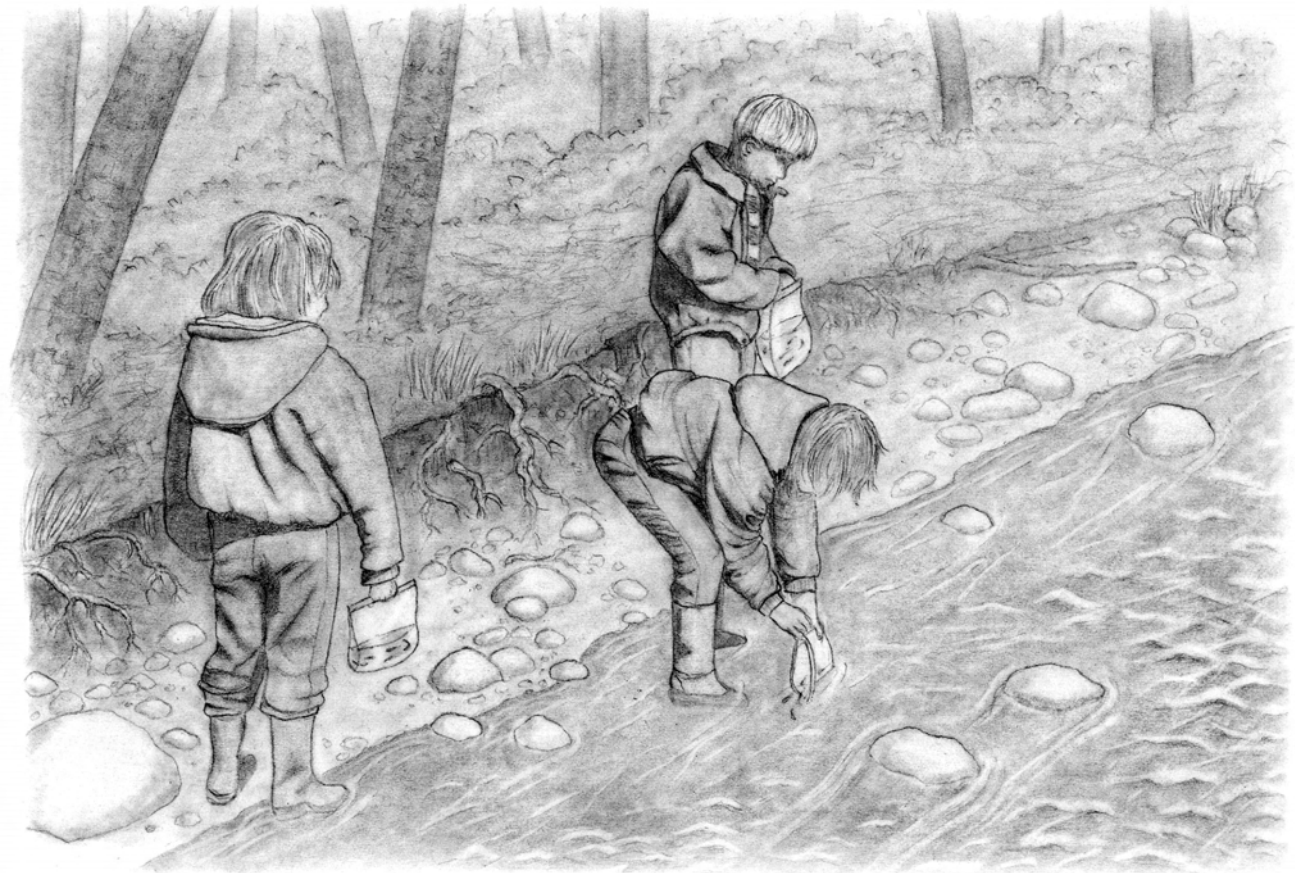
SALMONIDS IN THE CLASSROOM

PRIMARY



Fisheries and Oceans Canada
Pêches et Océans Canada

Canada

Salmonids in the Classroom: Primary
Field Test Version

A Teacher's Resource
for Studying the Biology, Habitat and Stewardship of Pacific Salmon

For Further Information, Contact:
Community Involvement Division
Fisheries and Oceans Canada
555 West Hastings Street,
Vancouver, BC V6B 5G3
(604) 666-6614

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Canada

SALMONIDS IN THE CLASSROOM

PRIMARY

DEDICATION

This package is dedicated to all of the teachers and students who have studied salmon over the years and especially to those classes who have gone on to turn study into action, aiding in the conservation of Pacific Salmon.

ORIGINAL VERSION

This publication takes inspiration from the original 1984 version and subsequent 1988 revised *Salmonids in the Classroom* package. Linda Bermbach, then Chief Curriculum Writer for Fisheries and Oceans Canada, coordinated the production of these first packages.

REVIEW/COORDINATION

Package development was conducted under the direction of Southam Consulting Inc. and in consultation with the review committee:

Bev Bowler, Education Coordinator, Lower Mainland, Fisheries and Oceans Canada

Mark Johnson, Chief, Community Involvement Division, Fisheries and Oceans Canada

Don Lowen, Education Coordinator, Vancouver Island, Fisheries and Oceans Canada

All education coordinators working for Fisheries and Oceans Canada

Biological Review: Anne Martin, Enhancement Data Coordinator, Fisheries and Oceans Canada, Carol Cross, Senior Regional Enhancement Biologist, Fisheries and Oceans Canada, Sue Lehmann, Regional Enhancement Biologist, Fisheries and Oceans Canada, Roberta Cook, Regional Enhancement Biologist, Fisheries and Oceans Canada, Don MacKinlay, Regional Enhancement Biologist, Fisheries and Oceans Canada, Brian Anderson, Regional Enhancement Biologist, Fisheries and Oceans Canada
Doug Lofthouse, Regional Enhancement Biologist, Fisheries and Oceans Canada, Don Bailey, Regional Enhancement Biologist, Fisheries and Oceans Canada

PRODUCTION TEAM

Research and Writing: Polestar Communications Inc.
Editing: Lorna Lyons, Twinflower Communications
Illustration: Freestyle Illustration, Penn and Gunn Associates
Design and Layout: Cone House Inc.
Poster: Robert Browne Graphics
Special thanks to Joanne Day and Joanne Nicklas for their support and research.
Cover illustration: Karen Uldall-Ekman

THE TEACHERS

The educators involved in conceptualizing and writing this package were:

Focus Group in Victoria, 1997
- Lenny Ross, Strawberry Vale Elementary School
- Eleada Grant, Glanford Elementary School
- Judith Sales, Lake Hill Elementary School
- Jennifer McDonald, Craigflower Elementary School
- Cecily Craigmyle, Frank Hobbs Elementary School
- Don Craigmyle, Uplands Elementary School
- Angus Stewart, Royal Oak Middle School

Focus Group in North Vancouver, 1998
- Kitty Morgan, Marlborough Elementary School
- Coleen Lavallee, Seaforth Elementary School
- JudiBeverley O'Conner, Shaughnessy Elementary School
- Brenda Hobbs, James Hill Elementary School
- Richard Unrau, Strawberry Hill Elementary School
- Greg Fraser, Quilchena Elementary School
- Donna Bouwman, Douglas Road Elementary School

Focus Group in Saanich, 1998
- Liz Priestman, Strawberry Vale Elementary School
- Frances Hancock, Margaret Jenkins Elementary School
- Rosina Werk, Margaret Jenkins Elementary School
- Shirley Cummins, Northridge Elementary School
- Judith Sales, Lake Hill Elementary School

Educators Consulted By Polestar Communications
- Jim Wiese, Science Education Consultant
- Bruce D. Horn, Primary Classroom Consultant
- Beverley O'Conner, Intermediate Classroom Consultant

Reviewer for Salmon Science
- John Stockner, Ph.D., Eco-Logic Ltd.

Many thanks to Fisheries and Oceans Canada's Education Coordinators and the 116 teachers who participated in an extensive field test review of *Salmonids in the Classroom* over the 2000-2001 school year.

FOREWORD

WHY SALMON?

"What we sometimes forget is that changing the way people think is not just a matter of reaching people's minds, but also touching their hearts."

David Guggenheim, Vice President,
The Ocean Conservancy

"Long before the environmental stress on a river becomes obvious to most of us, it shows up in the fish. They are canaries in a mine – but canaries that cannot sing. We must pay attention to what the fish are telling us, and to the whispering voices of our rivers, for they are speaking about our future."[1]

"Because so many human activities have harmed Pacific salmon, a serious effort to save them will affect almost everyone in the Northwest"[2] Education is key to this effort.

This learning resource, which focusses on salmon, biology, and stewardship, encourages an ecological approach, integrating science with social studies. Knowledge of salmon biology and habitat are viewed as building blocks toward a stewardship ethic. Stewardship means "making informed decisions and taking appropriate actions to protect and conserve all plants and animals who share our planet."[3] And stewardship is one of the building blocks of a sustainable community where the economy, the environment and society are all taken into consideration when decisions are made. In short, this resource is about teaching kids how to "take care in our own lives so that salmon thrive!"

Whether small or large, class projects based on salmon have the potential to engage students in stewardship and sustainability. Studying a local creek, raising salmon in an incubator, or touring a watershed, are just a few of the projects that your class or school can undertake to make a difference for salmon and for us all!

FISHERIES AND OCEANS CANADA

Salmonids in the Classroom is funded by the Habitat and Enhancement Branch (HEB), Pacific Region, Fisheries and Oceans Canada (DFO). DFO's national vision is:

"Safe, healthy, productive waters and aquatic ecosystems, for the benefit of present and future generations, by maintaining the highest possible standards of: service to Canadians; marine safety and environmental protection; scientific excellence; and conservation and sustainable resource use."

HEB is responsible for the protection and restoration of fish habitat, salmonid enhancement programs, integrated resource management planning, community involvement programs and public education. HEB also operates a large number of facilities, such as fishways,

[1] Mark Hume, *The Run of the River*
[2] Pacific Salmon Bring It All Back Home, *BioScience*, November, 1997, pp. 657-660
[3] *Water Stewardship: A Guide for Teachers, Students and Community Groups,* Ministry of Environment, Lands and Parks, 1995.

hatcheries and spawning channels. HEB is headquartered in Vancouver, with area offices and staff throughout the Pacific Region, which includes B.C. and the Yukon.

"One of the most important vehicles we have for change on our planet is education. With the right teacher, learning about one's natural environment while *experiencing* it can be a life-changing event that forever alters one's perspective and understanding. I suppose I am living proof."

David Guggenheim, Vice President,
The Ocean Conservancy

HOW TO USE THIS BOOK

The foreword to this learning resource contains a table that lists seasonal activities for areas in B.C. and the Yukon. The foreword also contains tables of Integrated Resource Package (IRP) connections. The table of contents lists all of the units organized according to the salmon life cycle. Each unit has an introductory activity (use this for prior knowledge assessment) and at least one science-based activity. The wrap-up sections in each unit give teachers ideas for assessment, activities students can do at home and ways to tie the unit into salmon incubation if your class has an incubator.

Utilizing the seasonal activities and IRP tables, a teacher can plan a unit that makes sense for their timetable and that relates to the resources available in their area.

PEOPLE AND CONNECTIONS THAT CAN HELP

Teachers are encouraged to contact a DFO office in their community and to talk to their area education coordinator or community advisor. These people will tell you about other fun DFO learning resources, classroom presentations or teacher workshops that may be available in your area. If you cannot find an office in your area, phone the Regional Office in Vancouver and ask for a community directory or visit the website http://www.pac.dfo-mpo.gc.ca.

RELATED LEARNING RESOURCES

Fisheries and Oceans Canada has a number of other learning resources. Contact the B.C. Teachers Federation (1-800-663-9163) and ask for a catalogue or visit their website at http://www.bctf.bc.ca. For more depth on any education resources related to marine and aquatic environments, refer to the *Marine and Aquatic Educators Resource Guide*, produced by DFO and distributed by BCTF Lesson Aids.

Fisheries and Oceans Canada works cooperatively with other organizations involved in aquatic education, such as Wild B.C. Wild BC is a government-sponsored education program that produces a number of excellent resources on aquatic education. It is funded and administered by the Habitat Conservation Trust Fund. Call 1-800-387-9853 for more information on Wild B.C.

"Their lives are part of a great cycle – the migration of fry or smolts from freshwater streams to the ocean; the grand travels of silvery adults through the North Pacific; the arduous migration upstream to their natal stream reach; the battles and lovemaking of gaudily coloured distorted bodies on the spawning grounds; and the inevitable swift decay and death of the battered fish among the eggs of the generation to follow. All aspects of this cycle have stirred the human imagination."

Sydney, Richard and Robert Cannings,
The World of Fresh Water

BRINGING IT ALL TOGETHER FOR ASSESSMENT

The following teaching strategies are suggested as a means of facilitating assessment.

Beans, Fish and the IRPs

Some of the activities in this learning resource (e.g., growing beans) may not seem at first to relate to fish. An effort was made to link this resouce to as many prescribed learning outcomes as possible. Beans and fish facilitate the comparison of plant and animal life cycles.

Learning Logs, Portfolios and Journals

Throughout the manual, children are encouraged to note their learning through writing or drawing. At the end of the salmon study, students and their teachers can reflect on the learning by referring to the student learning logs, portfolios or journals. If your students find writing and drawing challenging, have them work in groups. Capitalize on the strengths of each child and create collaboratively.

Murals and Mobiles

The poster that accompanies this manual shows the life cycle of the Pacific salmon. Teachers are encouraged to create their own class' creative depiction of the salmon life cycle, salmon habitat and human interactions with salmon in student-created murals, mobiles or watershed models.

Make a Salmon Book

By stapling together the student handouts for every unit, a book depicting the entire life cycle can be created for each student.

ETHICAL DISCUSSIONS

"The animals that eat carcasses poop along the streambanks and fertilize the soil. It's all tied together. The whole riparian ecosystem depends on salmon carcasses."

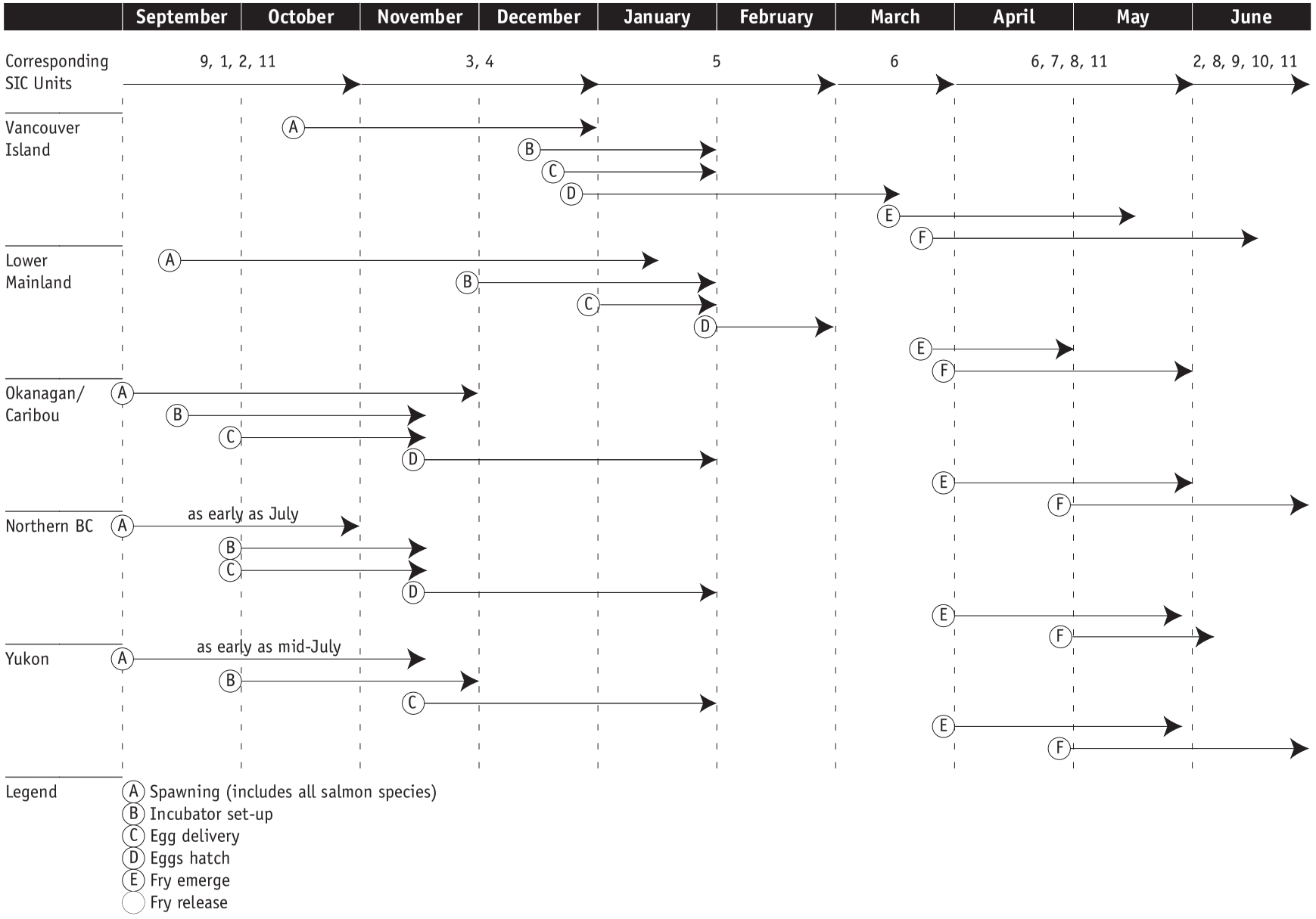
"Pacific Salmon Bring It All Back Home,"
BioScience,
November, 1997, pp. 657-660

Several of the activities in this manual involve growing plants or raising animals. Before beginning activities like this, set the ground rule for classroom conduct. *Introduce the basic rule that we must respect all living things.*

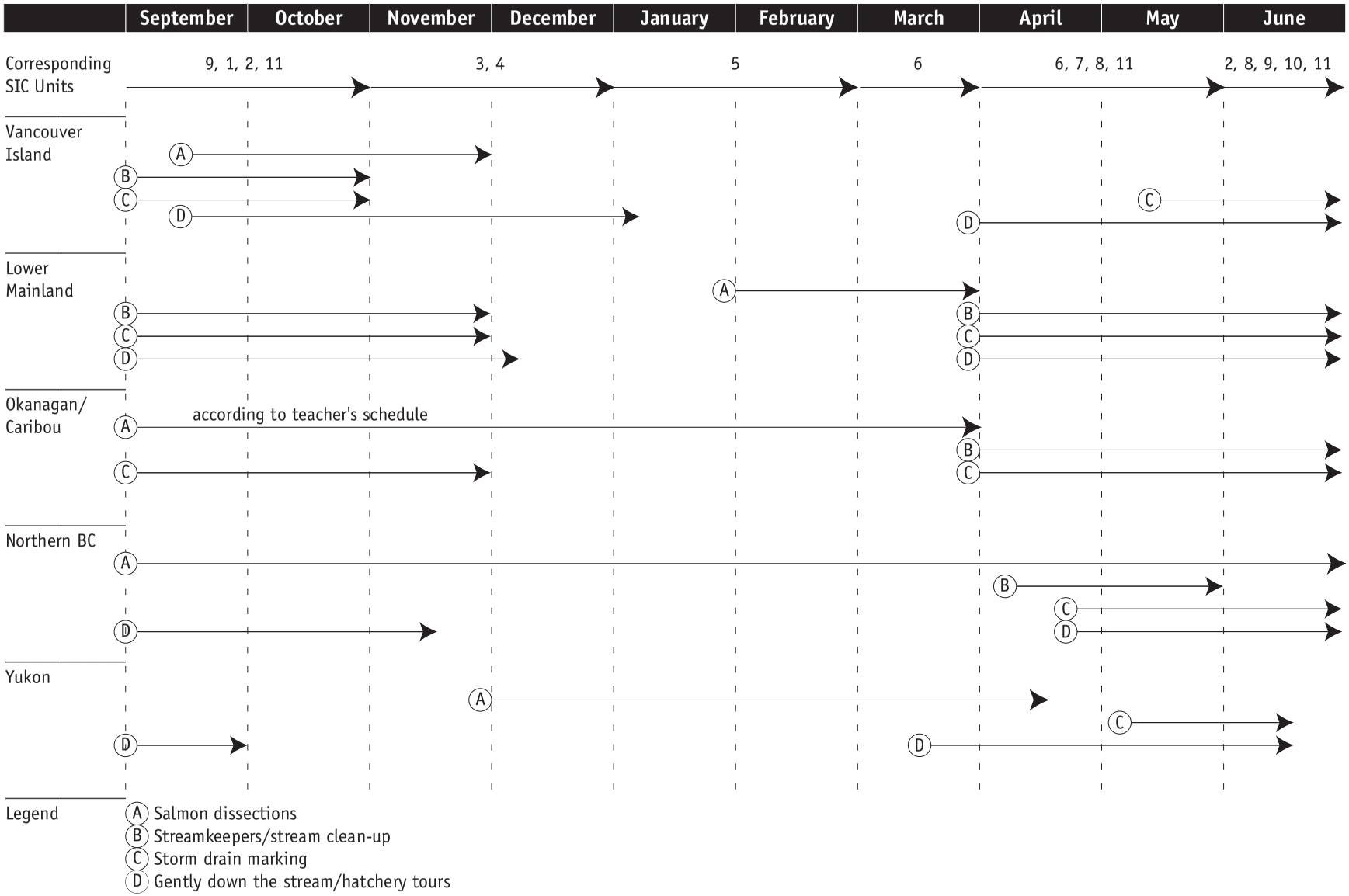
It is likely that questions about the difference between 'wild', 'native' and "cultured' will arise, but especially if your class wants to rear salmon or revegetate a streambank. If students want to raise salmon, talk to the area DFO education coordinator about where the eggs for your incubator will originate. DFO is trying to ensure that cultured juvenile salmon are returned to their home stream in most instances and children may not be able to release their salmon in the stream nearest to their school. If they want to revegetate a streambank talk to an area naturalist group first about what is native (i.e. grew and lived historically in the area) and either propagate native plant species or find a native plant nursery that sells native plants.

The genetic diversity activity in the Intermediate *Salmonids in the Classroom* resource facilitates discussions about "wild", "native" and "cultured". Maintaining genetic diversity (the native flora and fauna) is like maintaining a strong web. When we break the links (with non-native or cultured species), the web of life weakens. Alert the children to the fact that raising fish in the classroom is a positive achievement but that, alone, it will not solve the overall decline of salmon populations. Point out that their classroom incubator project will be most effective if it is just one tool in a whole array of community activities aimed at conserving native fish populations. Invite representatives of a local Streamkeepers group into your classroom and have them talk about the importance of habitat and stewardship.

Raising Salmon and Visiting Streams



Stewardship Activities



RELEVANCE TO CURRICULUM

The following charts document the prescribed learning outcomes met by units in this resource.

Primary IRP Prescribed Learning Outcomes

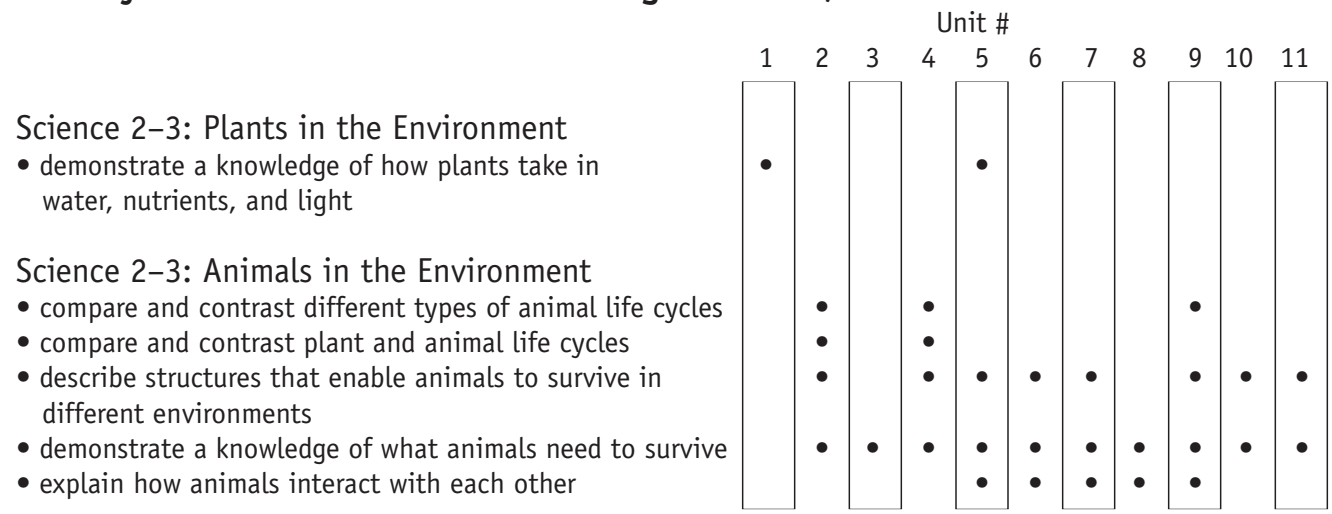
	Unit # 1	2	3	4	5	6	7	8	9	10	11
English Language Arts (K – 1)											
comprehend and respond (comprehension)	•	•	•	•	•	•	•	•	•	•	
communicate ideas and information (knowledge of language)	•	•	•	•	•	•	•	•	•	•	•
communicate ideas and information (composing & creating)	•	•	•		•	•	•	•	•	•	•
communicate ideas and information (improving communications)	•										•
communicate ideas and information (presenting and valuing)		•	•				•	•	•	•	•
self and society (working together)	•	•		•	•	•	•	•		•	•
self and society (building community)	•	•			•			•	•	•	•
English Language Arts (2 – 3)											
comprehend and respond (comprehension)		•	•	•	•	•	•	•	•	•	•
communicate ideas and information (knowledge of language)	•	•	•	•	•	•	•	•	•	•	•
communicate ideas and information (composing & creating)		•	•	•	•	•	•	•	•	•	•
communicate ideas and information (presenting and valuing)		•	•				•	•	•	•	•
self and society (working together)	•	•		•	•		•	•		•	•
Social Studies (K – 1)											
society and culture		•							•		
environment					•					•	
Social Studies (2 – 3)											
environment				•	•			•		•	•
Math (K – 1)											
statistics and Probability (data analysis)		•					•	•	•		
shape and space (measurement)		•									
Math (2 – 3)											
statistics and probability (data analysis)		•					•	•	•		
shape and space (measurement)		•									
patterns and relationships							•	•			

Primary Science IRP Prescribed Learning Outcomes

	Unit #										
	1	2	3	4	5	6	7	8	9	10	11
Science K–1: Applications of Science											
• safely carry out instructions and procedures involving a small number of steps		•	•	•	•	•	•	•	•		•
• collaborate with others in scientific investigations	•	•		•	•	•	•	•	•		•
• suggest possible interpretations for a set of observations	•	•	•	•	•	•	•	•	•		•
• describe the similarities and differences between simple objects		•	•		•				•		
• suggest questions for investigations	•										•
• handle equipment and materials safely		•		•		•	•	•	•		•
Science K–1: Plant and Animal Characteristics											
• describe the characteristics of a variety of plants		•					•				
• collaborate with others in the care of a plant or animal*	*	•		*	*	*					*
• describe the appearance and behaviour of a variety of animals		•	•	•	•			•	•		•
• determine the requirements of healthy plants and healthy animals		•		•	•	•	•		•		•
• identify similarities and differences among animal species		•	•	•	•	•					
Science K-1: Plant and Animal Life Cycles											
• identify the stages in the life cycle of a plant and of a pet or other animal	•	•		•	•	•	•	•	•	•	
• compare the life cycle of an animal hatched from an egg with one born from the mother	•							•			
Science 2–3: Applications of Science											
• conduct simple tests and describe observations		•	•	•	•	•	•	•	•		•
• formulate questions to guide observation and investigations	•								•		
• use a variety of measuring instruments to gather accurate information									•		
• identify patterns and groupings to draw conclusions from information	•	•	•	•	•	•	•			•	
• communicate scientific observations to peers, teachers, and family		•	•	•	•	•	•	•	•	•	•
• construct models to represent ideas or concepts			•	•	•	•	•	•	•		
• describe the ways people in the community use science						•				•	
• use a variety of science equipment safely		•	•	•		•	•	•	•		•

** Applicable for class using fish incubators*

Primary Science IRP Prescribed Learning Outcomes, continued



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UNIT 1

BUILDING VOCABULARY AND KNOWLEDGE

BUILDING VOCABULARY AND KNOWLEDGE

OVERVIEW

The class reviews what students know about salmon and prepares for activities to learn more.

THE BIG IDEA

Students learn basic vocabulary necessary for studying salmon, and identify what they know, wonder and want to learn about salmon.

KEY WORDS

For definitions refer to “Appendix 8: Glossary”.
Basic: salmon, fish, egg, alevin, fry, smolt, adult, spawner, life cycle

KNOW, WONDER, LEARN

Materials:

- Copies of "Handout 1.1: Know, Wonder, Learn" for each student, blown up on a photocopier to the largest size possible
- Chart paper and markers
- Portfolios to collect and store materials related to salmon

Time required:
One lesson

Level of conceptual difficulty:
Simple

Suggestions for assessment:
Monitor students' ideas and review their "Know, Wonder, Learn" pages to determine handout completion and students' willingness to participate.

- Divide a sheet of chart paper into three columns (or use three sheets) and label them "Know," "Wonder" and "Learn." Ask students to tell the class any facts they know about salmon, that is, things they know to be true. Ask the class if they agree with suggested facts. Write facts with which the class agrees in the column labelled "Know." Write statements with which the class does not agree in the column labelled "Wonder."
- Ask the class if anyone has any questions about salmon and its life cycle and habitat, and add any statements to the column labelled "Wonder." Explain that the class will add to the "Learn" column later.
- Give students copies of "Handout 1.1: Know, Wonder, Learn" and have them copy the information from the class chart to their page. You may alternatively wish to do this yourself and provide photocopies for younger students.
- Store the charts in a salmon studies portfolio, or post them in the classroom. Refer to the charts periodically as students find out more information through their salmon studies. Ask students what they have learned to answer their questions and add their information in the column labelled "Learn." Ask if they have new questions to add.
- Have students begin gathering materials from the following units for their salmon portfolios, and add to them as they complete further activities.

BUILDING VOCABULARY

Materials:

- Labelled pictures of various plants, animals and fish for each group of students
- Copies of "Handout 1.2: Salmon Words" for each group, cut into individual illustrations
- Notebook, learning log or portfolio to collect materials related to salmon
- *Option:* poster paper, glue and coloured pencils

Note: Salmon puppets may be purchased from the British Columbia Teachers' Federation by phoning 1-800-663-9163

Time required:
One lesson

Level of conceptual difficulty:
Simple

Suggestions for assessment:
Monitor students' ideas and comments to ensure that they understand the meanings of basic salmon vocabulary.

- Cut out and label pictures of various plants, animals and fish from "Handout 1.2: Salmon Words", magazines or other sources.
- Have students in groups sort labelled pictures into categories based on their own criteria.
- Have the groups explain their categories to the class and identify any words they do not know. Provide a definition for unknown words (see Glossary), and make a salmon dictionary on a chart posted on the classroom wall. Continue to add words to the dictionary in the units that follow.
- Have students select the pictures showing the salmon's life cycle and predict what the topic will be about (e.g., *egg, alevin, fry, smolt, adult, spawner)*. Encourage students to make a poster by putting the pictures into the life cycle sequence.
- Explain that the Salmon Studies activities will look at how salmon are born, grow up and become adults. If appropriate, outline how you plan to present the class' Salmon Studies through the year (see Foreword, page vii.)
- Have students write their new words in a journal or learning log.
- Optional: Have students make a poster of the salmon's life cycle by pasting the pictures in the correct habitat, and in the correct sequence. Students may wish to further illustrate salmon habitat using coloured pencils.

BUILDING VOCABULARY AND KNOWLEDGE

WRAP-UP

EVIDENCE FOR UNIT ASSESSMENT

- Have students use the materials from this unit to begin a learning log to which they can refer and add in the following units.

LANGUAGE AND ARTS INTEGRATION

- If possible, invite students from an older class to monitor and assist younger students in reading the unit fact sheets about salmon, carrying out experiments from the following units, and finding answers to questions asked by the younger students.
- Have students use the cards from "Handout 1.2: Salmon Words" to quiz each other on word recognition and spelling.
- Have students paint salmon pictures they can use on the cover of a salmon portfolio, or to decorate the classroom or a bulletin board.
- Read a short story to the class from the suggested resources about the salmon life cycle. Have students use the words they have discovered to write a story or poem about salmon.

HOME CONNECTIONS

- Have students read their new salmon words to an adult and explain what the words mean.
- Have students fill in "Appendix 4: Classroom Salmon Science News" and read it to an adult.

SALMON INCUBATION

If you have a classroom salmon egg incubator, have students learn the names of its components, examine how it works and set it up for receiving salmon eggs. For assistance, refer to "People and Connection That Can Help" on page viii of the Introduction.

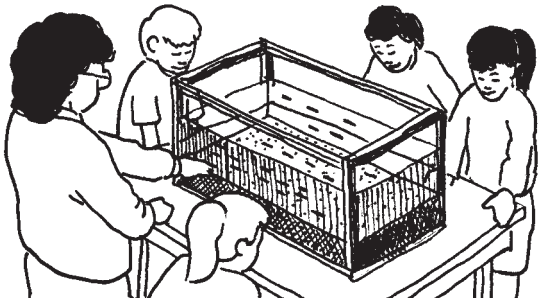


Illustration: Donald Gunn

➡ Have students use a shoebox to create a model of an incubation tank. Have them draw or cut out pictures of the tank's apparatus (filter, hoses, dechlorinator, etc.), then label and glue them into the model. Have the students add clean gravel to the box (or simulate gravel using foam chips or balls of paper). As you add eggs to the tank and watch them develop, have students use modelling clay to form eggs, alevins or fry and place them in the appropriate part of the box.

HANDOUT 1.1

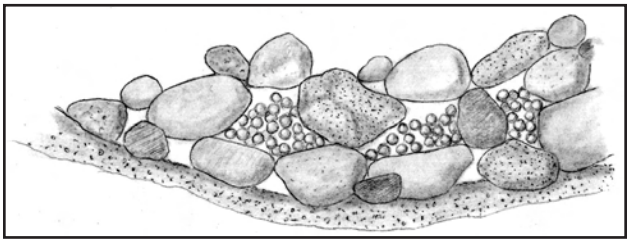
KNOW, WONDER, LEARN

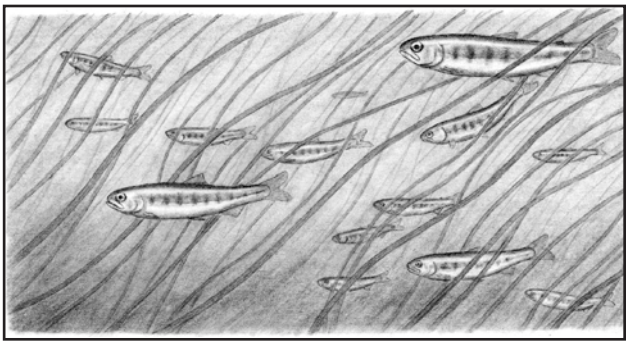
Use a photocopier to enlarge this page to the largest format available.

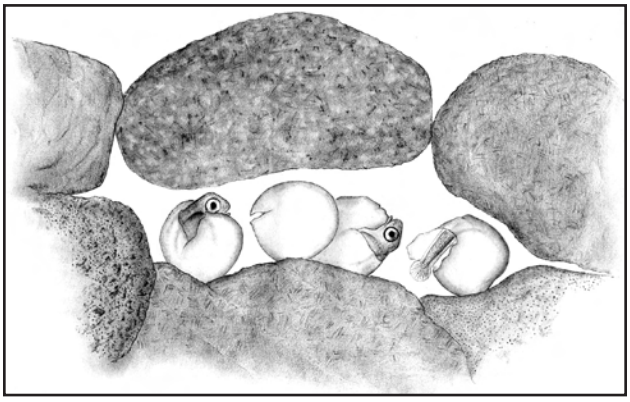
LEARN	
WONDER	
KNOW	

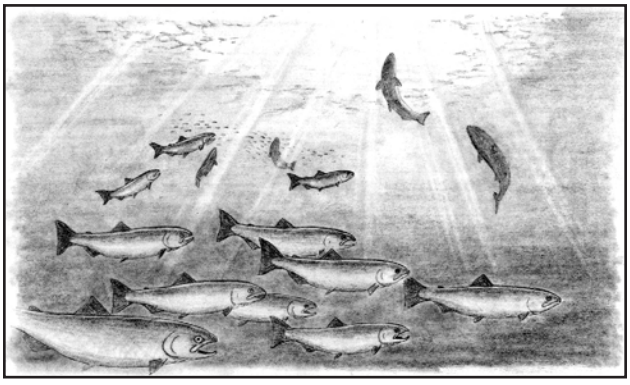
HANDOUT 1.1

KNOW, WONDER, LEARN





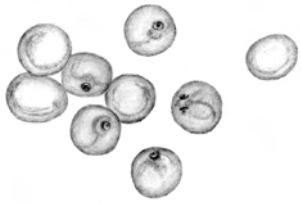




Illustrations: Karen Uldall-Ekman

HANDOUT 1.2

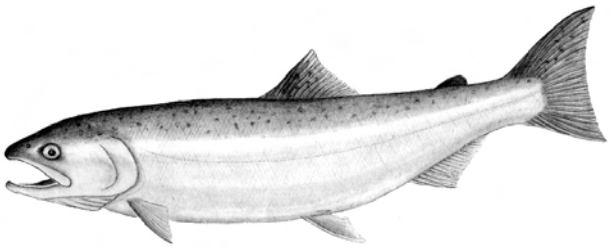
SALMON WORDS



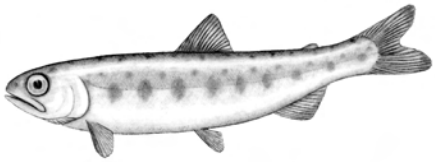
SALMON EGGS

FRY

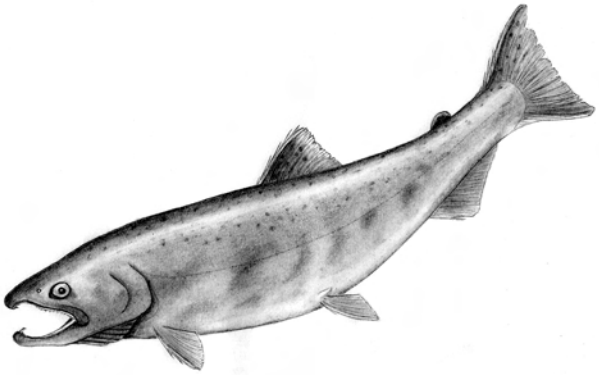
ALEVIN



ADULTS



SMOLTS

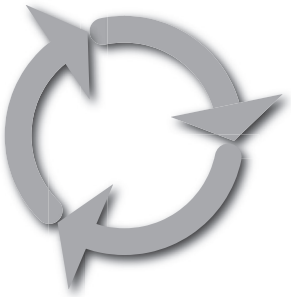


SPAWNERS

Illustration: Karen Udall-Ekman

UNIT 2

LIFE CYCLE AND HABITAT



LIFE CYCLE AND HABITAT

OVERVIEW

The class reviews the life cycle of familiar plants and animals to identify their life cycles and to see how organisms relate to their environment at different stages in their life cycles.

THE BIG IDEA

All living things have a life cycle that is related to their needs and their habitat.

KEY WORDS

For definitions refer to "Appendix 8: Glossary".
Basic: alevin, air, water, food, life, bean seed, egg, salmon, root, stem, leaf, life cycle, stage

BACKGROUND INFORMATION
LIFE CYCLES

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

The stages in the life of Pacific salmon are:

- **Eggs:** In late fall, adult salmon deposit thousands of eggs in a redd, a gravel depression in a flowing stream or on a lake shoreline, and cover the eggs with more gravel. The eggs, always sensitive to temperature, are particularly sensitive to movement at this stage and need to remain undisturbed in the gravel. As cold, clean water containing oxygen flows through the gravel, an embryo develops in the fertilized egg, and after about one month eyes become visible. The embryo gets the food it needs from the yolk of the egg and oxygen from the water. Disturbances, such as changing water temperature, speed of water flow and polluted water or silt deposited on the stream or lake bed, can destroy the eggs. In early spring, the surviving embryos break through the membrane of the egg and hatch out. They can move through the gravel, but they still face many threats: silt can still smother them, changes in water temperature or speed of water flow can be harmful, and predators catch many.

- **Alevins:** (The A is pronounced either AY as in *play,* or AH as in *cat*.) Alevins are mobile embryos. The yolk sac is still attached and provides food for the alevin for two to three months as it continues to develop, hidden in the gravel. Alevins extract oxygen from the flowing water by using their gills. They can move through the gravel, but silt can still smother them.

- **Fry:** Once the yolk sacs have been fully absorbed, the alevins leave the gravel to search for food. They emerge from the stream- or lakebed, usually in late spring, and swim to the surface. At the surface, they swallow air to inflate an internal swim bladder, which overcomes their natural body weight so they can achieve neutral buoyancy, allowing them to move easily up or down in the water. Salmon fry generally swim in a small territory and feed on whatever aquatic organisms drift through it. For protective colouring, they develop dark bars on their skin known as Parr marks, which disappear in the next stage of their lives. Depending on the species, they spend from a few days to a few years in their home stream or lake. At this stage, the fry learn to recognize their home, primarily by characteristic smells created in the water by rocks, plant life and other aquatic organisms.

- **Smolts:** After their time in a stream or lake, salmon migrate downstream. When they reach the estuary where the river meets the ocean, they spend some time there as smolts, adapting to the salt water. Smolts gradually develop the ability to swallow salt water and expel the salt in their urine and through their gills. They also begin to form scales on their skin, giving them a silvery colour. Estuary life is abundant with food, so smolts can grow rapidly, but estuaries are also home to many predators, such as birds, reptiles and larger fish, and also to human development.

- **Adults:** Salmon migrate into the ocean, where they grow to adulthood with silvery bellies and darker backs. Each species migrates to a particular part of the north Pacific coast, from California to the Gulf of Alaska, sometimes ranging thousands of kilometres. They eat smaller ocean fish and krill (tiny crustaceans), and grow to their mature weight. Predators include large fish, fish-eating birds, marine mammals and human fishers. After a time, varying from one to seven years, they return and congregate at the mouth of their river of origin.

Salmon seem to use a variety of visual and magnetic clues to navigate the ocean, then rely mainly on their sense of smell to identify their home stream or lake.

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

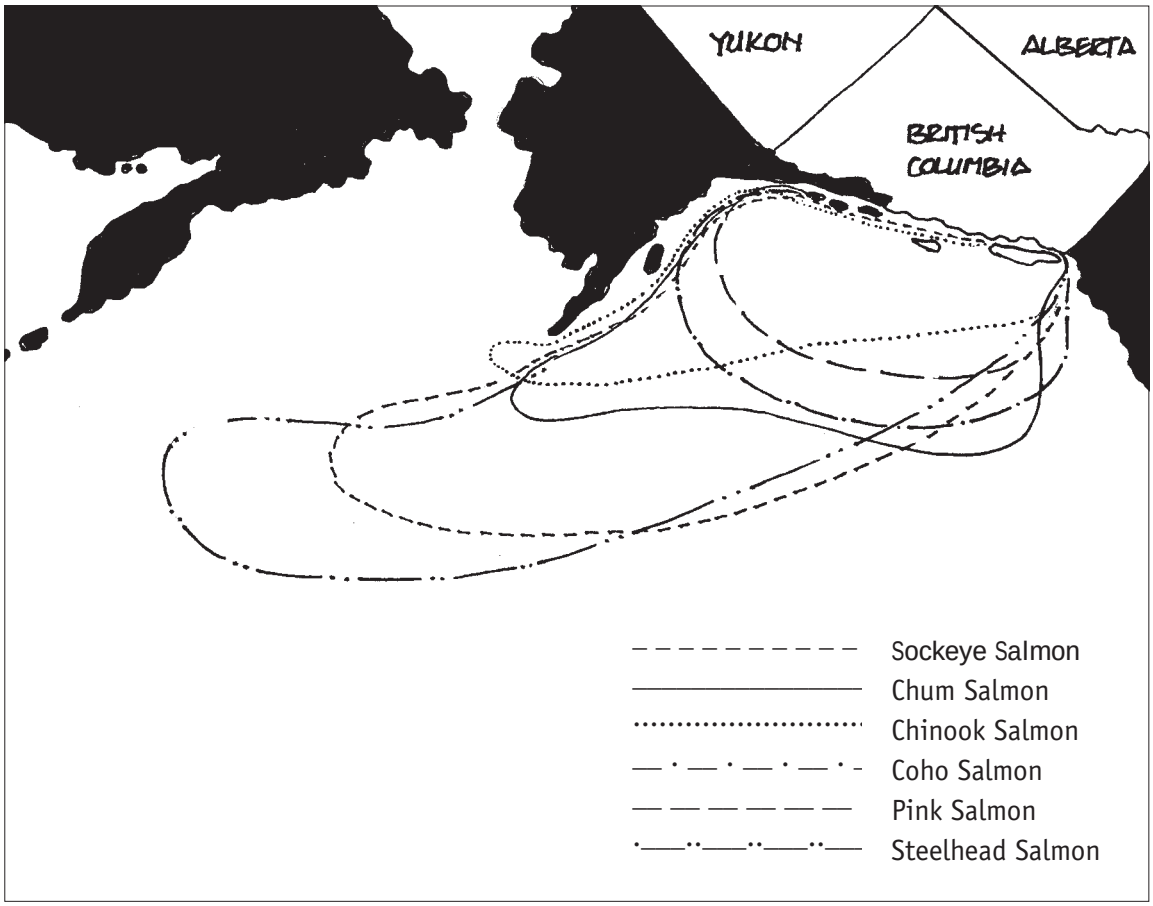


Illustration: Donald Gunn

LIFE CYCLES

Materials:

- Large pictures of a baby, a child, a youth, an adult and a senior
- Copies of "Handout 2.1: Life Cycles" for each student
- Salmon Life Cycle poster
- Egg to Fry Display
- *Option:* Copies of "Handout 1.2: Salmon Words" for each group, cut into individual illustrations
- Art supplies

Time required:
One or two lessons

Level of conceptual difficulty
Simple

Suggestions for assessment:
Monitor students' discussion and drawings to ensure that they can show that plants and animals go through a life cycle in orderly stages.

INTRODUCTION

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

DISCUSSION

- Discuss with the class the stages in the life cycle of a person. Draw the stages in a circular diagram as you discuss them. If necessary, prompt students with questions such as:
  - What happens when a baby grows older?
    He or she becomes a young child.
  - What happens when a child grows up?
    He or she becomes a teenager or an adult.
  - What happens when an adult gets old?
    He or she gets old and dies.
  - Where does a baby come from?
    From adult parents.
- Have the class describe how other animals and plants with which they are familiar go through a similar life cycle, e.g., birds, pets, beans.

EXPLANATION

- Explain that salmon are a kind of fish that lives in many local streams and lakes. Use "Handout 2.1: Life Cycles" or the Salmon Life Cycle Poster (or the illustrations from "Handout 1.2: Salmon Words") to show that salmon have a life cycle like other animals. Have students look at the Egg-to-Fry Display and observe the first stages in the life cycle of a salmon.
- Explain that all living things have a life cycle, and have students compare the stages of a salmon's life cycle with the stages of a human or other animal they know.

SUMMATION

- Have students go to the library and find a reference on an animal of their choice. Have them draw or paint the stages in the life cycle of their chosen animal.

LIFE CYCLE OF A BEAN

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

Materials:

For each group of students:

- One or more bean seeds
- A paper towel
- A zip-lock bag
- Water
- Rulers
- Copies of "Appendix 2: Daily Observations" for each student
- Graph paper
- Writing supplies
- Salmon Life Cycle poster

INTRODUCTION

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

EXPERIMENT

- Have students observe, measure and describe bean seeds, and record their observations.
- Have students predict what will happen if the beans are kept moist for several days.
- Have students in groups grow a bean seed between sheets of damp paper towelling in a half open zip-lock bag (or by placing them in a clear plastic cup filled with soil, next to the side of the cup where students can watch the beans grow). Have them moisten the paper regularly and keep it in an even-temperature location, out of direct sunlight.
- Have students carefully observe the bean each day, and use "Appendix 2: Daily Observations" to describe, draw, measure or graph the changes as the bean grows.

DISCUSSION

- Have students compare the growing beans with their original observations and their predictions. Ask students to suggest reasons for any differences between their observations and their predictions. Ask if anyone can describe what would happen to the bean if it were able to continue growing naturally. If necessary, prompt them with questions such as:
  - How big does a bean plant get if it grows in a garden? *One metre or more.*
  - What parts does a bean plant grow in a garden? *Roots, stem, leaves, flowers, pods, beans.*
  - What does a bean plant need to grow? *Soil, water, light.*
  - How does a bean plant grow new seeds? *The grown plant makes seeds in a pod.*

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

Level of conceptual difficulty:
Simple; young students will need a buddy to help with measurements and recording

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

- What are the steps in the life cycle of a bean?
  It is a seed, it grows roots, it grows above the soil, it grows leaves and stems, it grows new seeds, etc.

SUMMATION

- Outline and diagram the stages of a bean seed's life.
  Seed, seedling, growing plant, adult.
- Review and diagram the stages of a person's life.
  Baby, child, youth, adult, senior.
- Review and diagram the stages of a salmon's life.
  Egg, alevin, fry, smolt, adult, spawner.
- Make a chart with the class listing the stages in the growth of a bean seed, a person and a salmon. Have students compare the growth of a bean seed and a person with the life cycle of a salmon as they see it in the poster. If necessary, prompt them with questions such as:
  - Where on the poster do you see something like the bean seed?
    The egg.
  - How is the egg like a bean seed?
    Something grows from it.
  - What grows out of the egg?
    Baby salmon.
  - What does the baby fish grow into?
    An adult salmon.
  - Where does the salmon egg come from?
    The adult lays the eggs.

LIFE CYCLE NEEDS

Materials:
- Salmon Life Cycle poster
- Egg-to-Fry Display
- Writing supplies

Time required:
One lesson

Level of conceptual difficulty:
Simple to moderate

Suggestions for assessment:
Review students' lists and categories to ensure that they can identify the needs of various organisms, including, water, food, shelter and air.

INTRODUCTION

- As a whole class, have the students make a list of things that people need to survive. With older students, ask them to describe how they get the things they need. Write their suggestions on a chart labelled "People need." If necessary, prompt them with questions such as:
  - What do people need to breathe?
    Air.
  - What do people need to eat and drink?
    Food and water.
  - What do people need to stay safe and healthy?
    They live in houses and wear clothes.
- Have students find a place in the classroom where they can sit or stand without bumping into anyone or anything else. Ask students to crouch into a ball, as though they were bean seeds. While they are in this position, ask the students to share with the class things that a bean needs to survive. Each time a student provides a correct answer, instruct them to "grow" a little more, until they eventually come to full standing. If necessary, prompt them with questions such as:
  - What does a bean need to drink?
    Water.
  - What does a bean need for food?
    Nutrients from the soil, water, sunlight.
  - What does a bean need to breathe?
    Air.
  - What does a bean need to stay safe and healthy?
    A secure place to grow.
- Once students are back in their seats, write their suggestions on a chart labelled "Beans need."

RESEARCH/DISCUSSION

- Have the Egg-to-Fry display, the Salmon Life Cycle poster and, if applicable, the incubation tank set up in three different stations in the room. Divide the class into three groups and have each group move to one of the stations. Ask them to reflect silently on what salmon need to survive. After a few minutes have passed, instruct them to move to the next station and do the same until they have visited each station in the room.
- Once students are back in their seats, write their suggestions on a chart labelled "Salmon need." If necessary, prompt them with questions such as:
    - What do salmon need to breathe?
      Air in the water.
    - What do salmon need to eat and drink?
      Water and food such as insects and tiny water animals.
    - What do salmon need to stay safe and healthy?
      They live in clear streams, lakes and oceans.
- Have the class identify similar elements from the three lists, put them in categories (e.g., food, shelter) and name each category. With younger students, have them cut the words out of a piece of paper, then talk about and sort the words.

SUMMATION

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

CHANGING ENVIRONMENT

This experiment demonstrates that if beans' needs are not met in their environment, they grow poorly or die. It leads to a discussion about meeting the basic needs of salmon. You may wish to do this activity in association with the Salmon Habitat Studies in Unit 11.

Materials:

- Two or more bean seeds for each group of students
- Blotting paper
- Water
- Rulers
- Copies of "Appendix 3: Comparison Chart" for each student
- Graph paper
- Writing supplies
- Salmon Life Cycle poster

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

Level of conceptual difficulty:
Moderate; young students will need a buddy to help with measurements and recording

INTRODUCTION

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

EXPERIMENT

- Have students suggest various environments to compare how a bean grows with and without the elements it needs to survive, e.g., with light/without light, with water/without water, with air/without air (in a sealed plastic bag).
- As a demonstration, grow bean seeds, one with and one without one of the elements they identified. Have students carefully observe the bean seeds each day and describe, measure and graph what happens in each environment.
- Have students use "Appendix 3: Comparison Chart" to compare each of the growing beans. Ask older students to suggest explanations for any differences they observe or explanations as to why differences they predicted are not visible.

RESEARCH/DISCUSSION

- Have students list and compare what salmon, humans and other species need to survive, and use the Salmon Life Cycle poster to infer what they think would happen to a salmon if elements of its environment were removed (or damaged). If necessary, prompt them with questions such as:
  - What would happen to humans and other species if all the water in streams and lakes dried up?
    Humans and other species would not have water to drink and would die.
  - What would happen if the water in a salmon stream or lake dried up?
    Salmon and their eggs would die.

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

- What would happen to humans and other species if all the water in streams and lakes were very muddy?
  Without clean water, swimming and other recreation would be less enjoyable. Though the water may still be potable, it's possible that humans and other species could become sick and/or die.
- What would happen if the water in a salmon stream or lake became very muddy?
  Salmon and their eggs would smother.
- What would happen if the water in a salmon stream or lake was not shaded?
  It would warm the water and could harm salmon and their eggs.
- What would happen if you were swimming in a stream and the water flowed too fast?
  You could get carried away by the current.
- What would happen if stream water flowed too fast?
  Stream banks would erode. Eggs, young salmon, gravel and foods might be washed away.
- What would happen if streams were straightened or wetlands were filled in?
  Growing salmon lose important sites that give them shelter and allow them to grow safely.

SUMMATION

■ Have students suggest ways to protect the things salmon need to grow well.
Maintain fresh water flow, avoid pollution, avoid disturbing salmon streams, protect streamside vegetation and pools of calm water.

LIFE CYCLE AND HABITAT
WRAP-UP

REVIEW:

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

EVIDENCE FOR UNIT ASSESSMENT

- Have students make a painting or drawing about the life cycle of a salmon and describe what it shows about what salmon need to survive.
- Have students put pictures from the life cycle of a plant, a human and a salmon in correct order and explain why the order is correct.
- Have students complete a stem sentence such as "One thing I learned about life cycles is that..."
- Have students add their materials to their learning log and write a sentence explaining what they learned.

LANGUAGE AND ARTS INTEGRATION

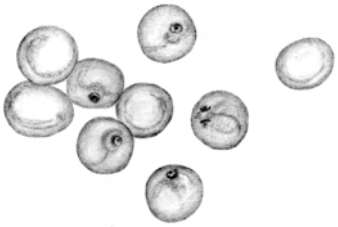
- Have students cut out cards with pictures labelled with the stages of a salmon's life and play matching and memory recognition games to reinforce their knowledge of the language, e.g., have students match cards with labels against cards with illustrations, or have students turn over an illustration card to read the label on the reverse side.
- Have students divide a paper plate into sections and draw in each section a stage in the life cycle of a plant or animal.

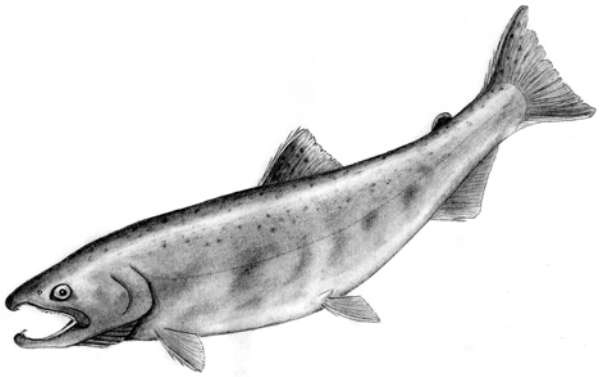
HOME CONNECTIONS

- Have students describe and act out the life cycle of a plant or animal for an adult and compare it with the life cycle of their family.
- Have students fill in "Appendix 4: Classroom Salmon Science News" and read it to an adult.

HANDOUT 2.1

SALMON LIFE CYCLE





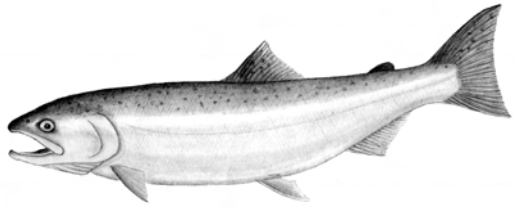


Illustration: Karen Uldall-Ekman

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

A salmon grows from an egg. It grows fins, a head and a tail. The salmon leaves the stream or lake where it grew up. When it grows enough, the salmon returns. It lays more eggs. More salmon grow from the eggs.

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

HANDOUT 2.2

BEAN LIFE CYCLE

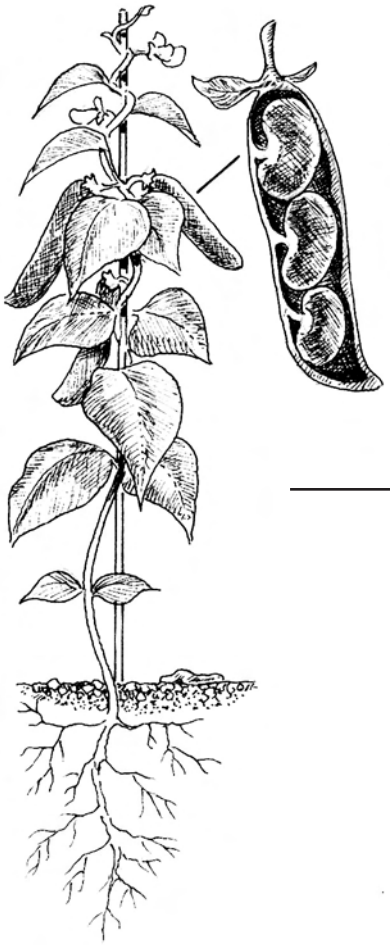
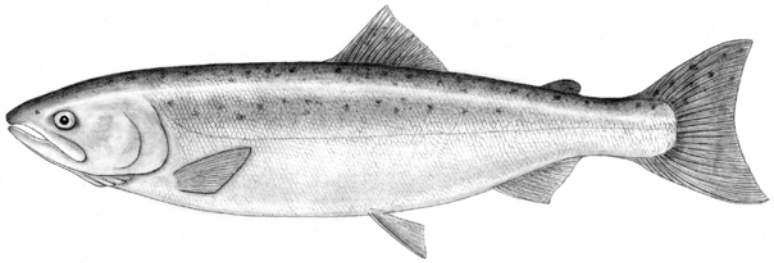
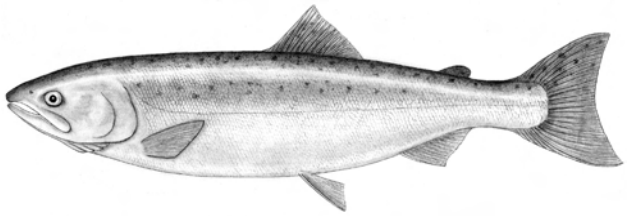


Illustration: Donald Gunn

UNIT 3
SALMON ANATOMY



SALMON ANATOMY



OVERVIEW

The class identifies the body parts of a fish and compares them to human body parts. They see how fish shape, skin, scales and gills help salmon live in water.

THE BIG IDEA

Fish, which are physically different from human beings, are suited to their watery environment.

KEY WORDS

For definitions refer to “Appendix 8: Glossary”.
Basic: head, mouth, eyes, nostrils, gills, body, fins, tail, skin, scales
Advanced: pectoral, pelvic, dorsal, anal, adipose, lateral line

BACKGROUND INFORMATION

SALMON ANATOMY

Only some of the animals that live in water are fish. All fish have four things in common:

- a flexible backbone,
- cold blood,
- fins, and
- gills.

Other animals that live in water have only some of these characteristics. For example, whales have flexible backbones, but their blood is warm and they use lungs to breathe. Frogs have flexible backbones and cold blood, but they breathe with lungs.

Fish are usually torpedo-shaped, although they may be long and slender, short and stocky, or even balloon-shaped. The shape allows the fish to move easily through water with the least amount of energy. Whatever their shape, all fish have a head, a body and a tail.

The fish's head contains eyes, ears, mouth, teeth, nostrils and gills. To breathe, fish take water into their mouth, then close their mouth and push the water out through their gills. The gills are full of blood vessels that absorb oxygen dissolved in the water as it passes through the gill openings. Fish can use their nostrils to smell scents in the water and to recognize the scent of their home stream.

Salmon have six bony fins on their body, which they use mainly for balance and steering:

- two pectoral fins near the head,
- two pelvic fins on the belly,
- an anal fin behind the belly, and
- a dorsal fin on the centre of the back.

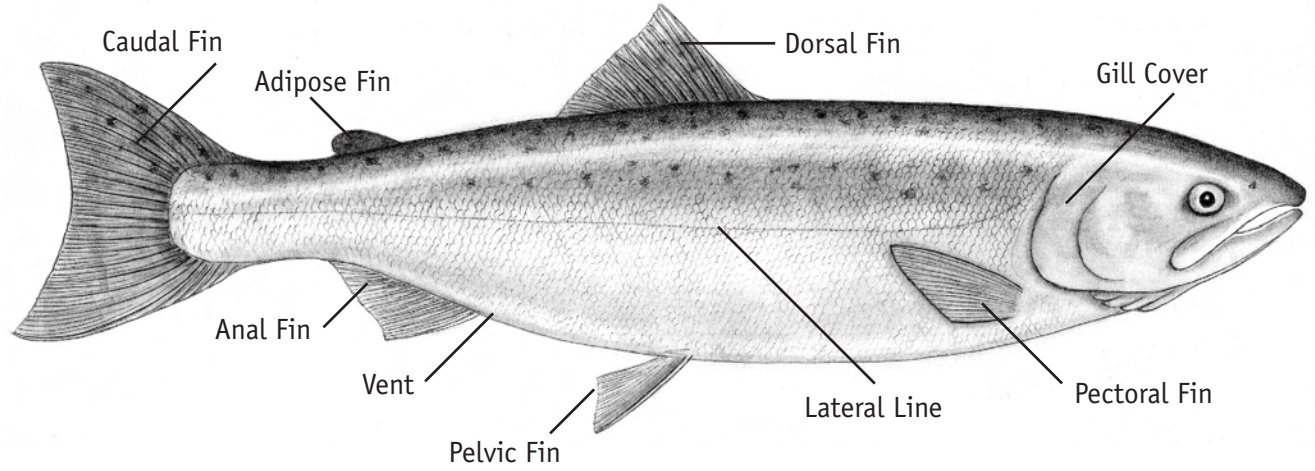
Salmon also have an adipose fin, a small fatty fin on the back just in front of the tail, with no known use.

The tail, also known as the caudal fin, helps the fish keep balance, and pushes the fish forward through the water. Female salmon also use the tail to dig the redd in which they lay their eggs.

Like most fish, salmon have a line of special cells along each side of their bodies. The cells, known as the lateral line, are extremely sensitive to pressure, and help fish sense movements and objects in the water.

Scales and skin cover the body of most fish, including salmon. Scales are small hard plates like fingernails, but they overlap like shingles on a roof and protect the fish from predators, as well as from bruising. Scales begin to grow when the salmon are very young, and show annual growth rings, like trees. If scales are knocked off, salmon can grow new scales. Salmon and many other fish also have a slime layer that makes them slippery and protects them from disease organisms in the water.

EXTERNAL ANATOMY (FEMALE)



INTERNAL ANATOMY (MALE)

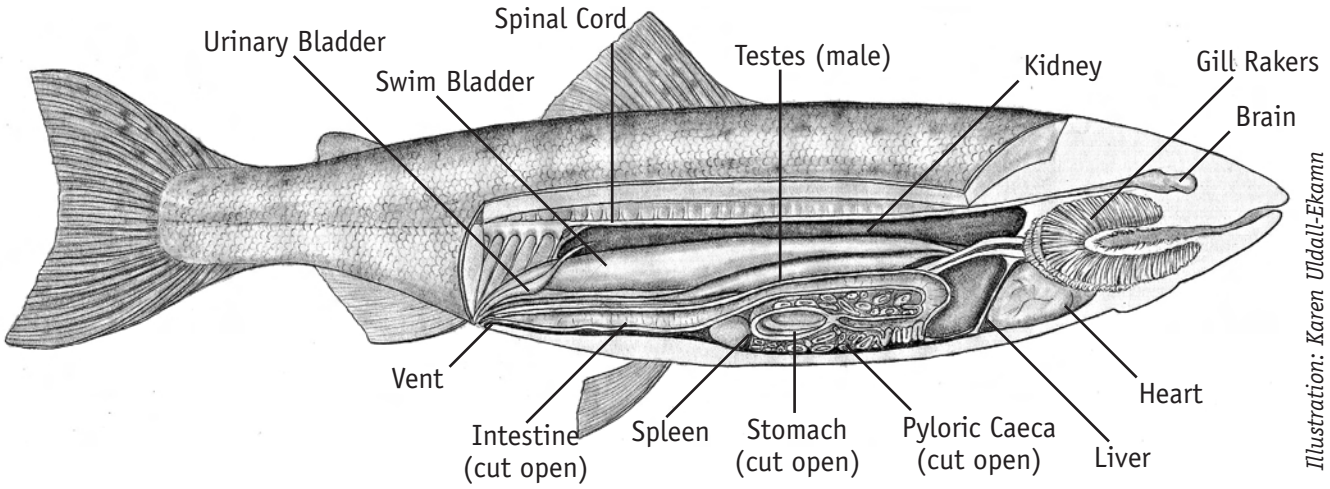


Illustration: Karen Udall-Ekamn

To	Fish Have (a)	People Have (a)
Eat	Mouth	Mouth
See	Eyes	Eyes
Breathe	Gills	Nose
Hear Sounds		Ears
Turn their heads		Neck
Hold the body	Backbone	Backbone
Hold things		Arms and Hands
Walk		Legs and Feet
Swim up and down	Fins	
Swim forward	Tail	
Cover their body	Skin	Skin
Sense pressure and vibration	Scales and slime	Hair

PARTS OF A FISH

Materials:

- *Option:* a classroom plant such as a bean plant
- *Option:* a fresh or frozen salmon
- Writing supplies
- Copies of "Handout 3.1: Parts of a Salmon" for each student
- Poster showing parts of a fish

Time required:
Two lessons

Level of conceptual difficulty:
Simple

Suggestions for assessment:
Monitor student discussion in making the Venn diagram to ensure that they recognize that salmon have features in common with people (e.g., ears, eyes, noses) but that they do not share others, such as fins and tails.

INTRODUCTION

- *Option:* Have students identify the parts of a plant and describe what each part does.
  The stem holds up the plant, the leaves collect sunlight and make food, the roots hold the plant in the ground and collect moisture, etc.
- *Option:* Have students identify the parts of a human and describe what each part 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 (or a fresh or frozen 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 3.1: Parts of a Salmon").
- *Option:* Some independent education suppliers, education supply stores and science education catalogues carry cloth fish, 3-D models and posters that could help you to introduce the external (and internal) body parts.

  Note: If you wish to teach your students the internal features of a salmon, refer to "Dissecting a Salmon" on page 69 of the activity section of "Unit 4: The Salmon Spawner" in *Salmonids in the Classroom: Intermediate*.

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. (See chart in Background Information.)
  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, arms, legs and hair and breathe air.
- *Option:* Have older students make a chart comparing the functions of the body parts of fish and humans. (See chart in Background Information.)
  To move, people use legs, fish use tails; to breathe, people use noses, fish use mouth and gills; etc.

FISH SHAPE

This experiment demonstrates that a salmon's shape helps it live in its environment.

Materials:
- Modelling clay
- Basin of water
- Long sticks (such as knitting needles or chopsticks)
- Copies of "Appendix 1: Observation Page" for each student

Time required:
One lesson

Level of conceptual difficulty:
Simple

Suggestions for assessment:
Review students' drawings and conclusions from the experiment to ensure that they can identify "fish shape" and recognize that the shape helps fish move easily through water.

INTRODUCTION

- Ask students to describe or draw the shape of a salmon. Ask if all salmon are shaped the same, and if all fish are shaped the same.
  Point out that all salmon have the same shape. Most fish have a narrow nose, a wider body and a narrow tail, but some are long and thin, while others are flat, and a few are rounder.

EXPERIMENT

- Have students use modelling clay to make a fish-shape 10 to 15 cm long, and to make objects of various other shapes, e.g., flat, round, square, human.
- Have students put a stick in the shapes they made, and gently move them through a basin of water.
- Have the class observe how different objects move in the water, and record their observations on a chart or chalkboard. If necessary, prompt them with questions such as:
  - What shape makes the fewest ripples when it moves? What makes the most?
  - What shape takes the least force to move? What takes the most?
  - What shape moves the quickest? What moves the slowest?
  - Do the shapes move the same backwards or sideways as they do forward?

DISCUSSION

- Ask students to suggest the reasons a fish shape is best for a salmon.
  The slender shape that narrows in the front lets the salmon swim forward quickly with little energy, so it does not tire quickly.

SUMMATION

- Have students use "Appendix 1: Observation Page" to draw the fish shape experiment and write the class' conclusions.

SCALES AND SKIN

Materials:

- Poster/illustration showing scales on a salmon
- Copies of "Handout 3.2: Salmon Scales" for each student
- Writing materials

Time required:
Two lessons

Level of conceptual difficulty:
Simple

Suggestions for assessment:
Review students' reports on scales 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-coloured, etc.
- Have them list words that describe their skin.
  Soft, covers the whole body, has feeling, different colours, 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 nail.
  - 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 nail.
  - 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 colour are the scales?
      Scales are clear but can look like they are many colours because they allow the colour of the skin below to show through.
    - What shape are the scales?
      They are not perfectly round.
    - 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 3.2: 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.

GILLS AND LUNGS

This experiment models how fish gills extract substances from water as the water passes across them. It leads to a discussion of how salmon extract oxygen from water, and the need for clean stream or lake water.

Materials:

- A clear jar with a lid
- A basin
- Board or similar object
- Water
- Food colouring
- White paper towels
- Copies of "Appendix 1: Observation Page" for each student

Time required:
One lesson

Level of conceptual difficulty:
Advanced

Suggestions for assessment:
Review students' drawings and conclusions from the fish gills demonstration to ensure that they can explain that fish extract air from water.

INTRODUCTION

- Ask students to describe how they breathe and to explain whether or not they could breathe under water.
- If the class has an aquarium, have them look at the opening of the fish's mouth and gills. Ask how they think fish breathe under water, and explain that the following demonstration will show them how.

EXPERIMENT

- Show the class a jar of water, and explain that most water has some air mixed into it. Shake the jar vigorously and have them look at the bubbles of air as they float to the top. Explain that, although most of the air bubbles disappear, many tiny ones remain in the water.
- Explain that, because it is too hard to see air in the water, you will use some colouring for this experiment. Add several drops of food colouring to the water.
- Line a board with a white paper towel and slowly pour the coloured water across the towel. Ask students to describe what happens to the colouring.
  Some colour passes along with the water, and some stays behind in the towel.
- Ask students to imagine that the colour in the water is air and that the towel is a fish's gills. Have them suggest how fish might get air from water.
  Fish move water through their gills and absorb air from the water as it passes along the gills. They take a mouthful of water, close their mouth, then push the water out through the gills in their throat. The gills are made up of rows of very fine folds of tissue similar to skin. The salmon absorb the air through these special gill cells.

DISCUSSION

- Ask students to describe what would happen to fish in silty or polluted water.
  Their gills could get irritated, making it difficult to breathe.
- *Option:* Have older students create a model of a fish's breathing by drawing an outline of a fish on a strong plastic bag, with the mouth at the open end of the bag. Have them cut a small opening for gills and tape a paper towel to the opening to represent gills. Have them take dyed water into the "mouth" of the model fish, push it out through the "gills" and note what happens to the dye.

SUMMATION

- Have the students use "Appendix 1: Observation Page" to draw the demonstration and write their conclusions.

SALMON SMOLTS
WRAP-UP

REVIEW:

- Materials: chalkboard or chart paper
- Draw a large outline of a salmon on the chalkboard or chart paper. Have the class locate and label, or draw on the outline, each of the following parts: head, mouth, eyes, nostrils, gills, body, lateral line, fins (pectoral, pelvic, dorsal, anal, adipose), tail, skin, scales.
- Explain that some of the salmon's body parts are like human body parts, but salmon have parts that humans do not, and each part helps salmon live in the streams and oceans.

EVIDENCE FOR UNIT ASSESSMENT

- Have students make a painting or drawing of a salmon and label its parts.
- Have students fill in answers to a chart comparing human and fish functions: e.g.,
  People use _____ to move; fish use _____;
  People use _____ to breathe; fish use _____;
  People use _____ to see; fish use _____;
  People use _____ to eat; fish use _____.
- Have students complete a stem sentence, such as, "I used to think… about salmon but now I know that…" or, "One thing I learned about salmon is that…"
- Have students add their materials to their learning log and write a sentence explaining what they learned.

LANGUAGE AND ARTS INTEGRATION

- Dissect an adult salmon, using the dissection guide on page 69 of *Salmonids in the Classroom: Intermediate* to identify the external parts of the fish and their functions.
- Have students form a model salmon using modelling clay, and attach sequins and/or foil to it in overlapping patterns to represent scales.

HOME CONNECTIONS

- Have students show an adult an outline drawing of a fish, name its parts and identify the parts that are like parts of a human.
- Have students fill in "Appendix 4: Classroom Salmon Science News" and read it to an adult.

HANDOUT 3.1

PARTS OF A SALMON

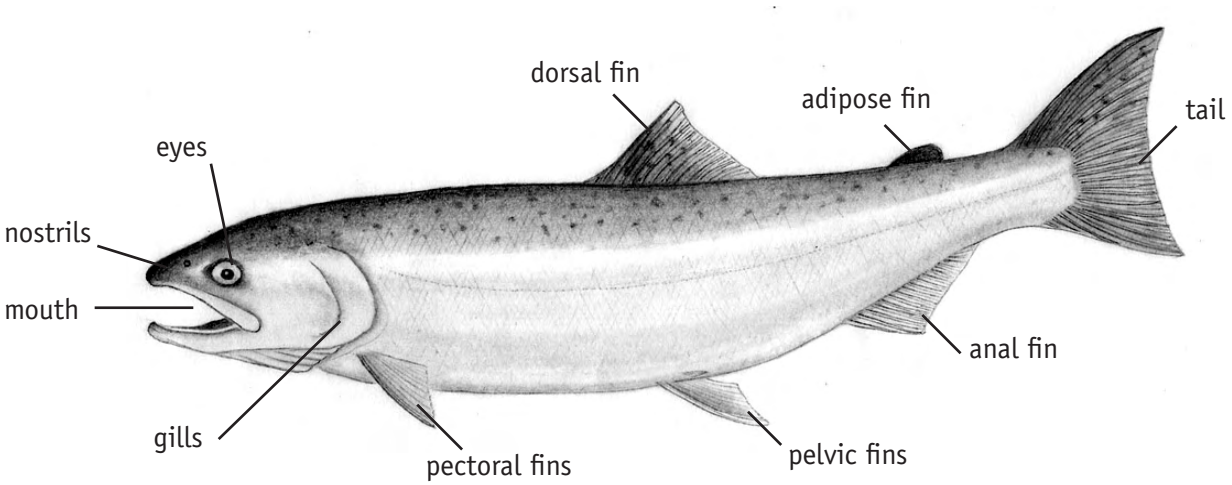


Illustration: Karen Udall-Ekman

Fins	— help salmon turn and balance	Nostrils	— let salmon smell water
Tail	— moves salmon forward	Mouth	— let salmon eat and breathe
Eyes	— let salmon see	Gills	— extract air from water

HANDOUT 3.2

SALMON SCALES

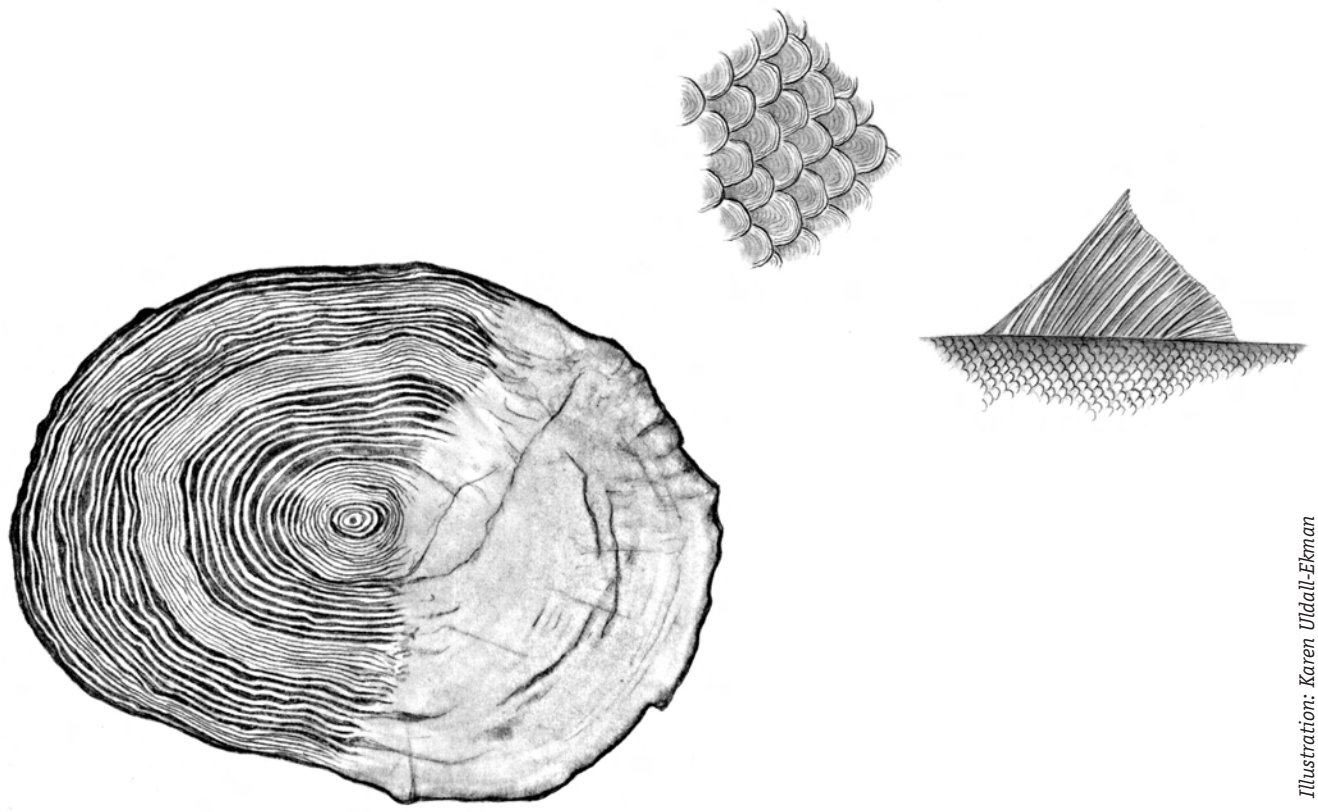


Illustration: Karen Uldall-Ekman

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.

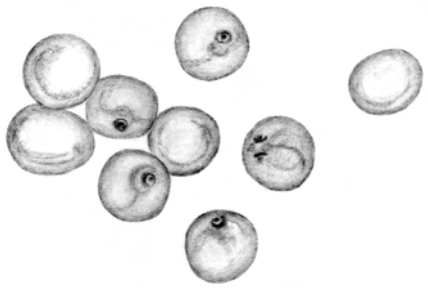
Scales are oval-shaped. They overlap and partly cover each other. The part you see looks like a small fan.

Fish scales can look silver, red, green or any colour. But scales have no colour. The colour of the skin below shows through the scales.

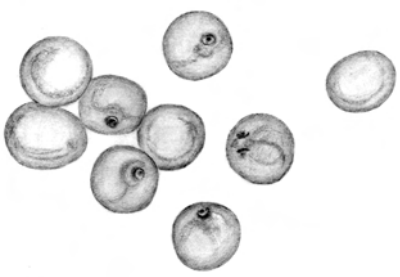
Scales protect the body of the fish. They let salmon slide over rocks or logs without getting hurt. They are hard for birds or animals to grab.

Scales grow a little every year. Each year, a line forms in the scale. With a microscope, you can see the lines. If you count the lines, you can tell how old the salmon is.

UNIT 4
SALMON EGGS



SALMON EGGS



OVERVIEW

The class examines the parts of a bean seed and a chicken egg, and compares them to a salmon egg. They use the poster and an information sheet, and make a model of a redd to identify what salmon eggs need to survive.

THE BIG IDEA

The egg contains a developing salmon. It needs certain elements in a protected environment to survive.

KEY WORDS

For definitions refer to “Appendix 8: Glossary”.
Basic: redd, yolk, egg white, hatch, gravel, shell, stream, oxygen

BACKGROUND INFORMATION
THE EGG

When adult salmon return upstream to spawn, each female lays from 2,000 to 2,500 spherical, pinky-orange eggs, which are about 6 to 9 mm in diameter. Instead of a hard shell like a chicken, each egg has a soft, transparent membrane for its outside surface. This surface offers little protection against predators or other disturbances, so the female covers the eggs with gravel in a rocky stream- or lakebed nest called a redd.

The redd is a shallow depression in the gravel, about one to three metres long and one to two metres wide. The female chooses a site in a stream with a high flow of fresh water or near a lakeshore where waves keep the water fresh. Salmon prefer gravel with stones averaging 12 to 15 cm and a water depth of 15 to 30 cm.

Salmon eggs are very sensitive - only one in 10 survives to hatch. In the first days, even a slight

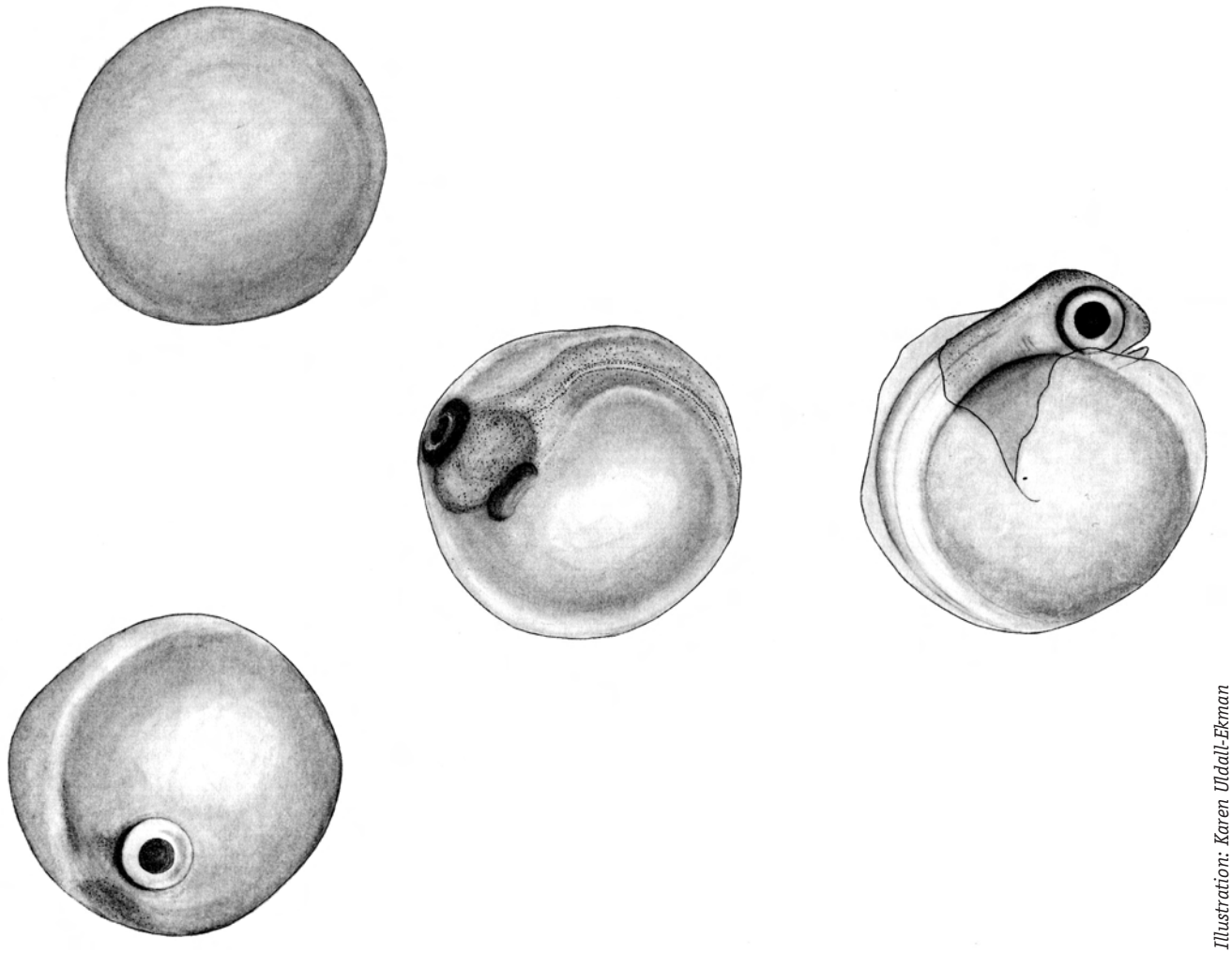
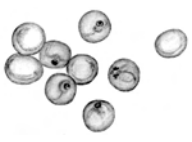


Illustration: Karen Uldall-Ekman



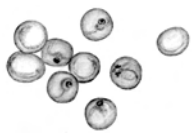
disturbance of the stream- or lakebed can be fatal. Changes in water level or temperature can kill the eggs. Predators such as birds, bears and racoons feed on the eggs if they can find them, and flooding, pollution and disease also destroy eggs.

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

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

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

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



WHERE DO EGGS COME FROM?

Materials:

- Egg-to-Fry Display
- Copies of "Handout 4.1: Salmon Eggs" for each student
- Salmon Life Cycle poster
- Bean seedlings (if available)

Time required:
One lesson

Level of conceptual difficulty:
Simple

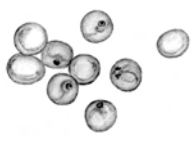
Suggestions for assessment:
Monitor the students' discussion of the Salmon Life Cycle poster and review their statements to ensure that they know what a redd is and that salmon hatch from eggs to begin their life cycle.

RESEARCH/DISCUSSION

- Have the class look at the Egg-to-Fry display and the Salmon Life Cycle poster. Draw their attention to the part about the egg. Ask students to explain what the poster shows about where salmon eggs come from.
  Spawning salmon lay the eggs in a redd, a nest-like depression in the stream- or lakebed.
- Have students compare a salmon egg to the growing bean.
  Both are small spheres from which a new organism grows, but salmon hatch and move around, while beans continue to grow from the seed in one place.

SUMMATION

- Read "Handout 4.1: Salmon Eggs" or have students use the handout to research the egg stage. Have students, in groups, write three important things about salmon eggs.
- *Option:* Remind students how the bean in Unit One grew into a bean plant. Ask them to describe what the bean looked like initially and how it changed as time went by. If the bean seedlings are available, have students describe what the bean seed looks like.



PARTS OF AN EGG

This experiment exposes the basic structure of a seed and an egg, and allows students to identify and draw parallels between the parts.

Materials:

- One or more hard-cooked or raw chicken eggs *(Note: The embryo disk is more easily visible in a raw egg, but students must be cautioned not to touch raw egg without thoroughly washing their hands after touching.)*
- Knife or other tools to dissect the egg
- Egg-to-Fry display
- *Option:* Soaked lima beans for each student
- Copies of "Handout 4.2: Salmon and Chicken Eggs" for each student
- Writing supplies

Time required:
One or more lessons

Level of conceptual difficulty:
Simple

Suggestions for assessment:
Review the students' drawings of salmon and chicken eggs to ensure that they can identify and name the yolk, white and egg wall.

INVESTIGATION

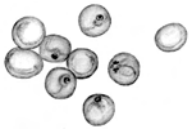
- Have students break a hard-boiled or raw chicken egg into a dish. Have them identify the parts of the egg.
  The white, yolk and outer membrane. Students may also observe the embryo disk on the top of the yolk: the embryo starts growing from the disk and, as it grows, it forms parts of the fish. The disk is a darker orange spot in salmon eggs; in chicken eggs, it is a thick, clear or cloudy area in the egg white attached to the yolk.
- Have students observe and describe the parts of a salmon egg, using the Egg-to-Fry display or "Handout 4.2: Salmon and Chicken Eggs".
- *Option:* Have students soak a lima bean overnight, open a lima bean and identify the parts.
  The seed coat; the cotyledons or food supply; and an embryo or baby plant attached to the food source.

DISCUSSION

- Have students compare the parts of the chicken's egg (or the bean) with the parts of a salmon egg:
  - Discuss with the class the functions of the parts of the egg.
  - The membrane (and the shell of a chicken egg) keeps the egg together and allows air to pass to the embryo.
  - The yolk provides food for the growing embryo.
  - The white provides a fluid in which the embryo can grow.
  - The embryo disk is the point at which the embryo begins to develop.

SUMMATION

- Have students draw and label the parts of the chicken egg and salmon egg.



THE REDD

This experiment demonstrates how vegetation can protect eggs in a redd from silt. It leads to a discussion of how people can protect salmon by protecting streamside vegetation.

Materials:

- Copies of "Handout 4.1: Salmon Eggs"
- Writing supplies
- Salmon Life Cycle poster

Time required:
Three to four lessons

Level of conceptual difficulty:
Moderate

Suggestions for assessment:
Have students use their model of a redd to explain that salmon eggs live in a redd in the stream- or lakebed and that salmon hatch from the eggs.

INTRODUCTION

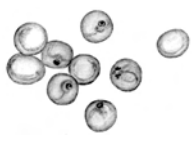
- *Option:* From the *Marine and Aquatic Educators' Resource Guide*, choose a video that demonstrates how a female spawner builds her redd. Watch the video with your students.
- Have students use the Salmon Life Cycle poster to explain what a redd is, who makes it, how it is made, and why. If necessary, prompt them with questions such as:
  - Where do you see a redd in the poster?
  - Who is making the redd?
    The female 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.

RESEARCH/DISCUSSION

- Have students refer to "Handout 4.1: Salmon Eggs" and make a list of things salmon eggs need to survive.
  A redd made of rocks and gravel; cold, clean water; air in the stream or lake water; yolk for food.
- Have students make a list of things baby humans need to survive, and compare the two lists.
  Baby humans need a parent or caregiver to supply food to eat, water to drink, warmth, shelter and nurturance.

SUMMATION

- Have students create a diorama with an empty shoebox turned on its side. Students can hang illustrations of spawners from the top and use other materials to create the habitat and/or other life cycle stages.



PROTECTING THE EGGS

Materials:
- Two large waterproof basins
- Rocks (2 to 5 cm diameter)
- Model salmon eggs (balls of modelling clay 0.5 to 1 cm diameter)
- Moist sand or fine dirt
- A watering can of water
- A strip of turf (or carpet to simulate turf) 10 to 12 cm wide
- Copies of "Appendix 3: Comparison Chart" for each student

Time required:
Two lessons

Level of conceptual difficulty:
Moderate

Suggestions for assessment:
Have students use their models to explain that when stream-side vegetation is lacking salmon eggs can be smothered by silt.

DEMONSTRATION/ EXPERIMENT

- Create two model stream environments by:
  - propping two large basins at an angle so that water poured at the top will run down,
  - placing some rocks (2 to 5 cm diameter) at the bottom and some model salmon eggs (balls of modelling clay 0.5 to 1 cm diameter) in the spaces between the rocks,
  - mounding some moist sand or fine dirt on the slope above the gravel, and
  - in one basin, placing a strip of turf (or carpet to simulate turf) 10 to 12 cm wide between the sand and the rocks.

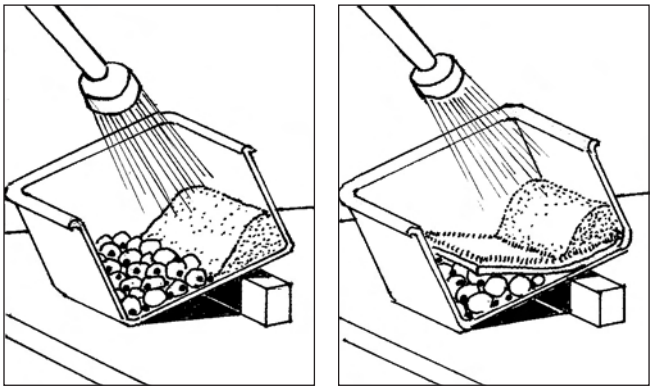
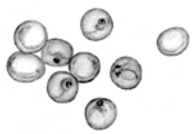
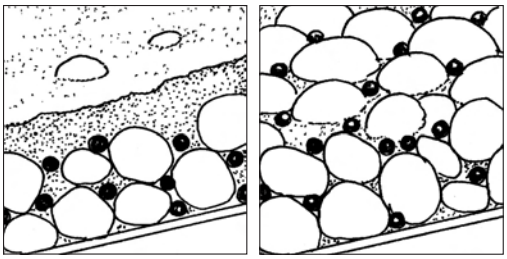


Illustration: Donald Gunn

- Explain that the two basins are like the side of a stream, with eggs in the gravel in the stream.
- Have students describe what they think will happen when water rains on the sand.





- Have students use a watering can to pour water gently on the sand in the basin without the turf/carpet, observe and describe what happens to the sand.
  It moves into the stream and covers the eggs.
- Have students pour water on the sand in the basin with the turf/carpet, observe and describe what happens to the sand.
  It moves, but most is caught in the turf/carpet.

SUMMATION

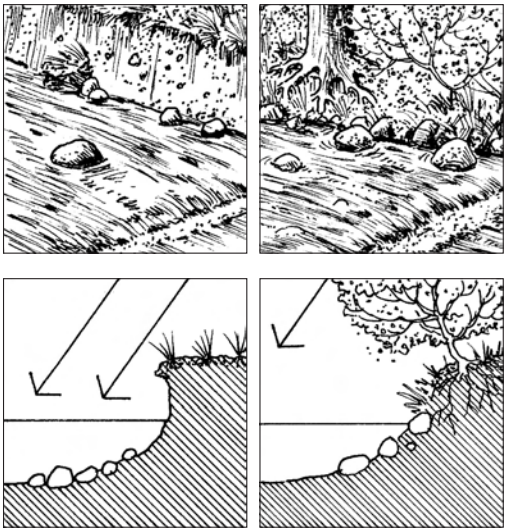
- Have students use "Appendix 3: Comparison Chart" to compare what happens in the two basins.

DISCUSSION

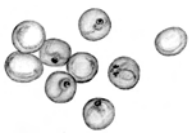
- Ask students how sand, fine soil or pollutant particles would affect salmon eggs, and discuss how plants on the stream bank would protect salmon. If necessary, prompt them with questions such as:

  - Where does the sand go when it washes off the model stream bank?
    It washes into the stream, and covers the eggs.
  - Can the salmon eggs get enough fresh water with air in it when they are covered?
    No.
  - What happens to salmon eggs if they don't get fresh water with air?
    They smother and die.
  - How do plants on the stream bank protect salmon eggs?
    The roots of plants hold soil in place on the stream bank and keep it from washing into the stream. This keeps sand and soil from smothering the eggs. The plants also shade the eggs from the sun and allow insects to grow; these insects will become a food source for salmon later in their lives.
  - How can people keep salmon eggs safe?
    Keep the water clean and prevent sand or dirt from running into the stream.

Without Vegetation With Vegetation



Illustrations: Donald Gunn



SALMON EGGS

WRAP-UP

REVIEW:

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

EVIDENCE FOR UNIT ASSESSMENT

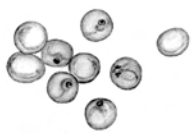
- Have students make a list or Venn diagram of overlapping circles (model the procedure if necessary) comparing the size, shape, colour and parts of a chicken egg and a salmon egg.
- Have students make a model or picture of a redd in a stream, and use it to explain how a redd protects salmon eggs.
-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

LANGUAGE AND ARTS INTEGRATION

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

HOME CONNECTIONS

- Have students describe a redd to an adult and compare it to their own home.
- Have students fill in "Appendix 4: Classroom Salmon Science News" and read it to an adult.



SALMON INCUBATION

If your school has an operating incubation tank, incubate salmon eggs and have students observe and record the results. For assitance, refer to "People And Connections That Can Help" on page viii of the Introduction.

- ➡ Have students use a thermometer to record the temperature of the water in the tank, then mark their reading on a drawing of a thermometer. Have them compare the readings from day to day by copying their readings to a daily bar graph. Have the students keep a running total of the temperature (the Accumulated Thermal Units or ATU) by adding each day's temperature to the previous day's total temperature.

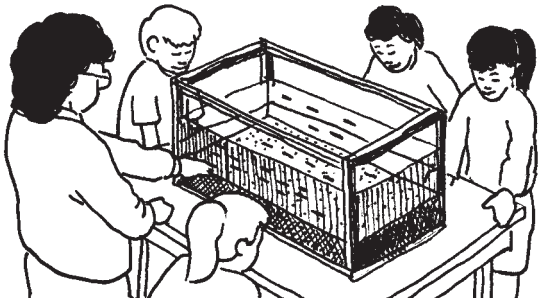
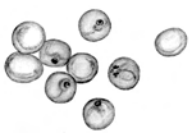


Illustration: Donald Gunn



HANDOUT 4.1

Salmon Eggs

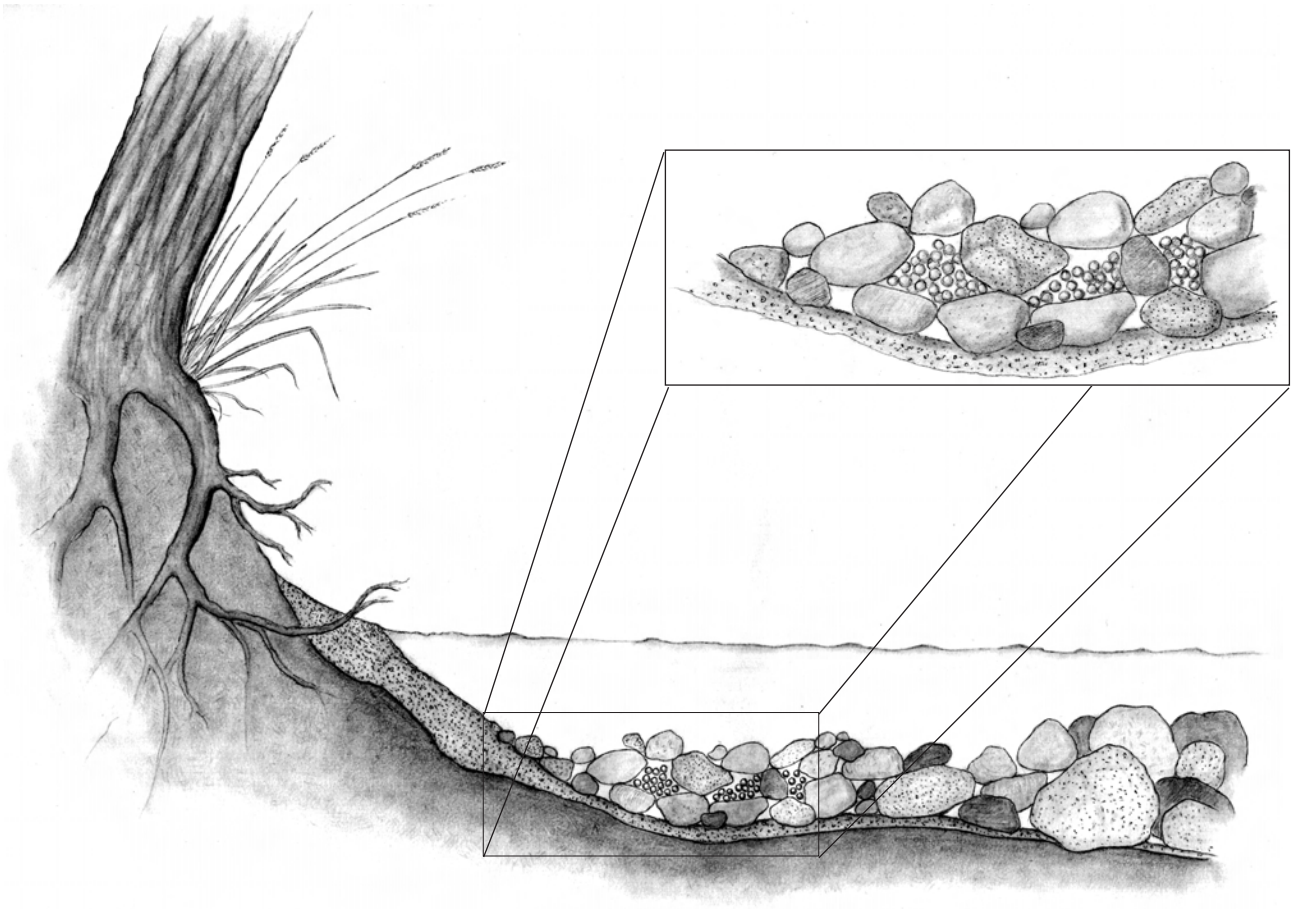


Illustration: Karen Udall-Ekman

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

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

Salmon eggs need cold water to live. If the water is too cold or too hot, the eggs will die.

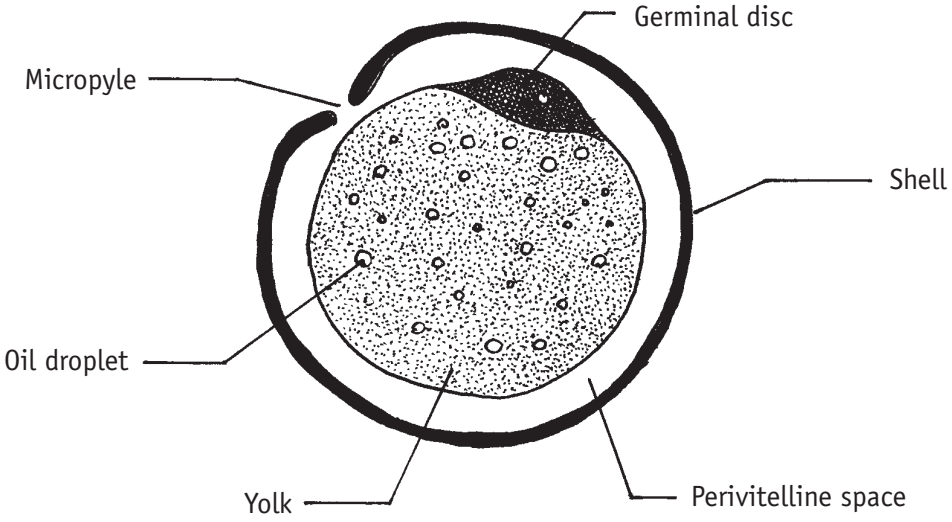
A salmon begins to grow inside the egg. The yolk gives it food. The salmon gets air through the egg wall from the stream or lake water. If the water stops running, the growing salmon inside the egg will die. Dirt in the water can bury the egg and smother the salmon that is growing inside.

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

HANDOUT 4.2

Salmon and Chicken Eggs

Fish Egg



Bird Egg

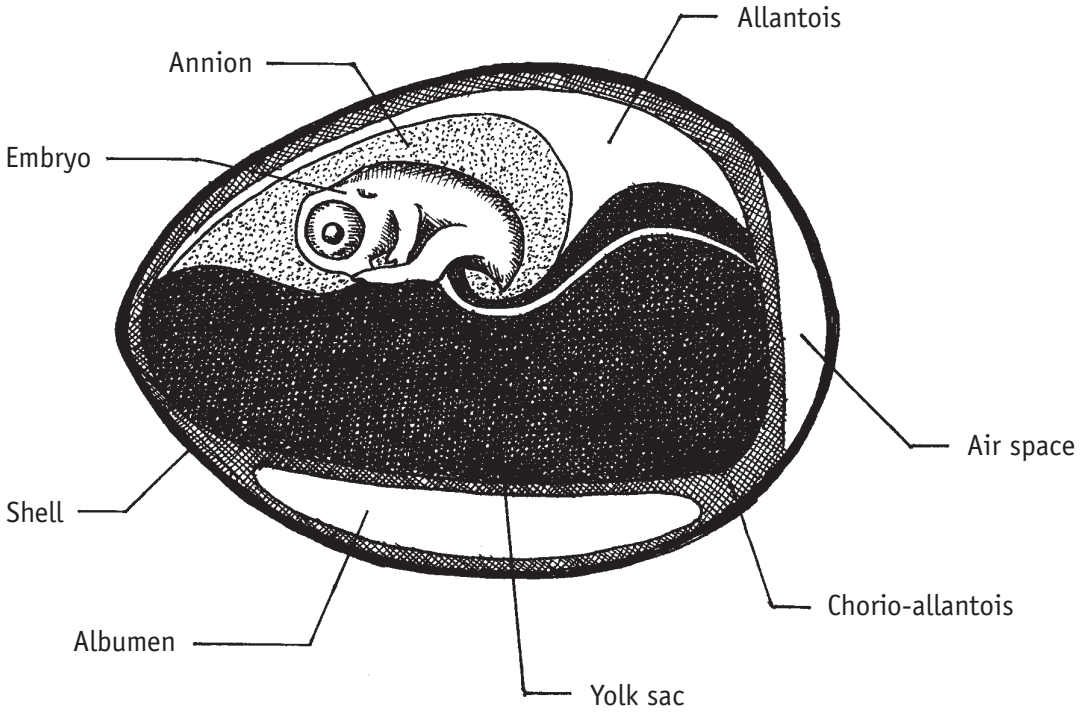
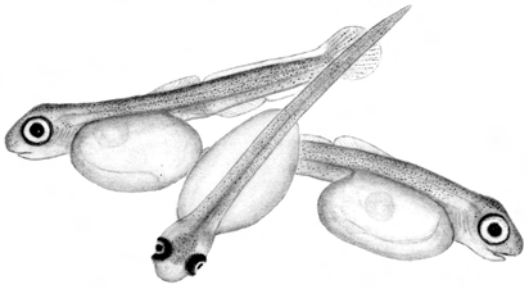


Illustration: Donald Gunn

UNIT 5
SALMON ALEVINS



SALMON ALEVINS

OVERVIEW

The class compares a bean seed and a bag lunch with the yolk sac of an alevin. They use the poster and an information sheet to identify what salmon alevin need to survive and how people affect alevin habitat.

THE BIG IDEA

An Alevin hatches from the egg and continues to grow by using food from the egg yolk.

KEY WORDS

For definitions refer to “Appendix 8: Glossary”.
Basic: alevin, yolk sac, hatch, egg wall, wiggle
Advanced: embryo

BACKGROUND INFORMATION
THE ALEVIN

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

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

Alevin cannot swim and their yolk sac makes movement slow, so they are an easy target for predators. To hide from predators, they avoid light and live as much as 30 cm down in the gravel. As they grow stronger and their yolk sac shrinks, the lose their bright orange colour and begin to develop a fish shape.

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

When the yolk sac is completely absorbed, or "buttoned up", the alevin grow to about 2.5 cm. Then they must emerge from the gravel and begin to search for food (at this stage they are known as fry). The alevin emerge in spring, when the water begins to warm and when algae and plankton grow in the lakes and rivers.

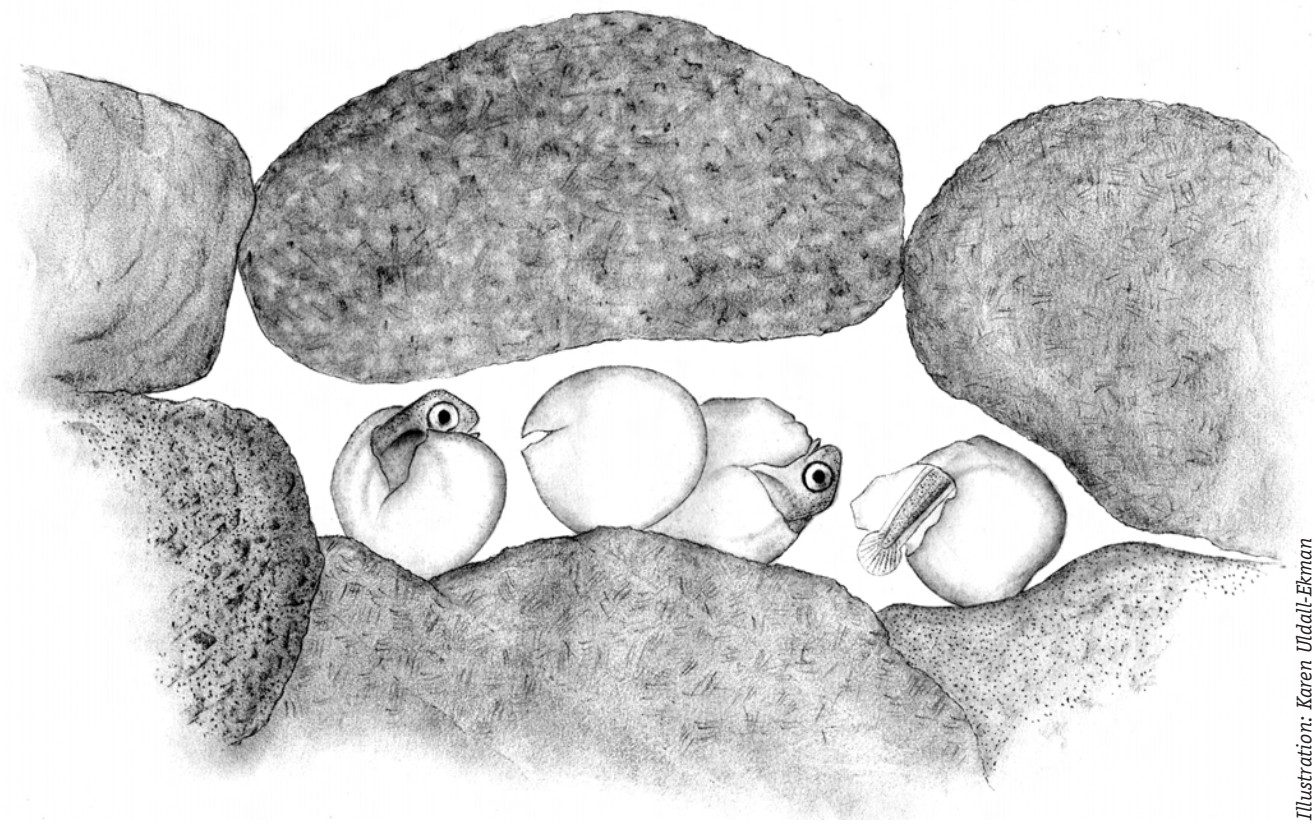


Illustration: Karen Udall-Ekman

BAG LUNCH

Materials:
- *Option:* Students' bag lunches
- *Option:* Growing bean seed
- Illustration of salmon alevin (from Salmon Life Cycle poster or "Handout 5.1: Salmon Alevins")
- Salmon Egg-to-Fry display

Time required:
One lesson

Level of conceptual difficulty:
Simple

Suggestions for assessment:
Monitor the students' discussion of bag lunches to ensure that they know that yolk sacs provide nutrition to alevins, just as bag lunches do for people.

INTRODUCTION

- Ask all students in the class to put their lunch box/bag on one table at the front of the classroom. Count the total number of lunch bags/boxes. Divide this number by three (this represents the average number of meals one person eats per day). The number you come up with here will indicate how many days all of the food on the table would last one person.
  e.g., 30 lunches / 3 (meals per day) = 10 days
  - Ask the students to envision how many more lunch bags/boxes they would need to last one person 3 months.
- With the class, list the kinds of food people bring in bag lunches and identify food categories.
  Breads, fruits, sweets, drinks, etc.
- Have the students explain what happens when they eat the food in the bags.
  The bag empties and they get full and grow.
- *Option:* Have students describe what happened to the bean seed as the bean plant grew.
  The food segments shrank as the bean grew.
- Have students explain how a bean is similar to a bag lunch.
  Both provide food for growing.

EXPLANATION

- Show students an illustration of a salmon alevin using the Salmon Life Cycle poster, "Handout 5.1: Salmon Alevin" or the Salmon Egg-to-Fry display. Explain that an egg yolk provides food (all required nutrients) for a chicken or a salmon in its egg, like a bag lunch or a bean seed. A baby salmon takes its lunch with it when it hatches.

WHERE DOES AN ALEVIN COME FROM?

Materials:

- Egg-to-Fry display
- Salmon Life Cycle poster
- Parachute (if available)
- Pinnies (if available)
- Copies of "Handout 5.1: Salmon Alevins" for each student
- Writing supplies

Time required:
One to two lessons

Level of conceptual difficulty:
Simple

Suggestions for assessment:
Review students' research from the handout to ensure that they can describe how the alevins come from eggs and begin to live in the stream or lake environment.

RESEARCH/DISCUSSION

- Have the students look at the Egg-to-Fry display and the Salmon Life Cycle poster, drawing their attention to the part about the alevins. Ask students to explain what the poster shows about where alevins come from.
  They hatch from the salmons' eggs.
- Bring students to an outside natural area or the school gymnasium. Instruct them to assume a comfortable position and close their eyes. Once you see a general state of relaxation, read "Handout 5.1: Salmon Alevins". (Remember to speak slowly and steadily, allowing students enough time to create rich mental images.)
- Have students use creative movement to simulate breaking out of an egg. If a parachute is available, have 3-4 students hold the edges down while the remaining students use the parachute as a membrane and wiggle out of it. After trying this, have the 3-4 other students hold the edges down so the original 3 or 4 students can experience breaking out of the egg.

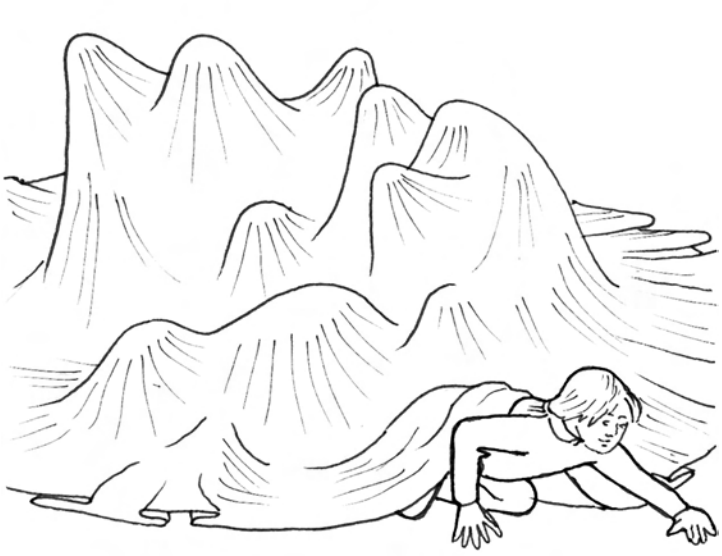


Illustration: Donald Gunn

- Next, choose 4-5 students to represent natural hazards (have the class brainstorm what the natural hazards might be). Provide these students with a coloured pinnie to identify them. Choose 4-5 other students to represent predators (have the class brainstorm what the predators might be). Provide these students with a different coloured pinnie to identify them. The rest of the class will be alevins.

Once the alevins "hatch" from under the parachute, they should try to escape from both predators and natural hazards, who try to tag the alevins as they run (swim) to a designated safe spot in the gym. Those who are tagged should stay frozen until the end of the game so those who make it to the "safe zone" can be counted.

- After completing the hazards simulation, discuss how the number of remaining alevins drops and why.
  Many alevins are caught by predators or don't survive natural hazards.

- Have students describe how the hatching of an alevin is similar to a growing bean or a hatching chicken.
  The chick starts growing inside the shell until it is too big, then pushes out.

- Have students describe how the hatching of an alevin is different from the birth of a human baby.
  A baby is born from its mother, not from inside an egg.

SUMMATION

- Have students use the handouts or other reference books to research the alevin stage. Have students, in groups, write three important things about an alevin.

HOW DO ALEVINS LIVE?

Materials:
- Salmon Life Cycle poster
- Writing or drawing supplies
- Chalkboard and chalk

Time required:
Two to three lessons

Level of conceptual difficulty:
Moderate

Suggestions for assessment:
Have students use their pictures of an alevin's environment to explain what alevin need to live. Monitor the students' discussion of human and alevin needs to ensure that the students can identify the habitat and key needs of alevin.

RESEARCH/DISCUSSION

- Have the class examine the life cycle poster to identify and list the habitat needs of an alevin.
  Gravel, clean water, oxygen, temperature, protection from predators.
  If necessary, prompt them with questions such as:
  - Where do alevins live?
    In water running through spaces between the gravel rocks.
  - What do alevins breathe?
    They use their gills to get air from the stream or lake water.
  - How do alevins keep safe?
    They hide between the rocks.
  - What do alevins eat?
    The food in their yolk sac and, when they get older, small pieces of food in the water.
  - What keeps alevins from getting too cold or too hot?
    The temperature of the water affects the alevin's temperature, so *the water must be at the right temperature.*
  - How are an alevin's needs similar to the needs of a salmon egg?
    They are very similar, although alevins can tolerate greater extremes.

SUMMATION

- Have the class list the needs of a human, then compare the needs of an alevin with the needs of a human.
  Alevins need clean water and gravel in which to live, air in the water to breathe, cold temperature; people need water to drink, air to breathe, houses in which to live, warm temperature, food to eat.
- *Option:* Have students draw or paint the gravel home of an alevin, using orange felts to draw alevin in the spaces.

PROTECTING ALEVINS

Materials:
- Writing or drawing supplies

Time required:
Two to three lessons

Level of conceptual difficulty:
Moderate

Suggestions for assessment:
Monitor students' discussion and review their list to ensure that the students can recognize ways in which people can protect alevins.

INTRODUCTION

- Have the class describe things people do that could harm alevins and/or the things alevins need to live. If necessary, prompt them with questions, such as:
  - What would cause sand or dirt to fall into the gravel where alevins live, possibly crushing or disturbing their home or smothering their gills?
    Driving machines through streams, various construction projects, building highways without erosion control (note: almost all construction projects now use erosion control mechanisms like straw bale barriers).
  - Why would someone dig gravel out of a stream or lake and reduce the areas where alevins could live?
    To build roads and drainage systems.
  - What might cause salmon streams to dry up, leaving no water in which alevins can live?
    Dams built to supply power to communities cause fluctuations in water levels. Streams are also occasionally diverted (made to run in a different direction). Homeowners get permits to take water from streams for their families.
  - What would reduce the soil's stability and the amount of shade along streams?
    Cutting down or removing trees from the stream bank to beautify it or as part of the construction activities.
  - How do pollutants poison the water in which alevins live?
    Many drains and sewers that people use flow directly into streams. Pollutants that are on the ground can be carried into streams by runoff rainwater.

DISCUSSION

- Have students, in small groups, identify two or three ways to protect alevins from harm.
  Don't disturb gravel in stream or lake beds; don't pollute the water; don't divert the water; don't remove the plants around a salmon streams; don't pour poisons into drains.
- Have the groups report their suggestions and create a class list from their reports. Have the class discuss and check off on the class list which items students could do themselves or with their families.

SUMMATION

- Have students write or draw one or more ways to protect alevins and the streams and lakes in which they live.

SALMON ALEVINS
WRAP-UP

REVIEW:

- Materials: chalkboard and chalk
- Have students draw and label on the chalkboard the things a salmon alevin needs for a healthy environment.
  Rocks and gravel; cold, clean water; air in the stream or lake water; vegetation on the stream bank.
- Explain that the alevin does not have to hunt for food because it carries its food in its yolk sac but, once the yolk sac is gone, the alevin will have to find its own food.

EVIDENCE FOR UNIT ASSESSMENT

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

LANGUAGE AND ARTS INTEGRATION

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

HOME CONNECTIONS

- Have students show an adult how alevins wiggle out of an egg, and explain how an alevin yolk sac is like a lunch bag.
- Have students fill in "Appendix 4: Classroom Salmon Science News" and read it to an adult.

SALMON INCUBATION

If your school has an operating incubation tank, have students observe the alevins emerging from the eggs and moving about, and record their observations. For assitance, refer to "People And Connections That Can Help" on page vii of the Forward.

- ➡ Have students feel the sides of the tank and note the cool temperature *(should be kept under 10 °C)*. Point out the water cooling system used for the tank, and describe how it keeps the water at the same cool temperature as an outdoor stream where the alevins live.
- ➡ Darken the room in which the tank is located and remove any protective materials around the tank. Have students observe the normal activity of the alevins and predict how the alevins will react when a flashlight shines into the tank. Shine a flashlight into the tank and discuss why alevins avoid the light.

Their colour makes them highly visible and they cannot swim quickly, so they move into the gravel to hide from predators. Have the class demonstrate how to move like alevins to hide in the gym or their classroom.

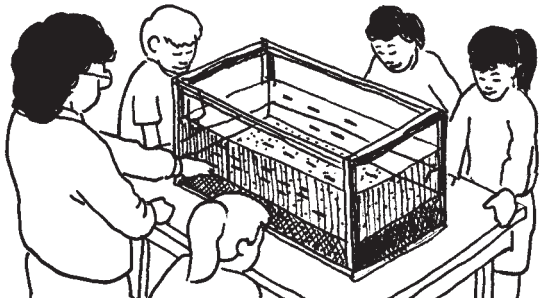


Illustration: Donald Gunn

HANDOUT 5.1

Salmon Alevins

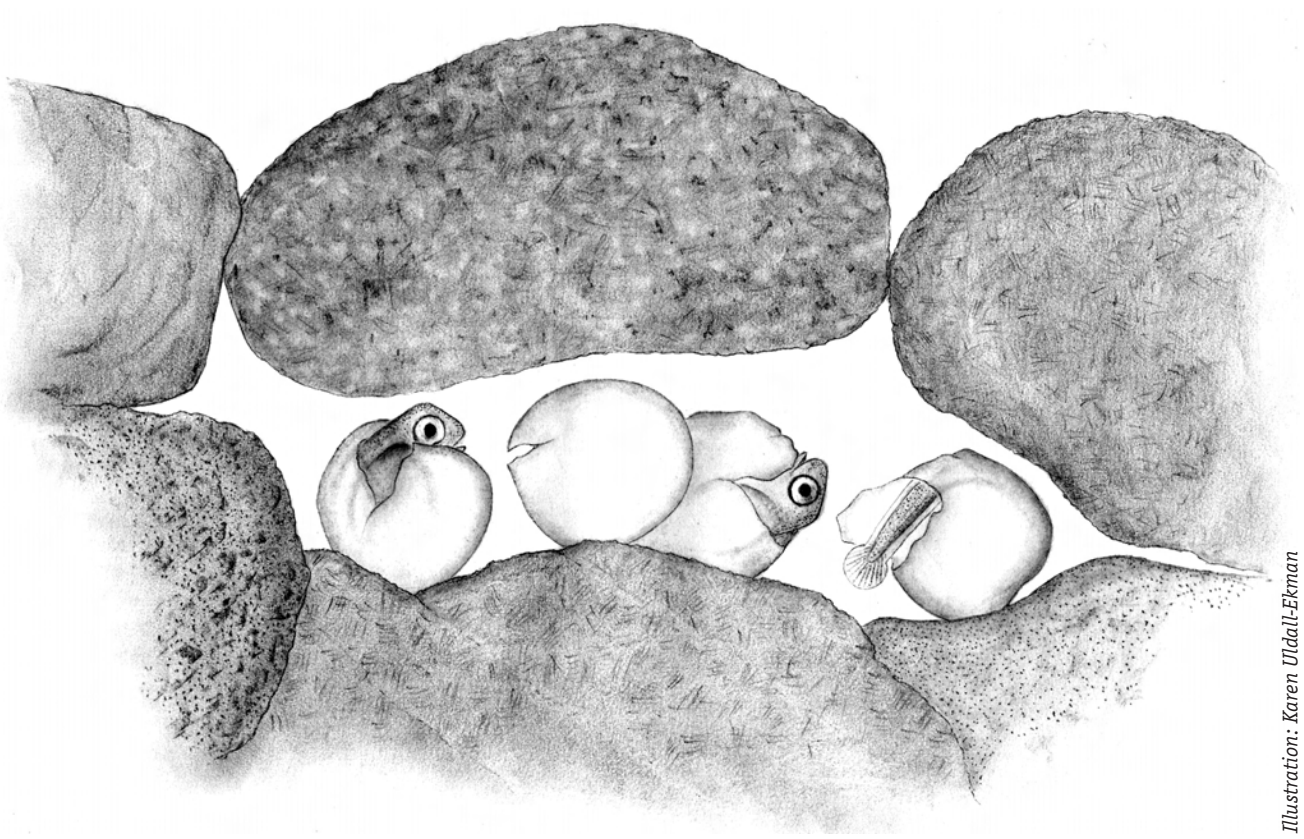


Illustration: Karen Udall-Ekman

Alevins hatch from salmon eggs. The salmon growing inside the egg gets too big for the egg. It wiggles and wiggles. The wiggling makes the egg wall break.

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

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

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

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

UNIT 6
SALMON FRY

SALMON FRY

OVERVIEW

The class uses the poster and an information sheet to identify where salmon fry come from and how they get food. The students test how air helps fry float in water and how protective colouration helps them hide.

THE BIG IDEA

Fry swim and search for food in their stream or lake habitat.

KEY WORDS

For definitions refer to “Appendix 8: Glossary”.
Basic: fry (note that the plural is also fry), Parr marks, camouflage
Advanced: predator, swim bladder

BACKGROUND INFORMATION
THE FRY

Alevins emerge from the gravel as "swim-up" fry. Rapidly vibrating their tails, they emerge from the gravel, then push themselves vertically up to the surface of the water, usually taking several hours right after nightfall, when they will be less visible to predators. They snap their mouths into the air, hold their gills closed and force a mouthful of air into a swim bladder, a balloon-like organ in their abdomen. They may have to repeat this motion several times until they have enough air to hold their position in the water. The air in the bladder is only for buoyancy, not for breathing. It counters their body weight, giving them neutral buoyancy in water. Now, they are known as "free-swimming fry."

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

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

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

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

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

WHERE DO FRY COME FROM?

Materials:
- Egg-to-Fry display
- Salmon Life Cycle poster
- Copies of "Handout 6.1: Salmon Fry" for each student
- Writing supplies

Time required:
Two to three lessons

Level of conceptual difficulty:
Simple

Suggestions for assessment:
Monitor the students' discussion of the life cycle poster and review their lists of important facts to ensure that they know that fry develop from alevins and begin to swim and catch food on their own.

RESEARCH/DISCUSSION

- Have the class look at the Egg-to-Fry display and Salmon Life Cycle poster, drawing their attention to the part about the fry. Ask students to explain what the poster shows about where salmon fry come from.
  They grow from alevins after the alevin has finished with its yolk sac.
- Have students use the poster to suggest ways that a fry begins to swim.
  It flutters its tail to swim to the surface and swallows air to achieve balance.
- Have students use creative movement to simulate swimming to the surface of a stream or lake and swallowing air.
- Have students use the poster to compare where a fry lives to where an alevin lives.
  Alevins live in the gravel. Fry swim around in a stream or lake.

SUMMATION

- Read "Handout 6.1: Salmon Fry" or have students use it to research the stage. Have students, in groups, write three important things about a fry.

THE SWIM BLADDER

Materials:
- Carbonated water
- Small raisins
- Clear container
- Plasticine
- Film canisters or other similar containers (2 per group)
- Basins of water
- Copies of "Appendix 3: Comparison Chart" for each student
- *Option:* Copies of "Appendix 1: Observation Page" for each student
- *Option:* Illustration of salmon anatomy, page 26

Time required:
Two to three lessons

Level of conceptual difficulty:
Moderate to advanced

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

INTRODUCTION

This experiment demonstrates that air can float objects that sink in water. It leads to a discussion of how salmon use a swim bladder to achieve neutral buoyancy. The process whereby fry are able to extract oxygen from water is a much more complicated process than we are able to convey in this activity.

- Ask the class to predict what will happen when raisins are placed in a glass of carbonated water.

- *Option:* Have students use copies of "Appendix 1: Observation Page" to record their predictions and experiment procedures.

EXPERIMENT

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

DISCUSSION

- Ask students to suggest reasons for the raisins rising and falling.
  Air clinging to the raisins helps them float in the water.

- Explain that fish, like raisins, are heavier than water, and that they would sink to the bottom of the water if they did not have an easy way to rise and fall. Humans, too, are

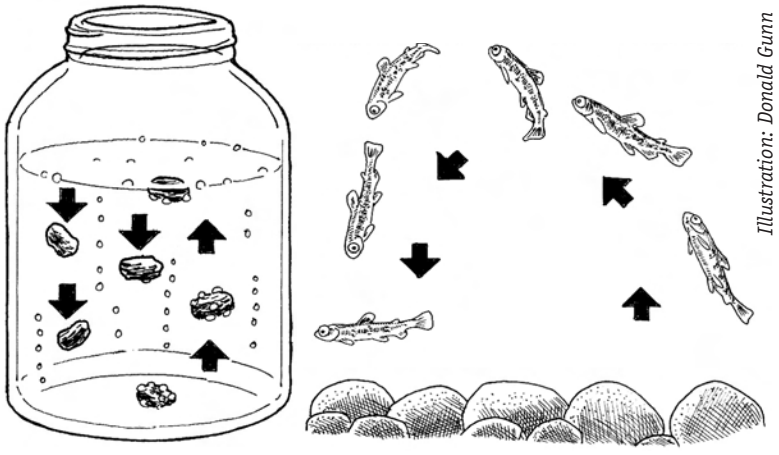


Illustration: Donald Gunn

heavier than water and would sink to the bottom of the water if they did not have a way to float. Ask students to suggest items that humans can use to help them float in water.
Waterwings, life preservers, rubber dinghies, etc.

- Ask students to suggest how humans can float without using any flotation items.
  By taking in a large breath of air to fill the lungs, humans have better floating ability.
- Ask students to suggest ways that fry can float in water.
  To help them float, fry fill their swim bladders by swallowing air from the surface of the water. (See next experiment.)

EXPERIMENT

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

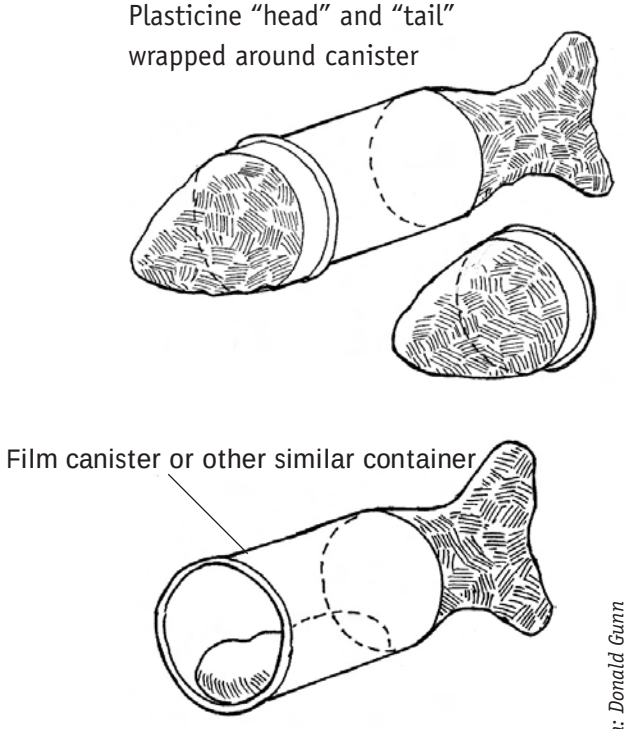


Illustration: Donald Gunn

DISCUSSION

- Have students describe what happened to their two models in the basin of water. Ask them to suggest reasons for one model sinking and the other not. Have students use "Appendix 3: Comparison Chart" to record their observations and conclusion.
- Have students explain how fry use a swim bladder to float in water.
  Fry have small bags like balloons inside their bodies. They swallow air into the bag until they do not rise or fall in the water. Then they use their fins to move up or down to whatever level they want.
- Ask students to suggest ways in which raisins floating in water is different from fry floating in water.
  Air bubbles that cling to the outside of the raisins help them to float. Fry swallow air from the surface of the water, filling their swim bladder to help them float.
  (Note: You may wish to use the salmon anatomy illustration on page 26 to show students where the swim bladder is located.)

FRY FIND FOOD

Materials:
- Chalkboard and chalk

Time required:
One lesson

Level of conceptual difficulty:
Simple

Suggestions for assessment:
Monitor the class discussion on how fry get food to ensure that the students can state that fry catch their own food.

DISCUSSION

- Have the class describe how people obtain food. Write their suggestions on chart paper or on the chalkboard under the title, "People".
  People plant seeds in soil. Seeds grow into plants that produce fruits and vegetables. People also raise and or hunt animals for meat. Once harvested and/or butchered, these foods either go directly to homes or are processed in factories and then delivered to be sold in stores.
- Have the class describe how pets obtain food. Write their suggestions on chart paper or on the chalkboard under the title, "Pets".
  They mainly eat the food that people put out for them, as do salmon fry in an aquarium.
- Have the class describe how plants obtain food. Write their suggestions on chart paper or on the chalkboard under the title, "Plants".
  They make food from nutrients in the soil around them.
- Have the class describe how wild animals obtain food. Write their suggestions on chart paper or on the chalkboard under the title, "Wild Animals".
  They search for, or chase and catch, food.
- Have the class describe how salmon fry obtain food. Write their suggestions on chart paper or on the chalkboard under the title, "Salmon Fry".
  They watch a small area and chase small insects or other edible things that float into their area.

SUMMATION

- With the class, make a chart comparing the foods eaten by fry and people; and the ways in which fry and people obtain their food.
- Discuss with the class how a fry's habitat affects its food.
  Fallen trees, leaves, still pools, etc., allow insects to breed; salmon fry eat the larvae, as well as insects that fall from plants on the stream bank.
- *Option:* Have students mime or act out a plant or animal getting food, while the class guesses what it is.

SALMON FRY CAMOUFLAGE

This experiment demonstrates that objects are harder to see when they are the same colour as their background. It leads to a discussion of how protective colouration can protect fish from predators.

Materials:

- "Handout 6.2: Salmon Fry Camouflage" photocopied onto several pieces of coloured paper (Note: one colour should match the floor where you will conduct the experiment)
- Scissors
- *Option:* Paints
- Copies of "Appendix 1: Observation Page" for each student
- Writing supplies
- Chart paper

Time required:
One lesson

Level of conceptual difficulty:
Simple

Suggestions for assessment:
Review class discussion and conclusions on camouflage to ensure that the students can describe how fry use protective colouration for safety.

INTRODUCTION

- Ask the class to describe animals, birds, etc., that blend into their surroundings and explain how their colouring helps protect people or animals.
  Many birds and insects use drab colours similar to dirt or trees as camouflage, making it harder for predators to see them. Tigers and leopards have stripes and spots to hide in grass or forest shade.
- Ask the students to suggest a way that salmon fry could use their colour as camouflage.
  The skin of salmon fry changes to take on the colour of the rocks they are swimming beside, so that hunting birds or other predators cannot see them easily.

EXPERIMENT

- Have students cut out the squares of fish from coloured copies of "Handout 6.2: Salmon Fry Camouflage". Ensure that there are the same number of each colour.
- *Option:* Have students paint some of the fish in multicoloured patches.
- Divide the class into three or four teams. Scatter the white fish randomly on the floor of a gym or open area (preferably indoors).
- Have the teams stand at the edge of the open area and gather as many fish as they can in 10 seconds.
- Repeat the steps of scattering and collecting the fish, using the black and coloured papers.
- Have the teams count the number of fish they found of each colour. Chart and graph the results for each colour. Ask how easy it was to spot the fish of each colour.

DISCUSSION

- With the class, use the data to draw a conclusion about how colour helps salmon fry hide in a stream or lake.
  The class caught fewer fish that were the same colour as the floor. Conclusion: salmon fry would be safest if they were the same colour as the stream or lake in which they live.

SUMMATION

- Have students write or draw their observations and conclusion on "Appendix 1: Observation Page".

SALMON FRY
WRAP-UP

REVIEW:

- Materials: chalkboard and chalk
- Have students draw and label on the chalkboard three ways by which a salmon fry survives in its environment.
  It swallows air to facilitate swimming up and down, it catches food, and it relies on camouflage to hide from predators.
- Explain that these elements make a safe home for a salmon fry, and that if it gets enough food and avoids predators, the fry will grow into a smolt.

EVIDENCE FOR UNIT ASSESSMENT

- Have students make a fry habitat in an aquarium or basin, using rocks, sand, water, plants and modelling clay, then use it to explain how fry live in the environment.
- Have students make a pop-up book with a mouth that opens and draw food that salmon fry would eat.
- Have students make a web linking a fry's needs with its environment, then use it to explain how a fry lives in its environment.
- Have students make a web or write a sentence listing ways in which a salmon fry is different from a salmon alevin.
- Have students complete a stem sentence, such as, "I used to think... about salmon fry but now I know that..." or "One thing I learned about salmon fry is that...".
- Have students add their materials to their learning log and write a sentence explaining what they learned.

LANGUAGE AND ARTS INTEGRATION

- If your school is near a salmon stream or lake, arrange a field trip to identify the plant and animal life living there. This activity is particularly meaningful if done when incubated fry are released into the stream or lake. (See "Unit Eleven: Salmon Habitat Studies".)
- Have students use a heavy paper clip to seal the end of a balloon and find out how much the balloon has to be inflated so it neither rises nor falls in a basin of water. Discuss how the balloon is like a salmon's swim bladder.

HOME CONNECTIONS

- Have students demonstrate to an adult how a salmon fry swallows air and catches food.
- Have students fill in "Appendix 4: Classroom Salmon Science News" and read it to an adult.

SALMON INCUBATION

If your school has an operating incubation tank, have students observe the fry, feed them and record their observations. For assistance, refer to "People And Connections That Can Help" on page viii of the Introduction. Explain that when salmon fry are released into a stream, they find many insects to eat, especially those in their egg and nymph forms, many of which spend much of their life cycle in the water.

Have students discuss the differences between a fry's life in a salmon tank and its life in a stream or lake.

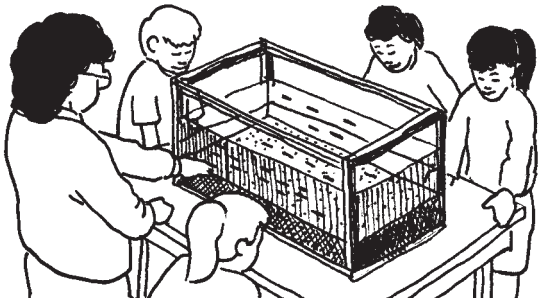


Illustration: Donald Gunn

In the Tank	Salmon Need	In Nature
Gravel	Shelter	Gravel
Riser tubes	Oxygen	Riffles caused by moving water
Comes from tap; gravel cleaner removes food and waste	Clean Water	Comes from stream, lake, rain, etc.; water organisms eat and convert wastes
"Fish food"*	Food	Insects

** "Fish food" is a composite of fish meal, fish oil, protein extracts from grains, animal protein, vitamins and minerals. In a hatchery, the size and form of the food would change as the fry gain weight and size.*

HANDOUT 6.1

SALMON FRY

Illustration: Karen Uldall-Ekman

When alevins finish the food in their yolk sacs, they grow into **fry**. Fry catch their own food.

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

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

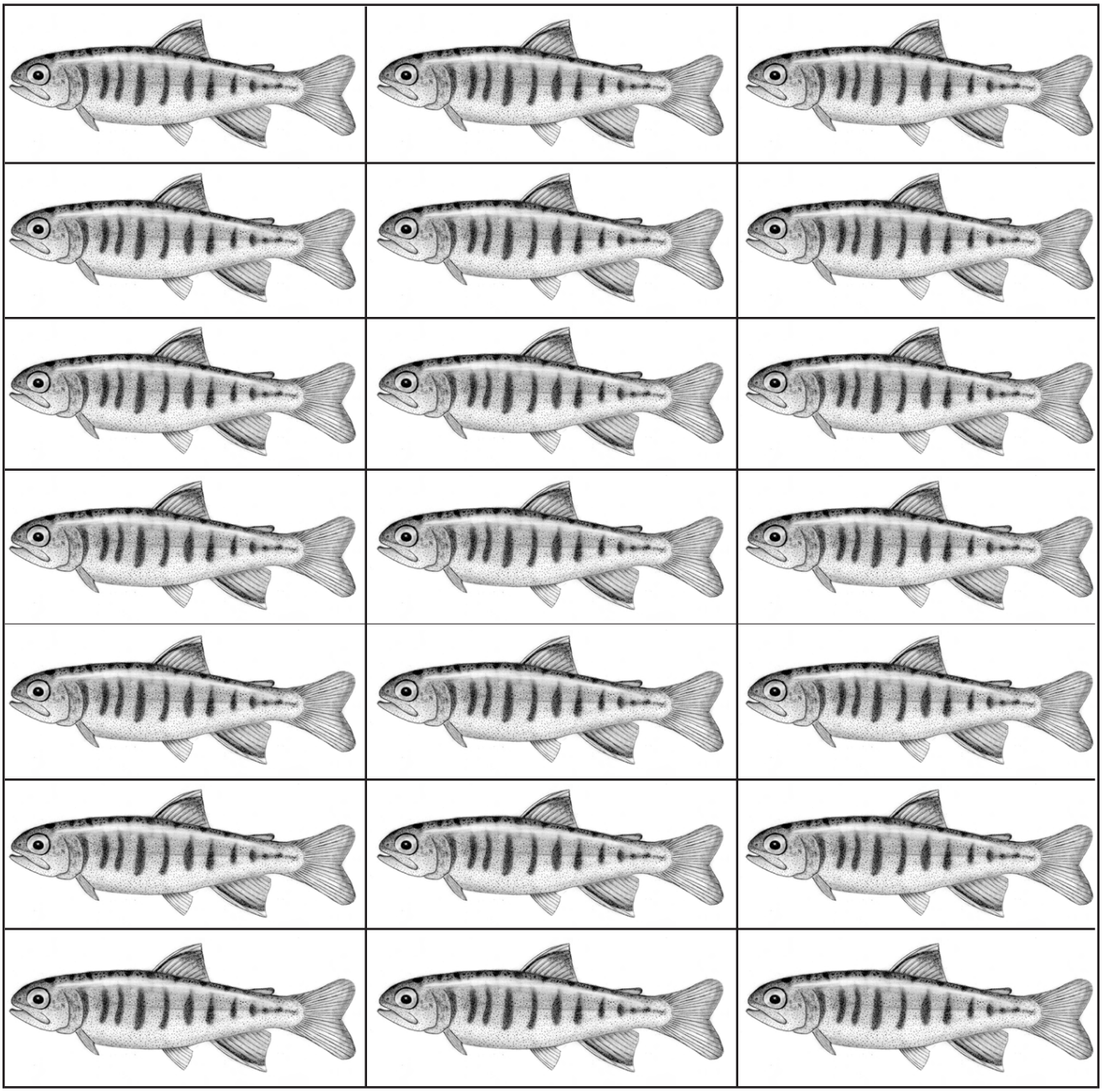
Plants beside the stream or lake keep the water cool and shady. Fry can hide in the shadows. Their skin changes colour to help them hide. Dark lines called **Parr marks** also help them hide.

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

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

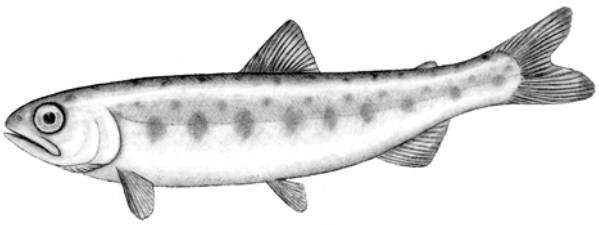
HANDOUT 6.2

SALMON FRY CAMOUFLAGE

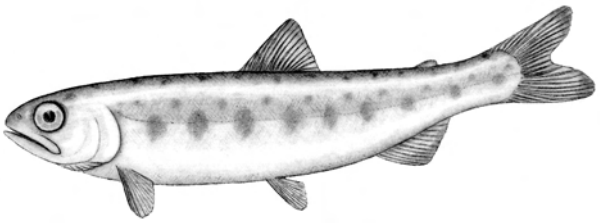


UNIT 7

SALMON SMOLTS



SALMON SMOLTS



OVERVIEW

The class uses the poster and an information sheet to identify where salmon smolts come from and how they live in an estuary. The students act as predators and prey to simulate survival and test how salt water affects cells.

THE BIG IDEA

Smolts migrate to the estuary before leaving to swim in the ocean.

KEY WORDS

For definitions refer to “Appendix 8: Glossary”.
Basic: salt water, fresh water, smolt, ocean, logs, dams, dyke
Advanced: hazard, polluted, estuary, factory

BACKGROUND INFORMATION
THE SMOLT

As salmon begin to mature, they adapt for life in salt water in an intermediary stage known as smolts. This process marks the beginning of their first migration from their home 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 smolts prepare for ocean life, their appearance also changes, from the dark colours of the fry to the silvery colour 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 shrimps for food. While in the estuary, smolts can grow from 4 or 5 cm in length to as much as 9 cm.

However, estuaries are home to many fish predators, including larger fish, birds, snakes, seals and even orcas. People build cities and industries on estuaries, as well as dyking 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 smolts 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 smolts, less than four survive to become adults.

WHERE DOES A SMOLT COME FROM?

Materials:
- Salmon Life Cycle poster
- Copies of "Handout 7.1: Salmon Smolts" for each student
- Writing supplies

Time required:
Two to three lessons

Level of conceptual difficulty:
Simple

Suggestions for assessment:
Monitor the students' discussion of the life cycle poster to ensure that they know that a smolt grows from a fry and travels to an estuary.

RESEARCH/DISCUSSION

- Have the class look at the Salmon Life Cycle poster, drawing their attention to the part about the smolt. Ask students to explain what the poster shows about where smolts come from.
  They are fry which are old enough to leave their home stream.
- Have students use the poster to explain where a smolt goes.
  It swims downstream to the ocean and spends time in an estuary.
- Have students discuss the difference between fresh water and salt water, and use the poster to compare conditions in a stream with those in an estuary.
  Water in an estuary is saltier.
  There are more plants and more to eat in an estuary, but more predators, also.

SUMMATION

- Read "Handout 7.1: Salmon Smolts" or have students use it to research the stage. Have students, in groups, write three important things about a smolt.

SALT WATER AND FRESH WATER

This experiment 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 of water in each
- Approximately 15 ml of salt
- Two fresh slices of cucumber
- Copies of "Appendix 3: Comparison Chart" for each student

Time required:
Two lessons

Level of conceptual difficulty:
Moderate

Suggestions for assessment:
Review students' observation pages and classroom discussion to ensure that they can describe how salt water makes plants wilt.

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 die in salt water. Salmon and a few other species are an exception.

EXPERIMENT

- 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 on "Appendix 3: Comparison Chart".
- 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.

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 smolts drink salt water from the ocean to keep from shrivelling up. They get rid of the extra salt through their gills and urine. (See Background Information on page 77.)

SUMMATION

- Have students write or draw their observations and conclusions on their comparison chart.

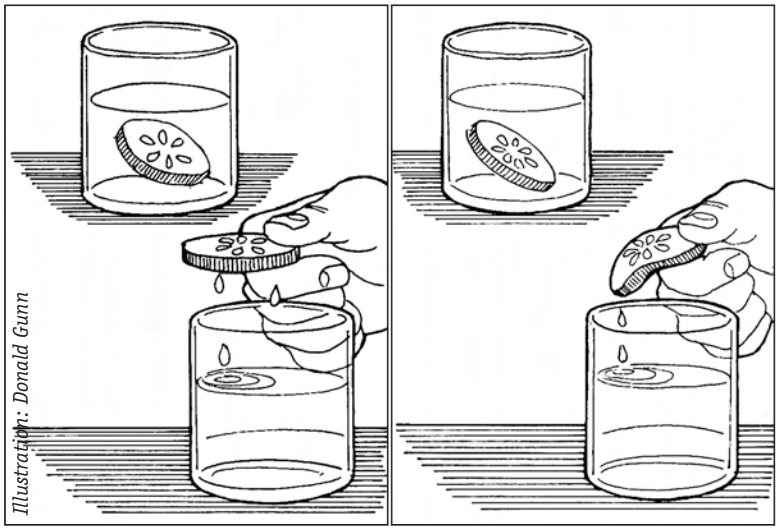


Illustration: Donald Gunn

Cucumber slice in fresh water Cucumber slice in salt water

PEOPLE AND SMOLTS

With younger grades, you may prefer to do this activity as a chalkboard demonstration.

Materials:
- Salmon Life Cycle poster
- Copies of "Handout 7.2: People and Smolts" for each student

Time required:
One to two lessons

Level of conceptual difficulty:
Moderate

Suggestions for assessment:
Review the students' estuary handouts and discussion to ensure that they can identify the impact of human activity on estuaries and smolts.

INTRODUCTION

- Explain that an estuary is an area where a stream or river enters a larger body of water, such as the ocean. Use the Salmon Life Cycle poster to discuss with the class why people like to live near estuaries.
  They are convenient for river transportation and fishing, they tend to be flat and good for construction and agriculture, they are often protected from climate extremes, etc.

DISCUSSION

- Have students discuss what happens to smolts and other wildlife when people build in estuaries.
  They are crowded out by construction, dyking, dredging, etc., and may be affected by pollution from human activities.

INVESTIGATION

- Give students, in small groups, a copy of "Handout 7.2: People and Smolts" and discuss it with the class. Have students work in their group to answer the questions.
- When students have completed the handout, discuss the results. If necessary, prompt them with questions, such as:
  - How many smolts could live in the estuary at the beginning of the activity?
    12.
  - How many smolts could live in the estuary at the end of the activity?
    3.
  - If all the activities listed were done, what would happen to the smolts?
    Many would die from lack of food or safe habitat.
  - What would happen to other plants and animals that live in the estuary?
    Many would die. If smolts cannot live in an estuary, it is a sign that other plants and animals might also be unable to live there.
  - How can people make sure fewer plants and animals that live in estuaries die?
    Try to build inland, protect estuaries, avoid pollution, etc.

DISCUSSION

- Discuss with students what happens to an estuary if people leave natural spaces around estuary construction, replant vegetation, remove polluting drains, etc.
  The estuary land can be reclaimed.
- Have students erase some markings from "Handout 7.2: People and Smolts" to show how land can be reclaimed.
- Discuss with the class how scientists could use information such as that from the game.
  To predict the impact of changes on the estuary and prevent harmful changes.

PREDATOR GAME

Materials:
- Chart paper
- Writing supplies
- Coloured gym sashes
- *Option:* Gym supplies
- Chalkboard
- Chalk

Time required:
One lesson

Level of conceptual difficulty:
Simple

Suggestions 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 smolts.

INTRODUCTION

- Have students use the poster or "Handout 7.1: Salmon Smolts" to list animals that prey on smolts and other dangers smolts face.
  Larger fish, birds, snakes, seals, orcas, construction of buildings and roads, pollution.

  Option: Have students make large nametags for all of the predators they identify. These can be used in the simulation.

SIMULATION

- Divide the class into two teams, with four-fifths of the students as smolts and one-fifth as various predators (e.g., predatory fish, birds). Give each group a different colour of sash.
- Label one side of a gym or open area "Home 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 smolts by tagging them as they cross the floor from the home stream to the ocean.
- Have the smolts try to move from the home 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 smolts 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).

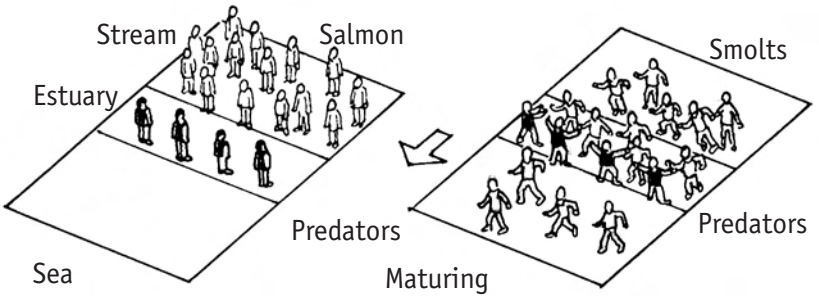


Illustration: Donald Gunn

- *Extension activity:* Use gym equipment to represent other hazards, such as dams, logs or polluted water. Play the game again and have students compare the outcome. Have smolts move together in a large school and compare the outcome, or have students create safe spaces and protected areas in the estuary where smolts can hide from predators.

DISCUSSION

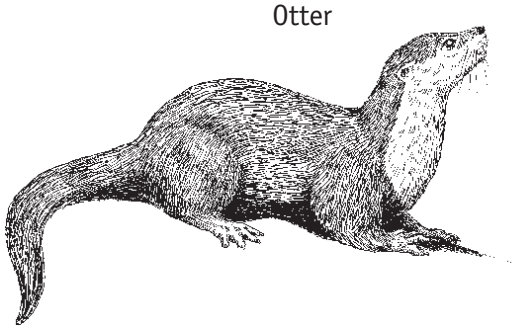
- Have students discuss how the game compares with the hazards smolts face as they travel to the ocean. If necessary, prompt them with questions, such as:
  - What are the similarities between the game and a real smolt's trip to the ocean?
    It is a hazardous trip and many smolts do not survive.
  - What are the differences between the game and a real smolt's trip to the ocean?
    The real route is much longer. Smolts can hide under the water.
  - What happens when the number of predators increases?
    Fewer smolts survive.
  - What happens when dams or other obstacles block the way?
    Fewer smolts survive.
  - What does the game show about the smolt's trip?
    Predators and obstacles prevent many smolts 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 on the chalkboard 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 smolts do not survive the trip to the ocean, but that the estuary is a rich environment for smolts to grow and prepare for life in the open ocean.

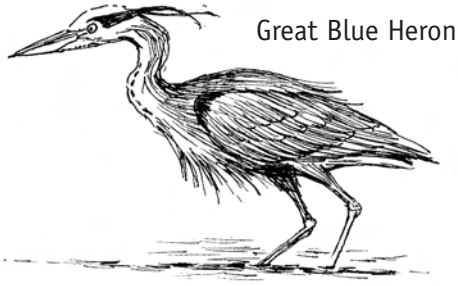
SMOLT PREDATORS

Otter



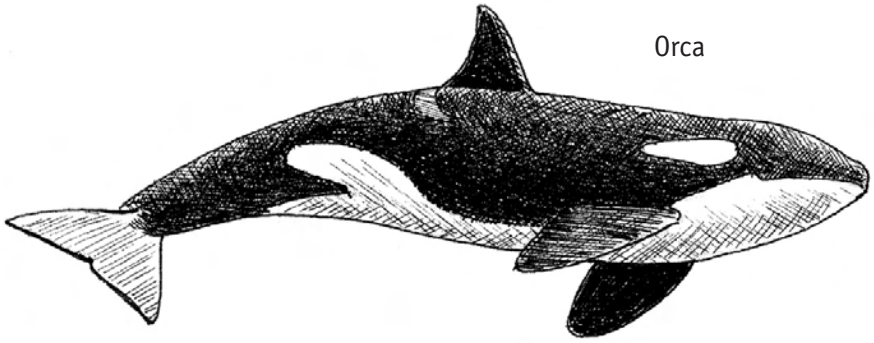
Belted Kingfisher

Red-breasted Merganser

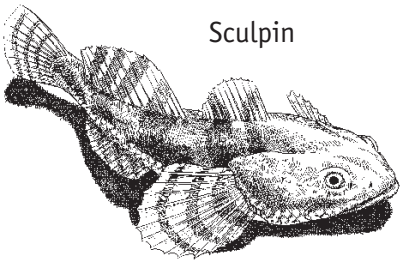


Great Blue Heron

Orca



Sculpin



Seal

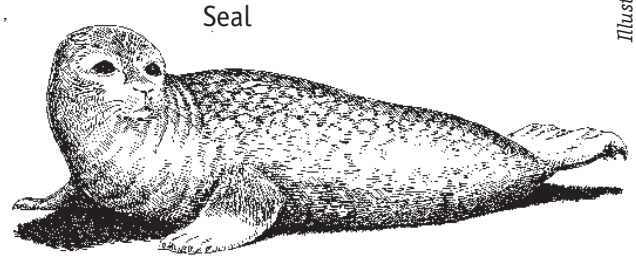


Illustration: Donald Gunn

SALMON SMOLTS
WRAP-UP

EVIDENCE FOR UNIT 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 regarding "Handout 7.2: People and Smolts" in a reflection sheet.
- 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 smolts but now I know that…," or, "One thing I learned about salmon smolts is that…".
- Have students add their materials to their learning logs and write a sentence explaining what they learned.

LANGUAGE AND ARTS INTEGRATION

- If your school is near a seaside estuary, arrange a field trip to identify the diversity of plant and animal life living there. (See *Discovering Your Estuary*, published by Straitkeepers and the B.C. Wetlands Society, for suggestions.)
- Have students construct a model estuary in a tank and use coloured 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 a heron's point of view.

HOME CONNECTIONS

- Have students describe an adult the ways in which people affect estuaries where smolts live, and ways in which people can reduce their impact.
- Have students fill in "Appendix 4: Classroom Salmon Science News" and read it to an adult.

HANDOUT 7.1

Salmon Smolts

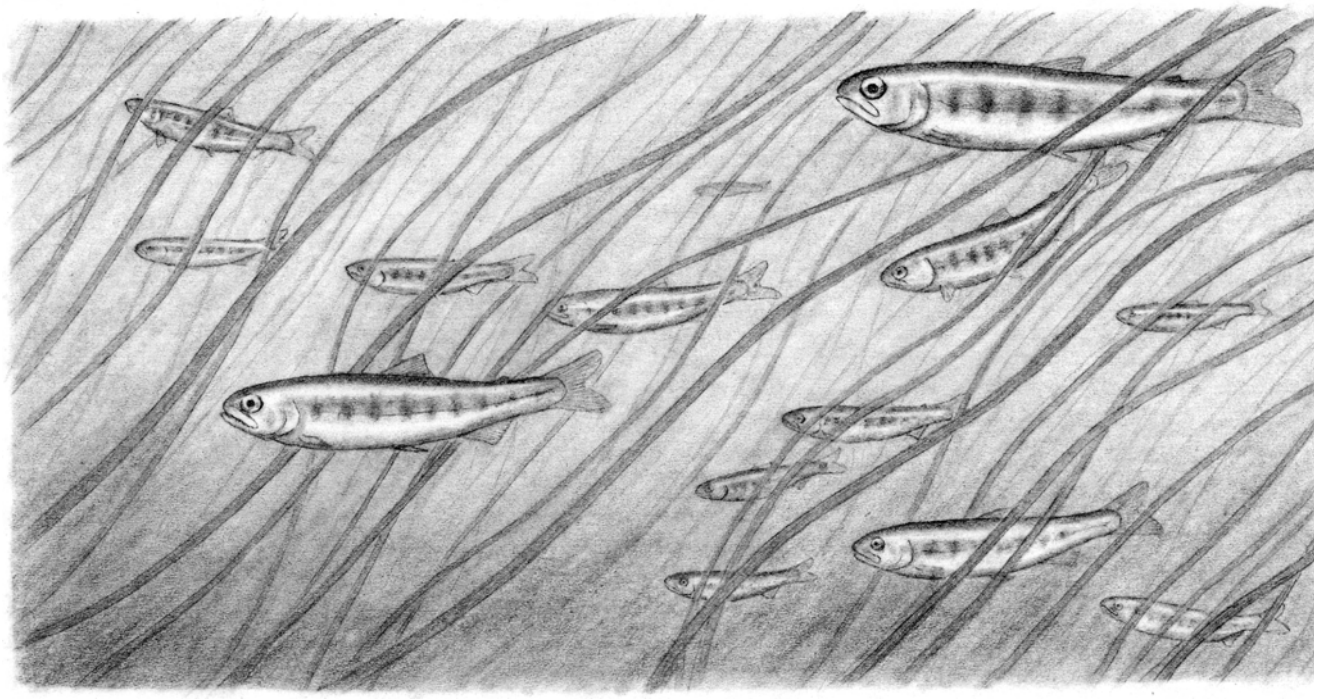


Illustration: Karen Uldall-Ekman

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

On the way, smolts face many hazards. Predators try to catch the smolts 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. Smolts get used to the salt water in the estuary.

Smolts find a lot of food in the estuary. Smolts can eat other fish, tiny shrimp and other animals. But there are also many predators. Larger fish, birds, snakes, seals and orcas eat smolts.

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

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

HANDOUT 7.2

PEOPLE & SMOLTS

Name: _____

The squares in the picture are part of an estuary. One smolt can live in each square. How many smolts can live in the estuary? _____

Fill in the squares as you answer the questions.

A. A farmer wants a bigger field. The farmer builds a dam around one square. How many smolts can live in the estuary? _____

B. A ship wants to come close to shore. People dig out one more square. How many smolts can live in the estuary? _____

C. The city builds a wharf out to the ship. It covers up one more square. How many smolts can live in the estuary? _____

D. People build two new factories next to the wharf. They fill in one more square. How many smolts can live in the estuary? _____

E. The city wants to build more houses. It fills in one square where houses will be built. How many smolts can live in the estuary? _____

F. A storm drain into the estuary poisons one square. How many smolts can live in the estuary? _____

G. The city builds a road across the estuary. It fills in one more square. How many smolts can live in the estuary? _____

H. The city wants to stop floods. It builds a dam around one more square. How many smolts can live in the estuary? _____

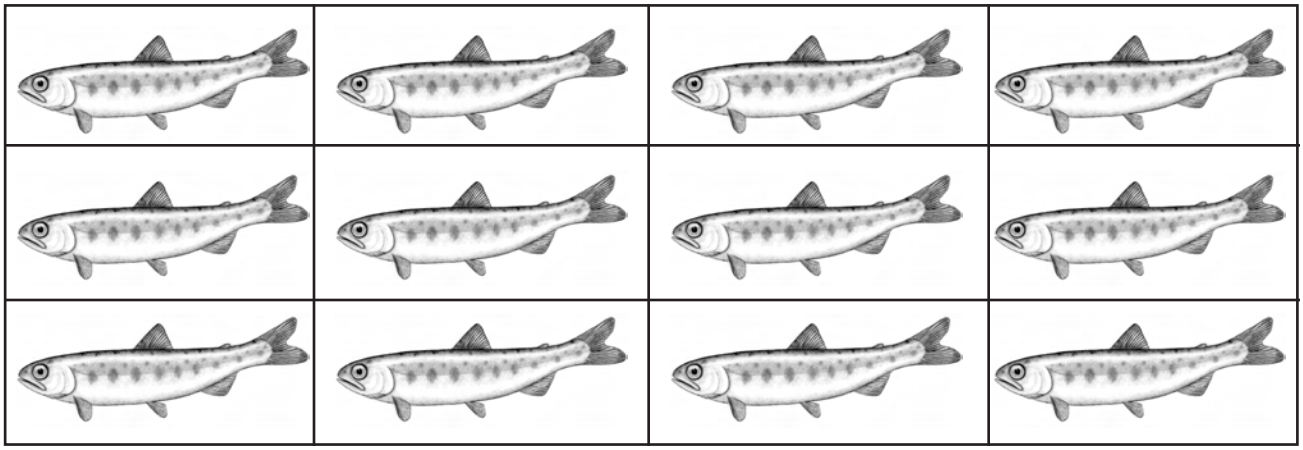
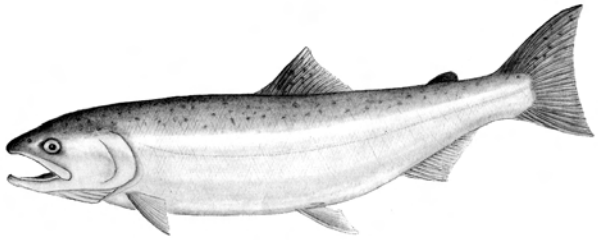


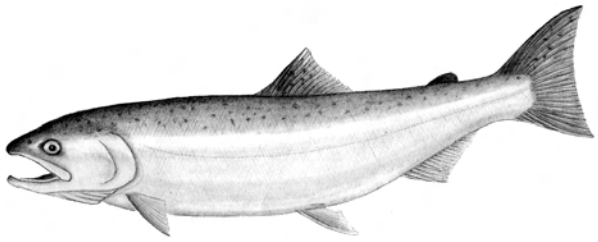
Illustration: Karen Uldall-Ekman

UNIT 8

ADULT SALMON



ADULT SALMON



OVERVIEW

The class uses the poster and an information sheet to identify where adult salmon come from and where they travel in the ocean. The students simulate fishing and the impact of predation on salmon, discuss salmon migration and test scent as a means of identifying a home area.

THE BIG IDEA

Adult salmon travel long distances in the ocean. People fish for salmon in different ways; some people catch many salmon, while others catch fewer. Surviving salmon return to their home rivers.

KEY WORDS

For definitions refer to “Appendix 8: Glossary”.
Basic: adult, ocean, school, fishers, fishing boats, home stream, scent

BACKGROUND INFORMATION

THE ADULT SALMON

After gaining weight in the estuary and adapting to the salt water, salmon travel along the coastline and then to the open ocean. Here they gain the full size, shape and colour of one of the species of mature salmon: coho, sockeye, pink, chum, chinook or steelhead. (Older references describe five species, but steelhead were recently reclassified as salmon.)

Because scientists cannot easily observe salmon in the ocean, knowledge of this part of the salmon's life cycle is limited. Scientists do know that most salmon spend the first part of their life in coastal waters, then migrate farther out to sea. Each species of Pacific salmon has a characteristic migration route and spends a different length of time in the ocean before returning home.

Young salmon can travel up to 20 km a day, while mature salmon can travel as much as 50 km a day. Salmon usually travel north in summer, as far as the Gulf of Alaska, and south in winter, possibly following ocean temperature changes while searching for food.

While at sea, salmon feed on a variety of smaller fish and plankton, often following schools of herring or krill. They can gain many kilograms, with mature adults reaching weights ranging from a few kilograms to 20 kilograms or more, depending on the species. Salmon are also prey for larger salmon species, seals, orcas, and other fish, such as tuna and cod.

Canada divides the right to catch salmon among the different fishing groups. First, scientists estimate how many salmon must return to their home streams and lakes to conserve the species. First Nations people have rights to catch some of the remaining fish for food and ceremonial purposes. After meeting these needs, regulators allocate the remaining fish among commercial and recreational fishers.

The largest number of salmon is probably taken by human fishers. People catch salmon mainly in coastal waters as large schools return from their ocean travels, although some are also caught in huge ocean drift nets. Commercial fishers use three main kinds of gear to catch salmon:

- gill nets: nets that hang like a curtain from the water's surface and entangle salmon by their gills (about 25% of the commercial catch);
- purse seine nets: nets that fishers first drag to form a circle around a school of fish, then pull in the bottom to form an enclosure from which fish cannot escape (about 50% of the commercial catch);
- troll lines: long steel fishing lines, each with several lures and hooks to catch salmon by the mouth (about 25% of the commercial catch).

Altogether, commercial fishers took about 85% of the salmon caught in 1998. Sport and native fishers also catch many salmon, both in coastal waters and as the salmon travel upstream. Recreational fishers usually catch salmon using single fishing lines with lures and hooks; they took about 3% of 1998's annual catch. Native fishers use both modern and traditional methods to catch fish; they took about 12% of 1998's annual catch.

After spending from one to seven years at sea, depending on the species, salmon return to their home stream or lake to spawn a new generation. No one knows how, but mature salmon form large schools and find their way to the mouth of their home stream. Scientists think salmon use ocean currents, the earth's magnetic field, water temperature and even the north star to find their way back. When they get near their home river, the scent of its water helps them identify the right river. The salmon congregate at the mouth of their home river before starting the difficult journey upstream.

WHERE DOES AN ADULT SALMON COME FROM?

Materials:
- Salmon Life Cycle poster
- Copies of "Handout 8.1: Adult Salmon" for each student

Time required:
One to two lessons

Level of conceptual difficulty:
Simple

Suggestions for assessment:
Monitor the students' discussion of the life cycle poster to ensure that they know an adult salmon grows from a smolt, travels to the ocean and returns to its original river.

RESEARCH/DISCUSSION

- Have the class look at the Salmon Life Cycle poster, drawing their attention to the part about the adult. Ask students to explain what the poster shows about where adults come from.
  When smolts have spent time in an estuary, they travel to the open ocean and grow into adults.
- Have students use the poster to explain where an adult salmon goes and to suggest reasons for it returning home.
  The salmon swims into the ocean until it is fully grown, and returns when it is ready to go back upstream to spawn.
- Have students use the poster to compare conditions in an estuary with those in the ocean.
  The ocean is bigger and more open. It has more big fish and fewer plants. Fishing boats catch salmon in the ocean.

SUMMATION

- Read "Handout 8.1: Adult Salmon" or have students use it to research the stage. Have students, in groups, write three important things about an adult salmon.

FISHING

This experiment demonstrates how different types and numbers of fishing tackle affect the number of fish caught. It leads to a discussion of how human fishing practices can affect fish survival.

Materials:

- Copies of "Appendix 1: Observation Page" for each student
- Several metre sticks
- String
- Magnets
- Paper
- Paper clips
- Scissors
- Chart paper

Time required:
Two to three lessons

Level of conceptual difficulty:
Simple

Suggestions for assessment:
Review the students' graphs and conclusions to ensure that the students recognize that fishing reduces salmon numbers.

INTRODUCTION

- Ask the class to predict what happens to a school of fish when a large number of fishers try to catch them. Have the students write their predictions on "Appendix 1: Observation Page".

EXPERIMENT

- Ask the students to suggest ways to test their predictions in class, using magnets for hooks on fishing poles. Make several fishing poles by tying one to two metres of string to a metre stick, with a magnet in place of the hook.
- Have the class make 10 to 20 paper fish, approximately 20 cm long, and clip a steel paper clip to the mouths.
- Have students arrange the fish behind a visual barrier, such as a row of desks. Have students take turns (30 seconds each) attempting to catch a fish with a pole and line. Have them count and graph their catch.
- Have several students together attempt to catch fish, then count and graph the number of fish they can catch in 30 seconds. (Arrange the students so they won't tangle their lines.)

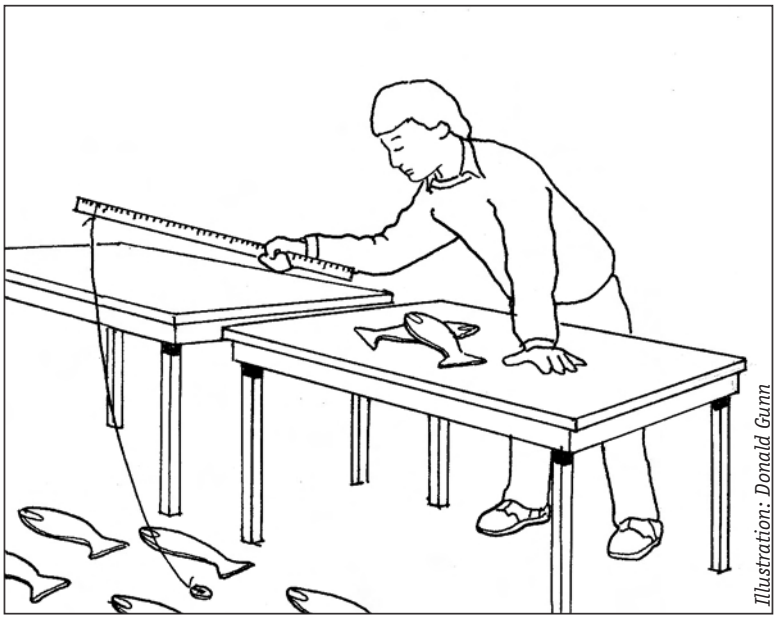


Illustration: Donald Gunn

DISCUSSION

- With the class, compare the graphs and discuss how many fish were left free when several students were fishing at the same time. Discuss whether the data support the predictions students made.

SUMMATION

- Have students write or draw the experiment on their observation page and write a conclusion comparing the impact of one person fishing with several people fishing. *Three people catch more fish in 30 seconds than does one person*.
- *Option:* Have older students tie several lines and magnets along a metre stick or broom handle and use graphs to compare their catch with the single line method. Have them attach magnets along the edge of a broom, drag the broom through the fish like a net and use graphs to compare their catch with the single line method. Discuss how the different fishing methods affect the number of fish caught and the ease of catching them.

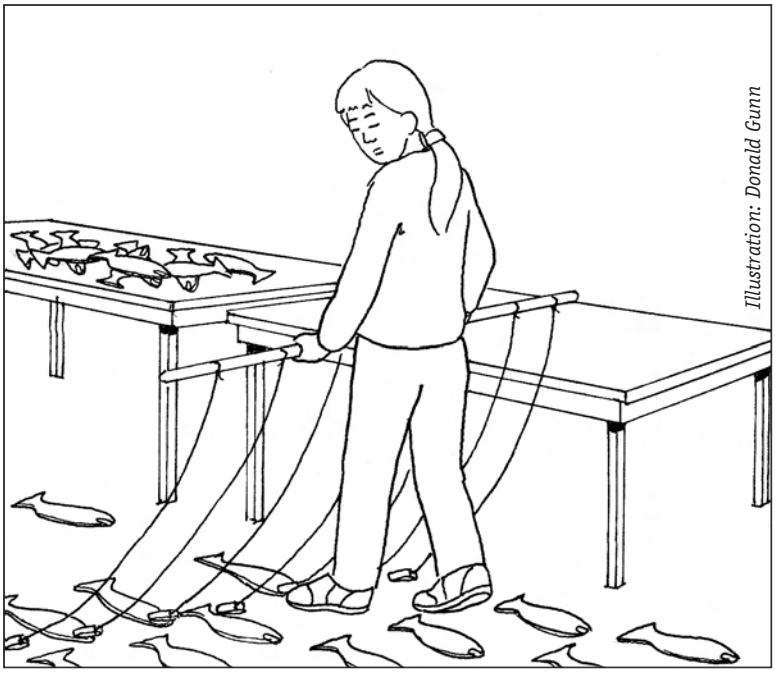


Illustration: Donald Gunn

PREDATOR GAME

Materials:
- Instructions from predator game ("Unit Six: Salmon Smolts")
- Chart paper

Time required:
Two to three lessons

Level of conceptual difficulty:
Simple to moderate

Suggestions for assessment:
Monitor student discussions and review their reflections on the predator game to ensure that the students recognize that predators and fishers reduce the number of salmon.

EXPERIMENT

- Have students repeat the predator game from "Unit Six: Salmon Smolts", with adult salmon going from the ocean back to the estuary. Add new predators, such as whales, seals and fishers. (You may want to increase the proportion of predators to adult salmon from one-fifth to two-fifths.) Have students count and record the number of salmon that are successful in reaching the estuary from the ocean.
- After students play the game a few times, vary the rules to allow animals to catch only one fish, while humans can catch as many as they can touch.
- Have students graph and compare the results under the different rules.

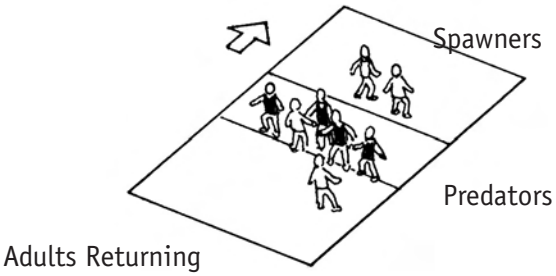


Illustration: Donald Gunn

DISCUSSION

- Discuss with the class the number of fish that survive when human fishers are allowed to catch as many fish as they can. If necessary, prompt them with questions, such as:
  - With the new rules, do animals or humans catch more fish? *Humans.*
  - How many fish return to the estuary under each set of rules?
  - Are the new rules fair or should they be changed?
  - Why do humans catch more fish?
    Humans can store fish, share them with others, or eat them later. But if they catch too many, there may be too few left.

SUMMATION

- Have students write a sentence or draw a picture reflecting their thoughts about the game.

SMELLING THE WAY HOME

This experiment demonstrates how a scent can be used to identify a location. It leads to a discussion of how salmon identify their home stream or lake by the scent of the water.

Materials:

- Copies of "Appendix 1: Observation Page" for each student
- Variety of strongly scented substances that students will recognize (preferably not artificial or allergenic scents)
- Opaque containers with perforated lids (e.g., plastic film canisters)
- *Option:* Cotton balls
- Writing supplies

Time required:
Two to three lessons

Level of conceptual difficulty:
Simple to moderate

Suggestions for assessment:
Review student discussion and observation pages to ensure that the students recognize that scents can be used to find a home area.

PREPARATION

- Place a variety of strongly scented substances, such as orange, banana, mint, toothpaste, maple syrup and chocolate, in plastic film canisters (or other opaque containers) with holes in the top. (You may prefer to place the scents on cotton balls in the containers. Avoid perfume or artificial scents that might cause allergic reactions.) Test the scents with the students so that they can recognize them prior to taking part in the activity.

INTRODUCTION

- Discuss with the class how people find their way on a trip. If necessary, prompt them with questions, such as:
  - How do you know when you are going in the right direction?
    By using memories and familiar sights as landmarks.
  - How do you know when to turn?
    By using memories and landmarks.
  - How do you know when you have arrived at your destination?
    By using memories and landmarks.
  - What do you do if the road is blocked?
    Look for another way until you find a familiar landmark.
- Have students, in pairs, describe to each other or map a trip they know how to take, e.g., from school, swimming pool or a friend's house to home. Have the pairs list any landmarks or memories that help them find their way and know when they have reached their destination. Model this activity for students, if necessary.
- Explain that one way salmon find their way home is by the scent of their home stream. They also use other factors, such as water temperature and current. This activity tests how to use scents to identify a home.
- Ask the class to name any smells that identify a place they know.
  A bakery, swimming pool, laundry, garbage, garden, etc.
- Ask the class to predict whether students could use scents to find a home area of the classroom.

EXPERIMENT

- Divide the class into groups and assign each group a home smell. Have the groups sniff and describe their scent sample.
- Place the samples in different parts of the room and have students try to find their home by sniffing each sample to identify their home area.

DISCUSSION

- With the class, discuss whether or not the test supports the predictions. Have students use "Appendix 1: Observation Page" to describe the experiment and the results.
- *Option:* With older students, reassign the samples, repeat the activity and compare the time needed to identify different home locations by their scent.
- *Option:* Use masking tape to mark a path on the floor representing a river system with tributary streams, and place a different home scent at each stream. Have students follow the river system to their home stream.

SUMMATION

- With the class, compare a salmon's sense of smell with a human's sense of smell.
  Salmon can smell under water, while people cannot. Salmon remember smells longer than people do. A salmon's sense of smell is more acute than a human's.

ADULT SALMON
WRAP-UP

REVIEW:

- Materials: chalkboard and chalk
- Have students draw and label or list on the chalkboard the benefits and dangers in a salmon's ocean environment.
  Lots of small fish to eat, clean water, many predators, fishers, etc.
- Explain that adult salmon grow large in this environment, then find their way back to their home stream or lake.

EVIDENCE FOR UNIT ASSESSMENT

- Have students make stick puppets of an adult fish and use them to explain, in a play, how an adult salmon swims through the ocean and then finds its way home.
- Have students make a web or write a sentence listing ways in which an adult salmon is different from a salmon smolt.
- Have students complete a stem sentence, such as, "I used to think... about adult salmon but now I know that...", or, "One thing I learned about adult salmon is that...".
- Have students add their materials to their learning log and write a sentence explaining what they learned.

LANGUAGE AND ARTS INTEGRATION

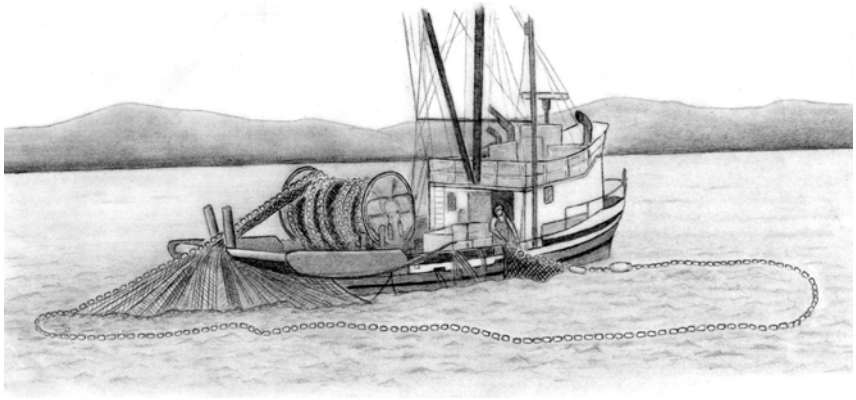
- If there are ocean fishers in your community, invite one to tell the class how they catch and process fish at sea, or arrange a field trip to a wharf and tour a fishing boat.
- If there is a fish cannery, native fishery or fish market in your area, arrange a tour to show students how fish get from the fishers to the home.
- Make canned salmon sandwiches, arrange a salmon barbecue for the class, or discuss how students enjoy eating salmon.
- Have students compare the migration of salmon with the annual migration of birds. If there is a migratory bird flyway in your area, arrange a field trip when the birds are migrating.
- Make fish prints by painting colours on a whole fish and gently pressing a page of paper against the paint.
- Make mobiles of salmon to represent a school of fish.

HOME CONNECTIONS

- Have students describe the fishing activity to an adult and explain how a larger number of fishers increases the catch.
- Have students fill in "Appendix 4: Classroom Salmon Science News" and read it to an adult.

HANDOUT 8.1

Adult Salmon



Salmon swim to the ocean to grow into adults. Some live in the ocean for one year. Others live in the ocean for many years.

Salmon find many smaller fish to eat in the ocean. They grow very large.

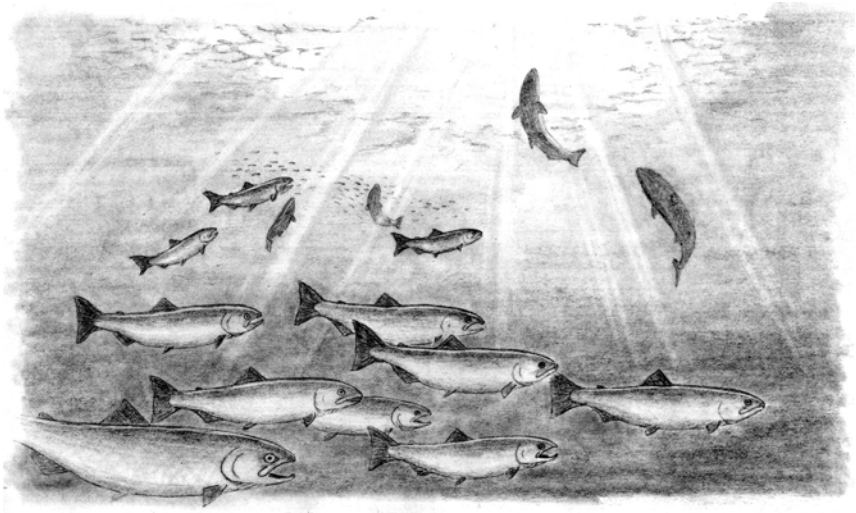
Their bodies become silver and grey. They are hard to see in the ocean.

Seals, whales and large fish catch salmon and eat them. Human fishers in fishing boats catch many salmon.

Like many birds, salmon can travel a very long way. Often they swim in big groups called schools. But they come back when their travel is finished.

No one knows how salmon find their way home. Scientists think they use all their senses to find the way.

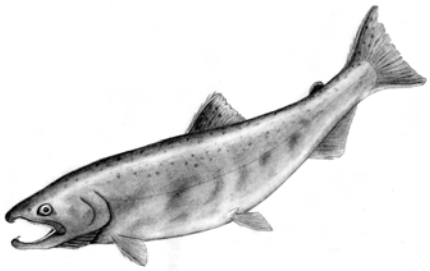
Salmon remember the scent of the water where they were born. The scent of their home river in the ocean tells them they are almost home.



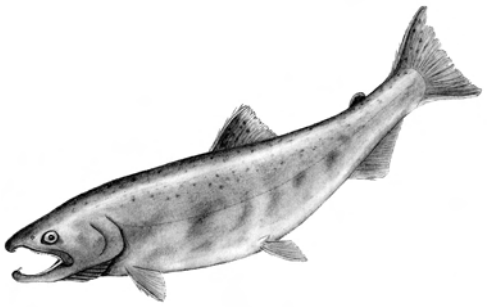
Illustrations: Karen Udall-Ekman

UNIT 9

SALMON SPAWNERS



SALMON SPAWNERS



OVERVIEW

The class uses the poster and an information sheet to identify how spawners leave the ocean and return to their home stream or lake. They examine changes of appearance in people and salmon, test how a redd protects eggs, and recycle paper salmon.

THE BIG IDEA

Spawners travel upriver to their home stream or lakeshore. Females lay eggs and males fertilize eggs. Salmon die after spawning and their carcasses return essential nutrients to the water and forest ecosystems.

KEY WORDS

For definitions refer to “Appendix 8: Glossary”.
Basic: spawner, redd, female, male
Advanced: fertilize

BACKGROUND INFORMATION
SALMON SPAWNERS

In the final stage of the salmon's life cycle, the adults re-enter their home river and swim back to the stream or lakeshore in which they grew as fry. Salmon from inland rivers may travel many hundreds or thousands of kilometres, swimming from 30 to 50 km a day against the current. They follow the scent of the water from their home stream, past rapids and other obstacles, such as dams, rock slides and log jams, before reaching their destination. Fishers and predators, such as bears, otters, racoons and eagles, catch many salmon on their trip upstream.

When they enter fresh water, the salmon stop eating and live only on stored body fat. Their kidneys, gills and skin change to regulate the water and salt balance in their cells. To save energy, they lose the slime coating that helps protect them; their skin becomes thick and leathery, and they absorb their scales.

The salmon's appearance changes dramatically, with males and females developing distinct differences. Both males and females lose their silvery colour and take on deep red, green, purple, brown and grey colours. Their teeth become long and they develop a hooked jaw, which is particularly noticeable in the males. The body shape can change, with some species developing a pronounced hump on their back. Eggs ripen in the ovaries of the females, while sperm in the males changes into liquid milt.

When they reach their home stream or lake, the female uses her fins and tail to find a spot with the right gravel size and water conditions. With strong sweeps of 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. Males fight among themselves to get close to a female. When a female chooses a male, they nudge and bump each other in an underwater courtship dance. 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 2,500. The female covers the eggs with gravel to protect them, and often moves on to build a second or third redd, which is fertilized by other males.

Both males and females die within a few days of spawning. 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 or lake. Salmon carcasses that are carried onto riverbanks fertilize the forest and bushes. If most of the adult salmon are caught, the water will have few nutrients for the next generations of salmon and for the rest of the ecosystem.

WHERE DOES A SPAWNER COME FROM?

Materials:
- Salmon Life Cycle poster
- Copies of "Handout 9.1: Salmon Spawners" for each student

Time required:
One to two lessons

Level of conceptual difficulty:
Simple

Suggestions for assessment:
Monitor the students' discussion of the life cycle poster to ensure that the students can describe the spawner's journey to its home stream, the building of a redd, and the laying and fertilizing of the eggs.

INTRODUCTION

- Ask the class to suggest reasons the salmon return to their home stream rather than staying in the ocean when they grow old and die.
  They return to their home 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, drawing 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 home 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, gravelly, fresh-water stream, usually the same stream in which the salmon was born.

SUMMATION

- Read Handout "9.1: Salmon Spawners" or have students use it to research the stage. Have students, in groups, write three important things about a salmon spawner.

APPEARANCE CHANGES

Materials:
- Several magazine pictures of people of different ages
- Writing materials or art supplies
- Salmon Life Cycle poster
- Painting supplies

Time required:
Two or more lessons

Level of conceptual difficulty:
Moderate

Suggestions for assessment:
Review the students' fact sheets or posters to ensure that the students can identify changes in the appearance of a spawner.

PREPARATION

- *Option:* Have students bring pictures from magazines or photos of people of different ages.

RESEARCH/DISCUSSION

- Give students, in groups, several magazine pictures of people of different ages. (If appropriate, point out that magazines often rely on stereotyped images which may not accurately reflect the people in the students' lives.) Have the groups sort the pictures into 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:
  - What do the babies in the pictures look like? How are they different from other people?
  - What do the small 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 older people look like? How are they different from other people?
  - Do all people change as they grow older? How do they change?
  - Do other animals change as they grow older? What changes have you seen in pets or other animals?
- Have students use the Salmon Life Cycle poster to compare the appearance of a spawner with the appearance of an adult fish.
  Spawners may have more colours, a large hump, a hooked jaw, more prominent teeth.
- Explain that, in people, fish and other animals, appearance changes as they grow older. Salmon have a very distinctive appearance at the spawning stage, as many other species do when they are ready for reproduction.
- *Option:* Have older students make a chart describing the features of salmon at each stage of their lives.

SUMMATION

- Have students paint a salmon spawner to show the new colours, hooked mouth, etc.

MAKING A REDD

This experiment demonstrates how a gravel redd protects salmon eggs from predators. If you have done "Unit Three: Salmon Eggs", you may prefer to replace parts one and two with a brief review.

Materials:

- Large basin(s)
- Water
- Modelling clay
- Toothpicks
- Rocks 5 to 10 cm in diameter and gravel
- Copies of "Handout 9.2: Making a Redd Observation Page" for each student

Time required:
Three lessons

Level of conceptual difficulty:
Moderate to advanced

Suggestions for assessment:
Review students' discussion and observation pages to ensure that the students can describe how a redd protects salmon eggs from predators and strong water flows.

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 lakebed, in which spawners lay their eggs.
- Have the class suggest reasons spawners create a redd in which to lay their eggs. Write their ideas on "Handout 9.2: Making a Redd Observation Page".

EXPERIMENT, PART ONE

- Decide whether you will do the following experiment as a demonstration or in groups. If in groups, provide each group with the items from the materials list.
- Have students make small eggs from modelling clay (about ½ cm in diameter), place them at one end of a basin and predict what might happen to them in a stream.
- Tilt the basin on 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 and use toothpicks to peck at the eggs. Count and record the eggs they catch in 10 seconds.

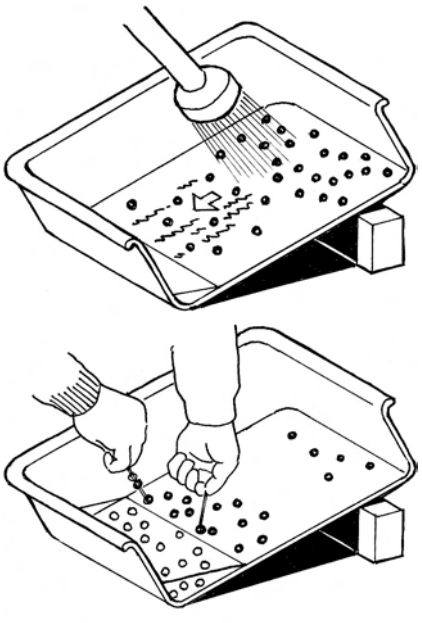
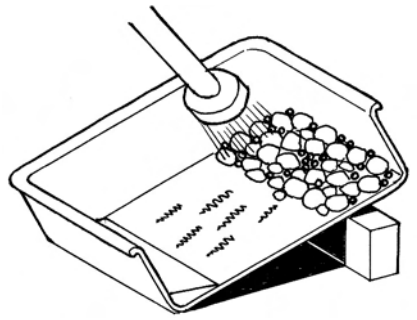


Illustration: Donald Gunn



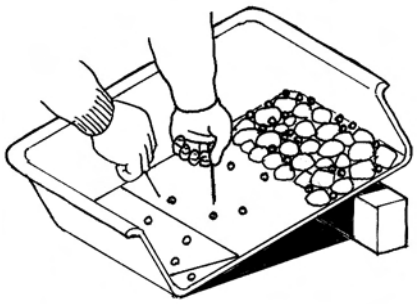


Illustration: Donald Gunn

EXPERIMENT, PART TWO

- Make a model redd, using rocks and gravel at one end of a basin. Place the model eggs in the redd and cover them with gravel. Have students predict what might happen to them in a stream.
- Pour water gently over the redd and have students count the eggs that are washed away.
- Have some students, in pairs, act as birds and use toothpicks to peck at the eggs. Count and record the eggs they catch in 10 seconds.

EXPERIMENT, PART THREE

- With the class, compare the outcomes for the eggs in the open stream and for the eggs in the redd. Make a graph to compare the number of eggs that were washed away or caught by birds in parts one and two of the experiment.

DISCUSSION

- Discuss with the class what conclusions they can add to "Handout 9.2: Making a Redd Observation Page". If necessary, prompt them with questions, such as:
  - 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 the eggs from birds and keep them from washing away. It would also help protect the eggs from other predators, such as fish and raccoons, so more would survive.

Illustration: Donald Gunn

RECYCLING SALMON

Materials:

- Paper or other art supplies
- Classroom composter, recycling bin or worm bin

Time required:
One lesson, plus observation time over several weeks

Level of conceptual difficulty:
Simple

Suggestions for assessment:
Review student's classroom discussion to ensure that they recognize that a salmon's death is part of the natural cycle that supports other life in the environment.

RESEARCH/DISCUSSION

- Have students cut salmon figures out of paper, bread or apples, and place them in a classroom composter, recycling bin or worm bin.

Illustration: Donald Gunn

- Explain that when spawners die after laying their eggs, their bodies break down and return to the environment (either by decomposition or when eaten by other animals). This process provides important food and other nutrients for the animals and plants that live along the stream or lake, and helps them stay alive and healthy.

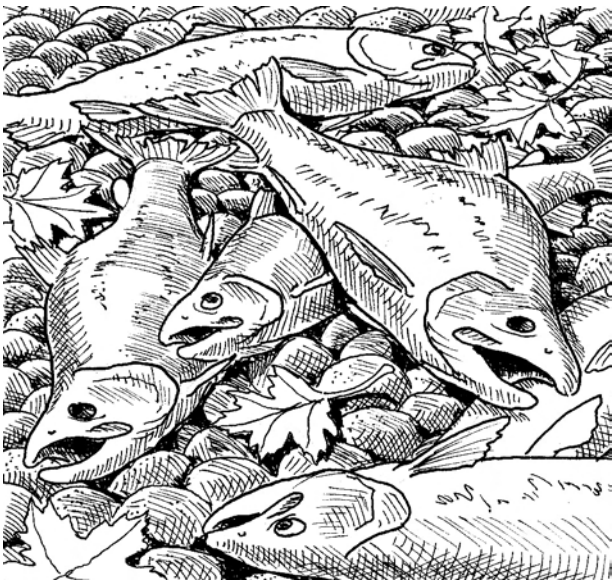


Illustration: Donald Gunn

- Discuss with the class what would happen if salmon did not die and provide food for plants and animals. If necessary, prompt them with questions, such as:
  - What happens to salmon bodies when they die?
    Birds, bears, racoons and other animals eat their bodies. Their bodies decay. They add nutrients to the stream and forest.
  - What would happen to the plants and animals if there were no salmon bodies?
    They might not get enough food. They might starve or not grow.
  - What would happen to the salmon fry if the plants and animals did not grow?
    The frys' home stream or lake would change. The fry might not live.
  - If the fry do not live, what would happen to the salmon?
    They would die out.

SUMMATION

- Have students write or draw a reflection describing their feelings about the salmons' death and how their bodies fertilize the stream or lake to provide for the next generation.
- *Option:* Have students use "Appendix 2: Daily Observations" to observe and record the changes to the paper salmon in the bin.
- *Option:* Have students compare the growth of plants in a school garden using fish fertilizer and using no fertilizer.

SALMON SPAWNERS
WRAP-UP

REVIEW:

- Materials: chalkboard and chalk
- Have students draw and label on the chalkboard 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 UNIT 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 salmons' 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 learning log 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 your local community advisor or a trained teacher 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 home 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 salmons' swim upstream, and explain how they find their home stream.
- Have students fill in "Appendix 4: Classroom Salmon Science News" and read it to an adult.

SALMON INCUBATION

If you are using the salmon spawner unit to begin your class's salmon studies and your school has a classroom incubation tank set up, have students compare the environment in the tank with that of a home stream.

Both have cold, clean water, oxygen, gravel, eggs, etc.; but the tank does not have streamside plants, predators, animals, adult carcasses, etc.

For assitance, refer to "People And Connections That Can Help" on page viii of the Introduction.

➡ Have students closely observe and describe the conditions in the tank, using a tape recorder or notes to record their observations.
What is the condition of the water?
Is the surface flat or rippled?
Does it feel warm or cold?
What colour is the gravel?
Is there any dirt in the gravel?
Where do you see bubbles?
Are there many bubbles or a few?
Are they large or small?
Are the walls of the tank clear?
Has moisture condensed on the tank?
Is anything growing in the tank?

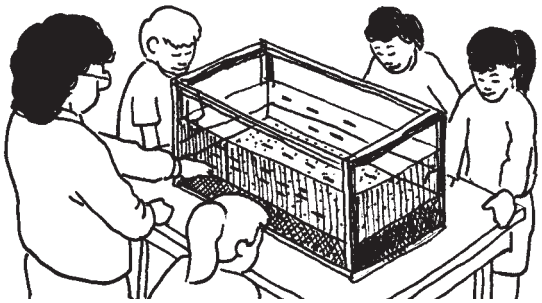


Illustration: Donald Gunn

HANDOUT 9.1

Salmon Spawner

Illustration: Karen Udall-Ekman

Salmon **spawners** leave the ocean in the fall or early winter. They swim upstream to the stream or lake where they were born.

On the long trip upstream, spawners do not stop to eat. Their shape and colour changes. Their skin may become bright red, green or purple. Some grow a large hump. Some grow 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 home stream or lake. When they reach their home stream or lake, the **female** builds a **redd**. She sweeps rocks and gravel with her tail to make a stone nest. Then she chooses a mate.

She lays her eggs in the redd. The **male** deposits his **milt** so the eggs will grow. The female covers the eggs. Often she builds another redd, finds another mate and lays more eggs.

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

HANDOUT 9.2

Making a Redd Observation Page

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

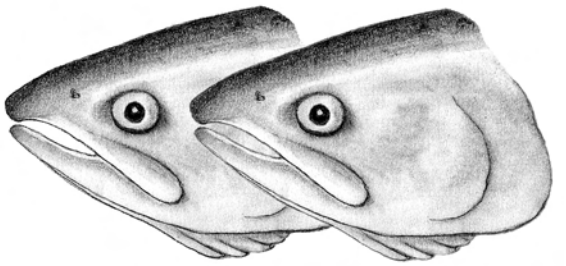
Eggs with no redd		**Eggs in redd**	
Washed away	Found by birds	Washed away	Found by birds

Conclusion

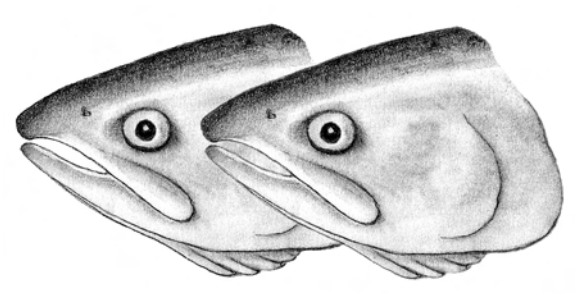
This experiment shows that

UNIT 10

SALMON LIFE CYCLE GOES ON



SALMON LIFE CYCLE GOES ON



OVERVIEW

The class uses a game to review the salmon life cycle and discusses activities they can undertake to help more salmon survive.

THE BIG IDEA

If people make careful decisions and satisfy their needs without taking away from future generations, they will help take care of salmon.

SALMON LIFE CYCLE REVIEW

Materials:
For each group of four or five students:

- Copies of "Handout 1.2: Salmon Words" for each group, cut into individual illustrations
- Option: Blank index cards (3" X 5")

Time required:
One lesson

Level of conceptual difficulty:
Simple

Suggestions for assessment:
Monitor students as they recall facts to ensure that they can state and confirm facts about each stage in the life cycle of a salmon.

REVIEW

- Have students, in small groups, place the illustrations face down on a table and pick one at random.
- Have each student, in turn, read the name of the life cycle stage on the illustration and tell the group one fact they learned about the stage. Have other students help the student, if necessary, and question the student if they disagree with the fact stated. If they are not sure about a fact, have the students confirm the facts from the information in their salmon studies portfolios.
- *Option:* Have the students write facts for each life cycle stage on blank index cards. Students can then play "concentration/memory" by turning all cards face down and taking turns choosing two at a time to try and match the fact to the appropriate illustration.

SALMON LIFE CYCLE GAME

Materials:
For each group of four or five students:
- One copy of "Handout 10.1: Life Cycle Game"
- One copy of "Handout 10.2: Life Cycle Game Rules"
- One die
- Ten small squares of paper per player to use as game markers
- Salmon Life Cycle poster

Time required:
Two or more lessons

Level of conceptual difficulty:
Simple

Suggestions for assessment:
Monitor students as they move through the stations and in discussion to ensure that the students recognize that salmon die at every stage and, on average, only two are left to spawn a new generation.

RESEARCH

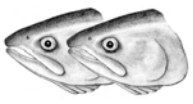
- Have the class refer to their notes or the Salmon Life Cycle poster to list and describe a variety of threats that salmon face throughout their life cycle.
  Predators, such as fish, birds, raccoons, bears, pollution, human activity in streams and estuaries, fishers, disease.
- Explain that this game will show the number of salmon that complete all the stages of their life cycle.

SIMULATION

- Have students write their name on 10 small squares of paper to use as game markers. Give groups of four or five students game markers, a die, a copy of "Handout 10.1: Life Cycle Game" and a copy of "Handout 10.2: Life Cycle Game Rules".
- Review the rules with the class. Have students cut out the stewardship cards. Have groups play the life cycle game until all the students win. Note: you may wish to laminate the life cycle game board and stewardship cards for future use.
- *Option:* Have students count and record the number that pass each stage of the game. With the class, create a graph, showing the number of survivors at each stage. Point out that the actual number of survivors is much smaller, only two out of 2,500 or more eggs.

DISCUSSION

- Discuss with the class what the game shows. If necessary, prompt them with questions, such as:
  - How many salmon die at the egg stage?
  - How many are left to grow to the next stage?
    Most salmon die. Only a few make it to the next stage.
  - What if two spawners do not survive?
    There are no eggs, but eggs from other spawners might survive and take their place.
  - How do stewardship cards help salmon finish the life cycle?
    They help the salmon survive the hazard squares.
  - What can people do to make sure enough spawners survive?
    Protect salmon and their environment, catch only those permitted.



STEWARD-SHIP

Stewardship means "making informed decisions and taking appropriate actions to protect and conserve water for all plants and animals who share our planet. It means leaving healthy, undiminished aquatic ecosystems for future generations.

Water Stewardship: A Guide for Teachers, Students and Community Groups
Ministry of Environment, Lands and Parks, 1995

Materials:

- Writing supplies

Time required:
One or more lessons

Level of conceptual difficulty:
Advanced

Suggestions for assessment:
Monitor the class discussion and lists to ensure that the students can identify hazards to salmon and describe actions that people, including the students, can take to help protect and conserve salmon and salmon habitat.

RESEARCH/DISCUSSION

- Have students, in small groups, list several dangers that can affect the life of a salmon.
  Loss of habitat, siltation, flooding, pollution, predation, capture by fishers, disease.
  Make a class list of the hazards the groups identify.
- Have the class identify the dangers that can be affected by human activity.
  Loss of habitat, siltation, flooding, pollution, capture by fishers.
- Have the class identify things that people can do reduce each of the dangers they identify.
  Avoid building or logging in salmon streams; dispose of hazardous wastes safely; fish only when and where permitted; don't harass spawners.
- Have students make a list of things they can do themselves to protect salmon and reasons for taking these actions.
  Stay out of salmon streams during and after spawning so that more salmon will survive; replant damaged stream banks; conserve water, energy and other resources; put garbage in waste containers.

SUMMATION

- Have students make a poster or display to encourage others to take steps to protect salmon near their home or school.
- *Option:* Have students carry out steps they can take in and around their school to protect salmon.
  Recycle waste, keep nearby streams clear, contact the local community advisor for information and supplies to mark storm drains that drain to creeks, don't remove salmon carcasses, etc.

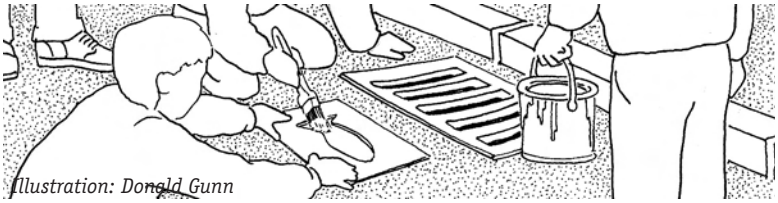


Illustration: Donald Gunn

- *Option:* Have students identify ways to protect other animals and reasons for taking these actions.
  Look after pets, don't harm wild animals or damage the environment.

SALMON LIFE CYCLE GOES ON
WRAP-UP

EVIDENCE FOR UNIT ASSESSMENT

- Have students draw life-sized pictures of each stage of the salmon's life cycle on chart paper and describe (or label) where the salmon live at each stage. In a conference, discuss the movement of salmon from stage to stage, to ensure that the students can describe the movement as a continuous cycle.
- Have students review their journals, including their initial questions about what they wanted to learn, and describe what new knowledge they acquired while studying the units.
- Have students complete a stem sentence, such as, "I used to think… about salmon life cycles but now I know that…," or, "One thing I learned about salmon life cycles is that…".
- Have students add their materials to their learning log and write a sentence explaining what they learned.

LANGUAGE AND ARTS INTEGRATION

- Have students research the life cycle of the salmon, linking the seasons with what happens in a salmon's life cycle and explaining why each stage takes place when it does.
  Eggs are sensitive to warm water, so most salmon spawn in the fall to protect the eggs; they tolerate warmer water in the spring when alevin and fry are growing and insect larvae are available for food.
- Have students work with the technology lab to develop a multimedia presentation on the salmon's life cycle, and ways of protecting salmon.
- Have students carry out activities from other environmental and resource programs, such as Destination Conservation, Greening Schoolyards, Power Smart; Aqua Wild, Water Stewardship; Project WET, Water for Tomorrow, Better Environmentally Sound Transportation. For references, see the *Marine and Aquatic Educators Resource Guide*, available by contacting the B.C. Teachers Federation (1-800-663-9163.)

HOME CONNECTIONS

- Have students describe to an adult the dangers a salmon faces throughout its life cycle and actions people can take to reduce the dangers.
- Have students fill in "Appendix 4: Classroom Salmon Science News" and read it to an adult.

HANDOUT 10.1

LIFECYCLE GAME

START: NEW REDD					
Eggs eaten by birds	Eggs poisoned by pollution	Eggs freeze	**SAFE REDD**	Eggs eaten by trout	Eggs killed by disease
Spawners lay eggs and die					**STEWARDSHIP CARD**
SAFE STREAM					Eggs smother in silt
Spawners eaten by eagle					Alevins fail to hatch
Spawners eaten by bears					**SAFE GRAVEL**
SAFE LAKE					Alevins eaten by trout
Spawners blocked by dam					Alevins die of disease
Spawners caught in nets					**SAFE GRAVEL**
SAFE RIVER					Alevins washed away in flood
Adults don't find way home					**SAFE POOL**
Adults caught on fishing line					Fry eaten by birds
STEWARDSHIP CARD					Fry eaten by trout
Adults eaten by seals					**SAFE POOL**
Adults eaten by mackerel					Fry overheat in sun
SAFE OCEAN					Fry can't find food to eat
Adults caught in nets					**SAFE STREAM**
Adults don't find food					Fry can't find pools to rest in
SAFE ESTUARY					Fry can't swim past dam
Smolts eaten by heron					**SAFE STREAM**
Smolts poisoned by pollution	**SAFE ESTUARY**	Smolts' habitat dyked	**STEWARDSHIP CARD**	Smolts eaten by eels	Fry poisoned by water pollution

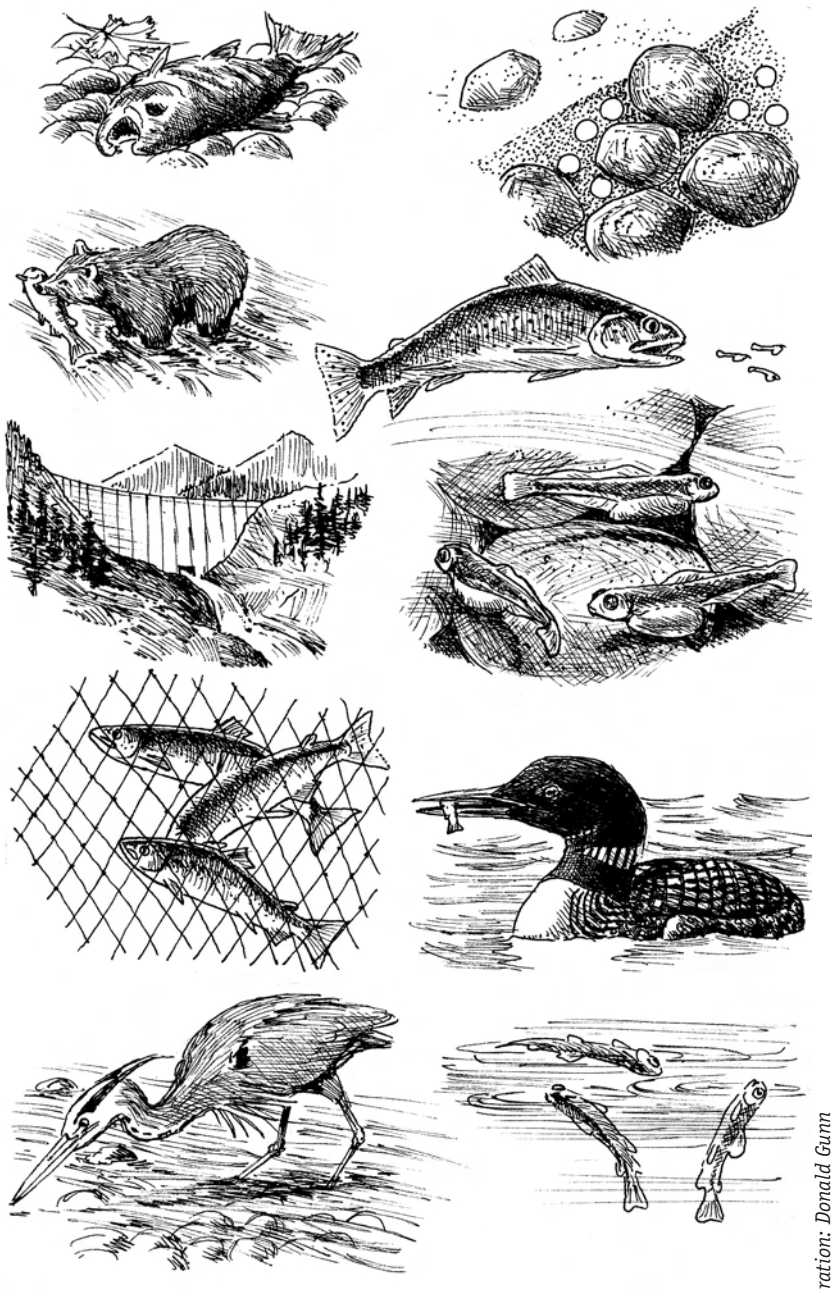


Illustration: Donald Gunn

HANDOUT 10.2

Life Cycle Game Rules

- Each player starts with ten markers. Players can use one or more markers at a time.
- Start at the new redd. Each person rolls the die. The highest number goes first and each player goes in clockwise order from the first person.
- Move clockwise around the life cycle game.
- Roll the die and enter the life cycle at the top left corner. Move the number of squares that show on the die.
- If you land on a Hazard Square (black text), your marker goes into the centre of the board.
- If you land on a Safe Square (grey text), stay there until your next turn.
- If you land on a Stewardship Card, pick a card from the pile and save it. Next time you land on a hazard square, you can use it to move ahead to the next safe square. Once you use a card, place it on the bottom of the stewardship card pile.
- Everyone wins when they move around the board and back to the New Redd.

Stewardship Card You protect salmon habitat. You can move to the next Safe Square.	**Stewardship Card** You protect salmon habitat. You can move to the next Safe Square.	**Stewardship Card** You protect salmon habitat. You can move to the next Safe Square.
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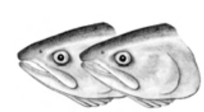
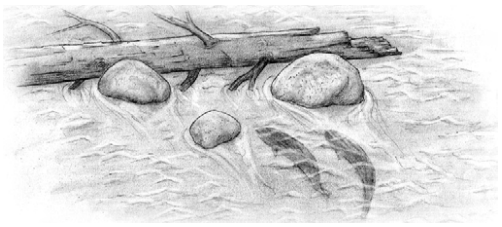


UNIT 11

SALMON HABITAT STUDIES

SALMON HABITAT STUDIES



OVERVIEW

The class researches features that make a stream or lake attractive to salmon and describes what they would expect to see on a field trip to a salmon habitat. They take observations on a field trip and discuss whether or not salmon would like the site.

THE BIG IDEA

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

KEY WORDS

For definitions refer to "Appendix 8: Glossary".
Basic: stream, streambed, stream bank, lake, gravel, riffle, pool, habitat
Advanced: polluted, garbage

BACKGROUND INFORMATION
SALMON HABITAT STUDY

Small streams and lakes produce most of the West Coast's fish, including six salmon species and over 80 species of freshwater fish. Salmon all spawn in shallow water, and many species spend a year or more in the stream or lake after they hatch. Salmon habitat is easily damaged by logging and mining activities, by urban and industrial construction, and by pollution. Many of these practices are changing to protect streams and revitalize streams that have been damaged in the past.

Water. At every stage in their life, salmon need clean water that is between 5˚C and 10˚C and which contains oxygen. A healthy salmon stream has a mix of fast running water and deep pools. Fast running water washes over rocks in riffles and picks up oxygen. Deep pools that form at the edge of a stream and in the water behind rocks, logs or other debris allow salmon to rest from the current and hide from predators. Cloudy water contains silt and mud that can smother eggs and irritate the gills of young salmon. Cloudy water also makes it harder for salmon fry to find and catch food.

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

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

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

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

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

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

RULES FOR SALMON HABITAT STUDY

These activities make a valuable extension to the units on the egg, alevin and fry, especially if your school has a classroom egg incubation tank and will be releasing the fry into a local stream.

Materials:

- Copies of "Handout 11.1: Rules for Salmon Habitat Study" for each student

Time required:
One lesson

Level of conceptual difficulty:
Simple

Suggestions for assessment:
Monitor pairs and class discussion to ensure that the students can explain all the rules.

ADVANCE PREPARATION

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

- If possible, tell the students that you have selected a variety of sites for a salmon habitat study and ask them to choose the site they would prefer to visit.
- Select an appropriate location for your class, then confirm transportation and any booking necessary for the site. If possible, choose a site within walking distance from your school so that students can relate the field trip to their own life experience and can visit with their family outside of class hours.
- Arrange adequate supervision from parent helpers or other volunteers. Most sites cannot provide supervision, although those with school programs can provide information and activities when informed in advance. If there is an on-site program, check what it offers and how to prepare the class.
- Walk the site before the class visit to check for appropriateness, safety and educational opportunities.
- Prepare the handouts and other materials students will need. Arrange permissions, as required by your school. Advise students to bring warm clothing, waterproof boots, a snack and a backpack.

RESEARCH/DISCUSSION

- Shortly before the visit, give students a copy of "Handout 11.1: Rules for Salmon Habitat Study". Have students, in pairs, read the handout and explain to each other any rules they do not understand.
- Have each pair tell another pair what one rule means. Repeat the procedure for all rules.
- Ask the class if there are any rules they want to add or remove from the list and have students write out any changes.

IF I WERE A SALMON

Materials:

- Copies of "Handout 11.2: A Healthy Salmon Habitat" for each student

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

Level of conceptual difficulty:
Simple to moderate

Suggestions for assessment:
Monitor class discussion to ensure that the students can identify features of a healthy salmon habitat.

INTRODUCTION

- Have the class brainstorm answers to the question, "If I were a salmon, what kind of habitat would I want?" If necessary, prompt them with questions, such as:
  - What kind of water would you want?
    Cold, clean, fresh-running, with riffles and still ponds.
  - What would you want at the bottom of the stream or lake?
    Clean gravel and rocks.
  - What would you want on stream banks?
    Shady, overhanging vegetation.
  - What would you want to eat?
    Insects, smaller fish, bits of plant and animal debris.

RESEARCH/DISCUSSION

- Have students, in small groups, use "Handout 11.2: A Healthy Salmon Habitat" to research and list items they would find in good salmon habitat.

SUMMATION

- Have the class make a list of plants, animals and other objects to look for when they are at a stream or lake and to decide whether or not each item is good for salmon. Discuss how students will make and record their observations on the salmon habitat study.
  Taking notes, drawing, taking photos, videotape, audiotape, etc.

WHAT TO LOOK FOR

Materials:

- Copies of "Handout 11.3: Salmon Habitat Study No. 1" for each student
- Copies of "Handout 11.4: Salmon Habitat Study No. 2" for each student
- Writing supplies
- Chart paper

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

Level of conceptual difficulty:
Simple

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

INTRODUCTION

- Shortly before the field trip (earlier in the day if feasible), have small groups of students use "Handout 11.3: Salmon Habitat Study No. 1" to list things they think they will see.
- Have the groups report their lists to the class and make a class list on a chart.
- Have the class divide the list into items from nature and items from humans.

RESEARCH/DISCUSSION

- Give the students copies of "Handout 11.4: Salmon Habitat Study No. 2" and have them use it on the field trip to write or draw their observations. Stop several times during the field trip and have students record their observations on the handout.
- Following the field trip, have students read their notes or describe their observations to the class.

SUMMATION

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

FIELD TRIP

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

Materials:

- Copies of "Handout 11.5: Salmon Habitat Survey" for each student
- Thermometer
- Measuring tape
- Watch
- Brightly coloured balls or other floating objects to estimate water velocity
- Writing and drawing supplies

Time required:
Several hours for field trip

Level of conceptual difficulty:
Moderate

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

INTRODUCTION

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

INVESTIGATIONS

- *Option:* Have different groups of students take a five-minute walk, each focusing on one specific thing.
  List all the colours you can identify; List all the sounds you hear; List all the smells you can; List all the trees or leaves you can find; List all the things you can see on the ground; List all the things less than one centimetre in size; etc.
  Have the groups reassemble and compare the results of their walks on-site or in class.
- Have the class walk to the stream or lakeshore. Have students identify features that would identify the site as good or bad for salmon.
  Clean, cold running water, gravel stream bottom, vegetation on stream banks, insects for food.
  Have them carefully look for signs of salmon or other fish in the water. Have them record their observations.
- Have students in pairs or small groups use "Handout 11.5: Salmon Habitat Survey" to record information about the stream. If necessary, have the adult supervisor lead students through the survey.
- Have the class look for evidence of people near the stream or lake.
  Signs, construction, trails, pipes, waste, etc.
  Have the students record their observations.
- Have the class look for things they could do to make the site better for salmon and other animals.
  Remove waste, restore minor damage, etc.

DEBRIEF IN CLASS

Materials:
- Student observations from field trip
- Writing supplies

Time required:
Two to three lessons

Level of conceptual difficulty:
Moderate to advanced

Suggestions for assessment:
Review students' descriptions or drawings to ensure that the students can identify features from the field trip that salmon would like.

INTRODUCTION

- Have students, in pairs, read or describe their observations from "Handout 11.4: Salmon Habitat Study No. 2" and "Handout 11.5: Salmon Habitat Survey" to a partner.
- *Option:* Have students describe to the class one thing they did not know before the trip, or one thing they found interesting on the field trip.

DISCUSSION

- With the class, discuss whether or not their observations show that the stream or lake is a good salmon habitat. If necessary, prompt them with questions, such as:
  - Did the stream or lake have water that salmon like? *Cold, clear, running with riffles and still pools.*
  - Did the stream or lake have a bed that salmon like? *Clean rocks and gravel.*
  - Did the stream or lake have banks that salmon like? *Overhung with vegetation.*
  - Did the stream or lake have food for salmon? *Insects, small fish.*
- Discuss how scientists could use information such as the data they collected.
  To identify potential salmon habitat and protect it or improve it.

SUMMATION

- Have students describe in writing or draw stream or lake features that salmon would like.
- *Option:* Have students write a thank-you letter to adult volunteers or site managers, identifying at least one thing they enjoyed or learned on the field trip.

SALMON HABITAT STUDIES
WRAP-UP

EVIDENCE FOR UNIT ASSESSMENT

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

LANGUAGE AND ARTS INTEGRATION

- Invite a local naturalist or other resource person to the class to prepare students or to lead the visit. For information, contact local organizations, such as the B.C. Wildlife Federation, the Federation of B.C. Naturalists, the Rod and Gun Clubs of British Columbia or your local fisheries stewardship co-ordinator (see Foreword, page vii).
- Arrange a visit to another type of salmon resource, such as a local hatchery or salmon enhancement project, a local spawning stream or lake, a traditional Aboriginal fishery, a salmon processing facility or a commercial fishing boat. Discuss the kinds of jobs people hold that involve working with salmon.
- Have students imagine the site from a bird's-eye view. Have them identify the main visible features, such as the road, parking lot, stream, clearings, trees, buildings. Have students draw the site as they would see it if they were a bird flying overhead.
- Arrange for the class, or for a group of students, to view the site at different seasons and to compare their observations using notes, illustrations, photos or other media.
- Have students make a map of a local stream or lake, showing its main features and ways to protect these features from damage.
- Have the class paint a mural showing the site and labelling features that salmon would like.

HOME CONNECTIONS

- Have students guide an adult around a stream or lake and identify features about the stream or lake that salmon would like.
- Have students fill in "Appendix 4: Classroom Salmon Science News" and read it to an adult.

SALMON INCUBATION

If your school has a classroom incubation tank set up, have students compare the environment in the tank with a stream.

Both have cold, clean water, oxygen, gravel, eggs, etc.; but the tank does not have streamside plants, predators, animals, adult carcasses, etc.

For assitance, refer to "People And Connections That Can Help" on page viii of the Introduction.

➡ Cut a piece of cardboard to the size of one wall of the incubation tank. Have students use art supplies to draw or cut out objects from a salmon's natural habitat, such as plants, fish, insects, stones and assemble them on the card to create a naturalistic background for the tank. Laminate the assembly and attach it to one side of the tank.

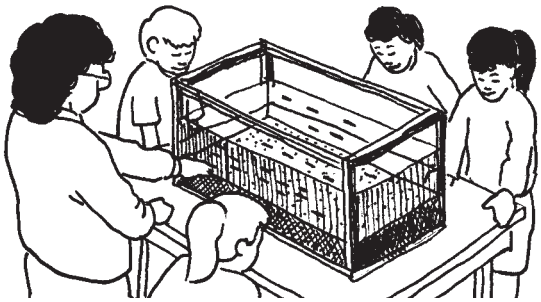


Illustration: Donald Gunn

HANDOUT 11.1

Rules for Salmonid Habitat Study

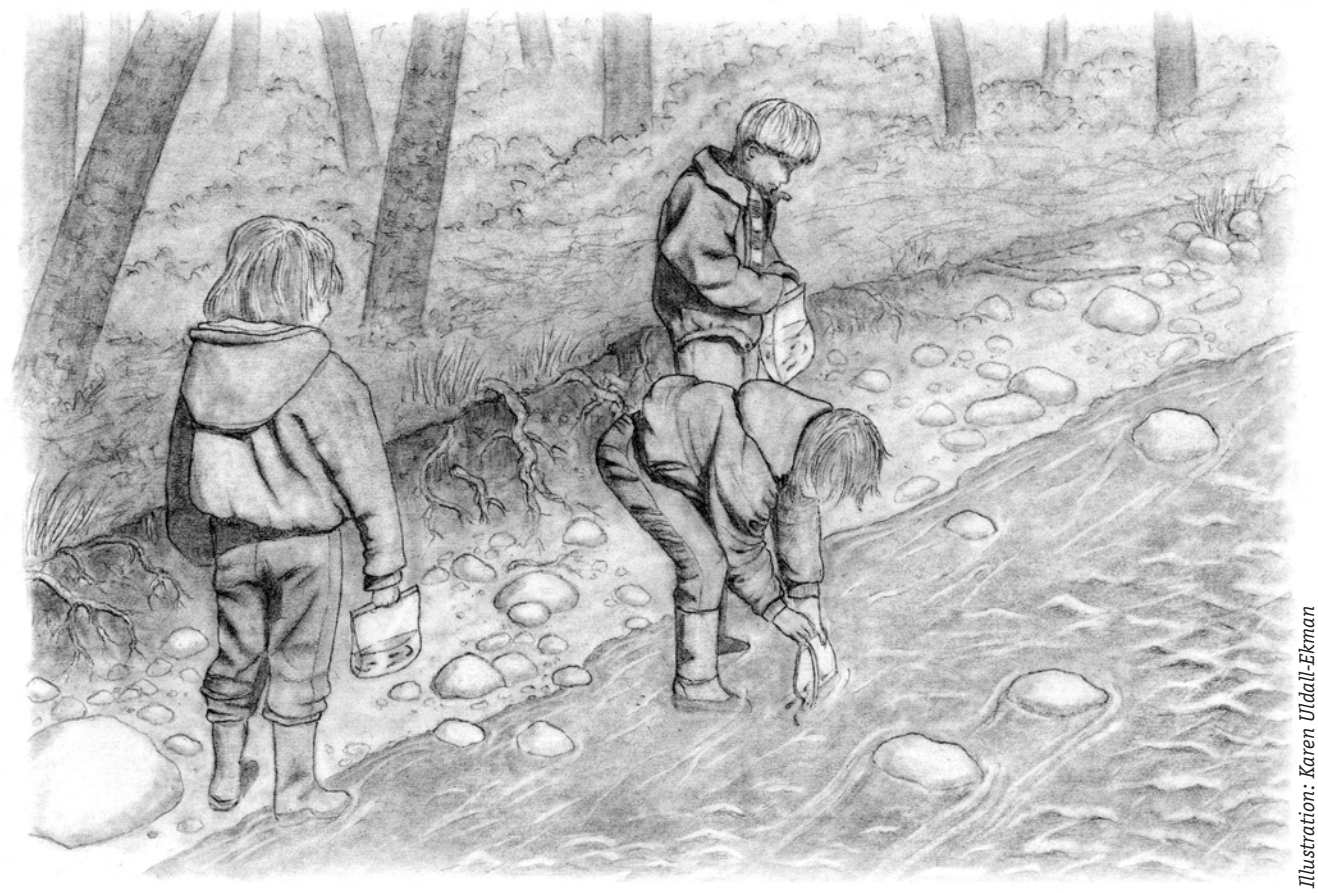


Illustration: Karen Uldall-Ekman

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

Other rules:

HANDOUT 11.2

A Healthy Salmon Habitat

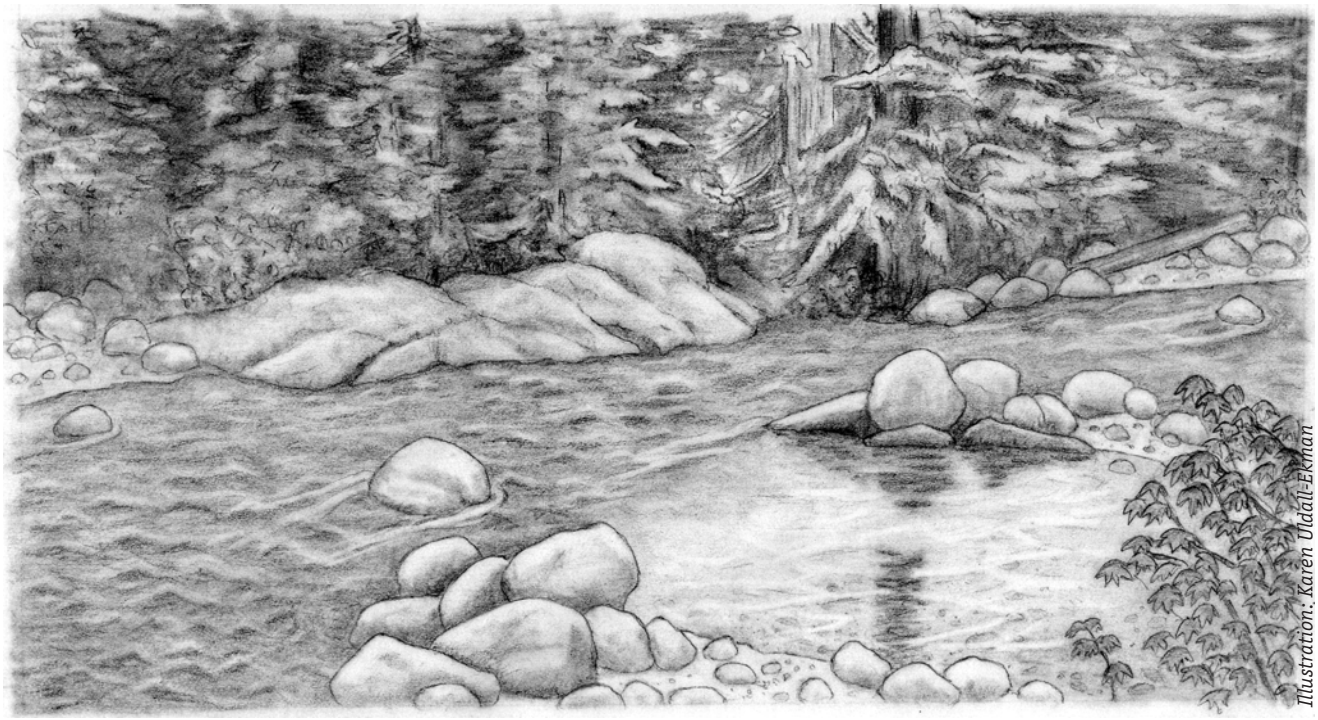


Illustration: Karen Udall-Ekman

Salmon need many things to make a home.

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

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

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

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

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

Salmon need a cool, clean habitat.
Is this stream a good salmon habitat?

HANDOUT 11.3

Salmon Habitat Study No. 1

On the salmon habitat study, I think

I WILL SEE

I WILL HEAR

I WILL TOUCH

I WILL SMELL

HANDOUT 11.4

Salmon Habitat Study

NO. 2

On the salmon habitat study, I think

I CAN SEE

I CAN HEAR

I CAN TOUCH

I CAN SMELL

HANDOUT 11.5

Salmon Habitat Survey

Name _____ Date _____

Materials:

- Thermometer
- Metre stick

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

   The water is _____ degrees Celsius.

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

   The water is _____ centimetres deep.

3. How clear is the water?

   The water is:
   ❑ clear ❑ muddy

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

   ❑ mud ❑ gravel ❑ boulders

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

   ❑ none ❑ low bushes ❑ trees

APPENDICES

APPENDICES

Science Instruction and Assessment (Introduction)
Appendix 1: Observation Page
Appendix 2: Daily Observations
Appendix 3: Comparison Chart
Appendix 4: Classroom Salmon Science News
Appendix 5: Assessment Observations
Appendix 6: Assessment Review
Appendix 7: Self-Assessment
Appendix 8: Glossary

SCIENCE INSTRUCTION AND ASSESSMENT

Primary students may not understand science procedures or the instructions on worksheets, particularly with younger students and students who are still learning English. You can do most activities in groups, with more advanced students assisting others, or as teacher-led activities. With teacher-led activities, have a student read one step of the procedure, then, demonstrate what the step means and have students follow your model to perform the step.

Students can work independently or in groups to make observations and develop answers to questions in the activity before writing the answers individually. They can then work in pairs to check their responses, with each student explaining his or her answer to a partner. Monitor the class during these procedures and note any questions that cause particular problems.

In experiment activities, you can use the opportunity to check student skills, such as the ability to make predictions and observations, to draw conclusions, and to use materials and equipment safely. Observe whether or not the students used the equipment safely and correctly and used the appropriate skills and strategies to solve the problems posed.

ASSESSING STUDENTS AT WORK

Circulate among the students as they work individually or in groups. Visit groups as they work and ask them to explain how they are planning to carry out the activity, especially if students are unsure of the procedure. Explaining their plans often helps students develop and refine them. Encourage groups to share ideas and question each other.

As you circulate, monitor students to ensure that they:

- understand and can follow the directions,
- can give reasons for their answers, and
- stay on task during the activity.

ASSESSING GROUP ACTIVITIES

Many activities suggest that students work in groups in order to share ideas, expand verbal fluency, and ensure that all students can participate. Group activities offer opportunities to assess students' communication and social skills. As you monitor the class in group activities, note whether students:

- understand and follow instructions,
- can organize their work,
- can use the vocabulary from the lessons to discuss their work,
- follow steps as outlined,
- participate and take on responsibilities,
- understand each task before beginning,
- listen to each other and resolve their different ideas, and
- respect each other's abilities and contributions.

ASSESSING STUDENT LEARNING

Bring the class together after they have done an assignment. Check their understanding by asking students to share their observations with the class and describe what they discovered. Note the students' responses, particularly if several students appear to have a common misunderstanding.

Review student materials with the students in a brief conference during the salmon studies, or in a wrap-up conference at the end. Have students use their observations, drawings, handouts, or other materials, such as the Salmon Life Cycle poster and the Egg-to-Fry display to explain orally what they have learned. Students with beginning language skills may be able to use a drawing or chart to demonstrate their learning more fully than they express their learning in writing. Have students take you on a classroom walkabout to explain the salmon science they see. Use "Appendix 5: Assessment Observations" to note their abilities and focus for further learning, including vocabulary, understanding of content, science skills, etc.

Have students use "Appendix 6: Assessment Review" and "Appendix 7: Self-Assessment" to allow students to reflect on their learning and to state what they learned and what they did well. With younger students, discuss the forms with the class and model appropriate responses. Have them dictate their responses to an older student or classroom volunteer, if necessary. Have students add these materials to their portfolios and discuss them in a wrap-up conference. Have students include their drawings and other results from an activity in their portfolios.

OBSERVATION PAGE

NAME
TITLE

My prediction is (write or draw your prediction)
In this experiment I saw (write or draw your observations)
This experiment shows that

DAILY OBSERVATIONS

NAME
TITLE

DATE Today I saw
DATE Today I saw
DATE Today I saw
DATE Today I saw
DATE Today I saw

COMPARISON CHART

NAME
TITLE

My prediction is (write or draw your prediction)	
In one exaple, I saw (write or draw size, colour or changes)	In the other example, I saw (write or draw size, colour or changes)
I think the two examples are different because	

CLASSROOM SALMON SCIENCE NEWS

WHAT OUR CLASS DID TO LEARN ABOUT SALMON

NAME
DATE

In our salmon science unit, we studied
I learned that
This is a picture of one thing we did

ASSESSMENT OBSERVATIONS

Use this page to record anecdotal comments about the student's learning based on conferences with the student, classroom walkabouts, in-class observations, etc.

STUDENT NAME: _____

Unit Two: Life Cycle and Habitat	Unit Three: Salmon Anatomy
Unit Four: Salmon Eggs	Unit Five: Salmon Alevins
Unit Six: Salmon Fry	Unit Seven: Salmon Smolts
Unit Eight: Adult Salmon	Unit Nine: Salmon Spawners
Unit Ten: Salmon Life Cycle	Unit Eleven: Salmon Habitat Studies

ASSESSMENT REVIEW

WHAT I LEARNED ABOUT SALMON

NAME
DATE

THREE THINGS I LEARNED ABOUT SALMON

WRITE	DRAW
1	
2	
3	

SELF-ASSESSMENT

SALMON SCIENCE — WHAT I THINK I KNOW

NAME
DATE

WHAT I DID WELL IN SALMON SCIENCE

WRITE	DRAW

WHAT I STILL WANT TO KNOW ABOUT SALMON

WRITE	DRAW

GLOSSARY
GLOSSARY FOR PRIMARY UNITS (GRADES K TO 3)

Note: These definitions refer to words in the context in which they are used in the *Salmonids in the Classroom* materials. They may have other meanings in other contexts.

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adipose fin — a small boneless fin on a salmon's back, near the tail
adult — fully grown; a salmon ready to return to its home stream
air — the invisible substance people and animals breathe
alevin — a salmon that has just hatched from the egg, with the yolk still attached
anal fin — a fin on a fish's belly near the tail
bean seed — a small living object from which a bean plant can grow
body — the main part of a person or animal
camouflage — colours that make an animal hard to see
city — a place where many people live
dam — a wall that holds back water in a stream or lake
dorsal fin — a fin on a fish's back
egg — a rounded object, laid by fish and some other animals, in which the young begin to grow
egg wall — the outer part of an egg
egg white — the clear liquid inside an egg
embryo — a very young salmon in the egg
estuary — a place where a river joins the sea
eyes — the part of the body used for seeing
factory — a building where people use machines to make things
female — a salmon that can produce eggs
fertilize — to make eggs ready to grow
fin — the part of a fish's body which it moves to balance and move around
fish — an animal with bones and fins that lives in water
fisher — someone who catches fish
fishing boat — a boat used to catch fish
food — what a fish eats to live and grow
fresh water — water with no salt in it
fry (plural: fry) — a young salmon that can swim freely in a stream or lake
garbage — something that someone has thrown away
gill — the part of a fish's body which it uses to breathe under water
gravel — a mixture of pebbles and rocks
hatch — when a salmon wiggles out of the egg
hazard — a danger
head — the front part of a fish's body, with the mouth, eyes and gills
home stream — the stream where a salmon grows up
krill — tiny animals that live in the sea

lateral line — the part of a fish's body in a line along its side that it uses to feel
leaf — the flat green part that grows on a plant
life cycle — all the stages in a plant or animal's life
log — the trunk of a tree that has been cut down
male — a salmon that can produce milt to fertilize eggs
mouth — the part of a fish's body which it uses to take in food and water
nostril — the part of a fish's body which it uses to smell the water
ocean — the body of salt water that covers most of the earth
Parr marks — dark up-and-down bars on the sides of salmon fry
pectoral fins — fins on a fish's side, behind the gills
pelvic fins — fins on a fish's belly in front of the anal fin
polluted — air or water with waste in it
pool — a small area of still water
predator — an animal that catches and eats other animals
redd — a stone nest in the gravel of a lake or stream for protecting eggs
riffle — an uneven area in a stream that makes the water form small waves or ripples
root — the part of a plant that grows down into the ground
salmon — a type of fish that hatches in fresh water, swims to the ocean, then returns to its home stream or lake
salt water — water that has salt in it, such as the sea
scales — small, hard, flat pieces that cover a fish's body like armour
scent — a smell
school — a large group of fish
shell — a hard casing that covers some animals, such as clams and snails
skin — the soft layer that covers the bodies of animals
smolt — a young salmon that is getting ready to enter salt water
spawner — a salmon that is getting ready to lay or fertilize eggs
stage — one part of a salmon's life cycle
stem — the part of a plant that holds the branches and leaves
stream — water flowing in a narrow path
stream bank — the sides of a stream
stream bed — the bottom of a stream
sustainability — meeting the needs of the needs of the present without compromising the ability of future generations to meet their own needs
sustainable development — development that meets the needs of the present without compromising the ability of future generations to meet their own needs
swim bladder — the part of a salmon's body which it can fill with air, like a balloon
tail — the part of a fish's body which it moves from side to side to move forward
water — the liquid that falls as rain and fills rivers and lakes
wiggle — to move and twist from side to side
yolk — the thick yellow part of an egg
yolk sac — a thin bag which contains egg yolk and grows on the belly of an alevin