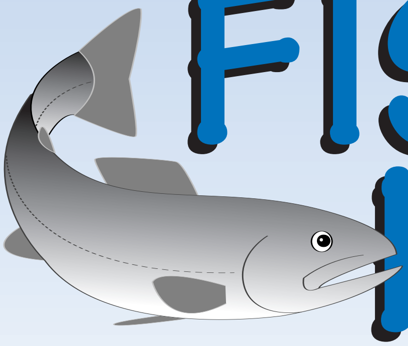
Atlantic Salmon Federation

Fédération du saumon atlantique



FISH FRIENDS

A Curriculum Supplement for Grades 4, 5 & 6

Developed, designed and Illustrated by
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Revisions 2001 by Atlantic Salmon Federation, Communications Department
Personnel and Troubleshooting Updates 2003-2007

We invite all users of this manual to keep up to date on Fish Friends, including new resources, through visiting the website, at **www.asf.ca/fish_friends.php**

FISH FRIENDS is a project of the Atlantic Salmon Federation's Education Program. Fish Friends, with more than 700 schools involved, is made possible through the assistance and support of hundreds of volunteers and sponsoring organizations. The Atlantic Salmon Federation also wishes to recognize the cooperation of Canada's Department of Fisheries and Oceans, and of the United States National Marine Fisheries Service.

Second Edition published 2001
First Edition published 1995

Foreword

Learning about wild Atlantic salmon and other fish species in our rivers and seas is fundamental to caring for them. The Atlantic Salmon Federation believes that effective public education and opportunities for hands-on learning are vital to making the right decisions on the balance between use of land, water and air and the health of living things and their environment.

It has been 10 years since ASF's *Fish Friends* education program began. In that time it has expanded to 700 schools throughout the range of the Atlantic salmon. More than 150,000 students have had the opportunity to explore the fascinating world presented by the program. *Fish Friends* has proven to be very adaptable to the realities of the classroom and the needs of teachers. The program has successfully captured the imagination of students whatever their background might be.

Students will likely use the insights they gain from the varied and entertaining activities of *Fish Friends* throughout their lives. Carefully crafted lessons allow students to appreciate the sensitivity of fish to environmental degradation and the importance of our recreational fisheries to society. ASF believes it is essential that we persuade tomorrow's adults to care enough never to poach, pollute waters or destroy habitat. Wild Atlantic salmon are indicators of healthy rivers and oceans as they are one of the first species to be affected by environmental change.

I invite teachers to introduce Fish Friends to their students, and thereby involve youth in a lifelong commitment to the conservation of fish and to a sustainable environment.

Yours sincerely

Bill Taylor,
President
Atlantic Salmon Federation

The **Atlantic Salmon Federation** is an international, non-profit organization that promotes the conservation and wise management of the wild Atlantic salmon and its environment. ASF has a network of seven regional councils (New Brunswick, Nova Scotia, Newfoundland, Prince Edward Island, Quebec, Maine and New England), which have a membership of more than 150 river associations and 40,000 volunteers. The regional councils cover the freshwater range of the Atlantic salmon in Canada and the United States.

Acknowledgements

A large number of individuals made significant contributions to the development of Fish Friends. Of particular value was the assistance provided by teachers who field tested the lessons in their classrooms. Also, the regional directors of the Atlantic Salmon Federation continue to provide substantial guidance, in addition to working with teachers throughout their regions. We thank you.

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About Fish Friends

Fish Friends is a supplement to support curriculum guidelines for Grades 4 to 6 in the Atlantic region of Canada. It is primarily a resource for teachers. It has also been used successfully by several hundred schools in New England.

As a curriculum supplement, *Fish Friends* develops a small number of themes and concepts. The threads that hold *Fish Friends* together are habitat, biodiversity, life cycles, change over time, adaptation to change, freshwater ecology, sustainability and stewardship. Using science curriculum guidelines as its foundation, *Fish Friends* integrates social studies, language arts, math and art. In addition, the skills of observation, measurement, communications, prediction, numeracy, the use of charts and graphs and the interpretation of data are promoted throughout.

Although designed for Grades 4, 5 and 6, field trials have indicated that *Fish Friends* may be better suited for Grades 5 and 6 students. Some of the concepts in the later lessons may be difficult for Grades 4. Adaptations, however, are possible.

Fish Friends has been developed following a few basic principles of learning:

- **Learning is an active process.** The activities in *Fish Friends* have been designed so that students are actively engaged in learning, not just watching the teacher or other students.

- **Students construct their own understandings and are therefore responsible for their own learning.** *Fish Friends* provides students with opportunities to develop an understanding of the various concepts, and then apply their understandings. Definitions of terms and the accumulation of factual information are not emphasized.

- **Learning begins at the point of prior understanding of the learner.** Through school, television, parents and peers, students have been exposed to many ideas and bring their own understanding to the classroom. In *Fish Friends*, students are frequently encouraged to express what they already understand about the various concepts being presented and then build on those understandings.

- **Learning is a social process that is greatly enhanced by the use of language.** Most of the activities in *Fish Friends* are designed to encourage cooperative learning approaches in which students work in small groups, sharing and discussing observations and conclusions. Many of the lessons contain tasks through which students develop language skills while expressing their understanding of concepts.

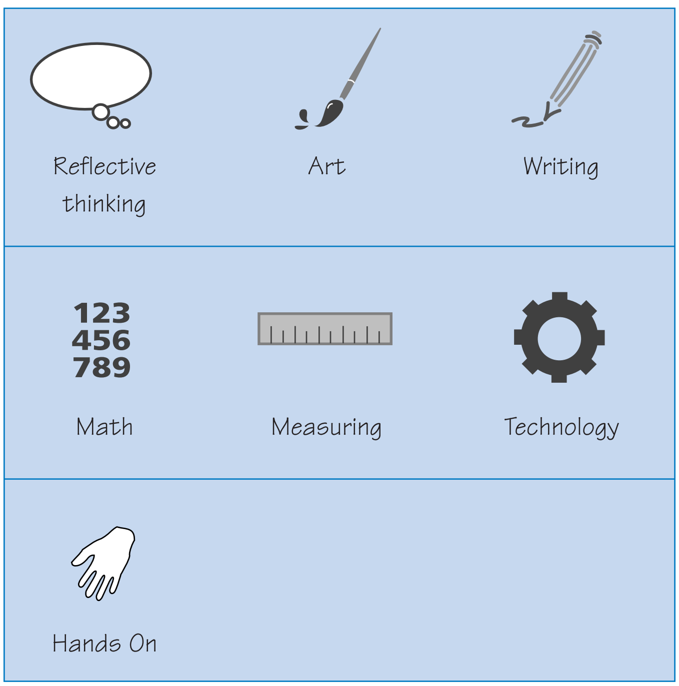
Fish Friends consists of twelve lessons. Lessons 11 and 12 are optional, as they relate specifically to the incubation of fish eggs and the subsequent hatching and release of the young fish. If you do not currently have an incubation unit in your classroom, you may wish to contact the Atlantic Salmon Federation representative in your area for advice on purchase and installation of a unit. A complete unit costs less than $1,000 and in some instances, funds have been provided by community groups and corporate sponsors.

Each lesson of *Fish Friends* includes:

- **Main Ideas and Objectives.** An overview of each lesson is presented, but detailed learning outcomes are not given. These can be obtained from the guidelines developed by provincial Departments of Education and vary slightly from province to province. *Fish Friends* supplements the provincial guidelines.

- **Suggested approaches for teaching each activity:** Required materials are illustrated along with icons that indicate the components of each activity.

These icon boxes indicate that there are Activity Pages to be photocopied for the students. The relevant page numbers are shown. One or more of these symbols will appear inside:



- **Black and white activity pages to be photocopied and distributed to the students:** These pages are identified by a solid black bar across the top containing the name of the activity. Although there are a few exceptions, most activities include at least one student page.

- **Additional background information:** Background information appears in blue type, either on the teacher's page or at the end of the lesson.

- **Language tasks and extension activities:** These are presented in separate boxes on the teacher's page.

Fish Friends can be used effectively within a variety of time lines. Field trials indicated that many factors determine how much time teachers devote to various lessons. Provincial guidelines, grade level, previous experiences of the students and relevance to local, national and international issues are all factors that influence time allotments.

As you and your students use this resource, we hope you enjoy your shared experience and that a growing awareness of the issues presented here will be a positive influence on your thoughts and actions in school, at home and in the community.

Fish Friends developers
Nan Armour, Randy Gaynor and Derek Sarty

Updating of text for 2001
Tom Moffatt, Todd Dupuis, Lewis Hinks & Sue Scott, ASF

Note for Teachers: There may be special resources made available in future via email. Teachers involved are strongly encouraged to submit a contact email to: asfweb@nbnet.nb.ca

Contents

Lesson 1

Home Sweet Home

Main Ideas

Our habitat is our home, the geographic location where we live and where our needs are met. Our habitat is also a community because we share it with other living things. Most living things can tolerate changes in their habitat, but to survive, their needs must continue to be met.

Objectives

The students will be introduced to the concept of habitat by first examining their own world, where they live, play and go to school. They then design a research task to determine the diversity of living things that share their habitat. They will apply their understanding of the concept of habitat in future lessons.

My Home

To understand the meaning of habitat, the students must first understand why they live where they do. Whether they live in a house or an apartment, basic necessities of life are provided. A brainstorming session with the class could be used to identify these needs: shelter, air, sources of food and water, and ways to eliminate waste.

The purpose of this activity is for the students to become aware of how their home meets their basic needs. This idea is expanded in the next few activities.

The students first draw a 'map' of their house or apartment like the example on the activity page. They could use a larger piece of paper. If they have difficulty visualizing their home, have them practice by first drawing a floor plan of their classroom or school. Exact scale is not important.

Discussion Questions

Is your home also a home for living things other than you and your family?

Our homes are shared not only by pets but by other living things as well. Unfortunately, we often take a negative view of their presence. Insects, spiders and rodents are the most common of these unpopular guests. On the other hand, many homes are brightened and enlivened by the presence of plants of many sizes and descriptions.

How has technology affected the space we need to meet our basic needs?

There are many ways in which technology has influenced our habitat requirements. Construction materials are an obvious example. Also, the appliances which we use to prepare and store food are products of technology. So too are our bathrooms. It would be very difficult to find a room in our homes (our habitat) that is not influenced by technology.

Using riddles, the students then discover where in their homes each of the basic needs are met. There may be more than one answer for each riddle. The activity will have to be done individually first and then students can compare their answers. They should be very similar since members of the same species tend to meet their needs in very similar ways:

1. shelter (the building itself)
2. food (kitchen, garden)
3. water (bathroom, kitchen)
4. oxygen (everywhere)
5. elimination of waste (bathroom, garbage cans)

Have the students exchange their own riddles in small groups or with the whole class. This may be an opportunity to talk about the differences between "wants" and "needs" in our lives. This and subsequent lessons deal with the basic needs of living things in order to survive. In a later lesson, we examine how our "wants" can have a negative impact on the ability of other living things to meet their basic needs.

Background

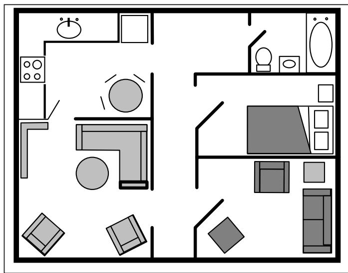
To understand the interactions among organisms in the environment, it is useful to draw boundaries around certain groups of organisms which interact in a relatively direct way, such as a community or neighbourhood grouping. Within these biological neighbourhoods, it is possible to assign organisms an "address", describing their typical location. An organism's address is its habitat.

A habitat is the natural abode or locality of an animal, plant, or person. Thus, it also includes all features of the environment in a given locality. Frequently, the terms "habitat" and "environment" are used primarily for physical features such as topography, water supplies, and climate, but the terms are not confined to physical features, for vegetation and other animals also form major components of any given habitat or environment.

When we describe how the organisms in the neighbourhood behave—how they interact, grow, and adapt, what they eat, how long they live, what happens to them when they die, what they require to stay healthy or to reproduce—we are dealing with the way in which the household system operates, and we are thinking SYSTEMatically. We are finding connections. This is an ecosystem.

An ecosystem includes populations, communities, habitats, and environments, and it specifically refers to the dynamic interaction of all parts of the environment, focusing particularly on the exchange of materials between the living and non-living parts.

My Home



This is a bird's-eye view of a house. Can you find a bedroom? A bathroom? A kitchen? What does your home look like? Draw it here.

What am I?

The answer to each riddle is something we need to survive. Where is each need met in your home?

1. Over your head and under your feet
I'm the safe place where you live and you sleep.

2. Without me you wouldn't even be here
Your stomach is hoping I'll always be near.

3. I come from the clouds, I'm clean, I'm bright
I sit in a glass by your bedside at night.

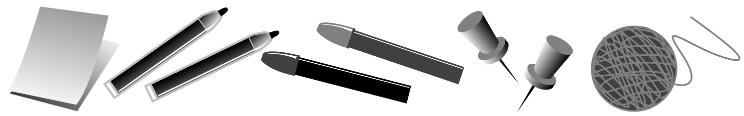
4. You breathe me in and breathe me out
So do the dogs, the bees and trout.

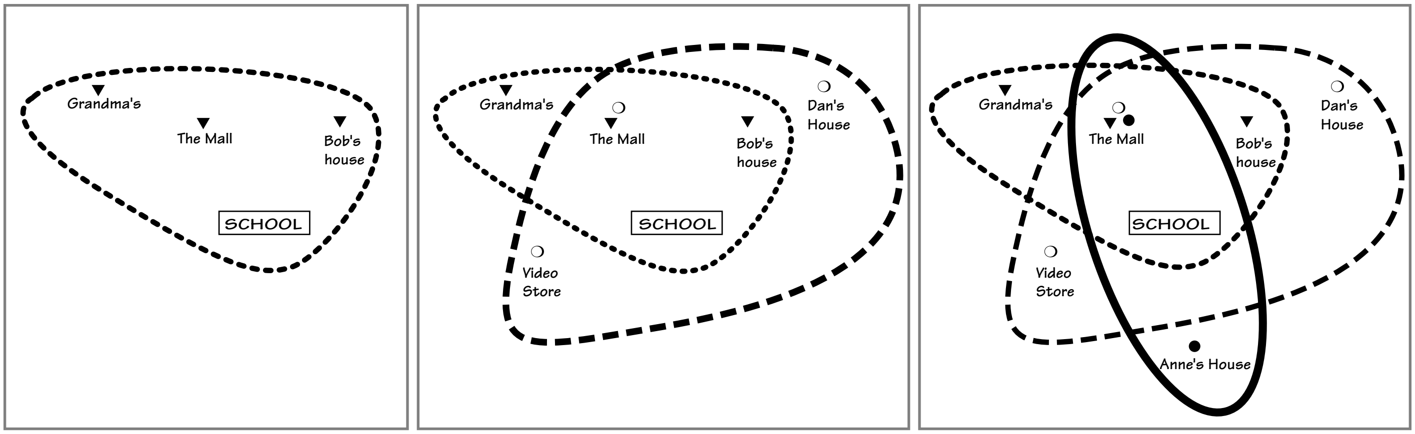
5. Most people throw me right out of their place
I'm one of the biggest problems you face.

Now it's your turn

Write a riddle about something else that's an important part of your home. Exchange riddles with your classmates.

My Neighbourhood





This activity builds on the previous one, expanding the students concept of home to include their neighbourhood. Point out that our home and the places we go on a regular basis to meet our needs is our **habitat**. The aim is for the students to understand the concept of habitat, not just define the term.

Divide students into groups of four or five. Provide each group with a large piece of paper. Have one student draw a small square in the center to represent the school. Each student, using a different coloured marker, shows the location of all the places they go on a regular basis: home, friends' homes, stores, etc. Then they each draw a line around the places they indicated. This represents their personal habitat. Where their personal habitats overlap, a larger group habitat emerges.

Each group could then present their group habitat to the rest of the class and describe the activities in the overlap areas.

Combining the various group habitats would result in an even larger class habitat. Again, the common element is the school. This is effective in showing how individuals of a population can share their habitat.

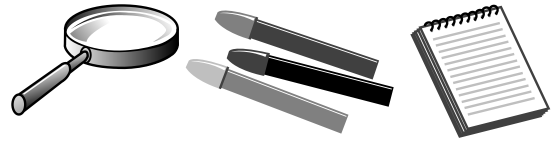
Obtain a map of your community or have the students create one. In rural areas a topographical map works best. (This can also be used in later lessons.) The students use push pins to locate their homes and some of the places they have in common (eg., school, churches, stores). Then wrap a piece of yarn around the push pins. Avoid creating a wheel with the school as a hub with spokes reaching out to other locations. This could develop into an art project using a large wall mural.

Discussion Question

What changes might occur in their habitat in the future?

Students should be encouraged to think of two sources of change. The habitat itself may change due to natural or human related activities. New roads and buildings, fires, floods and a wide range of events can change a habitat. Also, the student's personal habitat will change as they go to a different school, move to a new home or out of the community. The key point is that habitats change over time. We will return to this concept of change over time in future lessons.

We Are Not Alone



We do not live alone. We share our homes with members of our family and we share our habitat with other living things too. Some of these are obvious: the family pet, the tree in the back yard. Others are not so obvious.

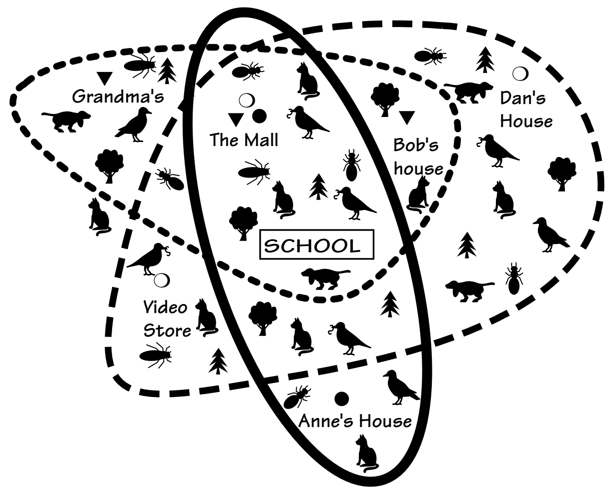
In this activity, the students will design their own research project. The key question is: What other types of living things share our habitat? You might begin with a brainstorming session about the types of living things they see in their neighbourhood.

Using the same groups as in the previous activity, the students design a method of collecting and reporting their data. They may decide to work individually, in pairs or as the whole group. The decision is theirs. They should be encouraged to record their data in an organized way that they can make sense of later. Questions to ask the groups before they begin:

- **How will you record your information?**
- **How can you avoid two people collecting data from the same area?**
- **How can you indicate that some things were found more often than others?**
- **Is the task for each person clear?**

Encourage them to look for the less-than-obvious living things, the small plants and animals that are not immediately obvious. Provide hand lenses if available. The purpose is to show that there is lots of diversity of living things in their habitat. Collecting data in large rural areas may be impractical. It might be easier to study the area immediately around the school.

After they have collected the data, have them show their results on their group habitat map or on the community map created in the previous activity. Use pictures, drawings, photographs or



any combination. The end result shows the diversity of life in the area. Depending on the grade level, you could expand this activity to involve classification.

Language Task

Have the students write a cinquain about their habitat, either their personal home habitat or their neighbourhood. A cinquain is a poem consisting of five lines.

Line 1:	One NOUN, the topic
Line 2:	Two ADJECTIVES, describing the topic
Line 3:	Three “ing” words related to the topic
Line 4:	One PHRASE, related to the topic
Line 5:	One word, a SYNONYM for the topic

Example:

Gravity
Powerful, Necessary
Attracting, Holding, Falling
Keeps our Feet on the Ground
Weight

Lesson 2

Fish Habitat

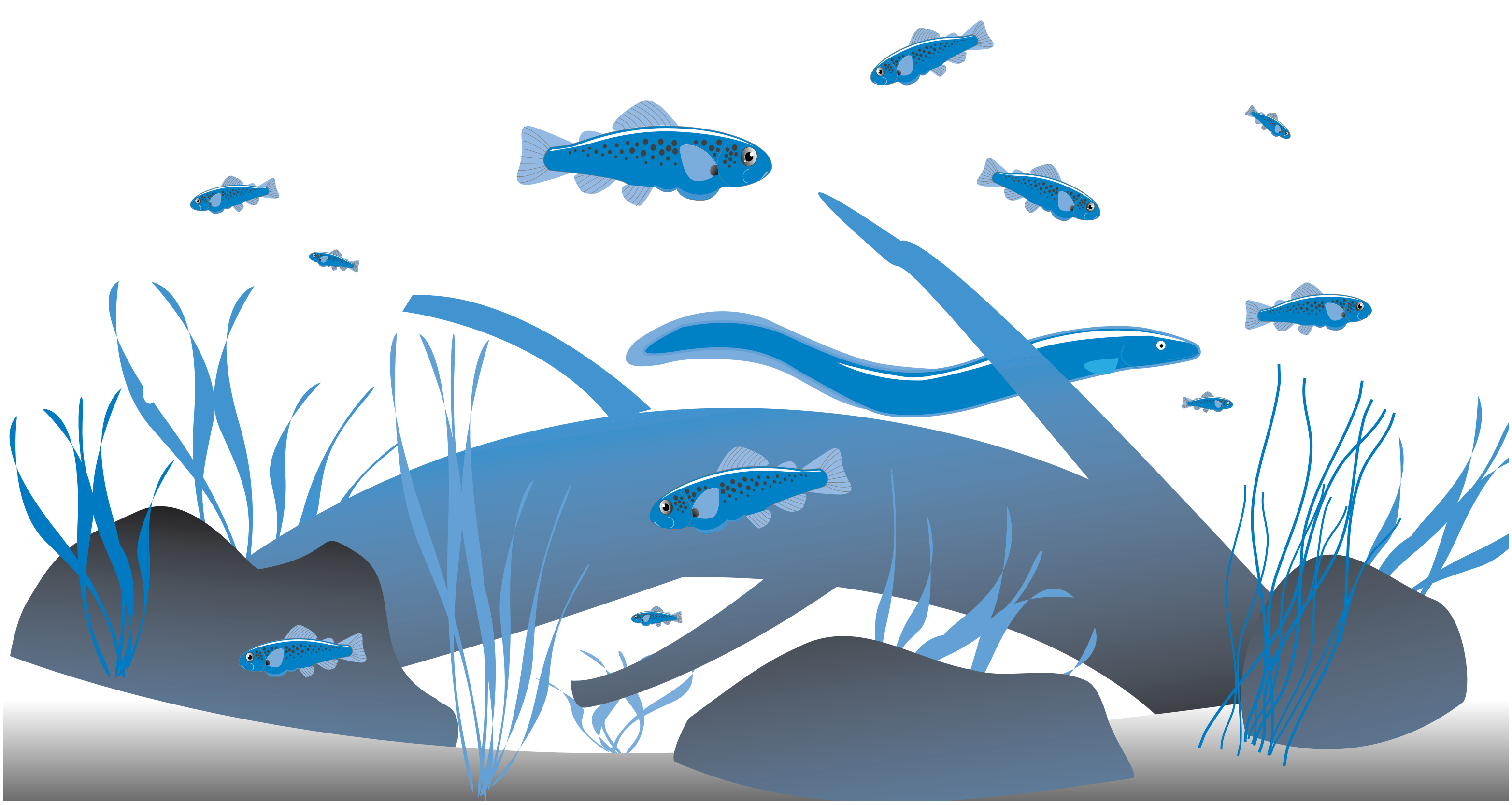
Main Ideas

The environment in which fish live is quite different from ours, but they have the same basic needs as humans: oxygen, food, shelter, water and ways to eliminate waste. In order for fish to survive, their needs must be met in a habitat that is shared with many other living things.

Objectives

In this lesson, the students will apply their understanding of habitat from the previous lesson to the habitat of a fish. Through a reading activity, they will reflect on how the needs of fish are met. They are encouraged to make comparisons with their own needs and habitat.

Students will also calculate the proportion of the earth's water supply that would be suitable habitat for freshwater fish.



Page 11

THINK ABOUT THIS!

A Day in the Life of a Fish

This is a short interactive reading activity involving a combination of text and graphics. Questions are provided to encourage the students to improve their reflective skills. The purpose is to promote language development while providing an opportunity for the students to apply their understanding of habitat.

The students learned about basic needs – shelter, food, water, air and elimination of waste – in the previous activity. These needs are the same for fish as for us. A fish's habitat must meet these needs in the same way that our habitat meets our needs. The main difference in the fish's habitat is obvious, it's made of water. This means that the air (oxygen) must be dissolved in the water. It also means that the fish is very vulnerable to drought and pollution.

The preferred habitat of fish varies depending on many factors. The young of some fish, like salmon and trout, prefer shallow streams with clean gravel bottoms. In later stages, they travel to deeper rivers with shaded protected pools. Other species like bass, catfish and eels prefer the deeper murky waters of ponds and lakes.

It is not necessary at this point to go into detail about what the fish eats, sources of pollution or fishing practices. These topics appear in later lessons. It's more important for the students to answer the questions based on their existing understanding and to make comparisons with their own habitat.

In the story, the students are encouraged to suggest their own ideas about the activities of the fish which are directly related to its basic needs. It seeks shelter behind the rocks and under the tree. It spends time searching for food and avoiding predators and pollution. You might use **stimulus** and **response** as new vocabulary terms here. The stimulus of food and stimulus of smell produce different responses in the fish.

In the writing task, the students are invited to expand the story by writing about the next day in the fish's life. Encourage them to write from the fish's point of view and include adventures that relate to its habitat and needs. Some students may want to illustrate their story.

Background

Down through the centuries, Atlantic salmon and American shad were important sources of food for aboriginal peoples and the European settlers of eastern North America. Both species were highly prized in springtime as some of the first sources of fresh protein, especially after a long, cold winter. The availability of nutritious food, for both local consumption and for trading purposes, contributed to the economic growth of coastal regions in eastern North America during the eighteenth and nineteenth centuries.

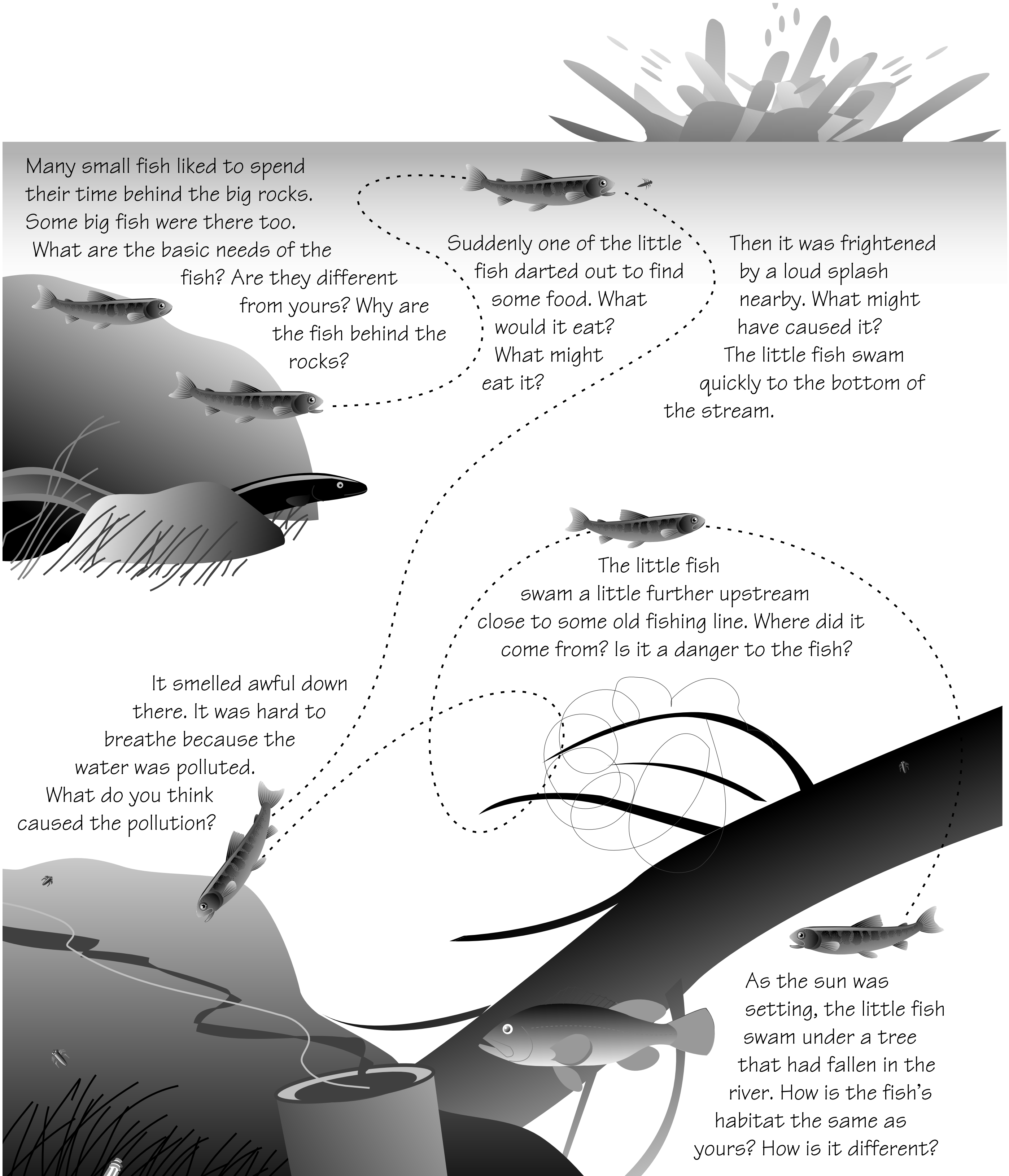
It is well known that salmon have disappeared from many parts of its former range, which extended as far south as the Hudson River in New York, inland along the St. Lawrence River to Niagara Falls and as far north as Ungava. Today, salmon are gone from most rivers of New England, and from the inland rivers of Quebec and Ontario along the St. Lawrence River up to Lake Ontario, due largely to polluted water conditions and impassable barriers to migration.

Shad has a larger range, extending north from Florida along the eastern Atlantic coast as far as southern Labrador, where they migrate into freshwater to spawn not too far upstream from the mouths of many fairly large rivers. However, like salmon, they are not nearly as abundant as they were in pre-industrial North America. Today, shad are gone from the Petitcodiac River in New Brunswick and reduced in the Annapolis River of Nova Scotia. They are gone too from the Ottawa River upstream from Montreal, where they were once abundant but had their spawning habitat destroyed first by beds of sawdust and, eventually, by large dams.

The decline of fisheries for shad and salmon coincided with the coming of the Industrial Revolution at the end of the eighteenth century. The revolution radically affected the economic structure of society, not only in England, but also in North America. The revolution caused an explosion of economic activity which resulted in an increase in population and the growth of towns and cities. The thinking behind the Industrial Revolution was that an increase in material wealth was good, regardless of its effect on the environment. Thus, in England and North America, particularly in New England, the best rivers were affected. They were polluted, dammed, and eventually ruined by the detrimental effects of industrial growth.

History has revealed a change in attitude regarding natural resources. The aboriginal populations in North America respected and protected species such as salmon and shad. With the coming of European settlers came careless disregard for their preservation in spite of their value as natural resources.

A Day in the Life of a Fish



Many small fish liked to spend their time behind the big rocks. Some big fish were there too. What are the basic needs of the fish? Are they different from yours? Why are the fish behind the rocks?

Suddenly one of the little fish darted out to find some food. What would it eat? What might eat it?

Then it was frightened by a loud splash nearby. What might have caused it? The little fish swam quickly to the bottom of the stream.

It smelled awful down there. It was hard to breathe because the water was polluted. What do you think caused the pollution?

The little fish swam a little further upstream close to some old fishing line. Where did it come from? Is it a danger to the fish?

As the sun was setting, the little fish swam under a tree that had fallen in the river. How is the fish's habitat the same as yours? How is it different?

Write a story that begins with "The next day, the fish swam further downstream and..."

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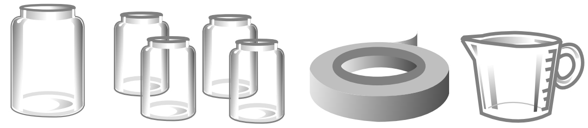
456
789

Just a Drop



Students know that water is a critical component of any fish's habitat. The purpose of this activity is to show that only a small proportion of the Earth's water supply is freshwater. This has serious implications for organisms that live in freshwater habitats.

Begin this activity with a brainstorming session involving the entire class. Ask the students to think about the total supply of water on Earth. Where is it found? It would help to have a globe or world map available. Write all their ideas on the board or flip chart. They may suggest a wide range of answers but all their suggestions should eventually be grouped into four main categories:

- oceans (salt water)
- lakes, rivers and streams
- ice and glaciers
- ground water

Just a Drop is based on these categories. Note that the proportions are based on total volume, not surface area. This will be a very dramatic activity. Most students don't realize how little water is contained in freshwater habitats. They may need to be convinced. Done as a demonstration, it will be less messy. However, if done by small groups, the students will gain experience in measuring and will be more convinced by the results.

Each group will need five containers; they will also need a way to measure water in milliliters and some masking tape or labels. Food colouring could be used to make the water levels more visible. Although the activity focuses more on proportions than actual measurements, the students should be encouraged to be as accurate as possible.

Depending on grade level, the water cycle could be discussed as part of this activity. Students are fascinated by the fact that the Earth's water supply has been recycling over and over again and

that there is basically no "new" water on earth.

In the end, the amount of water left for freshwater fish is only 1 ml. On a larger scale, this equates to significantly less than 1/10 of the total supply of water on Earth, actually 1/1000 or 0.001.

Discussion Question

What do the results of this activity mean for plants and animals that live in freshwater habitats?

The implications for freshwater organisms are great because it means there are very few places where they can live. Freshwater systems are vulnerable to both natural and human pressures. A fish's habitat can dry up because of little rainfall or because of activities such as road construction or infilling. Freshwater habitats are also being destroyed by pollutants from many sources. Access to freshwater is sometimes made difficult by hydrodams. When there is so little freshwater habitat available for fish, these threats are very serious.

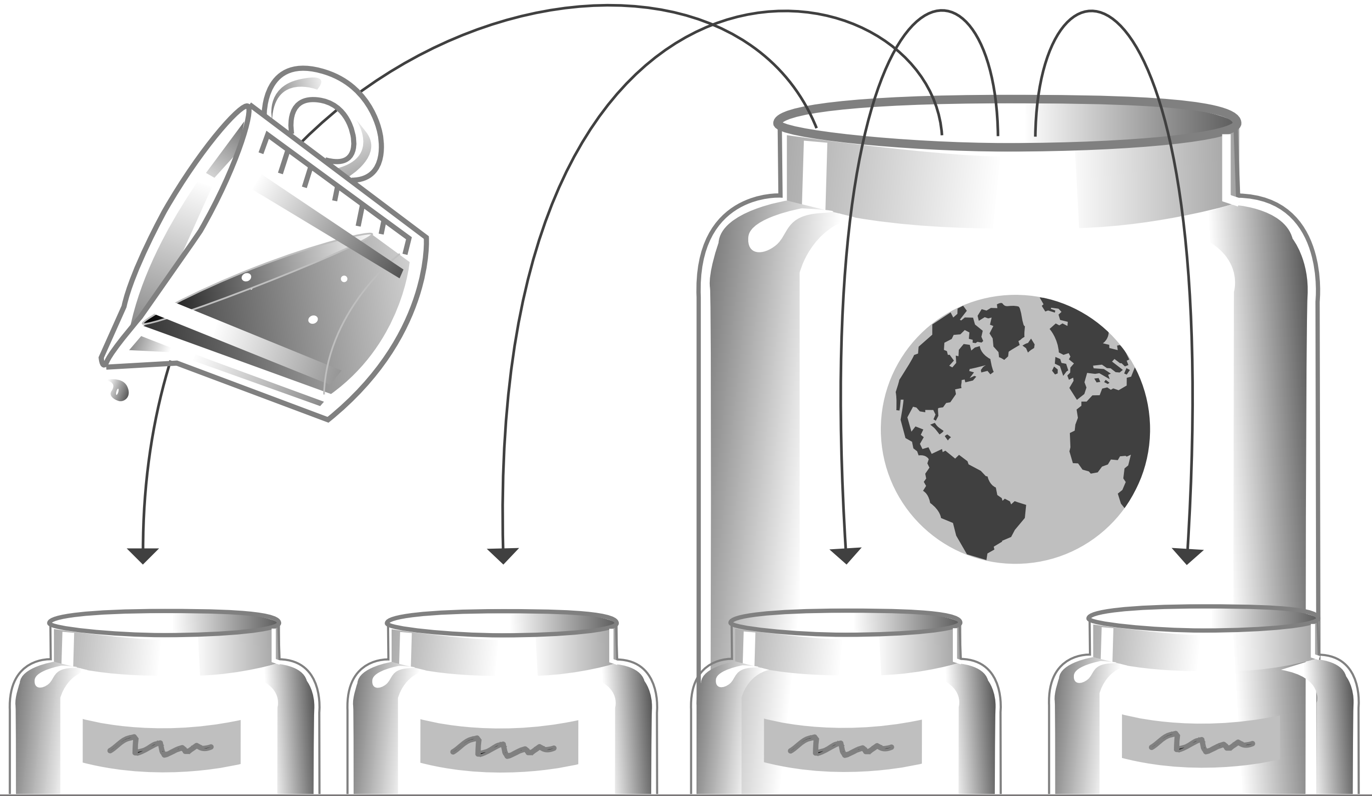
Just a Drop

How much of the world's water supply can fresh water fishes live in? What do you think?

1/2 ❑ 3/4 ❑ 1/4 ❑ 1/10 ❑ Less than 1/10 ❑

Here's a way to check your answer:

Place 1000 ml (1L) of water in a glass or plastic container. This represents the total water on Earth.



Measure 950 ml of the Earth's water and move it to another container. This amount represents **salt water** in the oceans. Label this container.

Move 15 ml of the Earth's water to another container. This represents water trapped in **ice caps** and **glaciers.**

Move 34 ml to another container. This represents **ground water.**

How much water is left?

____

Pour it into the last container. Where would this water be found?

Which container represents the water where freshwater fishes live? __________

Based on your results, how would you answer the question at the top of this page now?
1/2 ❑ 3/4 ❑ 1/4 ❑ 1/10 ❑ Less than 1/10 ❑

How does this compare to what you predicted?

____

THINK ABOUT THIS!

What do the results of this activity mean for plants and animals that live in freshwater habitats?

Lesson 3

Life in Freshwater

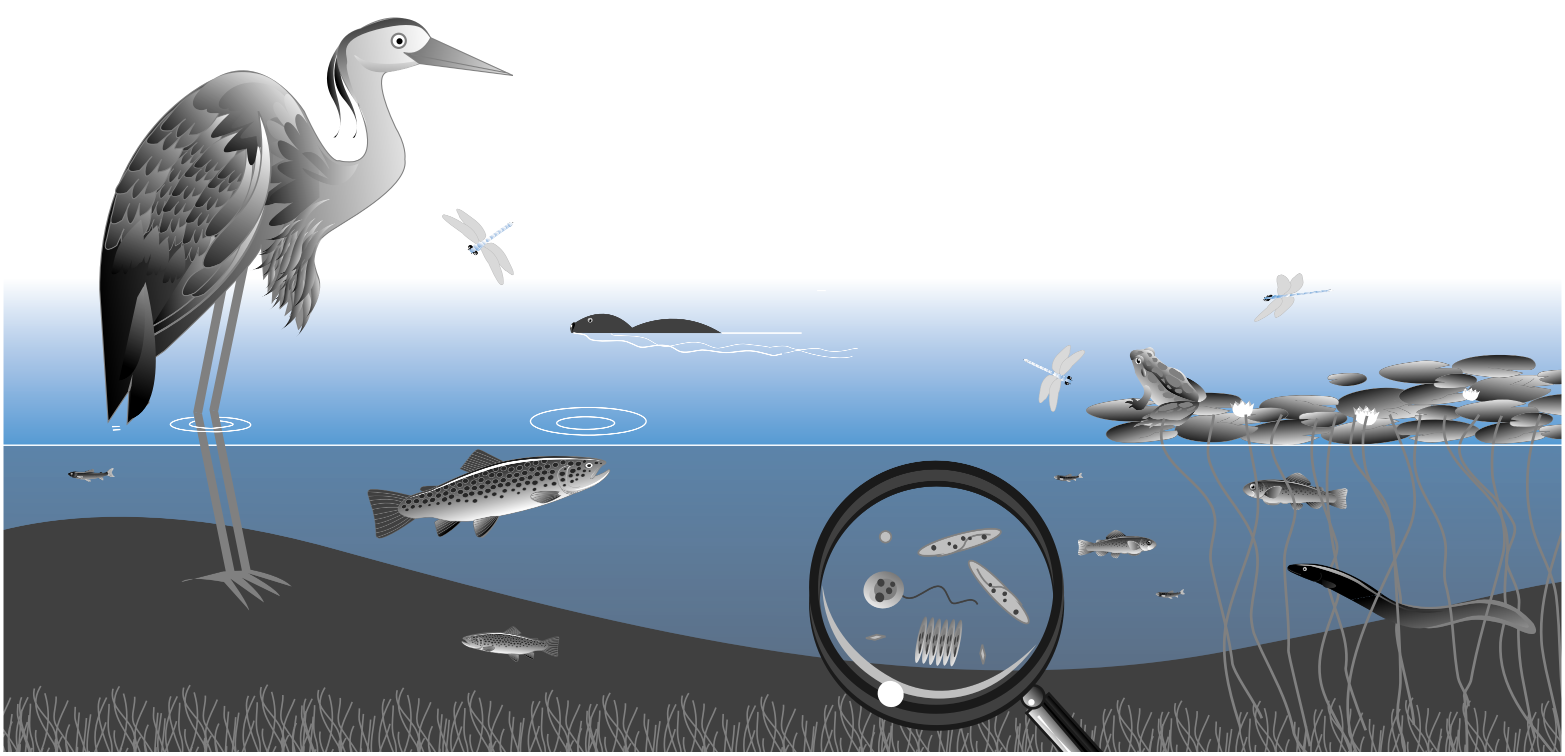
Main Ideas

Most habitats contain a great variety of living things. Plants and animals of different species, sizes and shapes along with microscopic organisms are commonly found together, sharing the same habitat and interacting with each other in complex relationships.

Diversity is important for the survival of living things in any habitat. In the absence of diversity, the loss of one or two key species can result in the collapse of all life in the habitat.

Objectives

In this lesson, the students begin to examine biodiversity and its importance to survival of a habitat. They first describe the variety of organisms living in freshwater and then examine some of the interactions among them.



Lots of Diversity

The purpose of this activity is for the students to suggest and record the vast variety of living things that can be found in freshwater. Their lists do not need to be exhaustive or all inclusive, nor are correct names necessary. The main point is that many different kinds of plants and animals live in freshwater habitats. In the next activity, the students will examine some of the interactions that take place among these living things.

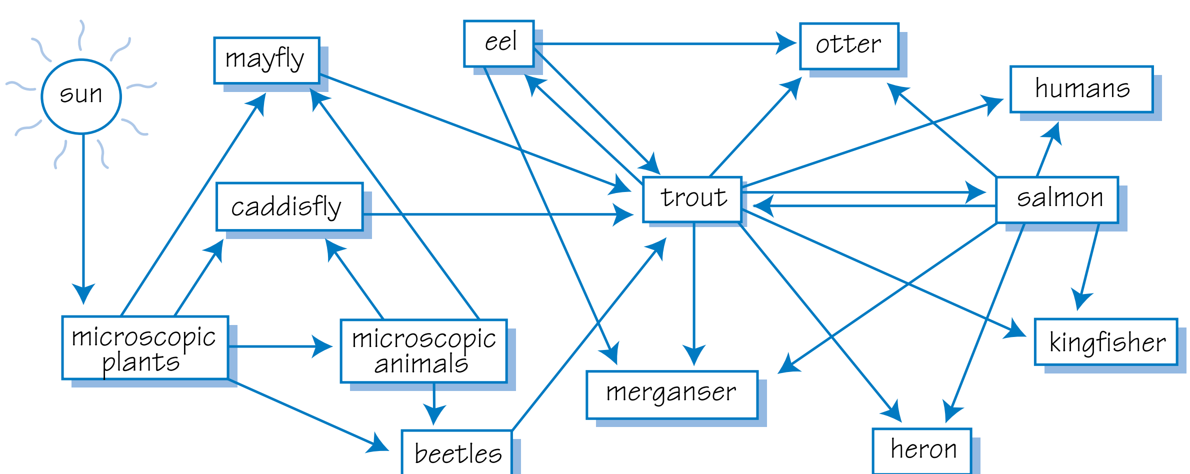
There are a variety of ways that this activity could be approached. Students could work individually or in small groups. Alternatively, you could have a brainstorming session with the entire class. The existing knowledge of the students will vary. Some will have little or no previous experience with freshwater habitats. For others, this will be very familiar. Encourage them to think about television programs they have seen as well. A classroom thematic display or a video could be used as a motivator.

At this time, the term "diversity" could be introduced in the context of their compiled list. Diversity refers to the variety of living things found in the habitat. Use local examples when possible; some examples are given below. This activity could be used in conjunction with a unit on classification of living things.

Fish	Birds	Mammals	Insects	Plants	Microscopic Organisms
eggs, alevin	kingfisher	mink	eggs	algae	eggs
parr, smolt	merganser	otter	caddisfly larva	water lily	algae
trout, sucker	gull, loon	humans	fly larva	grasses	bacteria
perch, pike	cormorant	muskrat	beetles, ants	pondweed	larvae
salmon, eel	heron, bittern	beaver	grasshopper	trees	plankton
stickleback	ducks, osprey		caterpillar		
char, bass			mayfly larva	**Amphibians**	
			water strider	frog, salamander	

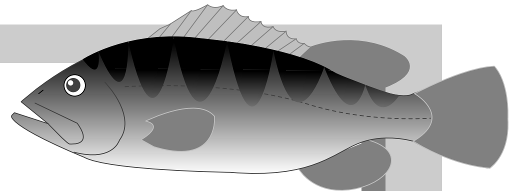
Who Eats Whom?

In this diagram, the direction of the arrows indicates the direction of the flow of food energy. One example of a freshwater **food chain** would be: microscopic plants → microscopic animals → mayfly → trout → humans. In any habitat, individual food chains interconnect to form a complex **food web**.

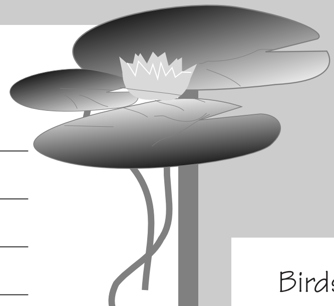


Lots of Diversity

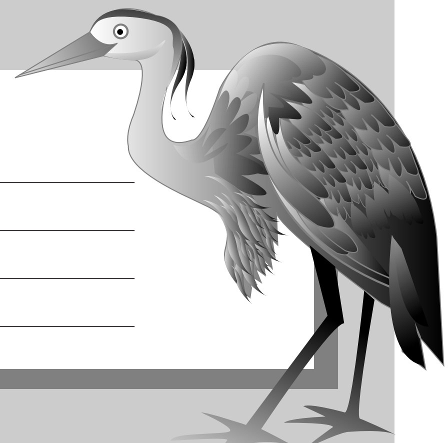
Insects



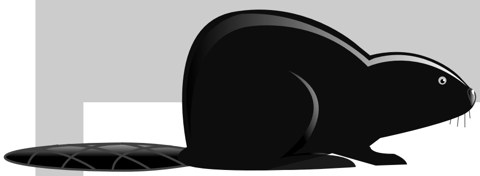
Fish



Plants



Birds

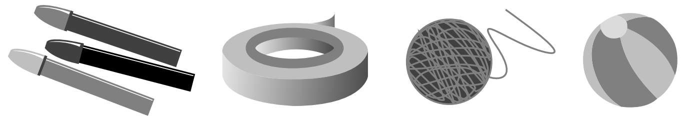


Mammals

Microscopic Organisms

Can you give some examples of things that live in fresh water?

Indra's Net



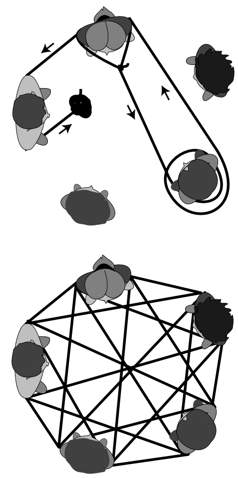
This activity uses the students' lists from the previous activity. They now consider the many ways in which the living things are "connected" to each other. The result is a complex web of inter-connections. This activity has been used in many forms in many settings. You will need a large open space, perhaps the classroom with the desks moved aside, or a gym, or outdoors.

Each student should choose (or be assigned) one of the living things mentioned in the previous activity. In addition, a few non-living components need to be included: the sun, water and air are the most important. Using masking tape, students can make large name tags of their new identities and attach them to their shirts.

The students then form a large circle so that everyone can see the name tags. Begin by tying the end of the ball of yarn around the waist of the "sun". Then ask, "Who is connected to the "sun"? One of the "plants" should answer. The ball of yarn is then passed (perhaps carried by you) from the sun and wrapped around the waist of the "plant". If other "plants" have spoken, the yarn should go back to the sun and then to each plant. Who is connected to the plants? Perhaps one of the "birds", who is then connected to a "fish", who's connected to an "insect", and so on. Be sure to keep the yarn taut. Each time the students make a connection, have them explain the relationship to the rest of the class. Precise accuracy is not important.

Eventually you will have a complex net or web of overlapping yarn. There are a number of ways to proceed:

- Have the students suggest what will happen if one of the organisms is removed. Then using scissors, cut the yarn that connects that organism to the web. What impact does this have on the other organisms?



Background

The palace of the ancient deity Indra was described as a net that encompassed the entire universe. Where any strand of the net met with another strand, there was a jewel that reflected (or contained) all other parts of the net.

- Alternatively, if the web is really tight, try tossing a large beach ball (representing the earth) into the middle of the web. It will be held up by all the connections. Now remove a species (perhaps one of the birds) and cut the pieces of yarn that connect that student to the rest of the ecosystem. What happens to the ball/earth? Continue until eventually the ball falls to the floor.

- Repeat the activity but this time have only one plant, one fish, one mammal, one bird and one insect. The students will see that there are not nearly as many connections when there are so few species. Use the "earth" again and let the students see how easy the system collapses where there is little diversity.

Language Task

There's a pond behind the school which contains lots of insects. Some of these are mosquitos and other annoying bugs. Some students in the Grade One class think all the insects should be killed. Have each of your students write a letter to the Grade One class. They should explain why diversity is important and why all the bugs should not be killed. Your students might prefer to do this as a drama production or as a radio play.

Background

Biological diversity - "biodiversity" - is the key to the maintenance of habitats and ecosystems as we know them. Life in a local habitat struck down by a passing storm springs back quickly because enough diversity still exists. Something resembling the original state of the environment will be restored.

Every habitat, from Brazilian rain forest to Antarctic bay, harbors a unique combination of living things. Each kind of plant and animal living there is linked to only a small part of the other species. Eliminate one species, and another increases in number to take its place. Eliminate a great many species, and the local habitat starts to decay visibly.

In an eroding habitat, life goes on, and it may look superficially the same. There are always species able to recolonize the impoverished area. Given enough time, a new combination of plants and animals will re-establish the habitat in a way that enables it to continue. But this restorative power of the plants and animals of the world as a whole depends on the existence of enough species to play that special role. Biodiversity is critical for habitat survival.

The term "ecosystem" is a convenience. We can draw an imaginary line around any section of the larger world and decide to treat its elements separately from the rest - and call it an ecosystem. How big is an ecosystem? The entire planet is sometimes referred to as an ecosystem; this ecosystem is termed the global ecosystem or biosphere. An ecosystem is really a term that represents an idea more than a place or set of things.

The term "ecosystem" describes a system in which there are living organisms, non-living components, and a primary source of energy. The sun is the "engine" driving the rest of the system. There are green plants and animals. The green plants capture some of the sun's energy in a process known as photosynthesis. Animals cannot do this. They rely on the green plants to catch solar energy and to use it to assemble food materials.

The green plants are the food factories in natural systems. They are called producers. The plants also provide oxygen as a by-product of this process, but use carbon dioxide and water as raw materials.

Not all animals eat plants. Those that eat only plants are known as herbivores, or primary consumers. Animals that eat other animals are two steps away from the sun, so they are often called secondary consumers or carnivores (meat eaters). The sequence gets more complex if we add animals that prey on other meat eaters. These are sometimes called tertiary consumers.

Although obtaining food is a critical activity of living things, many of the relationships in an ecosystem are not directly involved in this pursuit. Living things interact with each other to obtain shelter, to reproduce, for protection, and so on.

Ecosystems with simple interactions are usually more vulnerable to drastic change than are ecosystems with complex interactions. In the arctic terrestrial ecosystem, for example, if the production of lichens became impaired, the entire system would collapse, since all life depends upon lichens. Similarly, in the antarctic seas, if krill were eliminated by some ecological accident, there would be a catastrophic decline of virtually all marine mammals, birds, and fish which depend upon krill for food. In temperate or tropical systems, on the other hand, where alternate food supplies are available, the temporary loss of any one species does not necessarily endanger the entire system. There are exceptions to this, of course.

Thus, there is ecological strength and security in complex ecosystem structures that simplified systems do not have. It is no surprise, therefore, to note that complex ecosystems are usually more stable than simplified systems. Unfortunately, one of the major influences of humans has been to simplify the world's ecosystems. Moreover, agriculture fosters simplified systems. By plowing fields and prairies, we eliminate a hundred species of native herbs and grasses and replace them with pure stands of wheat, corn, or alfalfa. This increases efficiency, productivity, and yield, but it also increases ecological vulnerability and instability. If we have a pure stand of wheat, the possibility of ecological catastrophe is amplified; a pathogen (such as wheat rust) or an herbivore (such as grasshoppers or locusts) may sweep in suddenly to decimate the entire system.

We clearly pay a price for oversimplifying ecosystems and thereby reducing their natural stability. Why do we need so many different kinds of plants and animals? So what if a few of them do become extinct? Questions like this can seldom be answered in very specific terms, but the answer lies in complex ecological principles. There may be no immediate catastrophe if a certain species does disappear, but the system is thereby somewhat impaired from its natural state and is more vulnerable to ecological instability.

By conserving diverse habitats, we help to insure a more natural, more complex, and more stable flora and fauna.

Review Activity 1

This is an appropriate time for a review activity using a **concept map.** A concept map is simply a visual way of showing how ideas or concepts fit together. In the first three lessons, several concepts have been introduced. By using a concept map, students can demonstrate their understanding, not just of the individual concepts, but also of how they are related to each other. Concept mapping is a very effective way of helping students see how individual ideas connect to form a larger whole and are effective tools for helping students make logical connections.

Concept maps can take many forms and there is no one correct concept map for any given topic. They can be simple or very detailed; linear or branched. They should, however, be arranged following some logical reasoning. A good concept map should:

- begin with a general concept or 'big idea' and proceed to more specific ideas
- represent each concept with a noun or short phrase which appears only once
- link concepts using words or short phrases
- shows cross linkages where appropriate
- consist of more than a single path
- include examples where appropriate

Students can construct their own maps or can complete one which you have started for them. The most effective are the ones they construct on their own. If this is their first experience with concept maps, they may need assistance.

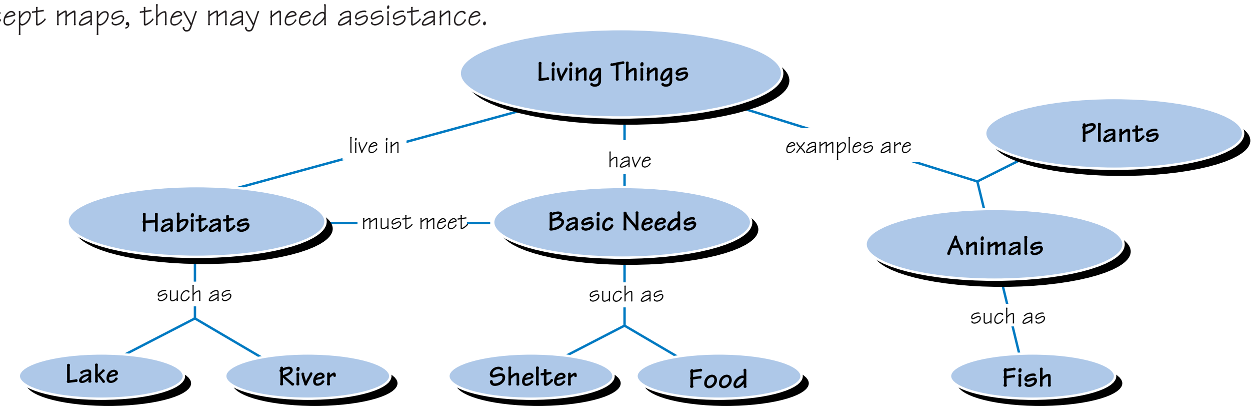
How to make a Concept Map

Begin by making a list of the concepts or main ideas from the first three lessons. You can brainstorm with the students or present them with a list. All students should use the same concepts.

Have the students write each concept on a separate piece of paper and spread them on their desks. They begin constructing their map by putting the most general concept at the top. The key question is 'How does this concept relate to the remaining concepts?' They then arrange the remaining concepts in order from the most general to the most specific. Finally, they connect related concepts with a line and on each line, write an action word or short phrase that shows how the concepts are related.

The students could work individually or in pairs first and then compare their maps with their classmates. There will be many variations but as long as they follow the basic rules, their maps will be acceptable.

For example, included in the first three lessons of Fish Friends are the concepts: Habitats, Living Things, Basic Needs, Plants, Animals, Fish, Lake, River, Shelter, Food. Here is an example of one possible concept map:



Lesson 4

Changes in Habitat

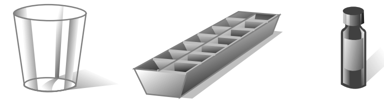
Main Idea

Habitats change. Some changes occur naturally (seasons ...) and some are caused by human impact (pollution, highway construction...). For living things to survive, they must be able to adapt to these changes so that their basic needs continue to be met.

Objectives

In this lesson, the students will begin to develop the concept of change over time. In the first activity, they examine how a freshwater habitat changes from one season to another. Another activity explores changes in a river habitat as it flows through different regions. Students will also examine changes caused by the activities of humans.

Meltdown



This activity provides an example of how a fresh-water habitat changes naturally. It is an example of a POE - Predict Observe Explain activity. Based on prior understandings, students first predict what they think will happen when the coloured ice cube is placed in the cold water. They then watch what actually happens. Finally they are challenged to compare their predictions with their observations and to explain what happened. This is an important teaching strategy allowing students to express their existing understanding and then to modify that understanding based on new knowledge.

This activity can be done as a demonstration or by small groups of students. In advance you will need to prepare some coloured water and freeze it in ice cube trays. Be sure it is completely frozen. Food colouring works best; ink may contain solid particles. You will need one ice cube per group plus a few extras for unforeseen needs.

Use tall, clear containers. Make sure the water is cold when you (or the students) put it in the containers so melting doesn't begin too quickly, before the students have a chance to observe. Instruct the students to watch closely and record their observations three times: when they first place the ice cube in the cold water, after 10 minutes or sooner, and after an hour. It may help to place a piece of plain white paper behind the container.

At first the ice cube will float at the surface of the water. Water is most dense at 4°C. As the ice cube melts, its water temperature is increasing. When it reaches 4°C, it is denser than the water in the container and therefore it sinks. Few students at this age will be able to understand density. Only the bravest of teachers will attempt an explanation! If the students have already completed work in an earlier grade on floaters and sinkers, they have begun to understand density. As it melts, coloured water can be seen sinking to the bottom of the container in thin strands. When these strands of coloured water reach the bottom of the container, they swirl around and form a layer. The water from the ice cube appears 'heavier' than the water in the container. This is because of its temperature, not the colouring. (As all the water in the container reaches the same temperature, the colouring becomes evenly dispersed.) Conclude by asking:

- **What effect does melting ice have on fish?**

When the ice starts to melt in spring, the denser water from the ice sinks to the bottom of the lake or stream, bringing with it oxygen that was trapped in the ice over the winter. The mixing process also stirs the sediments on the bottom and forces the nutrients which have settled there over the winter back into the water. This mixing is important for fish survival.

Extension Activity

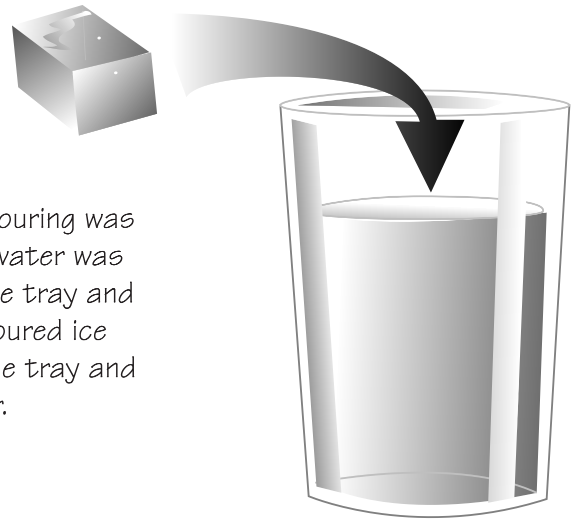
This activity could easily become another POE. The purpose is to imitate what happens as water in lakes and streams warms in summer.

Put a few drops of food colouring in a suitable container and add boiling water. Each group of students needs a container of cold water. Someone from each group fills a dropper with hot coloured water and gently releases a few drops on top of the cold water. Observations are noted. The students will see that the warm coloured water floats on top of the cold. Likewise, warm water heated by the sun floats on the surface of lakes in the summer. The students can mimic the wind by blowing on the surface of the water and observing the mixing that occurs.

Students may suggest that temperature had nothing to do with their observations, the same thing would happen if the coloured water was cold. Have them try it.

Since most freshwater fish require cool water, the fact that warm water stays at the surface of a lake or stream is important. If complete mixing occurs, water temperature may become too warm for them.

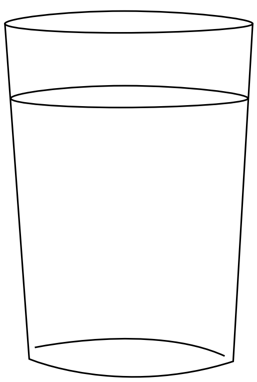
Meltdown



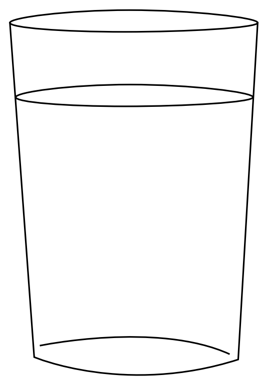
A small amount of food colouring was added to some water. The water was then poured into an ice cube tray and frozen solid. One of the coloured ice cubes was removed from the tray and put in a glass of cold water.

Predict: Draw what you think will happen:

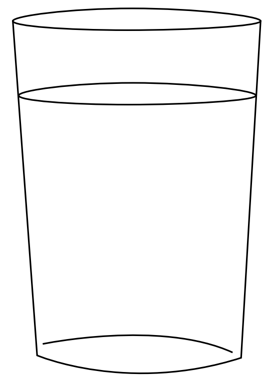
At first



After 10 minutes

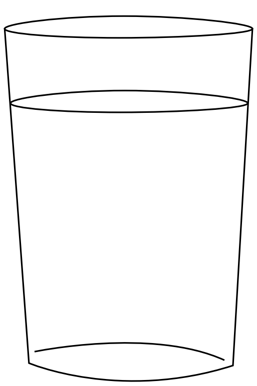


After 1 hour

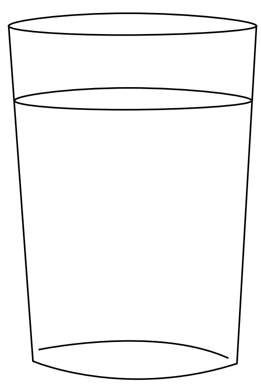


Observe: Place a coloured ice cube in some cold water. Draw what you see:

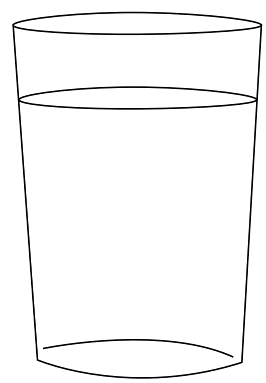
At first



After 10 minutes



After 1 hour



Did your observation agree with your prediction?

Yes ❑
No ❑
Sort of ❑

Explain: What do you think was happening? Why did the water mix the way it did?

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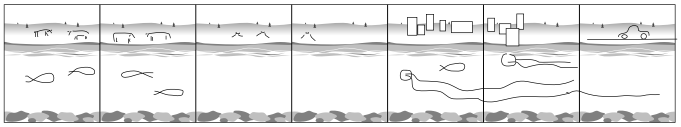
Flow Gently



The river habitat can change considerably as it meanders through ever-changing environments, through woodlands, past open fields, through towns and villages and alongside roadways. In this activity, the students will illustrate some of the changes in a river habitat.

Provide each student with a copy of the activity sheet. Divide the class into four groups (A, B, C, D) and assign each group one of the following sections of the river.

A. A **farming area** where fields are plowed to the edge of the river and cattle are grazing nearby
B. A **forest** where most of the trees have been cut down
C. The centre of a **town** with houses and businesses
D. Along the edge of a **gravel road** which leads to a local lake for fishing and swimming.

Directions for students:
- Draw a picture of what you think a 'side-on' view of your section of the river would look like. Include any living and non-living things that would be found there.
- Draw what would be seen along the riverbank.

Directions for each group:
- Put all the pictures from your group in a series to form a profile of your section of the river.

Find a place in your classroom where you can put the profiles of all groups in the sequence given above. When the entire river is displayed, have the students look for examples of how the river differs from one section to another. These will be obvious.

The students then return to their groups for a second task. They now alter their original drawings (or create new ones) to show how their section of the river would look after the following changes:

A. Cattle are walking in the shallow sections of the river in the farming area
B. Trees have been planted in the forest section right to the river's edge
C. People who live in the town have been dumping old tires and other garbage into the river
D. The road to the lake is being widened and paved

It is not necessary for the students to have a great deal of technical knowledge about the impacts of these changes on the river. It's more important for them to indicate what they think will happen, based on existing knowledge. This topic is addressed again in later lessons.

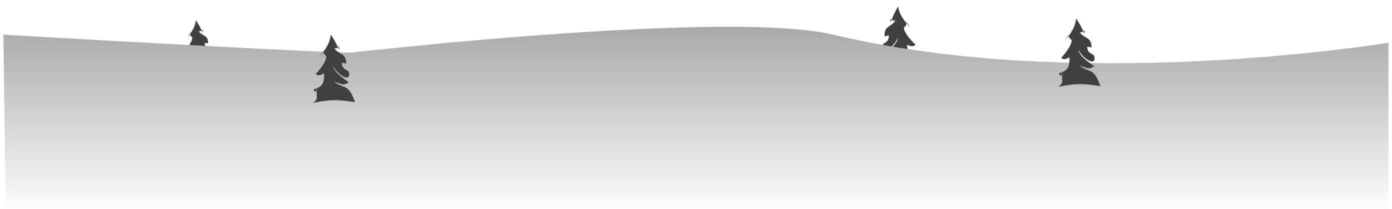
After the students have completed these new drawings, put them on the wall again in the same sequence. Have the students describe the changes that have occurred in their section of the river. To complete the activity, have a class discussion on cause and effect based on the question:

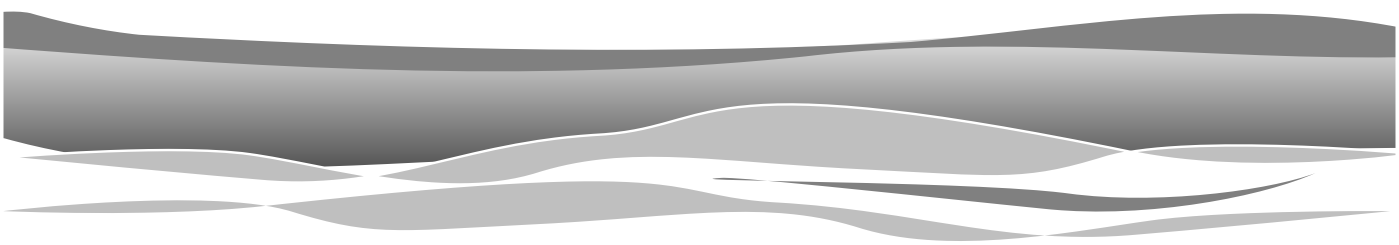
- **How does activity in one section of a river affect the habitat further downstream?**

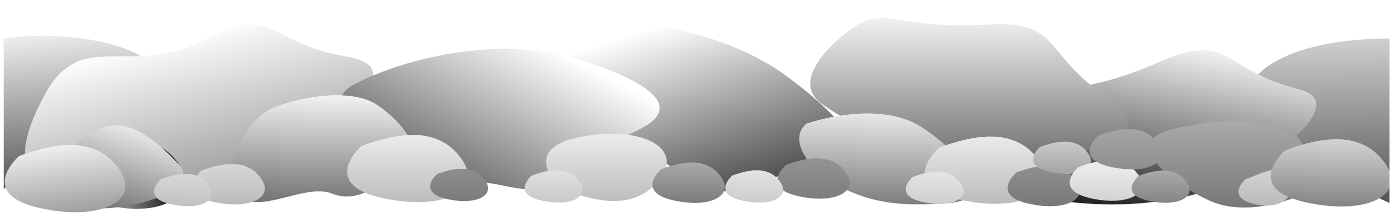
Language Task

Bring a few samples of tourist brochures to class for the students to see. The task for your students is to prepare the text and drawings for a brochure to encourage canoeists to visit this river. The brochure should contain descriptions of the river as it meanders through the different regions.

Flow Gently







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Smelliness Test

The purpose of this activity is for the students to assess the sense of smell as a means of determining levels of water pollution. This is an activity in which reaching a consensus is important and the students are given an opportunity to suggest ways of doing this.

What the students see are four jars of liquid, all looking the same. Their task is to use smell to properly label the jars. A later activity examines how fish use smell during migration.

In advance, you need to collect four jars that are large enough to hold a litre of liquid. In one jar, put a litre of water. In the remaining jars, pour 100 ml, 10 ml and 1 ml respectively of a clear, strong smelling liquid and add water to total a litre. In no particular order, mark these jars A, B, C, or D. (Be sure to make a note to yourself about which jar is which - you'll need it later.) Have large labels that read 100 ml, 10 ml and 1 ml on the table beside the jars.

Vinegar is recommended as it is colourless, has a strong odour, dissolves easily in water, and is readily available. You should not use oily substances because they tend to float to the surface, affecting the results of the test and disposal of them is a pollution problem. It's important that the solutions in each jar differ only in the strength of the odour. You should experiment with the amounts of pollutant to ensure there is a variation in the 'smelliness' of each sample. Adjust the labels if necessary. It should be very difficult to distinguish between the plain water and the jar with 1 ml of vinegar.

Divide the class into small groups. Using plastic bottles or other small containers, marked A, B, C, or D, have a student from each group collect a small sample from the corresponding jar. You might want to prepare these samples in advance. The challenge is for the class to come to a consensus on how to label the jars.

Using the activity sheets, students rate the solutions individually *(My Rating)*, combine their data *(Group Rating)*. and reach a class consensus *(Class Rating)*.

If your students have significant math background, you might use averages instead of totals to express group and class data.

Discussion Questions

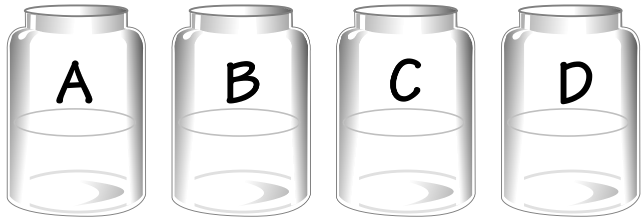
What are the advantages of this method of recording observations? What are the disadvantages?

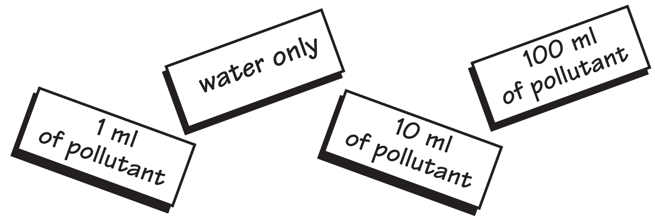
The advantage of using smell is that no special equipment or tools are needed, just a nose which tends to be readily available. It's easy and anyone can do it. One disadvantage of this method is that people's ability to smell varies considerably. What is considered a weak smell by one person may be interpreted as very strong by another. Also, a person's sense of smell can be influenced by environmental factors such as other smells.

Is smelling a reliable method of determining if a freshwater habitat is polluted?

Smelling is not a reliable method of determining the level of water pollution. In the case of severe pollution, the odour may be obvious, but some pollutants may be odourless. In addition, low levels of pollution which cannot be detected by smell can still be harmful to freshwater organisms.

Smelliness Test





On the table there are four jars marked A, B, C and D. One contains plain water. The others contain a bit of smelly pollutant mixed with the water. Your group will get a sample of the liquid from each of the four jars. Make sure your samples are also marked A, B, C, or D.

Also on the table are four labels each showing an amount of pollutant: 100ml, 10ml, 1ml and water only. The task is to put the correct labels on the jars. The only equipment you can use is your nose.

My Rating

Smell the samples and record your rating for each one in this chart. A rating of 1 means the liquid has no odour, 2 means a little odour and so on up to a rating of 5 which means that the liquid has a lot of odour.

Jar	no smell			lots of smell
A	1	2	3	4	5
B	1	2	3	4	5
C	1	2	3	4	5
D	1	2	3	4	5

Group Rating

Now combine your ratings with the other students in your group. What is the total group rating for the liquid in each jar? Record this in the table.
• What does a high 'Smelliness' score mean about the amount of pollution in the liquid?
• What does a low score mean?
Based on your group's totals, which label do you think should be placed on each jar?

Jar	Total Score	Group's Label
A		
B		
C		
D		

Class Rating

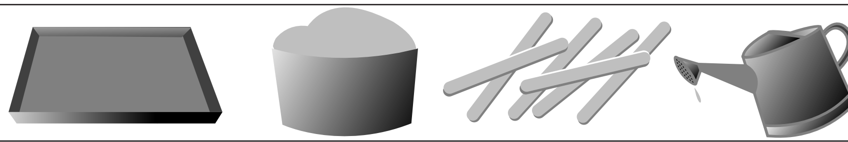
THINK ABOUT THIS!

We have to agree on the correct labels for the jars. Do your group's labels agree with the others? If not, how will the class decide which labels are correct ? Record the class's decision in the table.

Jar	Label
A	
B	
C	
D	

Is smelling a reliable method of determining if a freshwater habitat is polluted?

Muddy Waters



Models are often used to demonstrate events that happen in nature. In this activity, the students build a model to demonstrate the impact of trees on the amount of silt in a river. Depending on availability of supplies, this activity could be done as a demonstration or in small groups. You could even do it outdoors. You'll need some water (rain) and a container (a watering can is a possibility), some soil or mud, some 'trees' (popsicle sticks work well) and a large tray or pan to hold everything.

Directions to students:
Your task is to make a model that shows:

1. What happens to a river when it rains and there are lots of trees along the river bank.

2. What happens if there are no trees.

3. Try a different pattern or location for your 'trees'. Add some 'rain'. What was the effect on the river? Repeat with a different tree pattern.

You'll have to decide on a way to record your observations. You could use charts or tables or even diagrams. How can you compare your results after each investigation?

- **How do trees influence the muddiness of the water in a river? This muddiness is called silt.**

- **What effect would silt have on fish eggs?**

Extension Activity

This activity could be done as a demonstration or by student groups.

Gently place a paper clip on the surface of water in a wide mouthed glass or jar. What happens to the paper clip? (If done carefully, it will float.)

Add a drop or two of oil (cooking oil will work well) to the surface of the water. Now what happens to the paper clip? (It will now sink.)

The explanation involves the concept of surface tension, a special 'bond' or tension that exists between the water molecules on the surface of the water. This tension is strong enough to hold the paper clip. Some pollutants, especially oil, significantly reduce the surface tension so that the paper clip is no longer supported.

What are the implications? They are very significant for insects such as the water strider (or water doctor) that move and feed on the surface of lakes and streams because of this surface tension. In polluted water, they and things that feed on them are often unable to survive.

Lesson 5

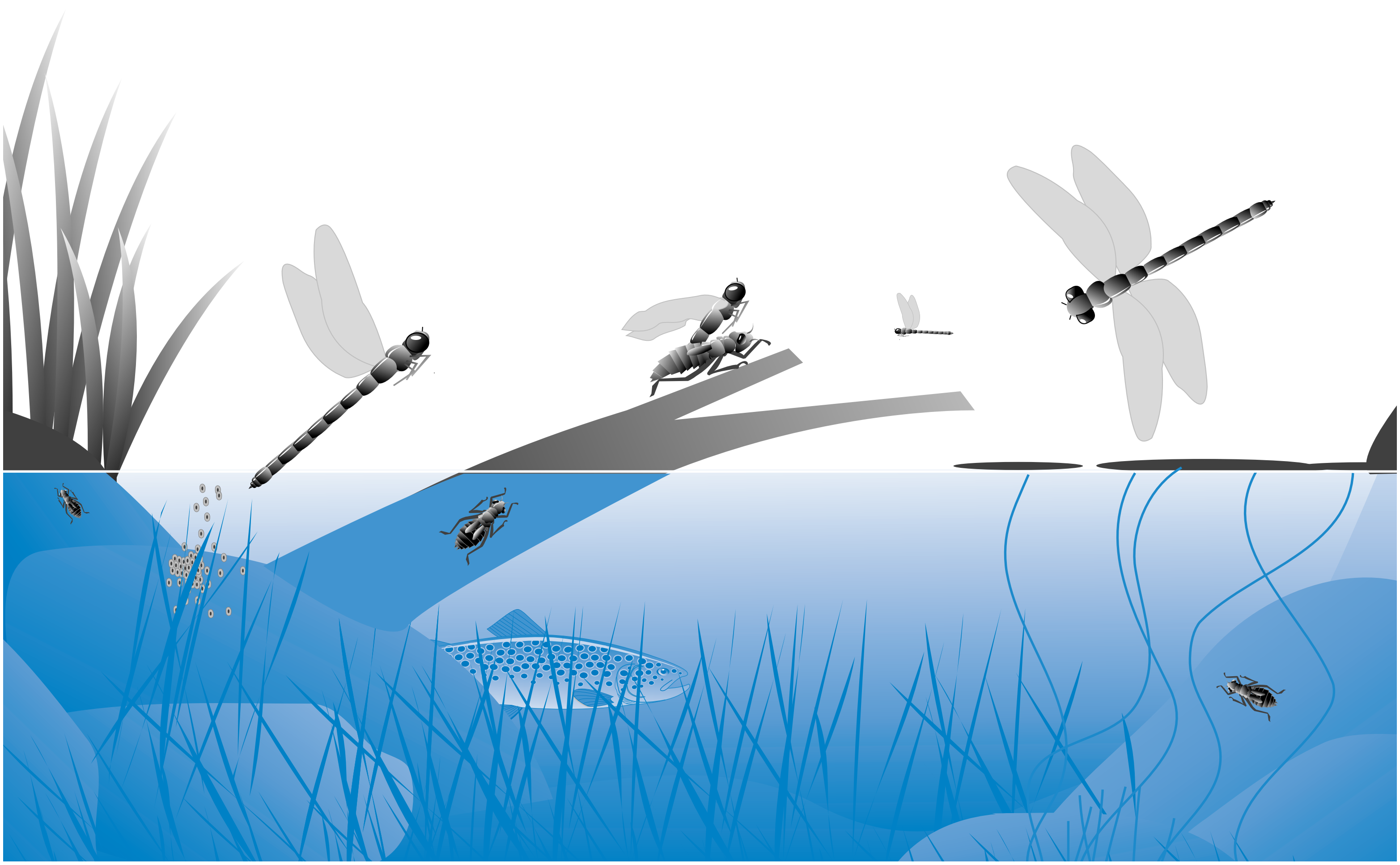
More Changes

Main Ideas

All living things change over time. They grow and develop as they advance through the various stages of their life cycle. In some species there are distinct differences in appearance and habitat at different stages. Survival of the species depends on meeting basic life needs at all stages.

Objectives

Through a sequencing activity, students will learn about the natural changes that take place in the life cycle of a fish. The rates of growth and development are then studied in two activities in which students interpret data and construct graphs.



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Salmon Life Cycle

This activity promotes understanding through reading. Use it as an introduction to fish life cycles to elicit students' existing understandings and to maximize its use as a reading activity. In this activity, students place the various stages of the salmon life cycle in the correct order. Since this is a life cycle, it can begin at any stage. If read carefully, the descriptions will enable the students to determine the proper sequence.

In this activity students work individually first. Have them cut out the stages and then arrange them in what they think is the correct sequence. They can then compare their sequence with other students in a small group. Alternatively, they could write the names of the stages in what they think is the correct sequence at the bottom of the activity page.

Eggs → Alevin → Fry → Parr → Smolt → Grilse / Adult

Follow with a video or further research to reinforce and extend the learning. Showing the video first may result in an activity that focuses on remembering the video rather than on reading the text.

Background

Adult salmon enter many rivers in the Atlantic region during the months between May and October. The salmon that survive the journey up the river arrive at a suitable place to lay their eggs. They spawn in freshwater anywhere from just above the influence of the saltwater to the extreme limits of the freshwater. They must contain a gravel bottom with many small and medium-sized stones. The salmon wait until late October or early November when water temperatures drop to about 5°C and the daylight hours grow short.

The female turns on her side and moves her tail very rapidly while staying in one position. The action produces water currents sufficient to wash a hole called a nest, or redd, in the gravely bottom of the river. The redd is between 20 to 45 centimeters deep. The male, meanwhile, keeps watch nearby. After the nest is made, both fish hover over it. The female lays her eggs. The male excretes a milky substance called milt which contains sperm to fertilize the eggs. The female then covers the eggs with gravel.

The female salmon lays approximately 1500-1600 eggs per kg of her weight. A fish of 5 kg would lay 7,000-8,000 eggs. Of those eggs, under ideal conditions as in fish hatcheries, 85% normally hatch. In the wild, even fewer can be expected to survive.

Once the eggs are laid and the salmon have finished spawning, the adults may stay in deep pools in the river over the winter and go to the sea in the spring. They are called kelts, slink, or black salmon. Some kelts, however, start their return journey after spawning and make their way down the river to the sea before freeze-up. The eggs develop slowly in the redd over the winter. From mid-April to mid-May, as the water temperature begins to rise, hatching occurs.

The small fish, about two centimeters long, is called an alevin. They feed on the yolk of the egg from which they have hatched. When this yolk is nearly gone, the tiny salmon wriggles its way up through the gravel out into the stream. Now it will feed on microscopic materials.

Until the young fish is five to eight centimeters long, it is referred to as a fry. Later on, fry are called fingerlings because the little salmon is then about the length of a finger. As the fingerling grows longer than about eight centimeters, marks appear on its sides and it is then called a parr.

The parr is identified by its dark back and lighter belly, with nine to eleven vertical bars, called parr marks, along the sides of the fish. A single red dot occurs between each pair of parr marks. These markings camouflage the parr while it lives among the rocks and weeds of the river.

The parr stage continues until it becomes approximately 12 to 24 centimeters in length, when it is called a smolt. This can take from one to seven years, depending on environmental conditions. Most parr develop into smolt by the second or third year. The longer duration of parr life is due to slower growth resulting from poorer feeding conditions, colder water temperatures and a shorter growing season in certain rivers.

Smolt undergo a transformation which enables them to survive in salt water. The parr marks have disappeared, and the smolt's silvery colour will protect it during its life at sea. It is dangerous for the fish to linger in the river as it is now easily seen by feeding birds - but less dangerous than if the smolt were to enter the sea with brightly coloured stripes and spots! It is carried downriver by the current, hopefully avoiding the hazards of power generators, logging runs, and natural predators.

During May and June, the smolt leave the river and can sometimes be seen at the mouth of the river. Then, as suddenly as they appeared, they disappear into the sea, not to be seen again near the river for at least another year.

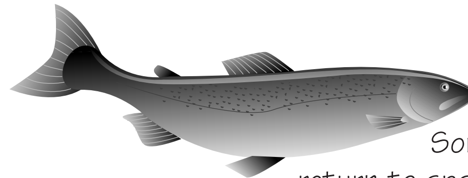
The great quantity of food in the sea causes tremendous growth. After one year at sea, the salmon may weight up to three kg; after two years, as large as 8 – 10 kg; in five years, up to 20 kg.

After one or more years at sea, the adult salmon return to spawn in the river in which they were born. A salmon that returns after only one year at sea is called a grilse. Some salmon do not return after the first year at sea. These fish return after two to four years as adult salmon. Some rivers contain mostly grilse; other mostly large salmon; still others contain a mixture of fish which have stayed one, two or three years at sea. The salmon then spawn, completing another generation and continuing the perpetual life cycle.

Salmon Life Cycle

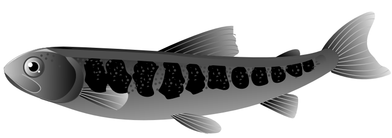
A salmon goes through many changes as it grows and become an adult. These changes are part of its life cycle. The stages are described below but the order is mixed up. Read each description carefully and then using scissors, cut them out and put them in the right order.

A female salmon lays approximately 1500-1600 **eggs** per kg of her weight. A fish of 5 kg would lay 7,000-8,000 eggs.

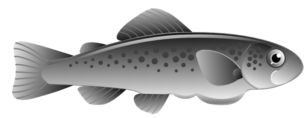


Some salmon return to spawn in freshwater after only one year at sea. They are called **grilse** and usually weigh about one or two kilograms.

Until the fish becomes approximately 12 to 24 centimeters in length, it is called a **parr.** A parr has a dark back with nine to eleven bars, called parr marks, along its sides. A single red dot occurs between each pair of parr marks. These markings help camouflage the parr while it lives among the rocks and weeds of the river.

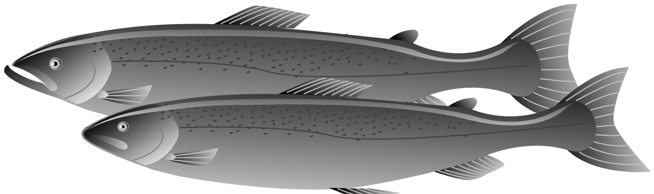


The small fish, about two centimeters long, is called an **alevin** . It feeds on the yolk of the egg from which it has hatched while it is still in the gravel. The yolk is contained in a yolk sac attached to the belly of the fish.

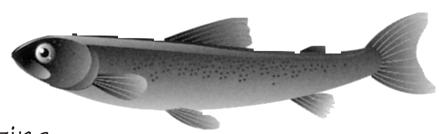


When the yolk sac is nearly gone, the tiny salmon wriggles its way up through the gravel out into the stream. Now it will feed on microscopic materials in the water. It is finally on its own. Until the young fish is five to eight centimeters long, it is called a **fry.**

Some salmon spend two, three or even four years at sea. They may weigh from 4 to 20 kg. They return as **adults** to the river where they were born.



They then spawn, completing another generation and continuing the life cycle.



An amazing change takes place. The marks and spots disappear and the fish becomes gleaming and silver. It is now called a **smolt.** It swims swiftly down the river, heading to sea where its silvery colour will protect it. It is dangerous for the fish to enter the sea with brightly coloured stripes and spots!

Pages 33 & 34

Every Scale Tells a Story

In this activity, the students will follow procedures that fisheries officers and scientists use to read fish scales. The purpose is for students to develop some of the interpretation skills needed in many fields of science. It stresses careful observation and the need to provide evidence for their interpretations.

The ideal situation is for students to use actual fish scales; if possible, remove a few scales from a fish and bring them to class. However, they are small and almost impossible to see clearly without a microscope. Unfortunately, most elementary teachers do not have access to microscopes. Hand lenses will magnify the scales enough to see that rings are present. Microfiche readers used by many public libraries can display the scale on a screen. You may be able to borrow one. The growth rings are clearly visible and several students can see it at the same time. You could also prepare an overhead of the scale illustration on the activity page.

The students are first lead through a step by step explanation of a sample scale. As they read, they are prompted to label the various sections of the scale. Encourage them to use straight lines when labeling and to write or print neatly. It makes for less confusion.

In the second activity page, the students are presented with another scale. They are asked to write a story through which they can indicate what they've learned and demonstrate their ability to provide evidence for their interpretations.

Background Information

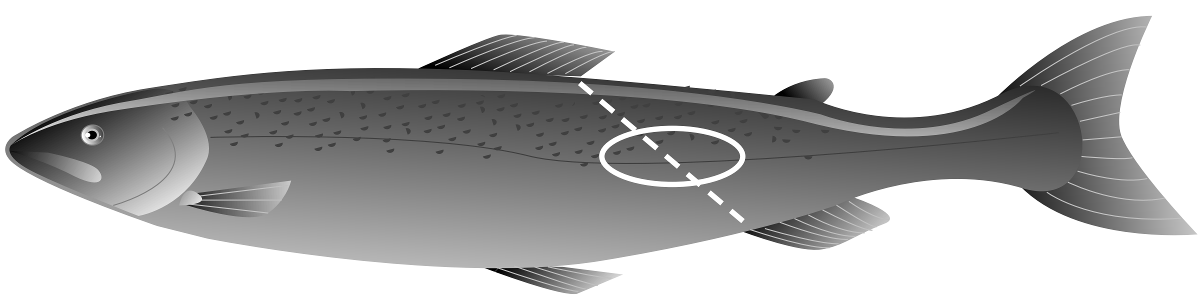
The most widespread method of aging salmon parr and adults involves collecting scales. When clean and undamaged, scales show progressive growth rings similar to the rings on a tree. As the salmon grows, new growth rings are laid down in the scale as it gets bigger. The scales with their growth rings can be magnified in order to accurately reveal the life history of an individual salmon.

During the growth of salmon, ridges (or rings) are formed around the centre of the scale, which is called the focus or nucleus. It has been determined that these rings are found in proportion to the growth of the fish (eg. groups of widely-spaced rings represent periods of rapid growth, while groups of narrowly-spaced rings indicate slower growth periods).

It is from these groupings that we can analyze the growth rates and ages of salmon. The wide-spaced rings are summer growth, while more narrowly-spaced rings are winter growth. While growth is usually determined by temperature and amount of food intake, these terms indicate increased food and growth in summer periods and a decrease in growth during winter when temperatures are colder and food is less abundant. One of the most important uses of the data gained from studying fish scales relates to management procedures.

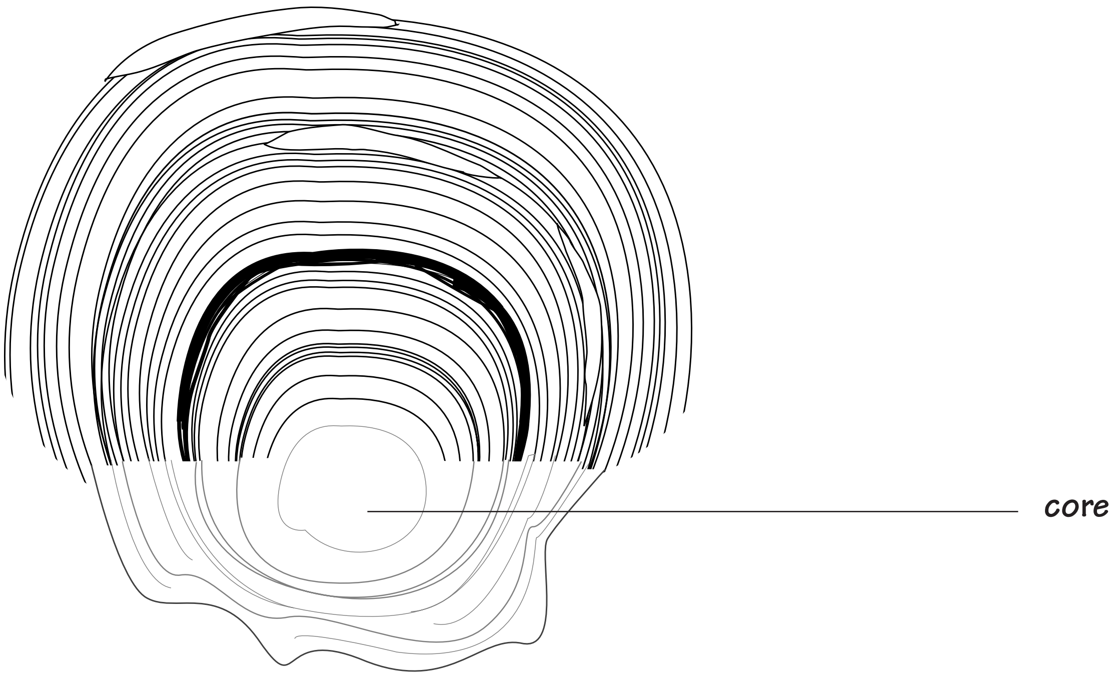
Based on the information gained from examining scales, it is possible to determine a profile of the present fish population as well as predict future populations. For example, if the current population is made up of 25% repeat spawners (or perhaps 50% that spawn in alternate years), future populations of the river can be predicted. This will enable fisheries management plans to be adjusted if necessary.

An advantage of scale sampling is that scales can be removed without harming the fish. Scale samples are regularly collected from the brood stock of an enhancement project and from fish collected during stream surveys and recreational fishery surveys.



The preferred area for removing scale samples is above and below the lateral line near the area indicated.

Every Scale Tells a Story • 1



The scales of a fish are like a book. They tell a story. They tell how old the fish is, where it has lived and if it has been eating well. As a fish grows, rings form around the centre of each scale. You can easily see the rings in this diagram.

Find the **core** or centre of the scale (it's not in the middle!). This has been labeled on the diagram. The first rings form when the fish is in its early stages. If the water is warm and there's lots of food, the fish will grow well. The rings will be spaced far apart. This is **summer growth**. Label this section of the scale.

Next are some rings that are very close together. These grow during the fish's first winter. The water is cold and there's little food. The fish doesn't grow very much and the rings are close together. This is **winter growth**. Label this section on the diagram. At this stage, the fish was a year old.

The fish then spends another year in freshwater. Can you find the summer and winter growth rings for the second year? Label these sections **second summer** and **second winter**.

Following the second winter, the fish feeds heavily and then starts its journey to sea. At this stage it is called a smolt. It goes through some major changes and the scales show a dark band. Find the **smolt mark** and label it.

The fish then spends its first summer at sea. There is lots of food and it eats and grows well. The growth rings are far apart. Can you find these? Label them **first summer at sea**.

This is followed by a winter at sea when the fish is not eating well and the rings are closer together. Find these rings and label them **first winter at sea**.

The fish then returns to freshwater to spawn. During this time it doesn't feed and the scales develop special marks or scars. They look like blank spots on the scale. Label these **spawning scars**.

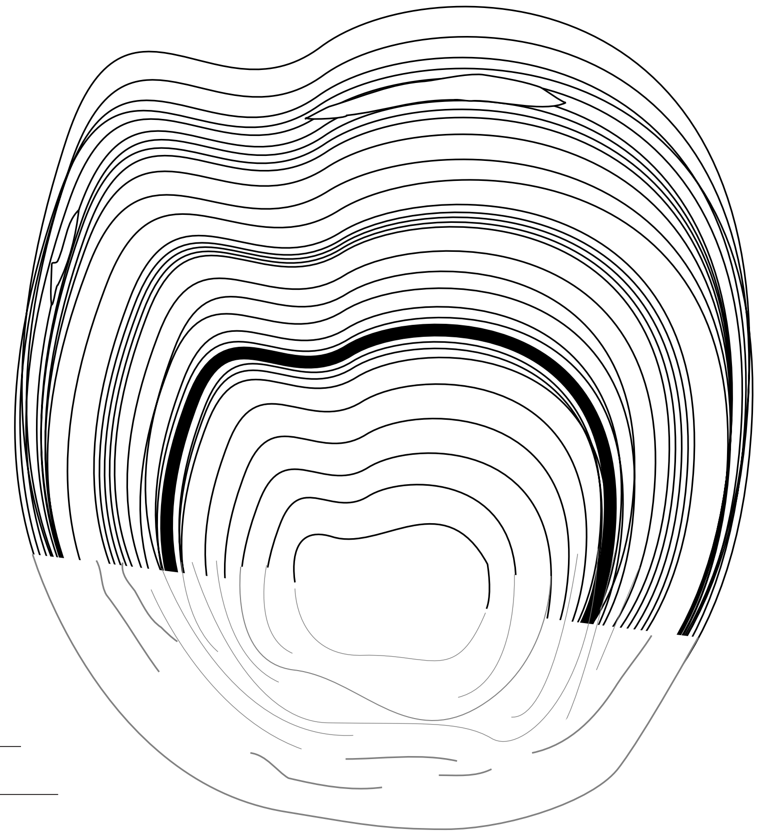
The fish spends the winter in freshwater and then returns to sea the next spring. After another summer and winter at sea, it comes back to freshwater to spawn again. Label **second summer at sea**, **second winter at sea**, and **second spawning scars**.

Every Scale Tells a Story • 2

Here's a scale from another fish.

Write a report about this fish. Tell how long it spent in freshwater before it went to sea, and how long it was at sea before it spawned. How many times has it spawned? What else does this scale tell you?

Title:



Growth and Development

In this activity, the students are given another opportunity to develop their graphing and interpretation skills. Your approach will depend on the students' previous experience using charts and graphs. If they've used graphs before, they could work individually or in small groups. Alternatively, this activity could be used as an introduction to graphing. In each of the writing tasks, it's important that the students support their comments with evidence from the charts and graphs.

The data in Figure I shows a serious decline in the fish population in the Adanac River since 1940. A line graph would be best to show this pattern. In their letter, the students should refer directly to the data and might conclude that action is needed to restore the fish population. They might suggest restocking with young fish, cleaning up pollution, or limiting fishing activity.

Figure 2 shows that the most common fish in 1990 were 16-25 cm in length. The Life Cycle Table shows us that these were probably smolts. Thirty-five of the fish captured that year were spawners, either grilse or adult salmon. (It may be necessary to review the salmon life cycle.)
In 1992, the fish in the 26–35 cm range were most common. These were probably grilse. The number of spawning fish that year was 100.

When comparing the two years, there are obvious patterns. The total population is increasing, from 200 in 1990 to 300 in 1992. In 1990, the greatest numbers were in the juvenile classes (parr and smolt). In 1992, the increase was reflected in the numbers of adult fish. The proportion of fish returning to breed (grilse and adult salmon) increased from 80 of 200 (2/5 or 40%) in 1990 to 200 of 300 (2/3 or 66.6%) in 1992.

The students' letters to the members of the Fishing Association should include reference to the trends they noted in the data, particularly the increase in the proportion of spawning fish. This is an indicator of recovery of the river's fish population. The students may notice that there has also been a decrease in the number of parr. There may be many reasons for this, including a drought or perhaps pollution. More data collected over the next few years is needed to determine the impact on the recovery of the river.

Background

The large number of eggs laid by female salmon (3,000 - 20,000) is the major means of insuring that enough fish will return to spawn each year for the species to survive. Assume a 4 kg female fish lays 7,500 eggs in the fall. Only 60% of these, or 4,500, hatch. From this point, the number of potential adult salmon is drastically reduced. Eels, trout and suckers eat the eggs as they are laid. These and other larger fish eat the fry and parr. Many birds of the Atlantic Coast, including loons, mergansers and kingfishers, feed almost exclusively on young salmon. Mammals such as mink and otter also take their toll. Even beavers affect young salmon by damming the streams and thereby raising water temperatures. Industries, factories and farms may also pollute the river or otherwise destroy young salmon. Dams can be obstacles for smolt leaving the river and adult salmon returning to spawn.

Of 4,500 alevin, only 50 survive to become smolts and migrate to sea. Even then, the loss does not stop. All types of fish - cod, pollock, tuna, for example, eat the smolts during their first weeks of life in the sea. Lampreys and disease also reduce their number. As the young salmon grow larger, humans capture them with nets and other mammals such as seals also eat them. Some salmon get lost at sea and never find their way to the spawning grounds. Of the 50 smolts that left the river, only four or five return. Of those that do return, additional hazards reduce the number of spawners to perhaps two. Anglers catch some of them. Low water, pollution and impassable dams or waterfalls prevent others from reaching the spawning grounds. An additional destructive factor are poachers who use spears, nets, even dynamite, to illegally kill many large salmon for financial gain.

Although a pair of spawning salmon will lay 3,000-20,000 eggs, on the average only two of their offspring survive to spawn. Some of the fish fail to find their rivers of birth; some cannot get up fish ladders; others are blocked by dams or suffocate in waters with not enough oxygen. None of these salmon survive to spawn, to maintain the species. The survival of the species now depends on people who must provide the salmon with water that is clean, rivers that are passable, and protected spawning areas.

Survival Rate for an Average Salmon Family

Eggs	7500
Alevin	4500
Fry	650
Parr	200
Smolts	50
Returning Adults	4
Adults Spawning	2

Growth and Development • 1

Since 1940, the number of fish in the Adanac River has been counted. To do this, a special cage is set for a period of two weeks at the same place on the river each year. The number and size of the fish passing through is recorded.

Use the information in **Figure 1** to draw a graph of the number of fish caught in the Adanac River from 1940 to 2000.

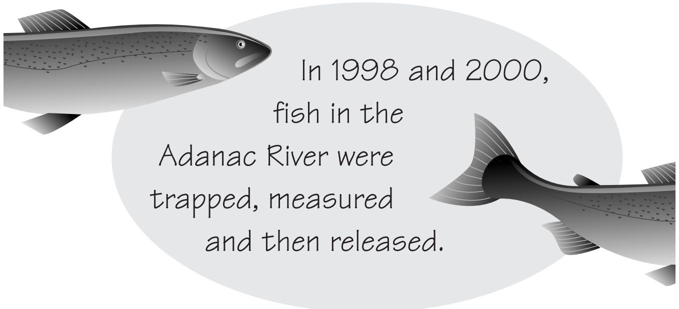
Figure 1 Number of Fish Caught in the Adanac River

Year	Number of Fish
1940	650
1950	575
1960	400
1970	225
1980	125
1990	100
2000	25

Draw your graph here:

Write a letter to the Adanac River Fishing Association. Should they be concerned about the number of fish in the river? What's your evidence? Should they take any action to help the fish population? What would you suggest?

Growth and Development • 2



In 1998 and 2000, fish in the Adanac River were trapped, measured and then released.

Life cycle stages

Stage	Average Length
Fry	5 - 8 cm
Parr	up to 12 cm
Smolt	12 - 24 cm
Grilse	up to 60 cm
Adult salmon	Varies

Figure 2 Number of fish caught in 1998

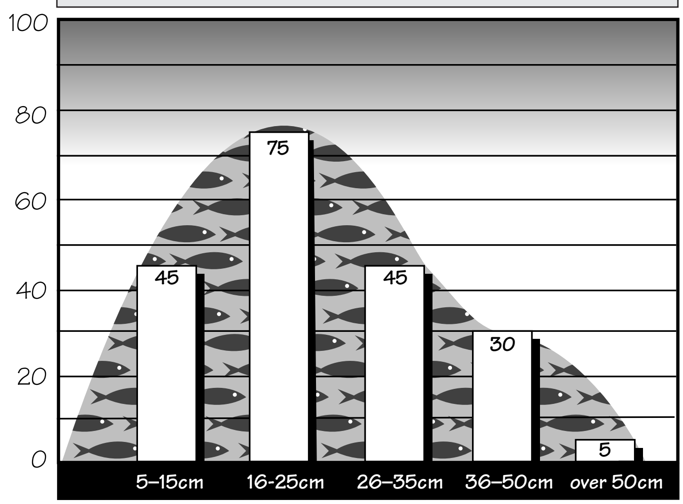
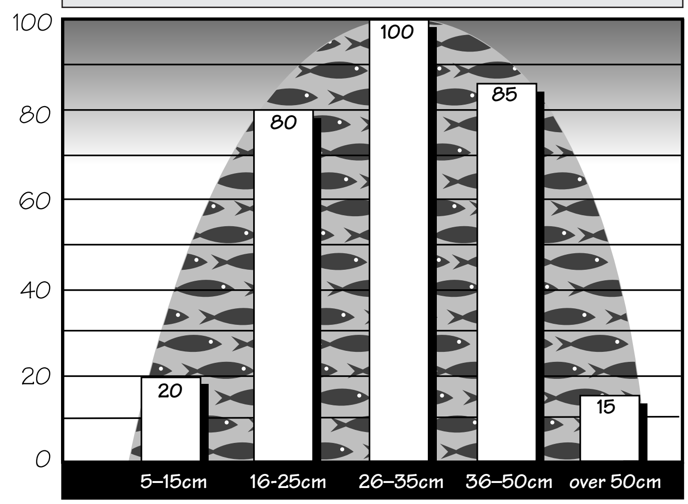


Figure 3 Number of fish caught in 2000



What size was most common in 1998?

____

At what stage of the life cycle were they?

____

How many returned to spawn that year?

____

What size was most common in 2000?

____

At what stage of the life cycle were they?

____

How many returned to spawn that year?

____

Compare the fish populations in 1998 and 2000. Is there a pattern?

____

____

What would you tell the Adanac River Fishing Association now? Are there signs that the fish population is recovering? What is your evidence?

Trout

Trout are found in many streams, rivers, lakes and ponds throughout Atlantic Canada. They prefer cool, well-oxygenated water, particularly when they are young. They inhabit lakes, rivers and streams that offer sufficient food and cover. Small streams provide a home for the largest number of young trout; good trout streams have overhanging cover and an alternation of pools and riffles (shallow sections of stream with swiftly flowing water). Adult and young brook trout are common in both streams and lakes.

While all trout can withstand relatively warm water for short periods of time, they are considered cold water fish. During the summer, water temperatures can increase and harm the trout. The fish will seek refuge in spring-fed waters, deeper pools or areas which are shaded by bank vegetation. The preferred water temperature for lake trout is 10°C. Brook and rainbow trout prefer temperatures between 10°C and 18°C while brown trout live in water ranging from 18°C to 24°C.

Trout are known for their vibrant colours. They have small scales, which can be almost invisible to the naked eye. Fish within the same species may look considerably different due to their age, the type of food they eat and the type of habitat in which they live (salt or fresh-water). Fish also look different at spawning (mating) time. There are four species of trout in Atlantic Canada. They differ from one another in their appearance and preferences for lake or stream habitats. All species of trout may be found in lakes or ponds at some time of the year. Lake trout live only in deep-water lakes that remain cool through the summer. Adult rainbow trout are generally restricted to lakes. Young rainbow trout are found in streams flowing into lakes during the summer.

Brook, rainbow and brown trout are able to live in saltwater. When these trout move between fresh and saltwater, they are called anadromous. Trout move between fresh and salt water in the spring and fall when temperatures are between 0°C and 14°C. Temperature and currents provide the stimulus for migration from the stream to the estuary.

All trout are carnivorous (flesh-eating) and will eat virtually any animal small enough for them to swallow. Their most common foods are aquatic and terrestrial insects, but older (and larger) trout may eat leeches, small fish (including trout), frogs, snakes, and salamanders. Trout at sea eat fish, shrimp and other invertebrates.

Most trout spawn in gravel that has water flowing through it. This water provides oxygen that is needed to keep the eggs from suffocating during the relatively long period of time they remain in the gravel. Trout generally spawn at the downstream end of a pool where the water is forced to flow through the gravel. Sometimes they spawn where springs flow through gravel.

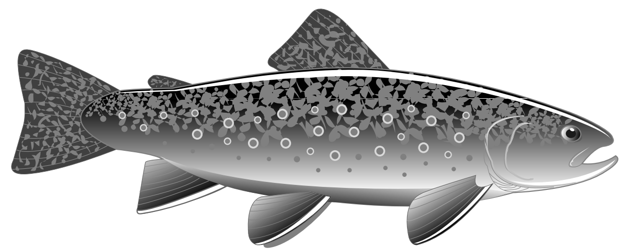
Spawning is similar in all trout. Male trout take on a breeding colouration and a hooked lower jaw, while the females may retain a more subdued appearance. Spawning sites suitable for trout vary according to the different species and the size of the fish.

Brook and brown trout usually spawn in late October or November. Fish are usually two years of age or older before they spawn. The eggs remain in the gravel over the winter, developing slowly in the flow of cold, oxygen-rich water. They usually hatch in April, releasing the new-born alevins into the gravel. The number of eggs deposited depends on the female's size, but an average 25 centimetre brook trout would lay about 500 eggs.

Unlike the other trout, rainbow trout spawn in the spring. During April or May, adults migrate upstream to rapidly flowing water where a redd is dug in gravel. The eggs hatch in about six weeks and fry are usually seen emerging from the nests from mid-June to mid-August.

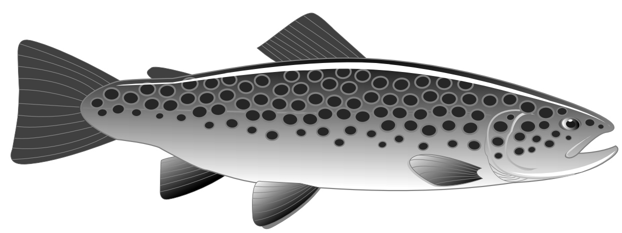
Lake trout spawn only in lakes. They do not dig nests as do the other trout. Instead, the male and female brush the rocks with their bodies or tails, or rub them with their heads. The fertilized eggs fall into small spaces between the rocks. Spawning occurs in October and takes place over large boulders or on a rocky bottom at a depth of less than 12 metres.

The eggs hatch in March or April. The alevins remain hidden in the rocks until their yolk sac is absorbed and then they move into deeper, cooler water.



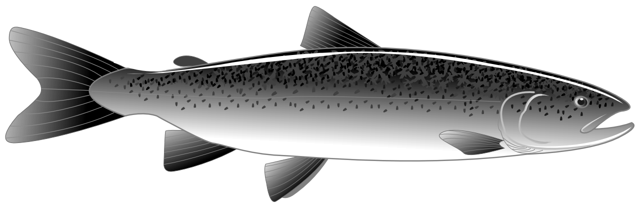
Brook (or Speckled) Trout are very common. Called **Mud Trout** in Newfoundland, they usually weigh less than one-half kilogram (one pound), but weights of over one kilogram are not uncommon.

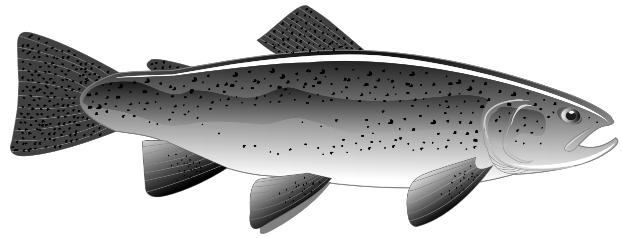
The back and sides of brook trout are greenish to dark brown or almost black. Dark worm-like markings are present on the head and back and extend onto the dorsal and tail fins. There are small but distinct red spots surrounded by light brown or bluish halos. The lower fins have a milky-white leading edge, followed by a black line and then, a reddish coloration. During spawning season, the lower body of the male brook trout becomes a vibrant orange-red. Sea-run brook trout are silver in colour.



Brown Trout are larger than the brook or rainbow trout. They average about three kilograms in weight but some weighing up to six kilograms have been caught.

The brown trout gets its name from its colouration: brown to golden brown on the back, lighter on the side and yellowish white on the belly. There are large black spots with light borders on the back of the fish, including the top fins, and on the upper sides. The tail fin has few or no black spots, a characteristic which easily distinguishes it from the rainbow trout. Large red or orange spots with pale margins may be interspersed with the black spots. The brown trout can be distinguished from the brook trout by the presence of dark spots, rather than light ones, on the sides and by the absence of worm-like streaks on the back. Male brown trout may become brightly coloured with reddish sides at mating time. Sea-run browns are silvery and are difficult to distinguish from the Atlantic salmon.





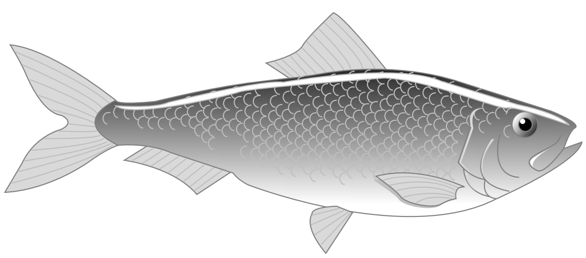
Lake Trout are the largest fish in the trout family. In Atlantic Canada, lake trout are found in deep lakes in northern New Brunswick, Labrador but rarely in Nova Scotia. The world's largest lake trout on record weighed 46 kilograms. However, the average lake trout weights less than two kilograms.

The lake trout varies in colour from grey to green to almost black on the back and sides. The body lacks brightly coloured spots but there are numerous light spots on the head, body and tail, as well as on the dorsal and tail fins. This species can be easily distinguished from other trout by its deeply forked tail fin.

Rainbow trout are more frequently caught in lakes than streams. Most rainbow trout tend to be larger than brook trout with the average size being one to three kilograms.

The rainbow trout gets its name from the broad reddish-purple band that extends from behind the eye to the tail fin in older fish. The back is green, becoming silvery-green on the sides and white on the belly. There are numerous small black spots on top of the head and along the back, including the top and tail fins. The spots on the tail fin are arranged in line with each fin ray. These spots are smaller and gradually fade on the lower sides of the fish. During spawning season, the coloration of the rainbow trout is less pronounced than in brook trout. Sea-run or Steelhead rainbows are silver-coloured.

Gaspereau



Gaspereau is only one of many common names used to refer to two species of fish in the herring family. Common only in Nova Scotia and New Brunswick, they may be called river herring, alewives, greybacks, bluebacks, kiacks or even sawbellies. They are also called “Sunday fish” because it takes all day Sunday to remove the bones from one of them. Although this is an obvious exaggeration, they are bony. This accounts for the fact that few are eaten by Maritimers.

Both species spawn in fresh water in early spring. The alewife tends to travel long distances upriver to spawn in quiet waters. The blueback usually arrives several weeks later and is more likely to stop at a minor obstruction to spawn in fast water. Eggs adhere to the rocky bottom and have been seen covering many square metres to a depth of several centimetres.

Hatching within a few days, the young fish may remain in fresh water until late summer or fall, then migrate to the ocean where they spend two or more years before returning to spawn. Many also survive to return and spawn in subsequent years.

Although there may be a few early arrivals, gaspereau often enter rivers in May and June. Large numbers can be seen moving upriver in schools.

Bass

The smallmouth bass is almost legendary in its attraction for anglers and for its sporting quality. Along with its cousin, the largemouth, it occupies top spot as North America's favourite gamefish.

The smallmouth bass is actually a member of the sunfish family. It is generally dark-brown with narrow vertical bands, a white belly, and spines in the front of the dorsal fin. Fanning out from the snout to the rear of the gill cover are three more or less distinct dark stripes. The eye is usually red. Their nearest relative are white and yellow perch.

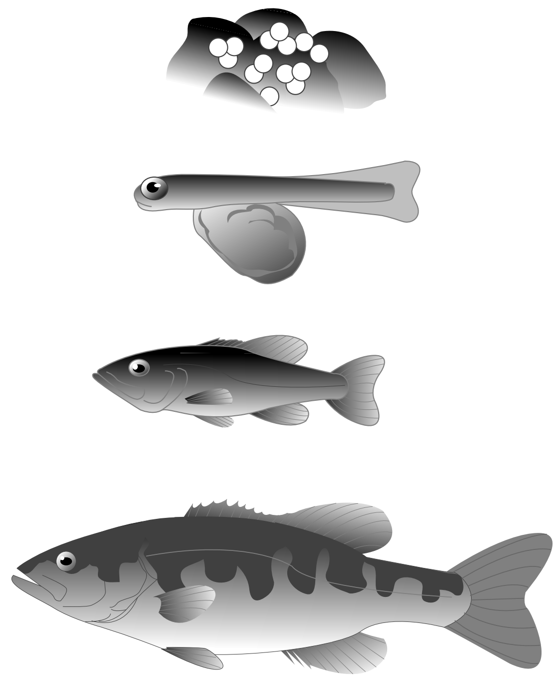
Smallmouth bass prefer large, fairly deep lakes with rocky shores and gravelly shoals. Dragonfly larvae, small fish and aquatic beetles were the most important food items. The slower growth rates in Nova Scotia bass may partly reflect an absence of crayfish, which in much of the smallmouth's range are a preferred food.

They can tolerate slightly higher temperatures than can brook trout, which gives them a distinct advantage during the warmer part of the growing season. Although the two species can survive in the same lake, brook trout populations are likely to be much smaller and in some cases may disappear altogether.

Smallmouth bass, like all living things, go through changes as part of their life cycle. Spawning generally begins in late May or early June when water temperature reaches 16-18°C. The male prepares a nest on a sandy, gravel or rocky bottom by brushing the area clean with his tail, sometimes even pushing out larger gravel with his nose. The final nest may be between .3 m and 1.8m in diameter. The male defends the nest from other males as he attracts a series of females into the nest to spawn. Depending on size, the females usually produce 5,000 to 14,000 eggs. After spawning, the female leaves while the male stays and fans the nest with his fins, guarding it against predators.

When they are laid, the eggs are grayish-white to pale yellow and range in diameter from 1.2 mm to 2.5 mm. They are very sticky and adhere to each other and to the stones on the bottom. As the embryo develops, the eggs lose their stickiness and drop between the fine gravel. Depending on the water temperature, the eggs hatch four to tend days later.

When the fry are born, they are about 5.8 mm in length and are nearly transparent. They remain in crevices in the nest for the next 10 to 12 days until their yolk sac is absorbed. As they grow and begin to feed, they rise off the bottom to hang in a dense cloud above the nest. At this stage, they fry are about 12.5 mm, and except for the gold iris of the eye, they are solid black in colour. They then change from black to green and move further and further from the safely of the nest until they finally disperse. The male may stay with the young for a month or more until they leave the nest for good.



Similar in shape to the adult, the young fish is distinguished by a tri-coloured tail which is edged in white, has a black band in the middle and is orange closest to the body. They prefer to stay in quiet areas with lots of cover while feeding on plankton. As they continue to grow, they feed on larger prey such as aquatic insects, amphibians and other fish.

At the end of two years, the Smallmouth bass will reach a length of about 12.7 cm. They will mature when they are three to six years of age, at about 17 to 28 cm. They tend to live longer in the northern waters of New Brunswick and Nova Scotia than they do in the warmer waters of the southern United States, some reaching in excess of 15 years of age.

Exotic species

Rainbow trout, Brown trout, and **Smallmouth bass** are all exotic species in Atlantic Canada, Maine and Quebec. This means they were introduced from another part of the world, and have succeeded in surviving in the new locations. Exotic species can compete for habitat and food with naturally occuring species, and in some instances will displace them entirely.

Rainbow trout and its ocean form **Steelhead** originated on the Pacific coast of North America. **Brown Trout** were introduced from Great Britain and western Europe. **Smallmouth bass** originated in the Great Lakes, Ohio River and elsewhere in central North America.

Lesson 6

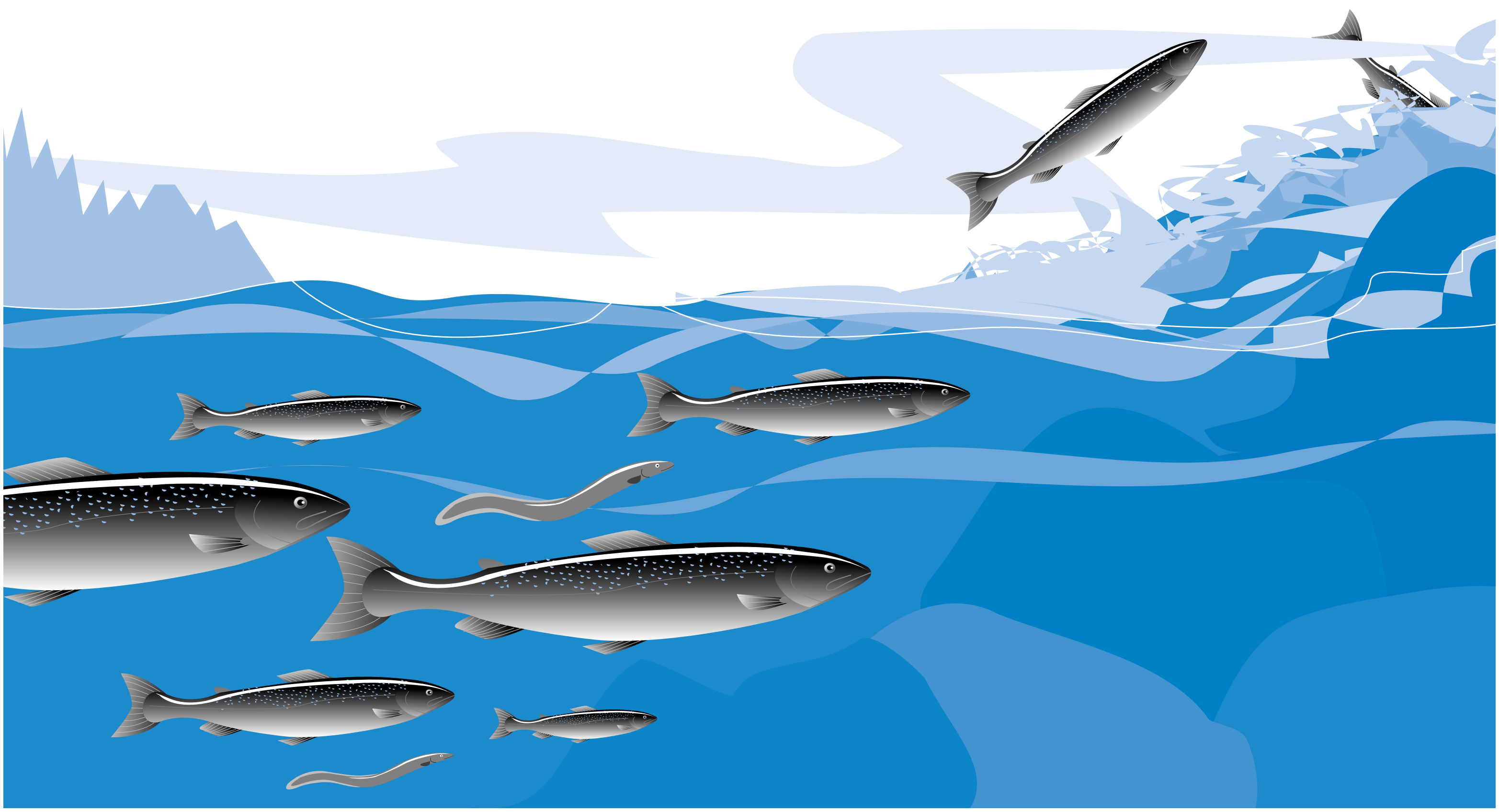
Migration

Main Idea

Another type of change occurs when fish migrate from one habitat to another. Migration may be stimulated by a change in climate or season, or by life cycle changes. Therefore, in order to survive, migrating species must be able to meet their basic life needs in more than one habitat.

Objectives

Through a combination of a guided imagery activity and a mapping activity, students will trace the migration of a fish from its home river to the ocean and back to the river. They will also learn how the sense of smell is used by fish to locate their home river on the return trip.



A Long Way Home

This is a guided imagery activity in which you read a story to the students. They will learn about migration by visualizing the experience through the eyes of a fish. Few people today migrate in the same way as our hunter/gatherer ancestors did many years ago, or as other animal species do today. Therefore, it's difficult for us to experience a true migration.

In some cases, guided imagery serves simply to provide a visual review of some of the students' past experiences. At other times, you are providing stimuli for the students to create original images.

Using Guided Imagery

1. Ask the students to lay aside all pens, pencils, books, etc.
2. Instruct the students to sit in a comfortable and relaxed position with their eyes closed.
3. Wait until you see a general state of relaxation before beginning.
4. Read the story aloud. Remember to speak slowly and steadily. If you want students to create rich mental images, you must allow them time to do so. It takes about as much time to observe mental images as it does to carefully review actual physical settings.
5. Once the story is finished, ask the students to review the images they saw in their minds. Allow one or two minutes for an adequate visual review. Remember, the review takes time.
6. Ask them to open their eyes.

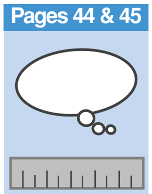
Have the students describe the images they visualized. What did they learn? What were their favourite parts of the story?

It is important to realize that there are no mistakes in mental images. If students create images that are inconsistent with what you expected, consider the images to represent different perspectives rather than wrong answers.

To complete the activity, have the students compare the different habitats that the fish lives in. How are they alike? How are they different? Are there different foods? Different predators?

They could also illustrate some of the scenes from the story, or write a poem, a song or perhaps a play about the fish's journey.

Pages 44 & 45



Long Distance Swimmers

In this activity, students follow the migration routes of the Atlantic Salmon and American Eel. A description of each migration is provided along with a map. You could also include the migration of American Shad. Background information about all three species is at the end of the lesson.

The students first indicate on the map where they live. They could also label the four Atlantic provinces and other relevant locations.

Using the descriptions of each species, students draw the migration routes on the map. Precision is not critical. It's more important for students to realize the magnitude of the migrations.

When they have finished drawing the routes, have them compare the migrations. The eel lives in freshwater, travels to sea to spawn and then dies. Salmon and shad spawn in freshwater, travel to sea and then return to spawn in freshwater.

A Long Way Home

You have just hatched from an egg as a tiny fish with a bit of yolk attached to your belly for food. Your new home is the cool, clear water at the top of a rocky riverbed. There are hundreds of other young fish swimming all around you.

In a few weeks, the yolk is used up and you begin to eat microscopic plants and animals. Your first summer passes, then fall, winter and spring as you grow larger and larger. Now you are eating other fish that are smaller than you. One day you swim past an old log and you see the sinister outline of a fish lurking in the shadows. Quickly, a large trout shoots out to eat you. You swim as hard as you can. Your heart is racing. There is a small crevice in the gravel up ahead and you dart in to safety just as the trout's jaws snap at you from behind. Whew! That was close.

Soon it is your second summer and you are a beautiful, two-year-old fish. Now you feel an overwhelming urge to swim downstream. The river grows deeper, warmer and less shaded as you swim. Wheee! It is really fun! Then you hear a whirring sound and see a great cement dam across the river with a shoot for water to pass through. At first you hesitate and swim from side-to-side looking for another way down, but there is none. So you drop into the dark hole and are soon spun around wildly by the metal blades of a turbine. Then you shoot into the river below the dam. Since you are small you survive with only a minor cut, but you see other young salmon who are hurt badly in the water around you.

Finally, you reach the salty sea and swim for several months and thousands of miles, all the way to Greenland. Your new home is a vast, blue-green sea where you swim with many other fish in a great school. Here, where there are plenty of small ocean fish to eat, you live and grow for another two years. Once, when you are about three years old, a great net is dragged up from behind you and you are just able to outswim it to keep from getting caught. But many of your friends are carried away and never seen again. Another time you narrowly escape the sharp teeth of a seal.

In time, your fourth summer arrives and the urge to go home to the stream where you were born drives you to begin a great journey. When you reach the shore, you swim for a time before you smell the waters of your home river and head upstream. Someone is fishing from shore but you swim right by the hook. In fact, you haven't eaten since you began your great journey. You are tired, but you keep going anyway.

Up ahead, there is the high cement wall of a large dam. After exploring for a time, you find a strong current leading up many small falls into little pools along the side of the dam. Up, rest... Up, rest... Up, rest you go until you reach the top.

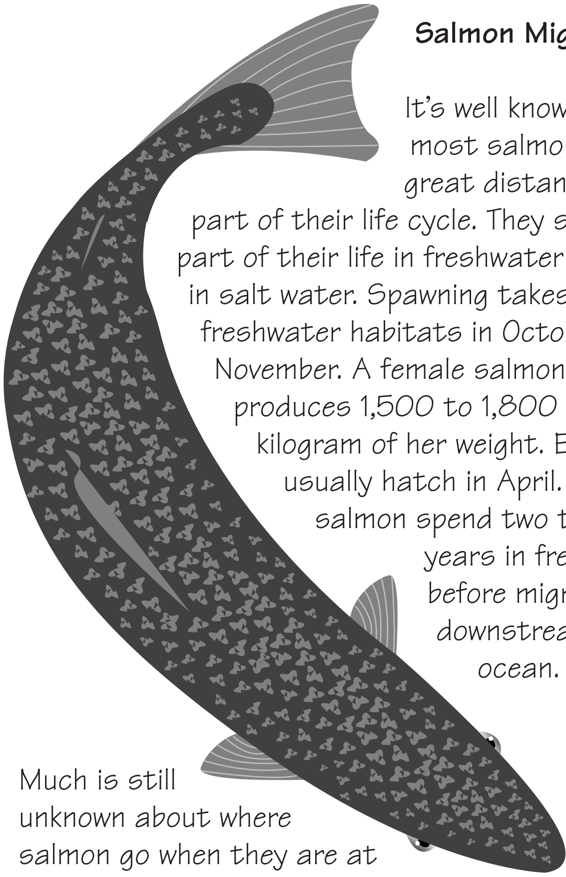
Look! A great waterfall. How will you ever get up? You back up and swim very fast, then leap as high as you can. Now you're in the air! Through the cool mist of the falls you see the sunlight, green leaves and a small rainbow. It is beautiful. Plop! You land above the falls and push on.

You are tired, but you push on. You still haven't eaten anything. There is a fork up ahead and the smell of the river water entering from the left tells you it is the way home. Very sluggishly you reach the place where you were born. Now you can recognize some of the large rocks in the riverbed. You summon all of your last strength to force a great mass of eggs from your body. There are hundreds of salmon all around you laying eggs and squirting milky sperm into the water. You feel light and relieved.

You rest for a while and then start the long journey back to the sea. Next summer you may return to your home river once again.

Long Distance Swimmers

Salmon Migration



It's well known that most salmon travel great distances as part of their life cycle. They spend part of their life in freshwater and part in salt water. Spawning takes place in freshwater habitats in October and November. A female salmon produces 1,500 to 1,800 eggs per kilogram of her weight. Eggs usually hatch in April. Young salmon spend two to four years in freshwater before migrating downstream to the ocean.

Much is still unknown about where salmon go when they are at sea.
It appears that some Atlantic salmon do not travel far beyond their home rivers. Other salmon travel long distances, many to the west coast of Greenland where there is lots of food.

Some salmon return to freshwater after only one year at sea. Others return after two years. They normally enter the rivers between May and October, although sometimes it's as early as March or April. They return to the same river where they were born. Sometimes pollution makes it difficult for the salmon to find the smell of their home river. Once they reach their preferred area, they spawn, continuing the life cycle.

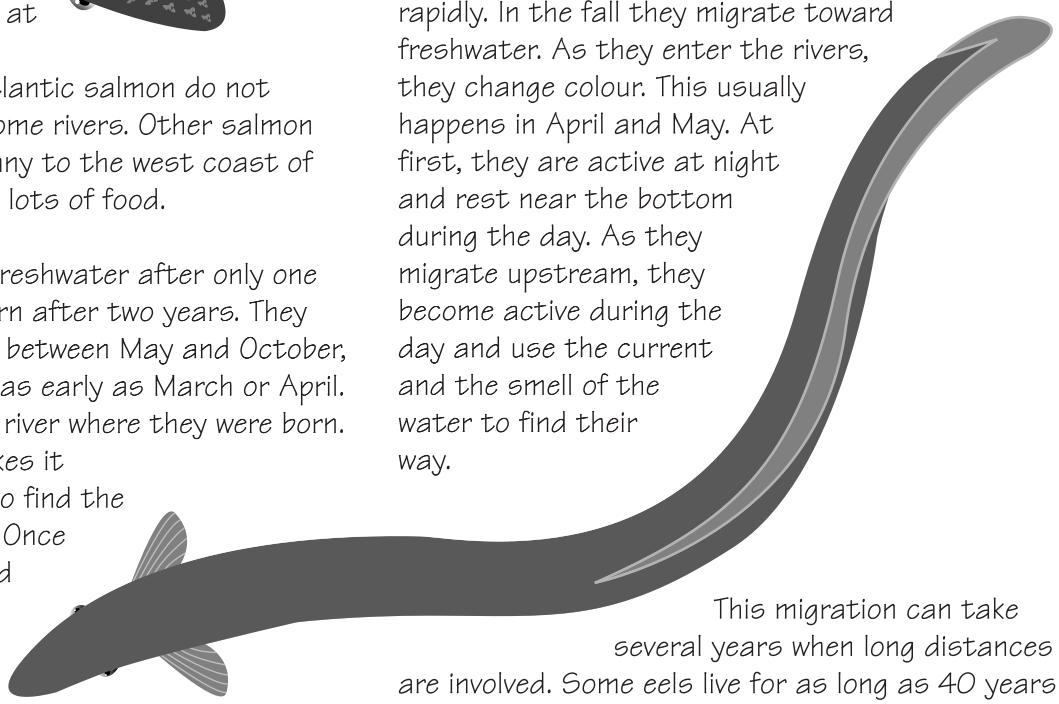
The Atlantic salmon normally survives at least one spawning. After living at sea for another year, some will return to freshwater to spawn at least one more time. Others may spawn three or four times.

Eel Migration

The eel that is commonly found in our region of Canada is called the American eel. It has a long snake-shaped body which is covered with a slippery substance called mucus. This is where the expression "slippery as an eel" comes from. Eels are found in freshwater streams and rivers. They are also found in the Atlantic Ocean. They are very common in the four Atlantic provinces.

Unlike salmon, eels spend most of their lives in freshwater and then go to the sea to spawn. They begin to migrate in late summer and fall. They travel all the way to spawn in the Sargasso Sea, between Bermuda and The Bahamas. Spawning occurs from February to April and the eggs hatch within a few days. Female eels can produce up to 4.0 million eggs. It is thought that all eels die after spawning.

The young eels are clear in colour and grow rapidly. In the fall they migrate toward freshwater. As they enter the rivers, they change colour. This usually happens in April and May. At first, they are active at night and rest near the bottom during the day. As they migrate upstream, they become active during the day and use the current and the smell of the water to find their way.



This migration can take several years when long distances are involved. Some eels live for as long as 40 years in freshwater before they migrate back to the sea to spawn.

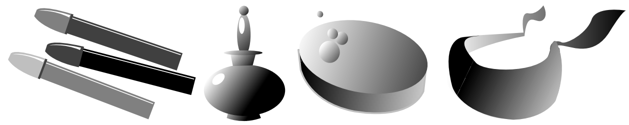
Long Distance Swimmers

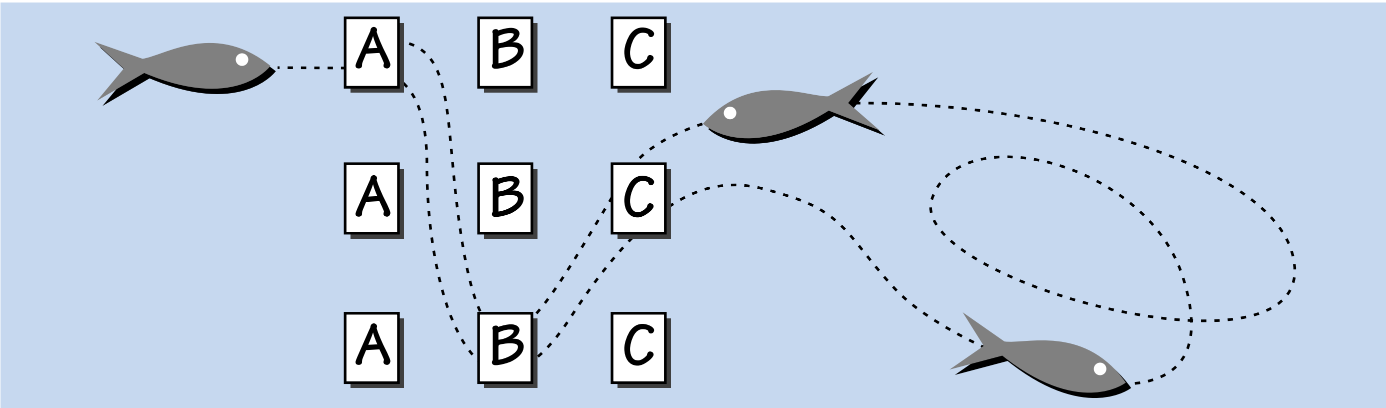
Locate where you live and mark it on the map.

Read about the migration of the salmon. Draw the route a salmon takes when it migrates from freshwater to sea and back to freshwater. How many kilometres does it travel in a complete migration?

Repeat for the migration of the eel.

Smell Your Way Home





Based on smell, fish identify the river in which they hatched and are able to return there to spawn. Using readily available substances, students will use their sense of smell to imitate how a fish finds its way during migration.

On the student activity page, there are nine fictitious rivers: three that begin with A, three with B, and three with C. You could modify this to use only six rivers (two A's, two B's and two C's). You could also use the names of local rivers.

You will need a different smell for each of the rivers. Some possible sources are perfumes, artificial flavourings, soaps, smelly markers, spices, food items (ketchup, vinegar...). CHECK FOR ALLERGIES.

For each group, cut out a set of rivers from the activity page, and put a small amount of one of the smells on each river. They can be the same for each group or can vary from group to group. Each group will also need a blindfold.

The activity is designed to give all students the opportunity to be a 'fish' and works best in groups of 3 – 5. (An alternative is for one or two students to be 'fish' and the others to be the rivers, holding the smells. The drawback of this is that only a few students are using their sense of smell, which is the purpose of the activity; the others are only observers.)

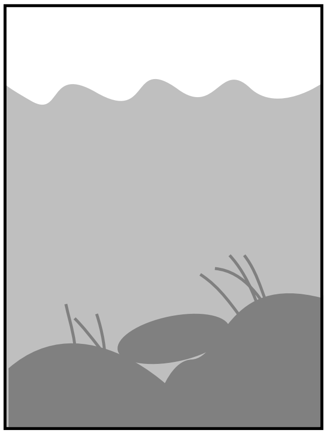
Directions for the Students

- Each group will receive a set of rivers which have different smells. Each student in the group will have a turn at being a fish. The fish will wear a blindfold.
- After the fish has been blindfolded, the other students in the group select a migration route. First select one of the A rivers. This is the home river, where the fish hatched. The fish smells River A. Now select one of the B rivers and have the fish smell it. Repeat this with River C, which is the last river the fish smells before going to sea. (One of the students should write down the correct sequence of rivers.)
- The blindfolded fish then goes to sea, or at least for a short guided walk around the classroom.
- When ready to return to its home river, the fish is presented with the smells of all three C rivers. Only one is the correct one. When the correct river is identified, the fish then smells the B rivers. Again, only one has the correct smell. Finally, the fish smells the A rivers, one of which is the home river with the correct smell.
- When the fish has arrived home, the blindfold is removed and another student becomes the fish.

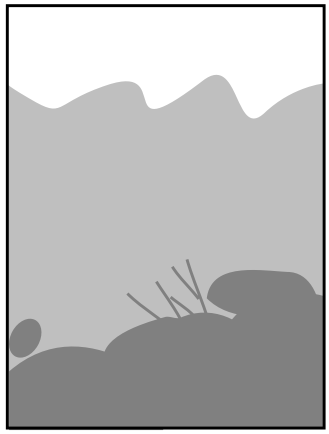
Complete the activity by having a class discussion on the question:

- **What are some problems that would make it difficult for fish to smell their way home?**

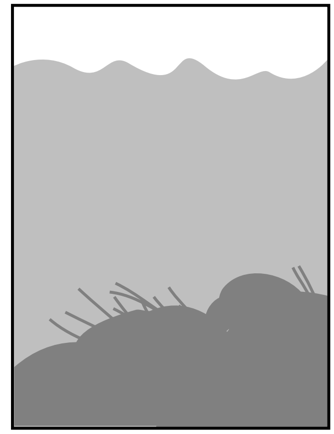
Smell Your Way Home



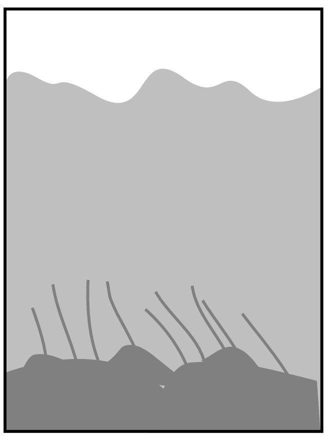
Apple River



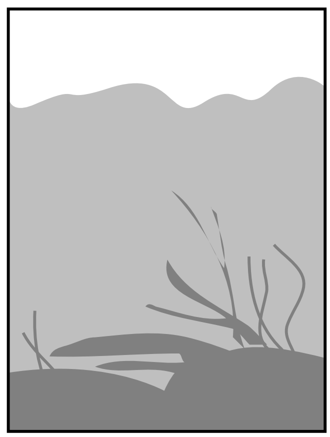
Alpine River



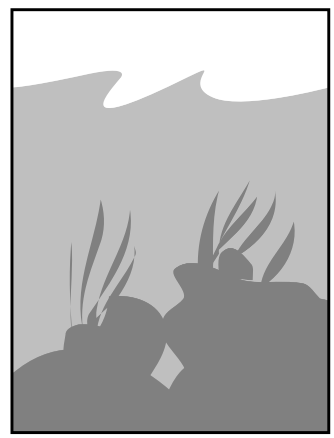
Arrow River



Brown River



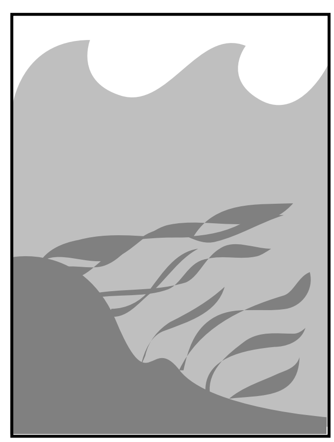
Babbling River



Buttercup River

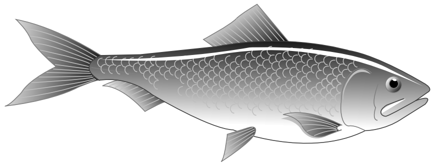
Crooked River

Crazy River



Country River

American Shad



Shad are members of the herring family like the alewife (gaspereau). They are anadromous which means they move from saltwater to freshwater to spawn and can migrate up to 3,000 km in one season. Much of their migration and behaviour is determined by water temperature and currents.

When water temperature reaches 12°C in spring, schools of shad use their sense of smell and begin to migrate up coastal rivers and tributaries. In the Maritime provinces, spawning usually occurs in June or July when the water temperature is 13–20°C. A female shad can produce from 60,000 to 600,000 eggs, although in Canadian rivers they usually produce about 130,000 eggs.

Young shad spend their first summer in the river feeding on insects and small crustaceans. During the day, they remain near the bottom, as deep as 3.7–4.9 m, and come to the surface to feed at night.

When fall arrives, they will have reached a length of 7.5 to 12.5 cm. As the river temperatures begin to drop, the schools of shad migrate to the sea. Immature and spawned-out shad remain off-shore in areas like the Bay of Fundy until winter when they move further out to sea, eventually finding areas that have their preferred temperature. At sea, they eat zooplankton (tiny invertebrates that live in water), small bottom crustaceans and, occasionally, small fish. Many of the shad in Nova Scotia and New Brunswick and all those from the eastern United States rivers spend some time in the Bay of Fundy.

Shad can live as long as 13 years, reaching maturity at four or five years of age. When they mature, they return to spawn in the same rivers in which they were born, and continue the life cycle. Many shad in the Maritimes spawn year after year. Southern populations of shad, however, die after spawning, just like Pacific Coast Salmon.

American Eel

The American eel has a long snake-shaped body. It has no pelvic fins and the dorsal, tail and anal fins are continuous. The body is covered with mucus, hence the expression "slippery as an eel". Their colour changes with different life stages. Young eels approaching the ocean shore are transparent with a black eye and are known as "glass eels". As they adapt to fresh water, they become grayish-green and are called "elvers". Adult freshwater eels can vary in colour from yellowish to greenish to olive-brown, being darker on the back and lighter on the belly. They are commonly called "yellow eels". Sexually mature eels darken to a bronze-black hue on the back and are silvery underneath. They are known as "silver eels", "bronze eels" or "black eels".

American eels are found in freshwater streams and rivers, brackish coastal waters and the Atlantic ocean of eastern North America from southern Greenland and Labrador to the Gulf of Mexico and northern South America. It is the only member of the freshwater eel family found in North America and is abundant in the four Atlantic provinces.

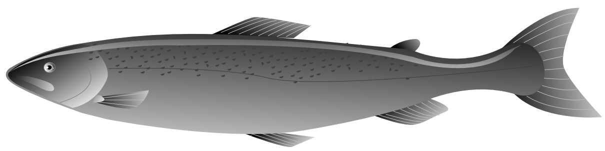
The American eel undertakes long oceanic migrations to reproduce. Unlike the more familiar anadromous Atlantic salmon, eels are catadromous; that is, they spend most of their lives in freshwater lakes and streams but return to the sea to spawn. No one has ever seen American eels spawn, but spawning is believed to occur in the Sargasso Sea, near the Bahamas, from February through April. Hatching probably occurs within a few days. The tiny transparent eel larvae, only a few millimetres long, drift with ocean currents to the coastal areas of North America. They grown rapidly until the fall when, between 8 - 12 months of age and at a size of 55 - 65 mm, the larvae transform into glass eels. At this stage, eels actively migrate toward freshwater. As they enter brackish and freshwater, they begin to develop pigment and are known as elvers. Elvers and glass eels reach eastern Canadian coasts in April and May. At first, the elvers are active at night and rest near the bottom during the day. They may stay in the estuaries for some time, moving up and downstream with the tide as they physiologically prepare to live in freshwater. When elvers begin to migrate upstream, they become active during the day and are thought to use the current and the odour of brook water to find their way. This upstream migration can take several years when long distances (sometimes more than 1000 km) are involved. Elvers eat aquatic insects, small crustaceans and fish parts. After a year in freshwater, elvers are about 127 mm long. Following the elver stage, eels enter a growth stage lasting many years in which they are known as yellow eels. Some eels do not migrate upstream as elvers but remain instead to live in estuaries. Yellow eels are most active at night and spend the day concealed in vegetation or burrowed in the bottom. Their diet includes most other animals in their habitat such as insect larvae, fish, crabs, worms, clams and frogs. They also feed on carrion and are able to tear pieces off food items too large to be swallowed whole. Adult eels are eaten by larger fishes such as sharks, haddock and swordfish as well as by gulls and bald eagles.

In late summer and fall, American eels in eastern Canada begin their spawning migration to the Sargasso Sea. During this time, they undergo a transformation to the “silver eel” stage and become sexually mature. Males can mature at age 3 but females mature later, usually at ages 4 to 7. However, eels can spend up to 40 years in fresh water. Female eels produce from 0.5 to 4.0 million eggs and it is thought that all eels die after spawning.

Eels do not become definitely male or female until they are 20 - 25 cm long! What sex an eel becomes is thought to be partly determined by environmental conditions such as crowding and food abundance.

In areas such as the southern U. S., where food abundance and water temperatures favour rapid growth rates, eel populations have a higher percentage of males. In cooler areas, such as the Atlantic provinces, eels grow more slowly but reach an overall larger size before they are sexually mature. These populations produce more females (an advantage since larger females produce more eggs and thus could contribute more offspring to the next generation).

Atlantic Salmon



The Atlantic salmon has been referred to as the classic anadromous fish which means it migrates from the sea into the rivers to spawn. In Canada, spawning runs of Atlantic salmon normally enter the rivers between May and November, although some runs begin as early as March or April. Salmon generally enter the river when the water is high. While some salmon may spawn within a mile of the sea, others travel several hundred miles before reaching their preferred spawning place. The salmon faces many natural hazards including shallow water, strong currents, waterfalls, beaver dams and rapids. After entering the river, salmon stop feeding. They often lose their lustre and become very thin.

Although adult fish enter rivers from early spring to late fall, actual spawning usually occurs in October and November. As the male salmon approaches sexual maturity prior to spawning, a marked change in its external appearance becomes evident. Its head becomes elongated and its lower jaw is enlarged and forms a pronounced hook at its tip.

The spawning site is normally a clean, well-aerated area with a gravel bottom. Still water and stream bottoms of mud, silt or sand are avoided, since water circulation may be inadequate and eggs can easily become smothered. Egg production varies directly with fish size, averaging 1,500 to 1,800 eggs per kilogram of female weight.

Although the adults of other salmon species, such as the Pacific Salmon, die shortly after spawning, the Atlantic salmon normally survives at least one spawning. They are then known as kelts, slinks or black salmon. These fish return to the sea, some immediately after spawning, and others the following spring. By this time, they have been in fresh water without feeding from a few months to almost one year. After reconditioning at sea, some will return to freshwater to spawn at least one more time. Others may spawn three or four times in subsequent seasons.

Under the cold (but not freezing) temperature conditions found in natural redds, eggs incubate over the winter months in the stream beds and usually hatch in April. Newly hatched salmon (alevins) remain buried in the gravel for the first few weeks. When they emerge from the gravel in late May, they are free-swimming fry and begin active feeding. They prefer an area where the water flow is rapid and the bottom gravely or stony. They soon develop into young parr which feed principally on the larvae of aquatic insects. As they become older, they also consume larger larvae and insects which fall into the water. In turn, they are preyed upon by fish-eating birds such as mergansers and kingfishers and predacious fish such as eels and trout. About 99 percent of salmon in their mobile, freshwater stages do not survive.

Parr usually spend from two to three years in freshwater before reaching the smolt stage and migrating downstream to the sea.

Much is still to be learned of marine feeding areas and migration routes. It appears that certain salmon from New Brunswick rivers may not venture beyond the waters of the Bay of Fundy. Others travel long distances in search of food, many to the coastal waters of West Greenland. It is only recently that scientists have gained detailed knowledge of the food of salmon in the sea. It has been found that smolt and larger salmon are voracious eaters and will feed on anything they find within their range. Herring, capelin, gaspereau, small mackerel, smelt, and shrimp, squid and amphipods are taken when the opportunity arises.

Salmon are strong swimmers and, because they are relatively large, are able to withstand predation better than some other fish. Their chief predators are larger fish such as tuna, sharks, swordfish and even cod and pollock. Seals are known to take salmon from nets.

For many centuries, not much was known about the salmon’s life at sea. Now, however, we have learned a great deal about the sea-life phase and migration routes of the Atlantic salmon. In the sea, salmon eat crustaceans such as shrimp, and smaller fish such as herring and capelin. These foods are found in abundance in the seas off the southwest coast of Greenland and that is the area where many salmon go. The great quantity of food in the sea causes tremendous growth.

Salmon are known to wander extensively at sea, but after one or more years at sea, the surviving salmon return to spawn in the river in which they were born. Some instances of recapture of tagged fish in other than their home streams are exceptions to this rule. Pollution in rivers and estuaries sometimes conceals the sensitive identification of home-stream water, thus preventing the salmon from going upstream to spawn. Damming of rivers has affected the reproductive cycle by barring salmon from some spawning reaches and by flooding spawning and rearing areas.

Some salmon return after only one year at sea (grilse) and usually weight about three or four pounds. Others return after two, three or even four years as large salmon, generally weighing from eight to forty pounds. Some rivers contain mostly grilse; others mostly large salmon; still others contain a mixture of fish which have stayed one, two or three years at sea. The salmon then spawn, completing another generation and continuing the perpetual life cycle.

Lesson 7

Adaptation

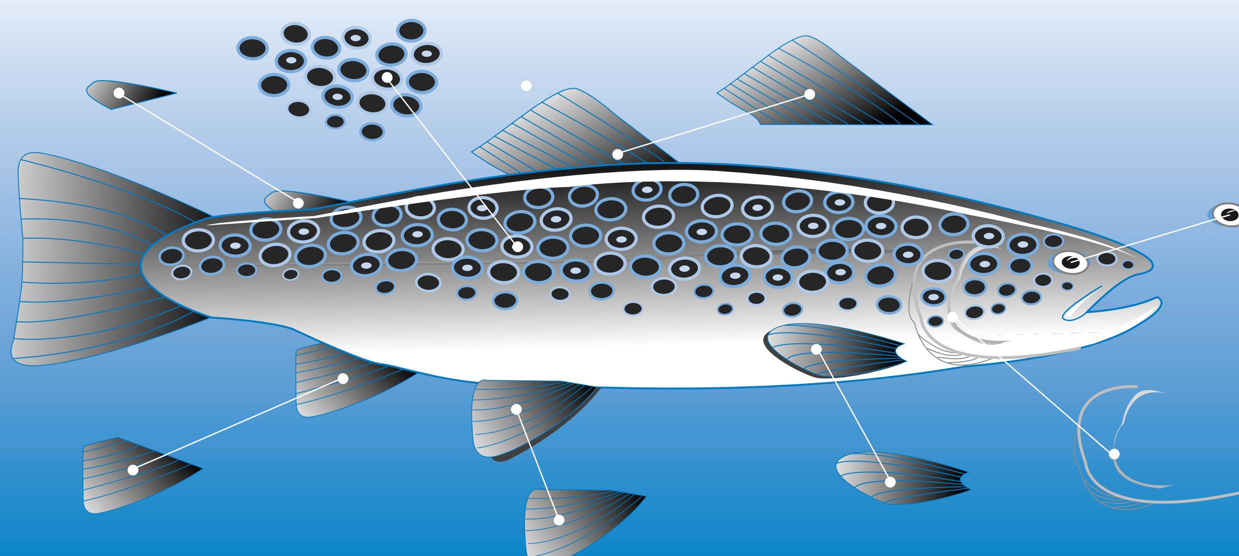
Main Ideas

Living things survive because they have characteristics which are suitable for their habitat. These characteristics are called adaptations and enable living things to meet their basic needs. Adaptations are passed from one generation to another through genetic material.

When habitats change, living things will survive only if suitable adaptations exist or develop. If not, the organisms will not be able to meet their needs. If the changes in habitat are drastic and rapid, there may not be sufficient time for adaptations to occur naturally and be passed to the next generation.

Objectives

Students first examine camouflage as a example of how some organisms have adapted to their environment. They then apply their understanding of adaptation in an activity which examines beaks and feet as examples of adaptations. In a third activity, they examine the various adaptive features of fish.



Camouflage

In this activity, the students are introduced to the concept of adaptation through colouration and markings as a form of camouflage. Camouflage helps animals hide from predators.

The first graphic shows moths on the bark of a tree. The second shows fish in a stream, with the small rocks on the stream bottom forming the background.

Begin with the moths. Prepare the students by telling them that moths are nocturnal. They are most active at night and many spend days sleeping on the bark of trees. Then hold the graphic high enough for all students to see, but for only two seconds. Ask the students how many moths they saw. Which ones were easiest to see? Why? If a bird was looking for food, which moths would it be more likely to eat? How does the colour of the moth help it to survive in its environment? This is an example of an adaptation through camouflage.

Repeat with the second graphic. How many fish do the students see? Which ones are better adapted for survival ? Why?

Complete this activity with a discussion about what would happen if the environment in each case changed. For example, what would happen to the moths if pollution caused the bark of the trees to become white in colour? Which moths would survive? Or what would happen if there was a lot of silt in the stream and the bottom became solid brown in colour? Would the fish still be camouflaged? Would their chances of survival change?

Page 55

Beaks and Feet

In this activity, the students apply their understanding of adaptations from the previous activity in a matching exercise in which they determine which beaks are most appropriate for different food sources.

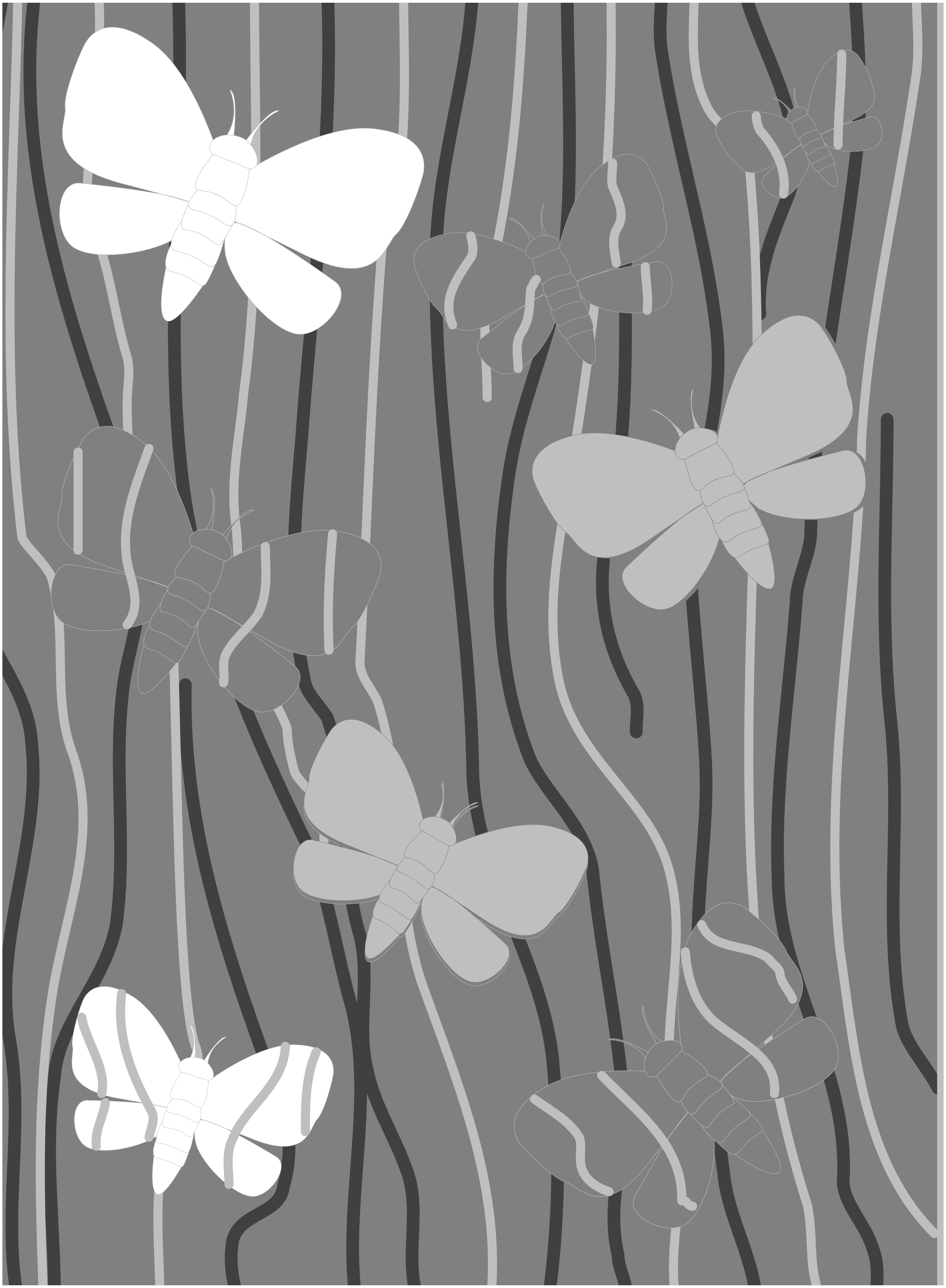
The long thick beak of the heron is most suitable for feeding on small fish in shallow bays and ponds. The hooked beak of the eagle is ideal for grasping and tearing the flesh of larger animals like the rabbit. The long thin beak of the hummingbird is necessary to obtain the nectar from deep inside tube-like flowers. The short tough beak of the grosbeak is ideally suited for feeding on seeds with very hard shells.

The students then combine their understanding of adaptation with their existing knowledge of the various shapes and forms of animal feet. As examples, they may draw the claws of cats, webbed feet of ducks or frogs, grasping claws of hawks, the wide paws of polar bears or Arctic hare, the legs of crabs and lobster, the grasping feet of monkeys, the sticky feet of many spiders, and many more.

Language Task

Who Am I? Write a riddle that describes at least two adaptations you have to help you survive in your habitat. Read it to your classmates and let them guess who you are.

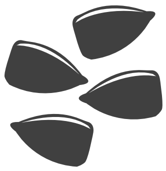
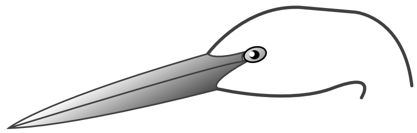
For example: I am mostly white in colour and live in the Arctic. My feet are covered with feathers to keep them warm. I am a good flyer and like to eat rabbits and mice. Who am I? (A snowy owl)

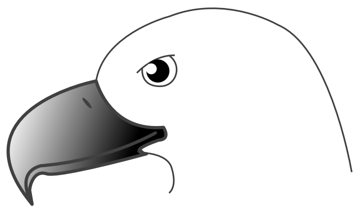


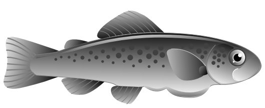
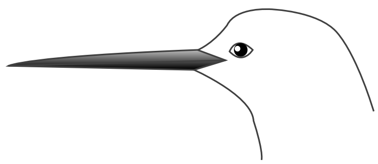
Beaks and Feet

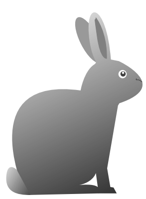
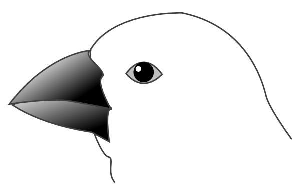
Here are four birds, each with a different type of beak, and four types of food. Draw a line from each bird to the food it eats.

How does the shape of the beak help the bird get its food?

There are also many shapes and sizes of feet. Draw two different examples and tell how they help the animal survive.

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Fish Adaptations

In this activity, the students complete a chart which describes various external features of the fish that are useful adaptations. Most of the features mentioned will be familiar to the students. However, they may not be so familiar with the features as examples of adaptations that help the fish survive in its environment. As the students work at filling in the table, encourage them to think about the advantage that each feature gives the fish.

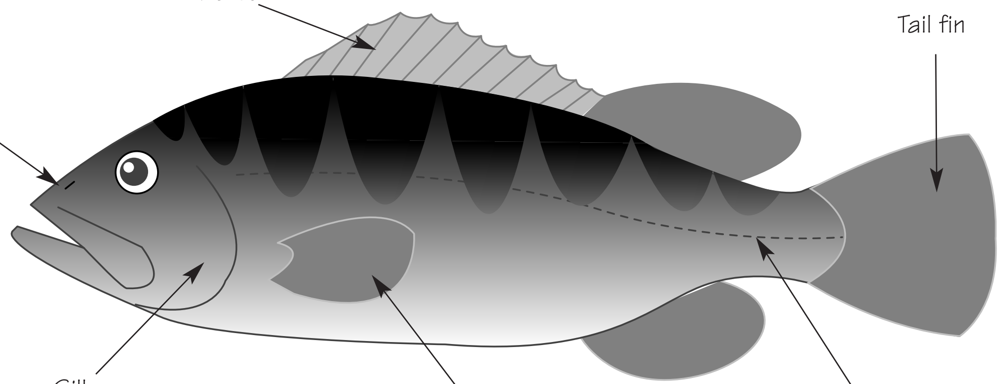
Fish Feature	**Advantage**
1. Steamlined body shape	1. Easy movement through the water
2. Camouflage, colouration	2. The fish is not easily seen by predators
3. Gill cover	3. Protects the soft gills underneath
4. Slippery body covering of mucus	4. Protects from disease; makes movement through water easier
5. Pectoral or shoulder fin	5. Helps the fish turn left and right, or to move up and down
6. Dorsal fin	6. Helps stability and prevents the fish from rolling over
7. Tail fin	7. Pushes the fish through the water
8. Nostrils	8. Used for smelling, not breathing

Extension Activity

You may wish to examine some internal features of a fish. Removing the gill cover exposes the gills which are protected by hard gill rakers. These rakers look like bony teeth and help prevent bits of debris from clogging the gills. A complete dissection of the fish reveals the internal organs many of which are good examples of adaptation to an aquatic environment. There are many guide books available.

Caution: Dissections can be upsetting for some students (and teachers too). It's often an issue of both the physical (blood and guts) and the ethical. Proceed carefully and thoughtfully.

Fish Adaptations



Fish Feature	Advantage
Example: Lateral line	Allows fish to sense sound vibrations
1. Steamlined body shape	1.
2.	2. The fish is not easily seen by predators
3. Gill cover	3.
4. Slippery body covering of mucus	4.
5.	5. Helps the fish turn left and right, or to move up and down
6. Dorsal fin	6.
7.	7. Pushes the fish through the water
8. Nostrils	8.

Can you think of any more?

9.	9.
10.	10.

Background Information

There are over 19,000 species of fish. Fish have lived successfully in the waters of our planet for over 400 million years. The members of this widespread and diverse group include the 10-meter long basking shark and the 2.5 centimeter long sea horse. There are fish even bigger and smaller than these. There are eyeless fish that live in caves, flying (gliding) fish, and fish that walk on land. Fish are found in the highest mountain lakes and the deepest ocean trenches. There are transparent fish living in the Antarctic and rainbow coloured fish living in the tropics.

Fish have many adaptations that make them suitable for their environment and contribute greatly to their survival. The streamlined torpedo shape of the fish allows it to swim through the water with little drag or resistance at bursts of speed up to 20 kilometers per hour, although its cruising speed is much less than this. The fish is powered by thrusts of its body and tail. When we eat fish, we are feeding on the muscles that propel it. Pairs of fins (pectoral fins in the front and pelvic fins in the rear) allow the fish to move up or down, left or right, and help to stabilize the fish. The pectoral fins are also used for propulsion at slow speeds. The unpaired fins (dorsal fin, adipose fin, anal fin, and tail) keep the fish stable and prevent rolling in the water. An internal swim bladder filled with gas helps the fish to control its depth in the water.

The outside of most fish is covered with scales embedded in a skin or epidermis that secretes a slippery mucus. This further reduces drag and allows the fish to swim as efficiently as possible while providing physical protection.

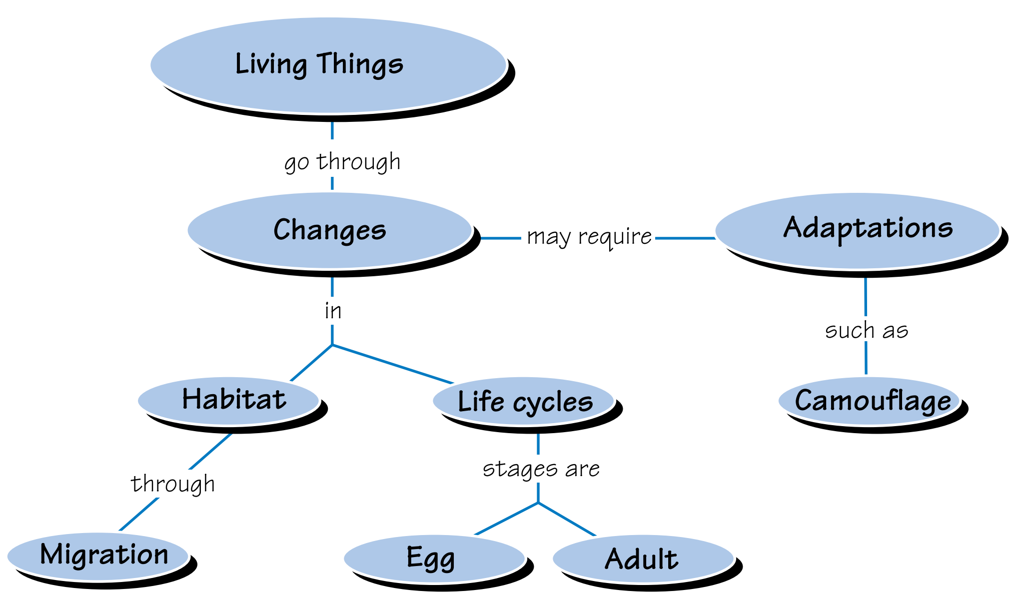
Many fish have large well-developed eyes that help them to avoid predators and capture prey. The nostrils are not used for breathing, but sense of smell is well developed; they can detect low concentrations of odour. Another sensory structure known as the lateral line system runs along both sides of the body and the head. The lateral line contains special sense organs that detect vibrations and movements in the water.

Located behind the eye is the thick, bony operculum that protects the delicate gills and covers the gill opening. The fish takes water in through its mouth, filters any dirt out using internal gill rakers, and passes the water over the gills where oxygen is taken into the blood and carbon dioxide is released into the water. The water then passes out through the gill opening, while the oxygenated blood is pumped around the body by the heart.

Most of the other internal organs of the fish are similar in function to the internal organs of other animals. The kidneys get rid of waste, the stomach digests the food, etc. In salmon and other anadromous fish, the gills and kidneys work together to allow the fish to adjust as it moves between salt water and fresh water.

Review Activity 2

This is an appropriate time to use another concept map as a form of review. Have the students suggest the concepts learned in Lessons 4–7 or provide them with a list. One possible concept map is shown here:



Lesson 8

Our Changing Role

Main Ideas

The role of humans in the environment has changed drastically, especially in industrialized nations. Originally we followed the same rules as other living things, competing for food and shelter, predator of some, prey for others.

In more recent years, however, our relationship with the environment has changed and consequently our role has changed. We have isolated ourselves from the rules that govern natural ecosystems. We have changed our habitat and in doing so we have changed the habitats of other living things. These changes are not without consequences. We must now take responsible action not only for our own survival but for that of other living things that share our planet.

Objectives

The students are presented with two stories about two very different approaches to environmental problem solving. The students first read the two accounts and then are asked to compare and contrast, to find the similarities and differences in the approaches used.

In a second activity, the students give their advice in response to questions related to a variety of environmental activities.

Pages 61 & 62

Two Stories

In this activity, students are presented with two stories. In each case, there is a problem that needs to be solved. The first story is a well known legend about how the parts of Earth interconnect with each other. The second represents the clash that often exists between developers and environmentalists. Students will compare the approaches taken to solve the problem in each story and describe the impact of each approach on the environment.

One of the purposes of this activity is to promote language development through reading. Although some of your students may find the stories difficult, they are given an opportunity to improve their reading skills.

It is not an easy task for students to compare and contrast ideas. The graphic organizer on the second activity page gives a structured format and guiding questions through which students compare the two stories. Allow them to complete the chart on their own first, followed by a class discussion.

Students may have difficulty finding similarities in the two stories. A problem has developed in each case and a process is established to solve it. After that, the stories are very different.

White Buffalo Calf Woman The problem is the shortage of food. This is solved when the scouts meet the White Buffalo Calf Woman and she teaches them how things on Earth are connected. The parts of the sacred pipe represent the animals, the plants, and the air that carries prayers to the Creator. The White Buffalo Calf Woman shows the people how to offer the pipe to the Earth and Sky and the four sacred directions. These lessons teach the people respect and to live in ways that honour the interconnectedness of all things. Herds of buffalo appear. The people see themselves as part of the environment and that all parts are connected. Their actions have minimal negative impact on the environment.

West River Dam: The problem is a shortage of inexpensive electricity. The construction of a dam is the solution. The developers feel that it's acceptable to destroy part of the environment in order to build the dam. The environmentalists have a different view. The construction will negatively affect the environment in many ways.

Following a class discussion, conclude the activity by asking the students to suggest some local examples that might be similar to either of the two stories.

Page 63

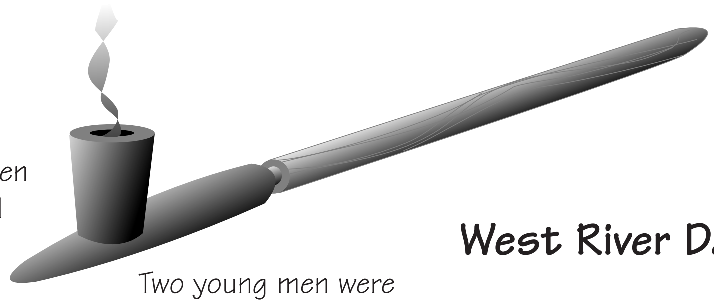
Dear Editor

In this activity, students become editors of a magazine and respond to letters sent in by readers. The activity develops reading, research and communication skills while the students apply what they have learned. It would be best to make this a research activity with the students working individually or in groups to answer one or more letters. They could use the information contained in Background in this and the next lesson or they could do their own research. Local staff of the Atlantic Salmon Federation and the Departments of Fisheries or Environment are usually good sources of information and resource people.

Alternatively, this activity could be done in a class period by assigning each letter to a different group of students. They then collectively answer the letter and read it to the rest of the class.

Two Stories

White Buffalo Calf Woman



There was a time on the Great Plains when there was little food left in the camp. Two young men were sent out to scout for game. They hunted a long time but had no luck. Finally they climbed to the top of a hill and looked to the west.

"What is that?" said one of the young men.

"I cannot tell, but it is coming toward us," said the other.

As the shape drew closer, they saw it was a woman. She was dressed in white buffalo skin and carried something in her hands. She said, "Tell your people that I am bringing a message from the Buffalo People. Put up a medicine lodge for me and make it ready. I will come there after four days have passed."

After four days, the people saw the White Buffalo Calf Woman coming toward them. In her hands, she carried a bundle. The people welcomed her into the medicine lodge and gave her the seat of honour. Then she unwrapped the bundle to show them what was inside. It was the Sacred Pipe.

"The bowl of the Pipe," she said, "is made of the red stone. It represents the flesh and blood of the Buffalo People and all other Peoples. The wooden stem of the Pipe represents all the trees and plants, all the things green and growing on this Earth. The smoke that passes through the Pipe represents the sacred wind."

As soon as the White Buffalo Calf Woman was gone, herds of buffalo were seen all around the camp. The people were able to hunt them and they gave thanks with the Sacred Pipe ceremony. As long as they remembered that all things are connected like the parts of the Pipe, they lived happily and well.

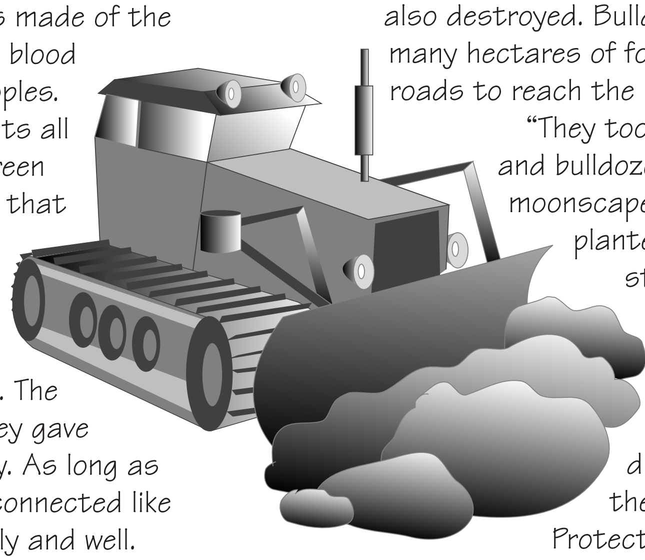
West River Dam

There was a time in the West River Valley when electricity was very expensive. The government gave permission to the Ridgeway Hydro Company to build a power plant on the West River. A dam and a reservoir behind the dam were also part of the project.

"By damming the river, enough electricity will be produced to supply all the families along the river. There will even be enough to sell some to the United States." said the president of Ridgeway.

Member of the West River Protection Committee were worried. They thought the local environment might be damaged by the construction of the dam. The Committee asked the government to do a complete environmental study before the project was started. It wasn't done.

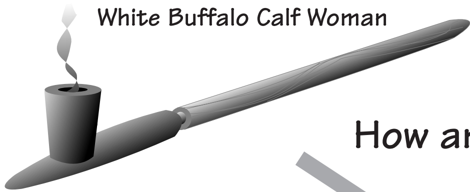
When the dam was built, it blocked upstream migration of salmon and flooded many acres of farmland. A large section of wetlands was also destroyed. Bulldozers destroyed many hectares of forests just to build roads to reach the project site.



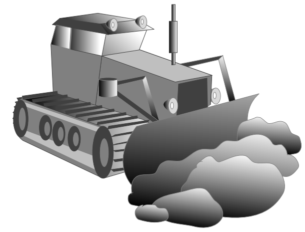
"They took a natural valley and bulldozed it into a moonscape. In exchange, they planted a bunch of little sticks that won't mature into trees for 20 or 30 years. Animals, fish and birds have disappeared." said the president of the Protection Committee.

Two Stories

White Buffalo Calf Woman



West River Dam



How are these two stories alike?

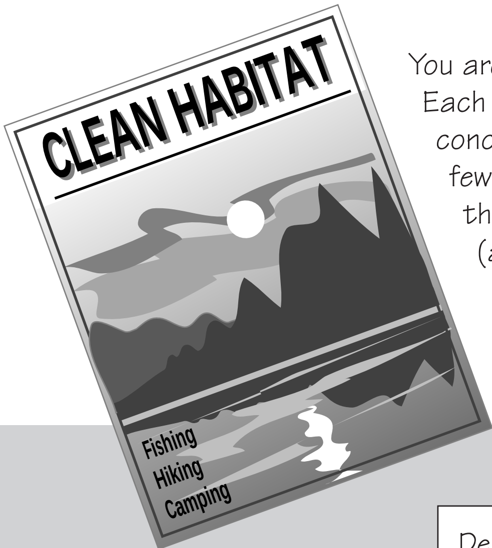
How are they different?

The problem

How the problem was solved

How the people's actions affected the environment

Dear Editor



You are the editor of Clean Habitat, a magazine about the environment. Each month, readers send letters about things they have seen or are concerned about. Your job is to answer each of the letters. Here are a few that have been received this month. In each case, write a response that describes:

(a) how the river or stream would be affected
(b) the impact on fish and other things that live in freshwater (think about water level, temperature, pollution...)
(c) suggestions for action that would improve the situation

Dear Editor:

I saw a program on TV last night that talked about natives and fishing. Why is there so much fuss about this issue? Do aboriginal peoples have special rights to fish? Why is there a problem?

Yours truly,
Jean

Dear Editor:

An old road is being widened outside the town where I live. The other day, I was watching the big machinery at work. To widen the road, they had to dig out a small river that runs beside the road. They're making the river much wider and shallower than it used to be. What effect will this have?

Yours truly,
Robert

Dear Editor:

Yesterday I went for a walk. I saw a large number of cows walking along the edge of a shallow stream that ran through the middle of a pasture. Many of them were in the stream. Do the cattle harm the stream?

Yours truly,
Linda

Dear Editor:

When I was a child, the river that ran through the town where I grew up used to be very crooked and had lots of bends. Since then it has been straightened and there are no bends at all. Will the fish be affected by this change?

Yours truly,
Marie

Dear Editor:

On a recent canoeing trip, I noticed a difference in the growth of trees along the bank of the river. In some places, there were lots of trees growing right to the edge of the river. In other places, the trees had been cut down and the banks were bare. Does this affect the things that live in the river?

Yours truly,
Daniel

Now it's your turn. Complete this letter and give it to a classmate to answer.

Dear Editor:
Last weekend I walked through the woods to a local waterfall. I saw...

River Enhancement

Some rivers and streams offer only 10 per cent of their original habitat to resident fish. Two hundred years ago, rivers formed a series of habitats teaming with trout, salmon and other aquatic life, but many changes have occurred. When early settlers arrived, rivers were more narrow than they are today. They often flooded their banks each spring, creating rich soils in the adjacent areas. High water was slowed by travel through vegetation and trees, minimizing the forces of erosion. Sediments carried in the floodwaters were filtered out by plants, and settled in the floodplains which acted as reservoirs, slowly leaking water, sponge like, into the rivers between summer rains.

To clear land for farming, settlers cut down trees, often to the water's edge. Massive live root systems that had held riverbanks in place were killed or eliminated. Pulp and log drives were the easiest way to get wood to the mills and to the coast. Rivers and even small streams flowing into them, were straightened for wood passage, eliminating many of the curves and pools that originally existed. Each river became shorter and faster, effectively increasing its slope. Higher water speeds brought increased erosion, cutting away at the riverbottom and widening the distance between opposite banks. Loose material began to be pulled downstream, filling in remaining pools. Flood waters began to stay in the wider channels. Sediments were carried downstream during high water, rather than nourishing the floodplain. Farmers were forced to apply manure, then fertilizer, to grow crops. Gradually, the floodplain dried up and no longer functioned as a sponge, leaking water into rivers to maintain summer water levels.

Clean rocks and gravel had once formed rough, bottom surfaces, catching autumn leaves. Small bacteria, aquatic insects and other bottom dwellers lived in the spaces between the rocks feeding on the leaves, and begining the aquatic food chain that supported abundant fish populations. Increasing amounts of silt from land clearing and unstable riverbanks began to invade the spaces between gravel. No longer trapped by the spaces between stones, tons of leaves now glide over the smooth, silt-sealed riverbottoms. As the silt combined with the gravel, the ability of rivers to sustain insects and fish diminished.

When surface ice formed in narrow, deep rivers, water was able to flow under the ice and over the riverbed. Fish retreated into pools, while other bottom dwellers waited out the winter in unfrozen gravel. In their present condition, the wider, shallow rivers freeze to the bottom and ice reaches as much as 12 inches into the gravel. Following a thaw, water flows over the ice which stays anchored to the bottom. Cold weather results in additional freezing and layers of thicker ice build up. Water continues to travel over the ice instead of under it. With spring breakup, a layer of ice up to 2 metres thick may lift off, carrying the frozen gravel with it and causing riverbank damage.

In shallow channels, more water surface is exposed to hot summer air and water temperatures may rise to 30° C. Lacking oxygen, trout and salmon may suffocate. In earlier times, cold water seepage from the floodplains moderated affects of air temperatures. The old channels, deeper and narrower, exposed less water to hot air, keeping the river cool. Fish remained healthy.

Cattle love wet places, including stream banks. They eat and tramp plants that stabilize the soil. Heavy hoof steps cause banks to slump, releasing silt into the waterway. Cows contaminate water with excrement. Given a chance, natural forces attempt to repair steam damage; we can help by restricting access to waterways. Cattle can be fenced from streams, allowing the return of plants to stabilize banks. Water can be delivered to cattle using gravity, solar or nose pumps. Alternately, cattle can be provided occasional access along the waterway. Watering "holes" can be stabilized to minimize stream damage.

Fortunately, there are ways to restore rivers and streams to a condition more like their original forms. Provincial and federal fisheries habitat staff are working with private groups who are interested in habitat solutions. Designs for watering sites are available, and programs like Adopt-A-Stream offer local people the opportunity to help nature restore stream and river habitats. On degraded waterways, rebuilding aquatic habitat for the entire food chain may be a prerequisite to the success of any fish enhancement or recovery program.

Aboriginal Constitutional and Treaty Rights

One of the most hotly debated fishing issues in Canada is the right of Aboriginal peoples to fish. The federal government and various provincial governments have recognized that the Aboriginal peoples of Canada have treaty rights which are protected under the Canadian Constitution. Two important federal court decisions have confirmed these rights:

Sparrow vs. the Queen

The Supreme Court of Canada held that the Canadian Constitution Act of 1982 protects the Aboriginal right to a subsistence fishery. It also found that an Aboriginal subsistence fishery is constitutionally entitled to priority over other interest groups and is subject only to vital conservation measures.

Simon vs. the Queen

In November, 1985, the Supreme Court of Canada affirmed that the Treaty of 1752 was still in force. Among other rights contained in the Treaty, the court found that the right of Netukulimk (pronounced Ned-dug-oo-limk) is a treaty right that cannot be restricted by Federal or Provincial legislation or regulation.

Netukulimk is a Mi'kmaq view of the world which includes the harvesting of the natural bounty provided by the Creator. This bounty was provided for the self support and well-being of the individual and the community at large, to achieve adequate standards of community nutrition.

Denny et al vs. the Queen:

The Appeal Division of the Supreme Court of Nova Scotia affirmed that the Mi'kmaq have an Aboriginal right to fish for themselves and their community in waters outside established Indian reserves.

The Queen vs. Donald Marshall

The 1999 decision of the Supreme Court of Canada recognizes a 1760 treaty giving First Nations in the Canadian Maritime Provinces the right to fish commercially and to sell their catch, with the intent that the community, rather than the individual, benefit from the fishing. It is also a right that is subject to regulation by the Federal Government, with an emphasis on conservation for the fish species. Up to the date of the decision these fishing rights were overlooked in the issuing of commercial licenses, and relatively few Indians were able to fish commercially.

Aboriginal harvesters are aware of the growing pressures on our natural resources. and they respect the need for conservation and management. They share the responsibility with non-Aboriginal harvesters to use methods and equipment that will not result in overfishing, and that are not harmful to the environment.

Unfortunately, there are many misunderstandings about the fishing rights of Aboriginal peoples in Canada. This has resulted in anger, frustration and at times confrontation. Education efforts will help to resolve this dilemma.

Lesson 9

Sustainability

Main Idea

Sustainable development, or sustainability, involves a holistic examination of the impact of our actions on the environment. Sustainability is more than environmental conservation; it also has economic and humanitarian dimensions. For a sustainable future, all dimensions of sustainability must be addressed.

Objectives

The students are introduced to the concept of sustainability within their own community. They examine how the people who live there meet their basic needs today and in the future. They will build on these fundamental principles of sustainability in later lessons.

In a second activity, the students examine how the recreational fishery, as an environmental activity, contributes to the economy of a region.

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Balancing Act

This activity introduces the concept of sustainability. The purpose is for students to examine how we meet our needs today and how our actions can influence the ability of future generations to meet their needs. This is the essence of sustainability. (See Background at the end of this lesson.)

An analogy is drawn between sustainability and a three-legged stool. The legs represent three ‘dimensions’ of sustainability - environment, economy, and people. In the same way that all three legs are needed for a stool to remain balanced, problems relating to all three dimensions of sustainability must be resolved for life on Earth to survive.

Have the students answer the questions individually first, followed by group or class discussion. It’s important that they have a chance for personal reflection before sharing their ideas with others. You may need to guide them through the questions but avoid the temptation to provide all the answers. It’s important that they come to their own conclusions.

The first question asks the students about the basic needs of living things. In earlier lessons, the students learned that food, water, air (oxygen), shelter and elimination of waste are basic needs.

The impact on the environment will be most obvious when the students consider needs for food and shelter, and the elimination of waste materials. The impacts of clearing land to grow crops, cutting trees to build houses, and dumping our waste materials may be well known to them. In this part of the world, we are fortunate not to have major problems obtaining clean air and water.

Most people in North America spend money to meet their basic needs. We have to buy food, and pay rent or purchase a house. Many people are employed in industries and businesses that are directly or indirectly related to supplying our basic needs. For example, buying food creates jobs for farmers, truck drivers, factory workers, and grocery store employees. In turn, these jobs provide an income so that people can buy food. Use examples that are specific to your area to help the students understand the economic linkages.

Many of our activities today will make it difficult for future generations to meet their basic life needs. If we continue to pollute our land and water today, it may be impossible to obtain food tomorrow. When we remove large amounts of forests, we are removing the major building materials for homes in the future. When we destroy countless habitats, we are destroying many species of living things that share our planet. All these activities threaten our water and air quality.

Encourage the students to think about ways they and their families can meet their needs without destroying the environment for future generations. This may lead to a debate on the value of the environment vs. the importance of jobs. It’s a debate for which there is no obvious resolution. Use examples that are relevant to your local community.

Students today seem to be aware of many of the inequities of the human condition that exist both locally and globally. Do we meet our needs to different degrees? (mansions vs shacks, obesity vs starvation) Is this fair? Is it right? This issue can lead to a discussion of morals and ethics.

Language Task

Have the students create slogans for bumper stickers that would promote sustainability. A common one is ‘Think globally, act locally’. Have them suggest others.

Balancing Act

Imagine Earth is a ball sitting on a stool with three legs. One leg is the environment, one is the economy and one is people. If the three legs are not balanced, the 'Earth' will roll off the stool, and some living things may not survive the fall.

In earlier lessons, we discussed the five basic things we need to survive. What are they?

1. ____________ 4. ____________
2. ____________ 5. ____________
3. ____________

As we meet these needs, how do we affect the environment?

Do we have to spend money to meet our needs? What do we spend it on? Are jobs created?

Are we doing anything today that will make it difficult for future generations to meet their needs? Give a few examples.

A stool will remain balanced as long as the three legs are stable. We could say it is **sustainable**. Life on Earth can be sustainable, too. But we must do things today that will help living things in the future meet their basic needs.

What can we and our families do to help life on our planet be sustainable?

What can our communities do?

THINK ABOUT THIS! Is there a difference between what we want and what we need? Do some people get what they want while others can't get what they need?

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123
456
789

How Much Is That Fish?

In this activity, the students will examine some of the benefits of the freshwater recreational fishery in the Atlantic provinces. They will use current figures to calculate the economic impacts in the form of jobs created and income generated by the activities of anglers.

Recreational fishing is a healthy, outdoor pastime that lasts a lifetime. It develops and promotes awareness of freshwater habitat, the wise use of our freshwater resources and the need for habitat conservation.

Wild fish stocks are often used as an indicator of the health of freshwater environments, and anglers are a source of critical information which is analysed by fisheries scientists. The recreational fishery is also a source of social interaction among anglers and a sharing of great stories!

The recreational fishery creates employment and economic activity. Based on the data provided for the students, there are 300,000 anglers in the Atlantic region. If each angler spends $850 per year, the total amount of money spent is about $255,000,000. That's $255 million, a very large sum. If 23 jobs are created for every 1000 anglers, the 300,000 anglers will generate about 6,900 jobs.

Anglers spend money on many items including special clothing and footwear, food, accommodations, travel and fishing equipment. Jobs are created in providing all of these goods and services. Some people are also employed as guides for the anglers.

Overall, the recreational fishery is an important source of economic activity in the Atlantic region.

Background

Sustainability

The concept of sustainablity is not new, as it has been an integral part of many aboriginal cultures in North America and around the world. More recently, conferences held in Paris and Washington in 1968 and 1980, the World Conservation Strategy reinforced the importance of sustainable development mainly through the conservation of living resources. It was the World Commission on Environment and Development (Brundtland Commission) that brought the concept of sustainable development to the attention of the general public.

Since the words "sustainable" and "development" were put together, a great number of definitions have been proposed. It is probably more beneficial to implement sustainable development principles than to attempt to create a definition that will reach a general consensus. The Brundtland Commission proposes:

Sustainable Development can be defined simply as development which meets the needs of the present without compromising the ability of future generations to meet their own needs.

Included within the concept of sustainable development is development that improves health care, education, and social well-being. Such human development is now recognized as critical to economic development. The United Nations Development Programme states: "men, women, and children must be the centre of attention - with development woven around people, not people around development".

An important component of virtually all definitions of sustainable development has to do with equity - equity for people living now who do not have equal access to natural resources or to social and economic "goods" and equity for human generations yet to come.

The new strategy outlined by the World Conservation Union, Caring for the Earth, defines sustainable development as "improving the quality of human life while living within the carrying capacity of supporting ecosystems".

In its broadest outlines, the concept of sustainable development or sustainability has been widely accepted and endorsed. However, translating this concept into practical goals, programs, and policies has proved to be harder to accomplish.

Sustainable development is not a "quick-fix" for complex crises; it is a context for rethinking some of our traditional assumptions about how we as humans interact with each other and with the planet. Sustainable development implies profound change in political, economic and social structures, policies, attitudes and behaviour, and new areas of cooperation and partnership. In this context, it is more crucial than ever to have a population that is trained and literate in relevant issues and skills.

The definition of sustainable development implies a need to work towards finding a sustainable relationship between ecological preservation and economic development. Therefore, sustainability education consists not only of environmental education. The economic and human dimensions of sustainable development must be considered along with the environmental issues. Additionally, the impact of technology both now and in the future must also be considered.

How Much Is That Fish?

Have you ever gone fishing? What types of fish did you catch? Some people have very large fishing boats and go out to sea for long periods of time. Others take a rod and a reel, some flies or a few worms and spend hours at their favourite lake or river. People who fish for fun or sport are often called **anglers.** In the Atlantic provinces, sportfishing is very popular on our freshwater ponds, lakes and rivers. The fish preferred by anglers are trout, salmon and bass, but other types are fished as well.

What do you think are some of the benefits of sportfishing?

____

____

____

Discuss your ideas with two or three of your classmates.

Sportfishing helps the economy of the four Atlantic provinces. It creates jobs and brings money to the area. How much money? How many jobs? Here's some information to help you answer these questions. It's difficult to know exactly how many anglers there are and how much money they spend. These figures are estimates.

The number of anglers in the Atlantic Provinces:

New Brunswick 80,000
Nova Scotia 68,000
Newfoundland.................140,000
Prince Edward Island........12,000

Total...__________

In the Atlantic region, each angler spends an average of $850 per year.

What is the total amount of money spent by anglers?

What do they buy?

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For every 1000 anglers, about 23 jobs are created.

How many jobs are created by sportfishing?

What are some examples of the jobs created?

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Knowledge, Skills and Values of Sustainability Education

Knowledge:

- The planet earth as a finite system and the elements that constitute the planetary environment.
- The resources of the earth, particularly soil, water, minerals, etc., their distribution and their role in supporting living organisms.
- The nature of ecosystems and biomes, their health and their interdependence within the biosphere.
- The dependence of humans on the environmental resources for life and sustenance.
- The sustainable relationship of native societies to the environment.
- The implications of resource distribution in determining the nature of societies and the rate and character of economic development.
- Characteristics of the development of human societies including nomadic, hunter - gatherer, agricultural, industrial and post-industrial, and the impact of each on the natural environment.
- The role of science and technology in the development of societies and the impact of these technologies on the environment.
- Philosophies and patterns of economic activity and their different impacts on the environment, societies and cultures.
- The process of urbanization and the implications of de-ruralization.
- The inter-connectedness of present world political, economic, environmental and social issues.
- Aspects of differing perspectives and philosophies concerning the ecological and human environments.
- Cooperative international and national efforts to find solutions to common global issues, and to implement strategies for a more sustainable future.
- The implications for the global community of the political, economic and socio-cultural changes needed for a more sustainable future.
- Processes of planning, policy-making and action for sustainability by governments, businesses, non-governmental organizations and the general public.

Skills:

- Frame appropriate questions to guide relevant study and research.
- Define such fundamental concepts as environment, community, development and technology, and apply definitions to local, national and global experience.
- Use a range of resources and technologies in addressing questions.
- Assess the nature of bias and evaluate different points of view.
- Develop hypotheses based on balanced information, critical analysis and careful synthesis, and test them against new information and personal experience and beliefs.
- Communicate information and viewpoints effectively.
- Work towards negotiated consensus and cooperative resolution of conflict.
- Develop cooperative strategies for appropriate action to change present relationships between ecological preservation and economic development.

Values:

- An appreciation of the resilience, fragility and beauty of nature and the interdependence and equal importance of all life forms.
- An appreciation of the dependence of human life on the resources of a finite planet.
- An appreciation of the role of human ingenuity and individual creativity in ensuring survival and the search for appropriate and sustainable progress.
- An appreciation of the power of human beings to modify the environment.
- A sense of self-worth and rootedness in one's own culture and community.
- A respect for other cultures and a recognition of the interdependence of the human community.
- A global perspective and loyalty to the world community.
- A concern for disparities and injustices, a commitment to human rights, and to the peaceful resolution of conflict.
- An appreciation of the challenges faced by the human community in defining the processes needed for sustainability and in implementing the changes needed.
- A sense of balance in deciding among conflicting priorities.
- Personal acceptance of a sustainable lifestyle and a commitment to participation in change.
- A realistic appreciation of the urgency of challenges facing the global community and the complexities that demand long-term planning for building a sustainable future.
- A sense of hope and a positive personal and social perspective on the future.
- An appreciation of the importance and worth of individual responsibility and action.

Lesson 10

Stewardship

Main Ideas

To make informed decisions about our environment, we must be knowledgeable about the various dimensions of sustainability and prepared to participate in the decision-making process.

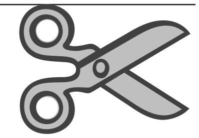
Objectives

Through two activities, the students are challenged to apply their understanding of the concepts developed in the unit. In one, they are presented with a series of difficult situations and are asked to suggest what action they would take.

In the second activity, students assume the roles of various community members in addressing a development proposal which has been presented to their town council.

Pages 73 & 74

What Would You Do?



In this activity, students apply their understanding of sustainability from previous lessons. They are presented with a series of situations in which they must decide what action they would take.

On the first activity page, situations are described along with a choice of possible actions that could be taken in each case. The task for the students is to decide on the one action they think is best and then explain their decision. This first part of the activity is designed for groups of four students. Provide each group with a copy of the activity page and a pair of scissors. Allow each student two or three minutes to read the dilemma they have chosen and decide what action they would take. They should be prepared to explain their decision to the other members of their group. Allow time for the group to ask questions and discuss alternative actions. Consensus is not necessary, but encourage the students to apply what they've learned from previous lessons in their discussion.

Each student will need a copy of the second activity page. They are given two new situations and then suggest a variety of possible actions that could follow each one. They are then encouraged to write their own dilemma.

You could extend this activity by having the students conduct additional research on the dilemmas presented here or on issues relevant to your community.

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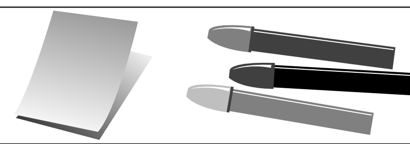
Sleepy Hollow



The purpose of this activity is for students to apply their understanding of the concepts developed in the previous lessons. This is accomplished through role playing.

A company that manufactures paint is making a proposal to the local town council for an industrial development. The student page provides the background of the proposal along with the names of the groups who will be responding to the proposal. You may wish to substitute or add others.

The class should be divided into as many groups as you have presentations at the special meeting. Encourage each group to conduct research and carefully plan their presentation. Some information is contained in the Background at the end of the lesson; additional information can be obtained from a variety of community resources.

This is a fairly typical role-playing activity. You can use as much or as little time as you feel appropriate for your students. One suggestion is to use three days: Day 1 - Research, Day 2 - Preparation, Day 3 - Presentations. Many other options are possible. Invite parents, teachers, or other students to represent the Town Council. After hearing all the presentations, they make their recommendation.

Detailed guidelines on preparing for and organizing the class for role-playing activities can be found in many resource books, particularily for social studies teachers.

What Would You Do? • 1

Sometimes it is not easy to know what to do to help the environment. Here are several situations where this happens. They are called **dilemmas** because it is not clear what action should be taken. In each situation described below, a dilemma is presented and you are given several choices about what you would do.

First, someone in your group should cut the dilemmas into separate cards and place them face down on the desk.

1. One student takes the top dilemma card, reads it silently and decides on **one** of the possible actions. Then they read the dilemma to the rest of the group and explain their decision.

2. The other students in the group can ask questions about the decision or suggest other ideas. Discuss all the suggestions.

3. Repeat until everyone in the group has had a turn.

You are fishing at a secluded lake and have caught seven fish during your first day at the lake. Now, on the second day, the fishing has been great and you have caught five fish in the first hour, all of which are bigger than yesterday's fish. The law allows you to possess 12 fish. Should you:

- continue to fish and keep all the fish
- get rid of the smaller fish you caught yesterday and keep the big ones to stay within your limit
- have fish for lunch
- quit fishing and go for a hike
- other

You are out in the woods with a friend when you spot a hawk perched on a high limb. Before you realize what is happening, your friend shoots the hawk. An hour later, you are leaving the woods and are approached by a game warden, who tells you a hawk has been illegally shot and asks if you know anything about it. Should you:

- deny any knowledge of the incident
- admit your friend did it
- make up a story implicating someone else
- say nothing, but call up later with an anonymous phone tip
- other

A high-quality fishing stream runs along the edge of your family's farm. The fertilizer which your family uses to increase crop production is carried into the stream by rain runoff. The fertilizer is affecting algae growth and the fish population in the stream. The farm is your sole source of income, but your family has always enjoyed fishing and doesn't want to lose the fish from the stream. Should you:

- change fertilizers, even if it reduces crops
- seek funding from the government to make up for fewer crops
- allow a portion of your land along the stream to grow wild
- do nothing
- other

You and a friend have a favourite lake where you like to fish. In the past, you used to catch trout, but now you catch only small perch. There is a dam at the end of the lake, so trout have not been able to leave the lake to spawn. Your friend wants to introduce a new species of fish to the lake, a type that eats perch. Should you:

- help your friend to introduce a new species
- report your friend for illegally introducing a new species
- form a group to build a fishway at the dam and restock the lake with trout
- organize a fishing competition to catch all the perch (a perch-a-thon)
- other

What Would You Do? • 2

Here are two more dilemmas. Suggest four possible actions that could be taken for each one. Have the other students in your group choose what they think is the best thing to do.

You and a friend have been fishing all day at a local lake and have caught lots of trout. On your way home, you find a fishing net hidden among some bushes at the edge of the lake.
Should you:

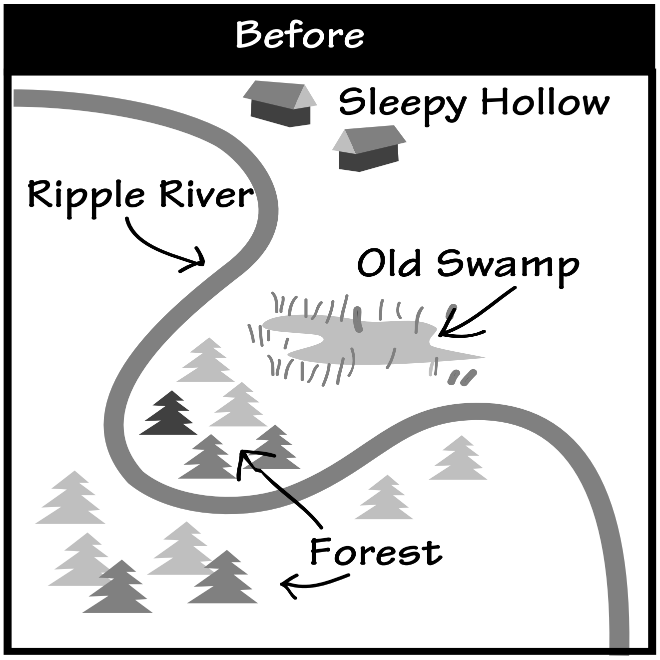
- ____________________
- ____________________
- ____________________
- ____________________

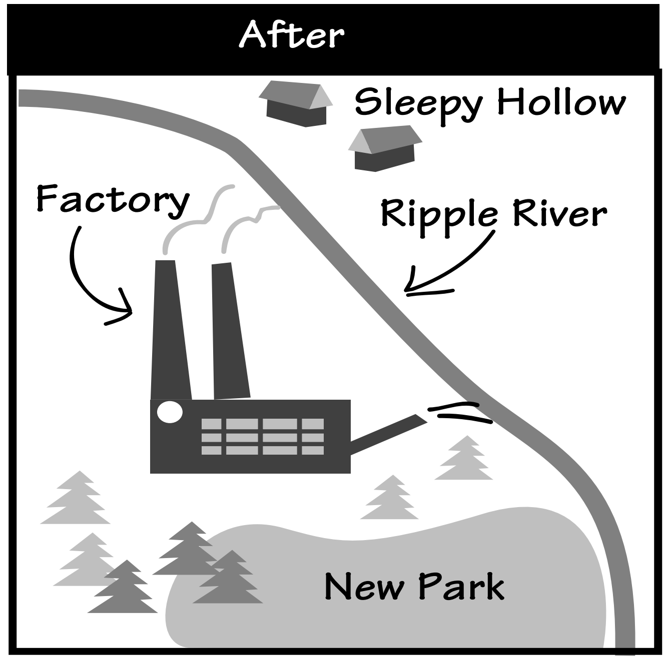
Your house is on a hill above a large town. The local government officials want to change the direction of a river that flows through your property to provide electricity for the town. You are concerned about the effect the change will have on fish and the freshwater habitat. You are also concerned about losing the enjoyment the river has given you and your family. Should you:

- ____________________
- ____________________
- ____________________
- ____________________

Now it is your turn. Write about a situation that could be a dilemma in your community. Have other members of your class suggest the best possible action to take.

Sleepy Hollow





Sleepy Hollow is a small town with high unemployment. The people who live there are looking for a business that will help create jobs. The Polka Dot Paint Company is one of the companies that has applied to build a factory in the town. The Company produces many types and colours of paint. The new factory will create jobs for 10 engineers, 30 technicians and 15 clerical staff.

The owners of the Company want to build the factory on forrested land along the edge of Ripple River which winds through Sleepy Hollow. The land is currently owned by the town.

During the production of the paint, chemicals will be used. Some of the waste products will be buried in a local dump, the rest will be diluted with water and poured in the river to be carried away. The Company has asked permission to widen one section of the river and to reroute another section. Although they will have to clear the land to build the factory, they have promised to build a public park behind the new factory.

A special meeting will be held next week. At that time, several presentations will be made and the Town Council will make a recommendation.

The following groups will be making presentations at the Council meeting:

- Representatives of the developers, the Polka Dot Paint Company
- Planet Care Environmentalist Group
- The Sleepy Hollow Recreational Fishery Association
- Representatives from several Sleepy Hollow youth groups
- The local member of the Provincial Legislature and advisors
- The Town Council

Guidelines for the presentations:

- Each group has a maximum of 10 minutes to make a presentation
- Each presentation must involve a visual display (poster, sign, pictures...)
- Each group has 3 minutes to speak again after all presentations have been made

Salmon Restoration and Trout Enhancement

Salmon and sea-run trout populations are currently being threatened and many rivers in the Atlantic provinces have been depleted of their normal healthy fish stocks. Some of these threats are natural but many are the result of human activities. Salmon and trout restortion activities have been designed to help depleted rivers produce close to the number of juvenile salmonids they are biologically capable of supporting. The success or failure of a restoration project can depend upon how all of the factors influencing the fish's life cycle and the river's health come together.

There are many types of salmon restoration and trout enhancement activities. If a river is large but has few spawning areas, the addition of suitable small clean rocks to an upstream section of the river can increase the amount of available spawning habitat. If a river has been overfished, the addition of extra juvenile fish, the closure of the river to sport fishing, or the restriction of commercial fishing in an area can increase salmon and trout numbers over time. The patrolling of a heavily poached river or the clean-up of a polluted river can also result in the enhancement of fish numbers. River protection and fishery closure can play a vital role in the success of an enhancement project.

Habitat improvement is also a type of enhancement. Natural obstructions such as waterfalls or beaver dams and barriers such as power dams, poorly constructed culverts, and log jams can make a water system inaccessible to migrating fish. Replacing poorly constructed culverts, building fishways, removing wooden barriers, or blasting a waterfall to change its shape can allow new access for sea-run fish in an unused river system or tributary.

Activities such as construction, agriculture or logging can affect salmon and trout habitat. Road construction near a river can stir up silt, which chokes and smothers river life, particularly the young fry and developing eggs. Logging in the area of a river bank removes trees that hold the soil in place and absorb rain water. During heavy rainfalls soil and silt can be washed into the river, choking and killing everything for long distances downstream. Proper construction practices (e.g. silt traps) and sensible logging operations can ensure that these factors have little effect on river health in the future.

Water pollution is another potential threat to salmon and trout habitat. This can refer to the presence of garbage, poisonous chemicals, or oil in a river or pond; but the most common sources in Atlantic Canada today are acid rain, sewage from communities, and washed-out fertilizers from farming areas. The addition of sewage and fertilizers can provide so much nutrition to the river that the freshwater plankton and plants undergo a population explosion. When they die, they can smother fish and insects by using most of the water's oxygen in the decaying process. This problem is called eutrophication: a badly eutrophied water system usually has its surface and bottom covered with green algae, scum, and dead fish.

Individuals and communities can participate in a number of simple enhancement activities:

- removal of debris that obstructs access to spawning areas
- cleanup of local pollution
- selective cutting and removal of overhanging trees along small streams to allow more light to increase primary food production
- plant vegetation along large streams to maintain bank stability and provide cover for fish
- create sheltered pools by placing logs, rocks and boulders in appropriate streams
- build fences along streams to prevent grazing farm animals from walking into the water
- when culverts are installed, provisions should be made for a stable stream flow at critical times for migrating fish

To assure success, some restoration projects incorporate the release of hatchery-reared juvenile salmon or trout to rivers or lakes. These projects are used in situations where previously unused habitat is being made accessible to migrating fish; and where over-fishing and pollution have reduced wild fish stocks to virtual elimination.

Once stocks are sufficiently abundant and natural reproduction is sustaining the fishery, hatchery releases can be curtailed.

In Atlantic Canada, fish culture stations, spawning channels, and stream-side satellite rearing and incubation operations are used to provide young fish for enhancement and restoration projects.

When salmon or sea-run trout are placed in rivers that were previously inaccessible due to barriers to upstream migration, these introductions are usually combined with the construction of a fishway. Fishways or fish ladders are man-made passageways that allow fish to get around or over barriers to reach what were previously inaccessible sections of river. They are built to allow for passage around barriers such as hydro dams and natural barriers such as impassable waterfalls. Fishways let fish bypass an obstacle by swimming around or over the barrier one step at a time, with each step up being built to include a resting area or area with little downstream current. Permanent fishways are built using concrete or are blasted into natural rock; temporary fishways are usually constructed of aluminum or wood and are used in some areas when there is doubt about the need for a fishway or the suitability of a particular design.

Salmon are famous for their ability to leap over waterfalls, but there are only certain types of barriers over which salmon can pass. The secret of a salmon's leap is the presence of an area of constant circular turbulence, known as a standing wave, at the base of a waterfall. If the bottom of a waterfall is deep enough and the height is not too great, a salmon can use the upward movement of a standing wave to help it leap over a waterfall. It has been estimated that a salmon can leap one foot for every one foot of depth under a waterfall to a height of 3 metres or more, provided the flow rate is sufficient; therefore, some fishways simply require the alteration of a river's natural rock formations or the addition of a single step, while others require expensive concrete structures to allow fish passage.

Some 'in stream' techniques are used to help nature restore the fish habitat to a more natural state. For example, a well placed digger log mimics a fallen tree and is positioned across the stream. It is anchored to both the bottom and the bank, either straight across or at an angle. As water flows over the log, silt is cleansed naturally from the stream bed, and rocks move from the downstream side and accumulate on the upstream side. Eventually a pool is formed on the downstream side.

Deflectors are used to narrow the channel of a stream or river. They are pyramid shaped, constructed of local rocks and logs and extend from the top of the bank down to the stream bed. As water flows over and around the deflector, sediments collect downstream along the bank. This area eventually becomes a home for vegetation. The deflectors also divert water into the middle of the channel forming a pool in the process. The newly formed stream bed is more narrow and deeper than the old one.

The counting fence is a very important tool in stream monitoring and salmon restoration. It is commonly used for collecting and counting adult fish, determining their origin, and collecting a scale sample for genetic research. The fence consists of closely packed, steel piping which slides up and down and fits the shape of the river. It is placed across the width of the river so that fish swimming upstream cannot get around it. As they attempt to move upstream, they are forced into a wooden trap in the centre of the V-shaped counting fence. Technicians, volunteer workers and biologists are able to capture and count every fish larger than half a kilogram that moves upstream. Useful information about fish migrations and populations can be gained by keeping careful records of the fish passing through a river during the summer. These exact species and population counts conducted over the years can help biologists determine if a river is in need of enhancement or if past enhancement projects have been successful. The counting fence also provides a method of capturing brood stock for next year's eggs and fry.

Electrofishing is a method that is often used to catch fish from a section of a river. The downstream and upstream borders of the station are netted off, trapping all of the fish in the area. The station is fished or swept slowly and thoroughly in regular side to side movements from the upstream barrier net to the downstream barrier net, using the electrofishing probe.

When fish are subjected to an electrical current, they are either stunned, stimulated to swim towards the electrical source, or stimulated to flee from their hiding places. The fish are fairly easy to capture. Usually they are picked up with a dip net and held in a bucket of water until they can be identified, counted, and subjected to any other required procedures such as tagging, scale sampling, or measuring. The fish are then released. The fish are 'stunned' for only a few minutes at most.

Since fast flowing water is very difficult to sample, most electrofishing surveys are carried out when water levels are fairly low during midsummer. Electrofishing in autumn could potentially injure fish preparing to spawn or the newly deposited eggs.

Lessons 11 and 12

Introduction

Lessons 11 and 12 are intended to be used in classrooms that have received an incubation unit and fish eggs from the Atlantic Salmon Federation or one of its affiliates.

Lesson 11 deals with setting up the aquarium and incubating the eggs.

Lesson 12 deals with the newly hatched fish and preparation for their release into local streams.

Lesson 11

GETTING READY

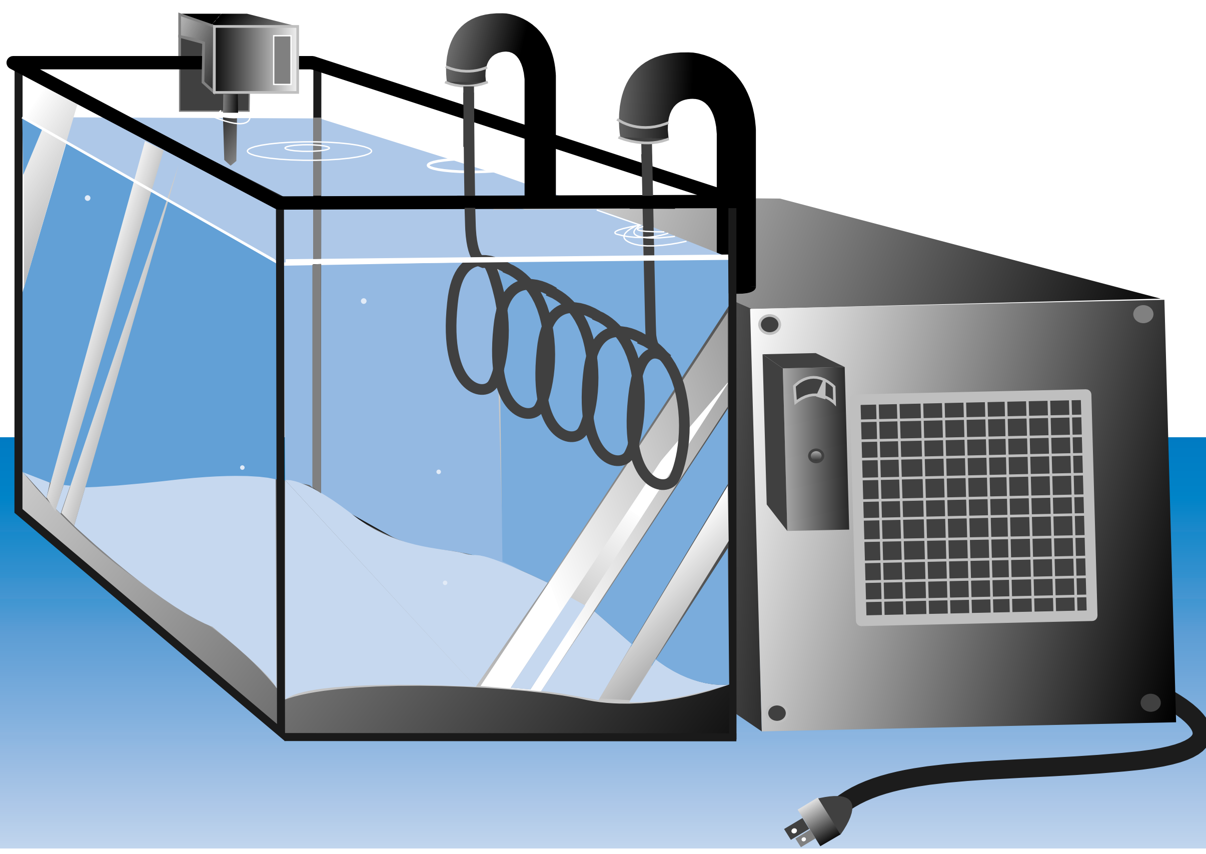
Main Ideas

All living things have needs that must be met in order to survive. Fish, as with other living things, meet these needs in a variety of ways within their immediate environment.

Fish have a life cycle, beginning as eggs and, if favourable environmental conditions exist, they will develop and change through various stages over time. Their basic life needs must be met at all stages of their life cycle.

Objectives

Through this lesson, students will apply their existing knowledge in the design of an appropriate environment for fish eggs. They will design and maintain appropriate charts and graphs to record observations related to the incubation of the eggs and make close observations of the eggs before they hatch.



A Lesson in Survival

Having an aquarium in your classroom will be a tremendous motivator for the students. Ideally this activity should be done before the aquarium is set up. The purpose is to give the students an opportunity to express and apply what they already know about fish and their needs. Most students will already have some experience with an aquarium and know about its maintenance. They will also have some understanding of what living things need to survive. This activity allows them to express their understanding and apply it to the design (on paper at least) of an aquarium.

You will be tempted to provide answers to all their questions even before the lesson has begun. Try to avoid this! There are some opportunities for worthwhile learning activities prior to and during the actual set up of the aquarium which shouldn't be missed.

Encourage the students to work in small discussion groups. They will probably suggest that fish need things such as food and water, oxygen (air), and some protection from predators, and maybe a few other things you won't think of. The accuracy of their list is not as important as the linkage between the list and the aquarium they design. Are the needs they identified being met? Have the groups share their designs and make changes, if necessary, based on what they hear from the other groups.

The needs of the eggs are basically the same as those of the adults; how those needs are met is a bit different however. For example, since the food supply is the yolk, the embryo doesn't need an external supply of food. The students may suggest this; if not you could encourage them to think about hen's eggs and where they get food. The analogy with hen's eggs could also be used to encourage the students to think about other needs such as protection.

A critical need for the eggs to hatch is a constant, low temperature, between 4°C and 5°C. It will be a challenge for the students to suggest a solution to this need. Let them brainstorm some possible solutions in their groups and then share these with the whole class. You may be able to test some of their ideas. For example, if someone suggests adding ice cubes to the aquarium, try it (but perhaps use another container). Measure the water temperature before adding the ice cubes, and several times after that, including the next day. The students will quickly see that the temperature does not remain constant and will eventually return to room temperature. They may have some other suggestions you could test as well.

A few leading questions will direct the students to a workable solution for the temperature problem. Ask them to think about how the problem is solved at home i.e., how do they keep food cold? They all have experience with refrigerators. The key here is to get them to think about what's happens inside. Some questions might be:

- **What happens when you put something warm in a refrigerator? (It gets cold!)**
- **Why does it get cold? Is cold 'added' to the object? Is heat 'taken away'?**

A refrigerator involves the removal of heat, not the addition of cold. Sometimes a flow of warm air can be felt near a refrigerator. This is the warm air being removed from the contents. If the students arrive at a basic understanding of this, they can apply it to the design of their aquarium. What's needed is some way to remove the heat from the water in the aquarium, not to add cold. Remember too that the surrounding room is adding heat to the water (probably 20°–22° C) on a regular basis. The solution is to attach a cooling coil to the aquarium, similar to that used in refrigerators, to remove the heat from the water. This coil is supplied with your aquarium.

A Lesson in Survival

What are all the things a fish needs to survive in its environment?

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Do fish in an aquarium need anything different?

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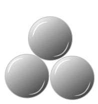
Design an aquarium that would be an ideal environment for a fish. Draw it here.

THINK ABOUT THIS!

Look again at your list of what a fish needs.

- Are each of these needs being met in your aquarium?
- Do you need to add anything?



Suppose the aquarium contains only fish eggs, not adult fish. Would you make any changes in the design of your aquarium?

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In nature, fish eggs need to be between 4°C and 5°C to hatch. How would you keep the water in your aquarium at this temperature? Suggest two or three possible solutions.

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Putting it Together

The students now advance from an aquarium of their own design to the one provided. The complete incubation unit consists of several parts and needs to be assembled. Guidelines for assembly can be found in the introductory section of Fish Friends. This activity allows the students to speculate on the purpose of each piece and how they will fit together. Encourage them to relate the purpose of each component of the incubation unit to the needs of the eggs as they discucssed in the previous lesson.

Although the conditions in the aquarium are somewhat controlled, it is more similar to a natural environment than to a fish hatchery. In a hatchery, the environmental conditions are greatly controlled and mortality is relatively low. Your aquarium is not controlled to this extent and some of the eggs will die. The students should understand that this is natural and to be expected.

Technology is all around us, aiming to solve problems and make our lives easier. If you already integrate technology studies in your curriculum and classroom, the students will be able to list many ways that technology is represented in the aquarium (the glass, thermometer, coil, motor, styrofoam...). If this is a new topic for your students you may want to use an introductory activity first. Try Technology Treasure Hunt.

The purpose of the styrofoam is to insulate the water from the much warmer classroom and to simulate the darkened conditions found in a natural stream environment.

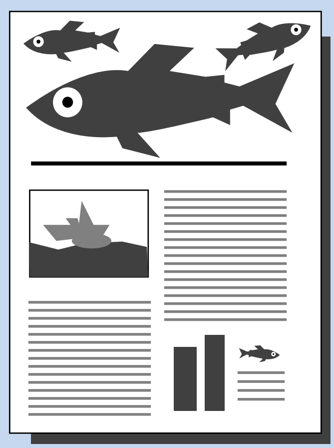
Technology Treasure Hunt

This could be done as a class brainstorming session or in groups or pairs of students.

Three or four suggestions for each question would be adequate. The point is to get the students thinking about how familiar technology is, it's not all hi-tech and beyond their everyday experiences. You can add more questions to the list.

- What examples of technology helped you get to school today?
- What things around the room need electricity to make them work?
- What examples of technology are you wearing?
- What examples of technology were used to make your lunch?
- Look around the classroom. What are some useful inventions you see? Which are most useful?
- What examples of technology would fit in a matchbox?

Class Newsletter — on the web

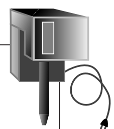


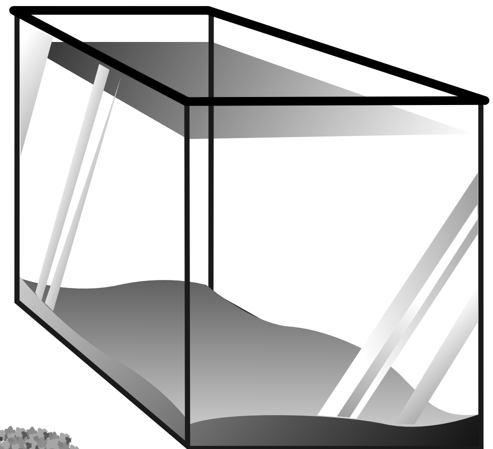
Consider starting a web newsletter, prepared and hosted by your students. The purpose is to update students, parents and others beyond the school about the progress of the eggs and young fish. The students can contribute articles, recent observations, interviews, cartoons ... whatever they think is suitable. They might use the opportunity to explain to others the advantages of studying first hand our environment.

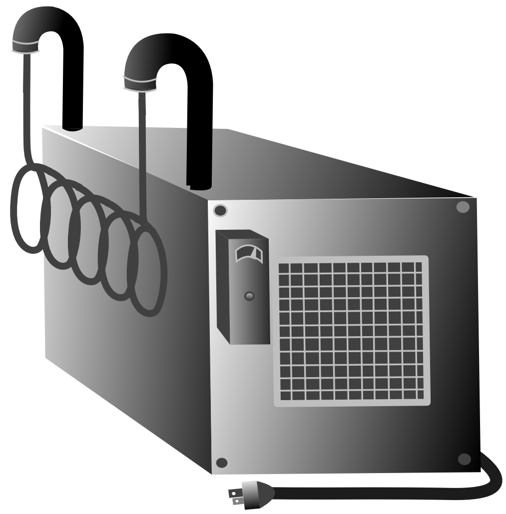
This activity could be an opportunity for students to develop editing and design skills on a computer. Also consider regular updates on the fish over the PA system.

Putting it Together

Here are the things we need to create an environment for fish eggs. What is the purpose of each part?







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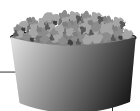


Gravel

Aquarium

Cooling unit

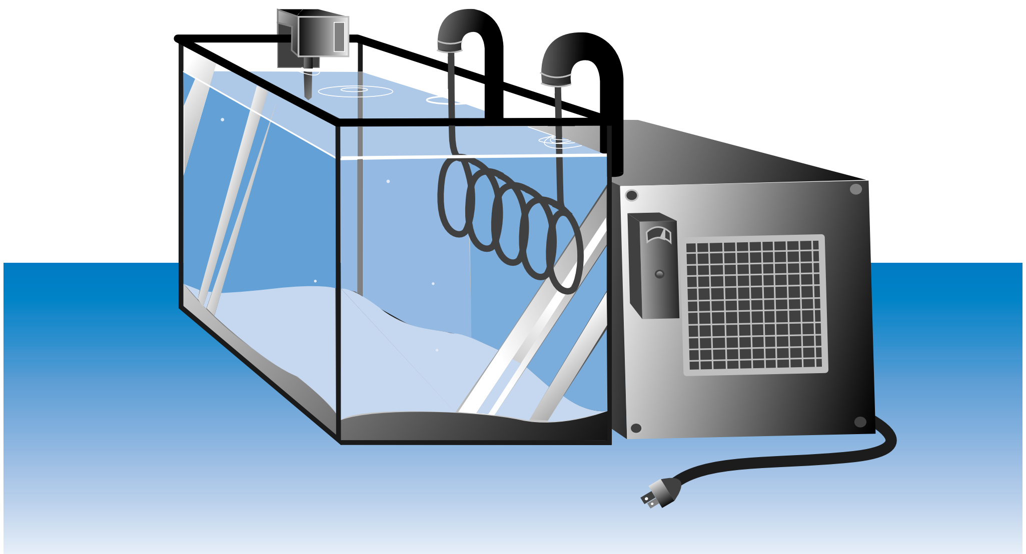
THINK ABOUT THIS!

Large pieces of styrofoam will also be used. What for?

How does this compare with the aquarium you designed in *A Lesson in Survival*?
How is it the same? How is it different?

What are all the ways that technology is being used in the aquarium?

Incubation Unit Guidelines



Looking after fish is a art. There are many experts who apply their own variations to good fish care. Even though experts often disagree, these guidelines form a core of information that will enable you to look after your unit. Detailed instructions will be provided by a representative from the Atlantic Salmon Federation or its affiliate. The units have proven to be quite reliable. If you have a problem, read the guidelines and then check the trouble shooting section at the end.

- The unit should be set up and filled with water at least one week before the arrival of the eggs. This will get rid of any chlorine from the water and give you a chance to establish the proper water temperature and become familiar with the unit, particularly the temperature controls.

- Ensure that you have a solid table or platform that is wide and level. A water-filled aquarium is very heavy and needs lots of support.

- Locate the unit near an electrical outlet and in an area not exposed to direct sunlight. Avoid using an extension cord if possible; if not, use a good quality, heavy-duty cord. The unit should be set up in an area where it can be supervised at all times.

- Pre-cut styrofoam may be provided. The ends of the aquarium should be covered, but the front could be left exposed.

- Fill the unit with well water that has been approved by the Department of Health or from a chlorinated water supply. Let tap water run for 3 minutes before use and let the water stand in the aquarium at least 72 hours to allow the chlorine to be released. As a precaution against disease, do not use water from a river or pond.

- On the bottom, place a layer of washed gravel or rocks with a diameter of 2.5–7.5 cm. The students could collect and scrub the rocks but do not use any cleaners.

- Become familiar with the cooling system. Before the eggs arrive, practice making adjustments on the thermostat. Since the aquarium water is slow to change temperature, you should check it several hours after making an adjustment. (It may have frozen solid!) **Know where the reset button and on/off switch are located.**

- If your unit freezes (the coil becomes encased in a chunk of ice), unplug it, increase the therm-ostat setting, and wait for the ice to melt. You can keep the filter on if there is enough water. Start the cooling unit again. Note the temperature at which the refrigerator motor starts. This is an important indicator that your thermostat is properly adjusted. Temperatures indicated on the thermostat dial are often different from the water temperatures indicated by the thermometer. **Trust your thermometer!** Make a few quick notes (eg., thermostat reading of 1°C is really a water temperature of 5°C). Discuss this issue with your coordinator.

- Adjust the water temperature to 10°C as a starting point and gradually reduce the temperature to 5°C over the first few days.

- The filter is a basic unit found on almost all aquariums and comes with simple instructions. If in doubt, speak to the ASF representative. The filter inserts do not need to be changed unless you overfeed the fish, but they should be washed periodically. Once the alevins emerge, it is wise to rinse one of the inserts each week (eg. week one, rinse the foam filter; week two, rinse the charcoal insert; week three, rinse the ammonia insert). Do not rinse them at the same time. Make sure that you have a mesh cover over the filter intake so that fish are not drawn into the filter.

- Make sure that the unit is ready when the eggs arrive. Water temperature should be 4°–6°C. The ASF representative will provide you with specific information, including any temperature adjustments for your particular stock of fish.

- When finished for the year, remove and clean the gravel. Clean the empty aquarium with diluted Javex or another disinfectant. **Rinse everything thoroughly.** Disconnect the filter and discard the cartridges and sponge. Store the unit in a safe place.

TROUBLE SHOOTING

Problem: **Ice has formed around the coils**
Solution: Coil freeze-ups are often due to poor setting of the thermostat or non-submerged temperature probes. Re-adjust the thermostat using a screw driver. Check the temperature probe and ensure it is in contact with the water.

Problem: **Cooling system is not running.**
Solution:
1. This may be due to a burned out fuse or a tripped circuit breaker. Push the reset button on the cooling unit or replace a fuse if necessary.
2. Some older units have an on/off switch. Be sure it is in the 'on' position.
3. Be sure the unit is plugged into the wall
4. Test the wall outlet to ensure it has not tripped a breaker.
5. Screening around the cooling unit may be plugged. Vacuum the screening on the cooling unit to allow for better air flow to the unit.

Problem: **Pump and/or filter not running**
Solution:
1. Be sure the unit is plugged into a wall or cooling unit outlet
2. Be sure the outlet has not tripped a breaker.
3. The unit may have de-primed itself during a power outage. Fill the unit to the top with water.
4. The impeller may be stuck. This will sometimes happen if the system is shut down for a period of time (power outage). The electric motor on the bottom of the unit must be removed and the impeller cleaned. Refer to aquaclear 300 instructions.

5. Screening around intake pipe inside the aquarium needs cleaning to allow water into the unit.

Problem: **On first use of the year, the unit does not cool well.**
Solution: Vacuum the air screen, clean the coils thoroughly, and check that fan is working properly.

Problem: **The water in the aquarium is murky.**
Solution: This is probably due to overfeeding. Refer to the feeding directions on page 98.

Problem: **Condensation has formed on the outside of the tank.**
Solution: Temperature differences between the room and the water in the tank can cause condensation. Increasing the water temperature in your tank may solve this problem as long as you remain within the allowable temperature range for the fish. Also, large numbers of people in airtight rooms can cause condensation. Opening some windows may reduce the problem.

Problem: **Newly hatched fish are being drawn into the mesh screen on the pump.**
Solution: Adjust the filter speed to 'slow'. Refer to pump instructions.

Biological troubleshooting guide

This guide is intended to help you deal with problems that may arise with the eggs and fry during the Fish Friends program. Sometimes fish get sick and die and it is good to know why this is happening and what you can do if anything to correct the problem and reduce the numbers of dead fish.

Problem: **Dead eggs**
Solution: Eggs turn white when dead. It is important to remove dead eggs immediately. If dead eggs are left in the tank a fungus may develop on them. This fungus looks like white cotton. The egg eventually looks like a little cotton ball. This fungus can attack nearby live eggs and kill them. So again, it is important to remove the dead eggs.

Problem: **Fungus on fish**
Solution: Sometimes the cotton-like fungus attacks live fish. If this happens, you should remove the infected fish or give them a salt bath.

Salt Bath for Fungus:Caution Notes: 1. Do NOT used iodized salt for this - get salt from a fish plant instead.2. Do NOT use tap water, as it may well be chlorinated which will kill the fish. A fish plant is usually the best place to find non-iodized salt. Contact the one closest to you.

Mix two tablespoons of iodine-free salt into a gallon of clean water (probably well water), and stir until it is dissolved. Then place the fry in this mixture for two to three minutes, then remove. Remove them sooner if they appear to be in distress, i.e. rolling over. If the fry do have a fungus, it would be a good idea to change the water in the tank and to clean the tank and other equipment thoroughly using a mild javex and then rinsing well afterwards.

Problem: **Fungus on the bottom of the tank**

Solution: This usually occurs when too much feed has been put in the tank. The fungus attacks decaying food. Again, it should be removed immediately.

Problem: **Gill disease**

Solution: Again this may be a function of too much feed. The extra feed in the water can irritate the gills and the fish produce a mucus to rid them of the irritants. A sign that your fish have gill disease is that the gill plates or operculum are flared out. As this is likely to happen when you are close to releasing the fish, you can release them sooner or do salt bath as described above. Again the best way to prevent this is to make sure you do not over feed and that your water is clean.

Problem: **Premature hatch**

Solution: Hatching can occur basically any time after the eggs have eyed. The causes for premature hatch are not clear, but it seems that once the fish hatch, they continue to develop as if they were still in the egg shell. There is really not much we can do, but careful handling during pickup, transport and placing the eggs in the tank can help reduce this problem.

Problem: **Fish dying**

Solution: Not every fish that is hatched lives. If they all did, then we would be overrun with them. If you notice one or two fish dead in your tank, do not worry. If you notice many per day then you have a problem. Something killing them off may have been introduced to the water.

Questions to ask are:

a. were the fish healthy and eating well before this happened?
b. are the fish behaving like they are trying to escape from the tank (ie. get away from the problem.)
c. is the water cloudy or does it have a bad smell? These are all signs that a substance has been added to the water. Try changing the water in the tank or plan to release the fish as soon as possible.

Any of the following can have a major impact on your fish - <u>strong detergents, hand lotion, chlorinated tap water</u>. Check for foreign objects such as <u>pennies</u>, which can kill the fish.

Sometimes, fish never learn to eat. They continue to swim around and look normal, but eventually they weaken and die. These fish are referred to as pinheads due to their shape. These pinheads usually all die around the same time, so your dead fish count will be very high. The only solution is to release them early. The pinhead die-off usually occurs very close to your release date.

Problem: **Transporting the fry**

Solution: If you have access to a fry tank from the local Department of Fisheries and Oceans or Provincial hatchery, use that. If not, a large cooler works well. Fill about halfway.

Problem: **None of the above provides a solution.**

Solution: Contact your regional representative for help. see page iv

Page 89

Fish Are Cool

Through this activity, the students will develop their own understanding of the meaning of warm blooded and cold blooded and then relate this understanding to fish eggs. It's a relatively short activity and appropriate for students to do individually or in groups. It will help them understand why the water temperature in the aquarium must be kept low and constant and why it's important to monitor the temperature. These ideas are further developed in the next activity, *Adding Degrees.*

Begin the activity by asking the students:

- **What does "cold blooded" mean?**
- **What does "warm blooded" mean?**

Write their suggestions on the board or flip chart so you will be able to refer to them later.

Some students may think that warm blooded organisms have warm blood and cold blooded organisms have cold blood. This is not so. Encourage them to think about the effects of the change in the temperature of the water on the body temperatures of the fish and the swimmer. The main difference is that the temperature of the fish changes while that of the swimmer remains constant, regardless of the water temperature. This is the essence of the difference between cold blooded and warm blooded animals; the body temperature of cold blooded animals fluctuates with the temperature of their environment while warm blooded animals maintain a constant body temperature. The students should be encouraged to describe this in their own words. Ask the students what it means when they 'have a temperature'.

To end the activity, have the students compare their understanding of warm blooded and cold blooded with the ideas they expressed earlier.

Since fish are cold blooded, their body temperature remains close to that of the water around them. This also applies to fish eggs. If the water gets warmer or colder than they can tolerate, they will die. The water temperature will have to be monitored and recorded on a regular basis until the fish are released. During the egg stage, the temperature should be kept between 4°C and 5°C. After the eggs have hatched, a constant (but slightly higher) water temperature is needed to stimulate feeding activity.

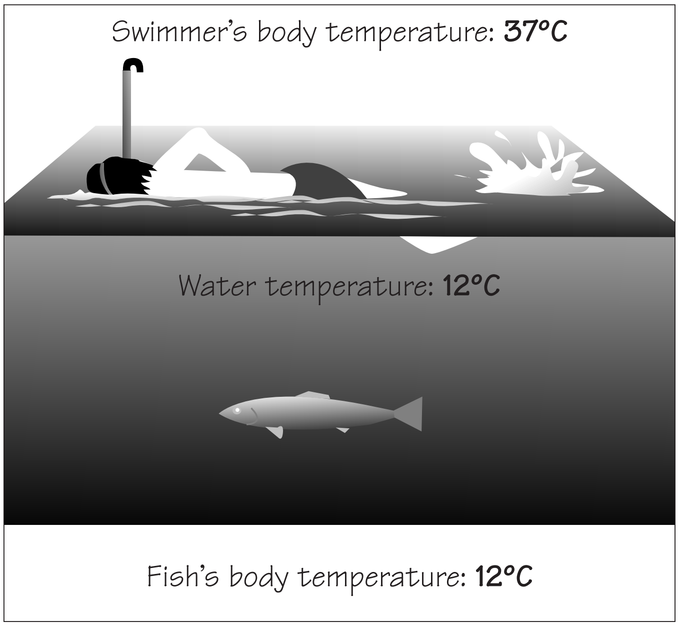
Background

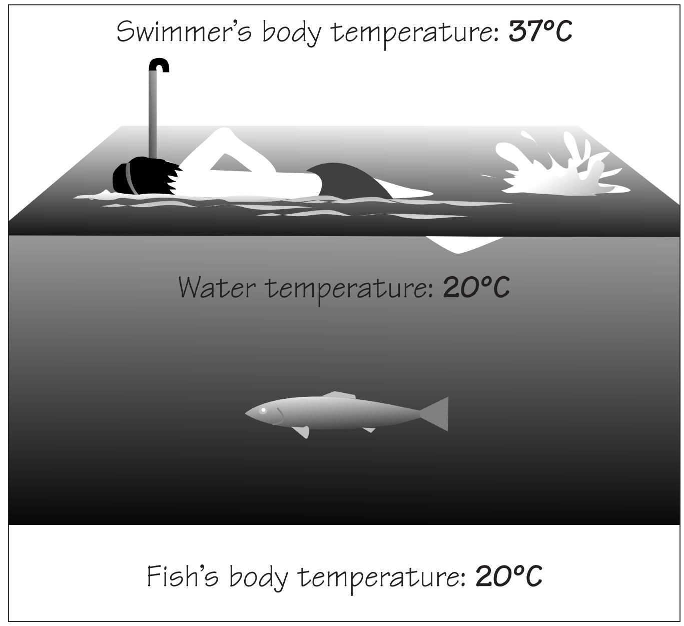
Water temperature is important because the sum of the average temperature of each day (sometimes referred to as **Degree Days** or **Accumulated Thermal Units, ATUs**) determines when the eggs will hatch. When you receive your eggs, they will be in the **eyed stage**. This means they have already developed from fertilization to the stage where the eyes are visible. This usually requires a total of about 250 accumulated degrees . The hatchery which has supplied the eggs has been maintaining a water temperature of about 4°C to 5°C. This means that to accumulate 250 degrees, the eggs have been developing for about 50–60 days.

This method of recording the accumulation of degrees is used to determine the stages of egg development and to predict the date of hatching. The eggs will hatch when they have accumulated a total of 430–450 degrees. The aquarium in your classroom will not be as efficient at maintaining a constant temperature as in the hatchery and the fluctuations may be greater. However, by recording the temperature daily, your students will be able to calculate the accumulated degrees and, later, predict when the eggs will hatch.

Fish Are Cool

Look carefully at these two pictures:





What has happened to the temperature of the water?

What has happened to the body temperature of the fish?

What has happened to the body temperature of the swimmer?

The fish is described as **cold blooded** and the swimmer is **warm blooded.** What do you think these terms mean?

cold blooded:

warm blooded:

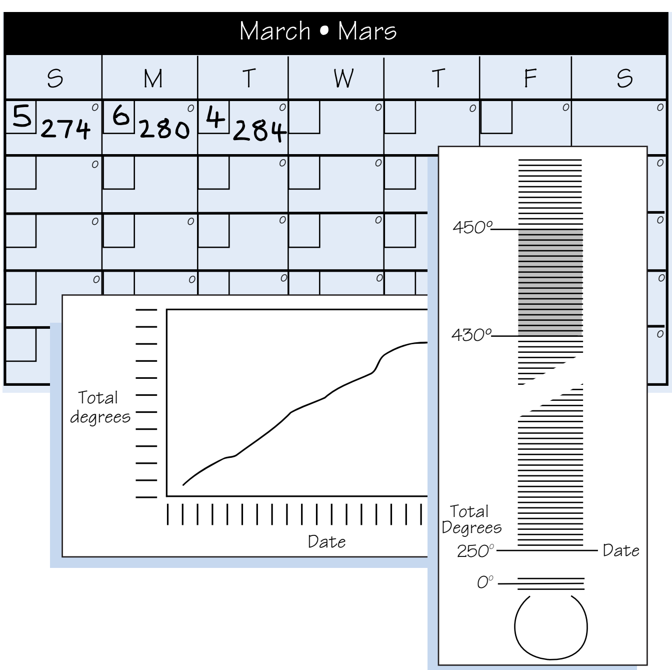
Fish eggs are also cold blooded. What will happen to the temperature of the egg if the water temperature in your aquarium changes?

Adding Degrees

Adding Degrees introduces the idea of total degrees and challenges the students to design appropriate charts to record their data. A few simple math exercises are included to provide examples for the students of the types of calculations they will be making. You may want to include more.

This activity is probably done best in small groups. It's important to encourage the students to suggest what they think are some of the ways they can record their own observations. Depending on their previous experiences in recording data, they may need some guidance.

The critical data to be recorded are daily temperature and total degrees. Charts and/or graphs are easiest and a variety of forms will work. A few possible examples are shown below. The students may also want to record other observations on a regular basis. Information such as the number of dead eggs removed, changes in the appearance of the eggs, when the aquarium had to be cleaned, could also be noted. An exchange of suggestions from each group will show many similarities.
The next step is for the entire class to decide which are the best charts/graphs/tables to use and then prepare them to be mounted on a wall for everyone to use. Encourage at least 3 or 4 approaches even if they don't seem to be the most suitable and may eventually prove to be inefficient. In a later activity, after all the data has been collected, the students will be given the opportunity to evaluate the appropriateness of the various methods they used. The data recorded will also be used in the next lesson to predict when hatching will occur.



You will have to develop a schedule for recording the data. This could be assigned to a different student each day or to teams on a weekly basis. Regardless of the approach taken, the students should record the data in each of the charts being used. This should be done at the same time each school day. It's not necessary to record data on weekends or holidays. Once a pattern in the daily temperature has been established, the students can estimate the total degrees on any Monday. A practice exercise is included.

On the student's page, note that the data recorded for March 3 and 4 become estimates based on knowing the constant water temperature (5°C). School was cancelled on March 6.

Date	Temperature	Total Degrees
Feb 26	5°C	265
Feb 27	4°C	269
Feb 28	5°C	**274**
Mar 1	5°C	**279**
Mar 2	**5°C**	284
Mar 3	**5°C**	**289**
Mar 4	**5°C**	**294**
Mar 5	5°C	299
Mar 6	**5°C**	**304**
Mar 7	6°C	310

Adding Degrees

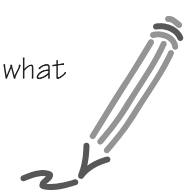
It's important to watch the temperature in your aquarium each day. It is also important to know the sum of the degrees (today's temperature added to yesterday's total). From this figure, we can find out when the eggs will hatch. Here's an example:

First day .....temperature 5°C ....total degrees 5
Second day..temperature 6°C ......total degrees 11
Third day.......temperature 5°C ....total degrees __?
and so on until the eggs hatch at a total of 430–450 degrees.

Here is an example of a table that a class used last year. Some of the numbers are missing. Can you fill in the blanks?

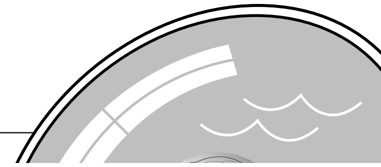
Date	**Temperature**	**Total Degrees**
Feb 26	5°C	265
Feb 27	4°C	269
Feb 28	5°C	
Mar 1	5°C	
Mar 2		284
Mar 3 (Sat)		
Mar 4 (Sun)		
Mar 5	5°C	299
Mar 6		
Mar 7	6°C	310

Imagine you are a fish egg. Tell what it's like to live in the aquarium, especially if the temperature changes!



Before the eggs arrived in your classroom, people at the hatchery recorded the necessary information. Now it's your turn. Design some charts or graphs that you could use to record water temperature and the total degrees for the eggs each day.

Egg Watching



In this activity the students will observe the eggs, and predict what they'll look like after hatching. The students are also challenged to measure the size of an egg without touching it.

Petri dishes would be ideal but not essential; any clear container, glass or plastic, will do. Small medicine cups may be readily available. A turkey baster could be used to transfer the eggs. Stress with the students that it is important to be careful when handling the eggs as they are very fragile. Be prepared for some mortality of eggs in this activity, not just from the mechanics of moving them from the aquarium but also from the change in water temperature. The temperature of the water in the small containers will rapidly increase to room temperature and you may lose a few eggs. Consequently, it's probably not wise to provide each student with an egg to observe. Pairs or small groups would be best.

Let the students describe the eggs before using a magnifying lens, encouraging them to practice the use of descriptive vocabulary. They could describe its shape, what it looks like from different angles, and any recognizable body parts.

To measure the eggs they can simply place a ruler under or behind the container directly where the egg is located. They'll be able to read the measurement through the water and the container. Note that they will be measuring the diameter of the egg, not the length of the fish inside which is somewhat curled up.

Each group should have at least one magnifying lens. If you are able to borrow a microscope, so much the better. A regular monocular microscope will be of little help, however. What you need is a binocular microscope, which allows you to place a small dish containing the egg directly under the lens. A local high school may be able to help.

March Break

It is not necessary to record data over the March Break. You can use average daily temperatures based on the data collected so far. Here is a table you could put on the board or a wall chart before you go.

Date of last school day before Break	____
Total Degrees so far	____
Normal daily temperature so far	____
Date of first day back after Break	____
Number of days away	____
New Total Degrees	____

If you think the eggs will hatch during March Break, reduce the temperature on the cooling unit to delay development.

Egg Watching

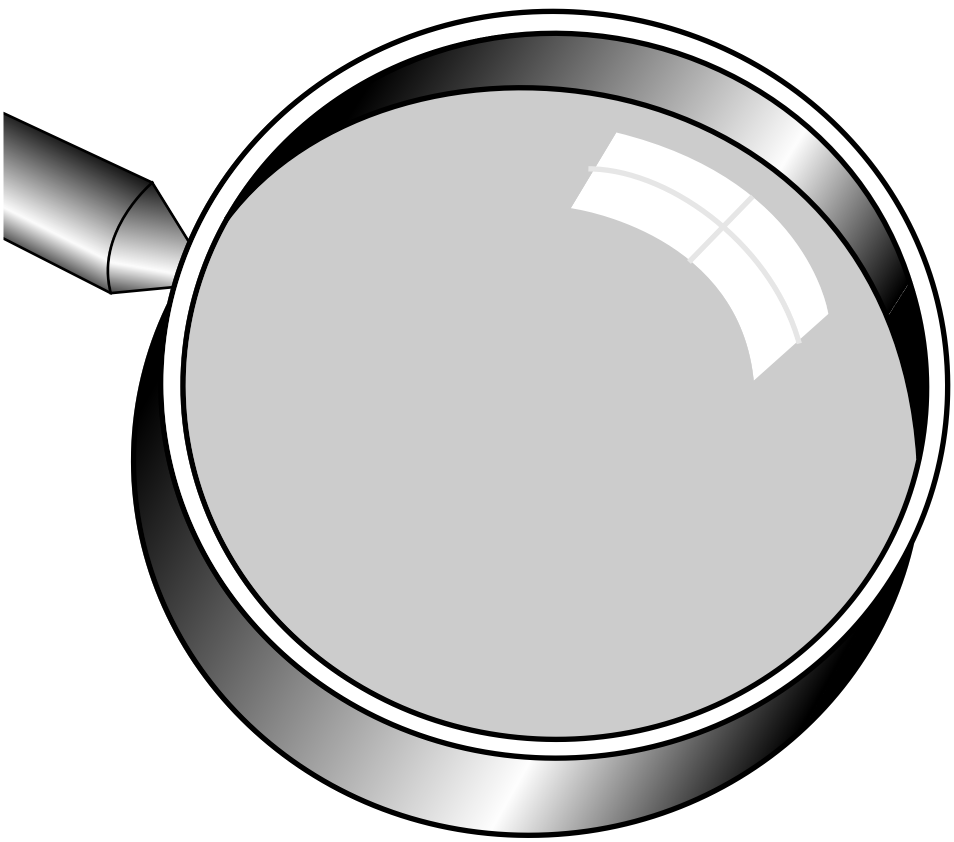
Put some of the aquarium water in a small dish and then add one of the fish eggs. Describe what the egg looks like.

How could you measure the egg without touching it?

Try it! How big is it?

What do you think will hatch from the egg?
Draw it.

Draw what you see through a magnifying glass.



Did You Know? An adult female salmon lays about 1700 eggs per kilogram. If she weighs 4.5 kg. how many eggs will she lay?

Lesson 12

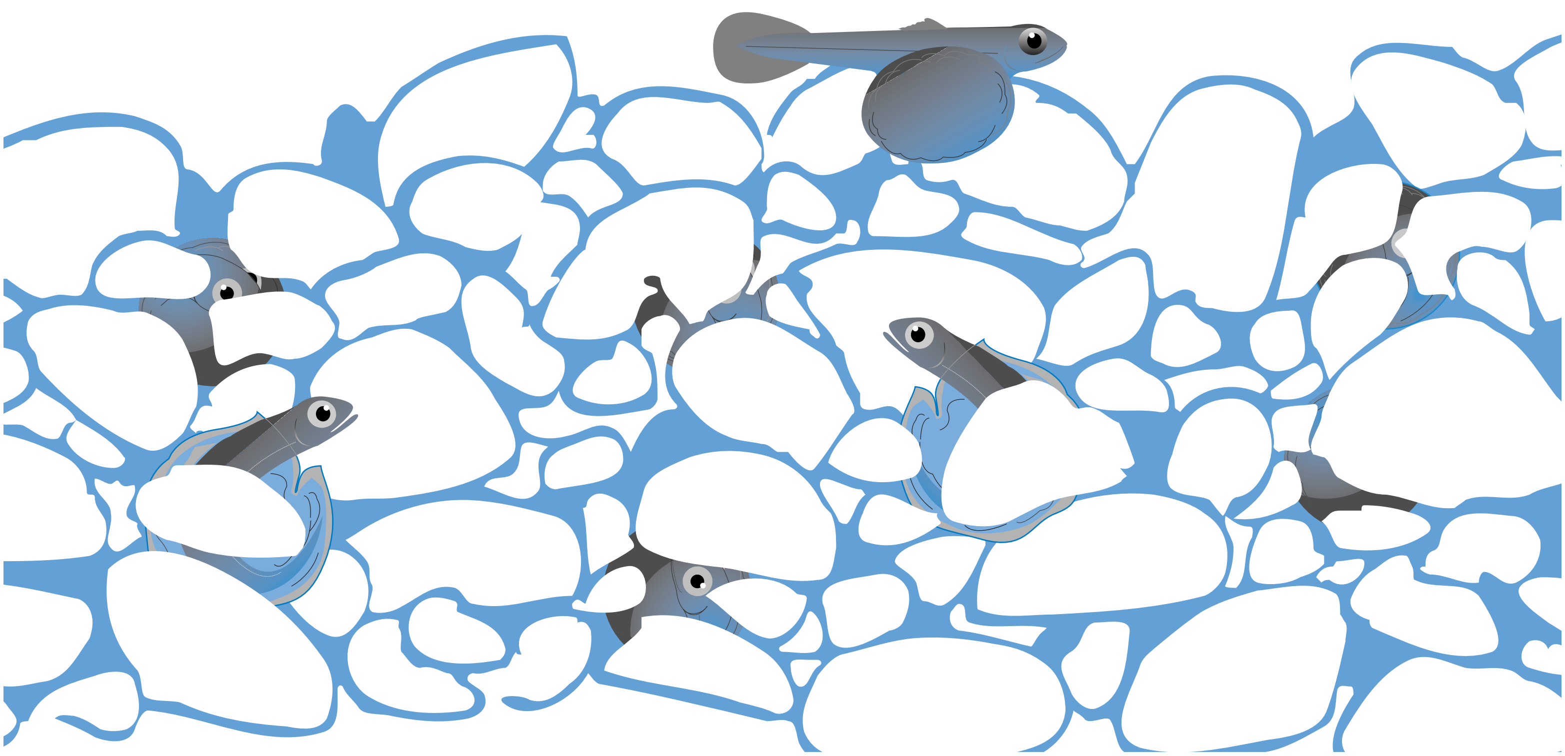
EGGS TO FRY

Main Ideas

Newly hatched fish have special needs and their survival depends on the environment's capacity to meet these needs. The conditions in a fish's natural environment must be reproduced and monitored as closely as possible in the classroom aquarium to assure that the survival rate is as high as possible. Using appropriate data, it is possible to predict when fish eggs will hatch.

Objectives

The students will continue to record data using the charts and graphs they developed in the previous lesson. Based on the data they collect, the students will predict when the fish eggs will hatch. They observe the newly hatched fish and examine some of the physical and biological conditions the fish will face after they are released into a stream environment.



When Will They Hatch?

The purpose of this activity is for the students to predict when the eggs will hatch. You will need to know the total degrees accumulated at the hatchery before your eggs were delivered. It's important for the students themselves to determine the steps required to make their predictions. It will take a week or so to collect enough data. Have them think about:

- **What information they need to predict the hatching date**
- **The steps they will use to make their prediction**

Encourage them to look closely at the charts. All the information they need is there. They will use the total number of degrees needed to hatch, the current total degrees, and the average number of degrees accumulated each day. The students may already have an understanding of averages. If not, you can avoid 'average' by encouraging the students to look for patterns in the daily charts.

The students could make predictions independently and then form small groups. In the groups they expain their predictions. The group then reaches agreement on a predicted hatch date. Record all predictions (group or individual) on a wall chart.

Since all the students are using the same information, the predictions should be similar. The total degrees needed to hatch is presented as a range from 430–450 and therefore the predictions will also be a range of possible hatching dates.

For example:

Total degrees needed to hatch	430–450
Today's total degrees	285
Number of degrees still needed	145– 170
Average daily temperature	5°C
Number of days still needed	29–34
Today's date	Mar 1
Predicted hatching date (range)	Mar 30 –Apr 4

This provides a range of possible hatching dates within which specific dates can be chosen. If conditions change, eg., water temperature, ask the students if they want to change their predictions.

The eggs will probably hatch over a period of a day or so. You may be able to see them 'jumping' as they try to break out of their cases. The newly hatched fish, called **alevins,** are about 15mm long and have an obvious yolk sac attached, providing them with food. Be prepared! They will not be visible for long. They will soon move down into the gravel and spend the next several weeks there until the yolk sac is gone.

After hatching, a scum or foam may appear on the surface of the water. Don't panic. This is residue from the egg cases. Simply skim it off.

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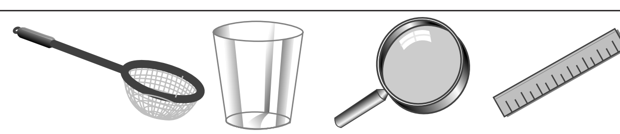
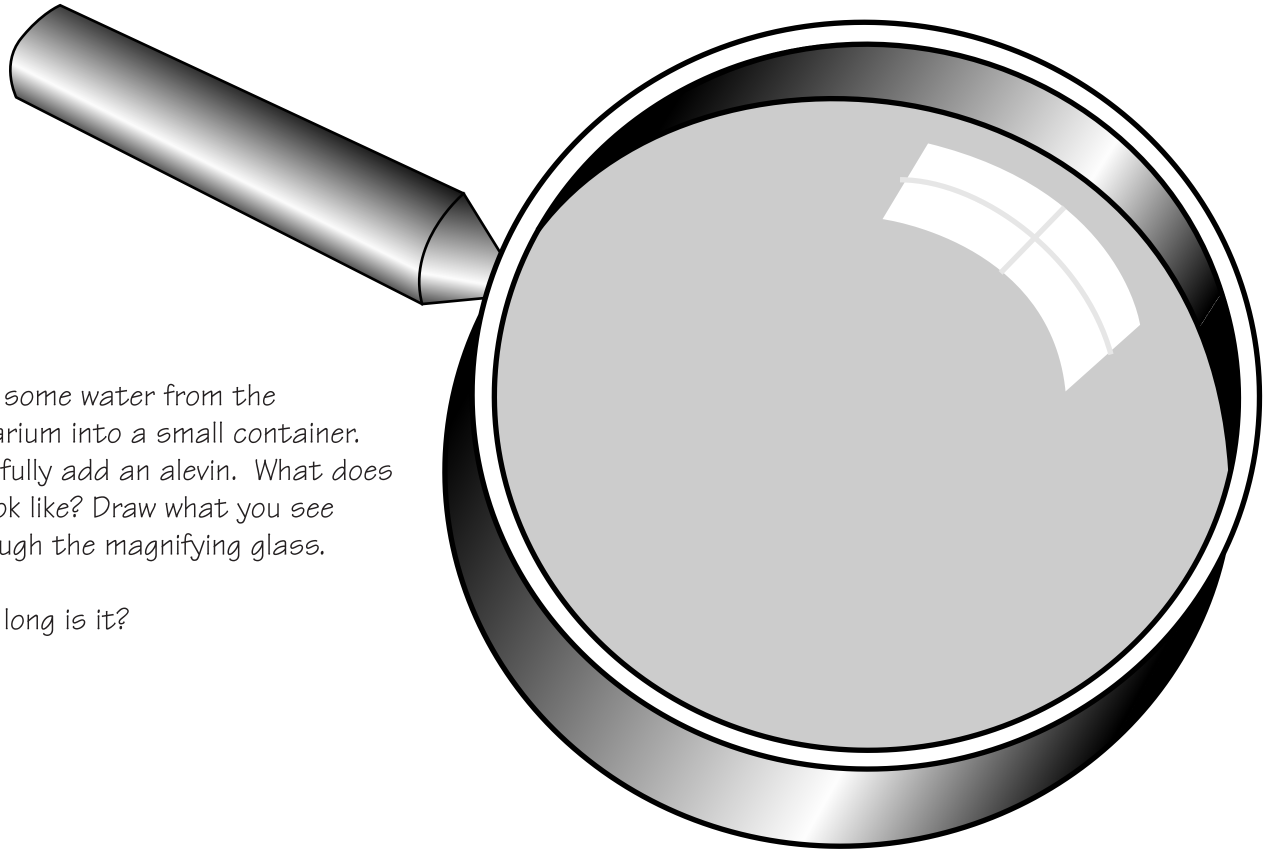
Where's Alevin?



Before the alevins disappear under the gravel, students will observe, draw and measure them. Care must be taken when moving them from the aquarium for observation. Small dip nets could be used for this purpose. The alevins are very small and it will be difficult for the students to observe them without magnification. Therefore, it is important to use hand lenses. Students can work individually or in groups, depending on the number of lenses avaliable.

Where's Alevin?



Put some water from the aquarium into a small container. Carefully add an alevin. What does it look like? Draw what you see through the magnifying glass.

How long is it?

In *Egg Watching* you drew a picture of what you expected to see when the egg hatched. How does that picture compare with what you now see? Is anything different?

____

____

____

____

The alevins will soon disappear. They will wiggle into the gravel and live there for several weeks. Can you see any special features of the alevins that will help them survive while in the gravel? Explain.

____

____

____

____

Use your imagination!

Draw a cartoon about two alevins living in the gravel.

Brave New World

After 6–8 weeks the fish, now called **fry**, will emerge from the gravel. Have the students make a final drawing and describe any differences they see between the fry and the alevins.

It is now necessary to provide food for the fish. Wait until the fry are sitting on the gravel and water temperature has been adjusted to stimulate feeding before sprinkling food on the surface of the water. The fish need only small amounts of food at this stage. Give them about .5 ml (1/8 tsp)in the morning. Feed again just before leaving for the day only if you are certain all the food has been consumed.

Overfeeding contaminates the water and will kill the fish. Stay with the regular amount and on schedule. There is no need to feed on weekends or over holidays. Do not feed extra amounts to make up for days missed.

Before the fish are released, the students compare the environment of the aquarium with the natural environment of a stream. They will examine the differences between the two environments in terms of challenges to survival.

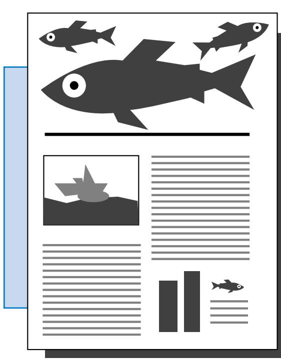
In the aquarium, the fish were well protected and taken care of. In a natural stream environment, they will face challenges from predators, pollution, lack of food, storms, drought, etc. This may be a good time to talk again about survival rates in natural environments.

Humans can have both positive and negative impacts on a stream. Many students are well aware of the problems of pollution and habitat destruction from human activities. Encourage them to think of the ways in which people can have a positive influence on the stream environment. Anti-litter campaigns, stream clean-up projects, active protests against the destruction caused by some industrial, forestry and farming practices (large and small), and education programs can all play a significant role.

A representative from the Atlantic Salmon Federation or one of its affiliates will coordinate the release of the fish into an appropriate stream. This will occur shortly after the fry emerge from the gravel and begin to feed on their own, probably in early to mid June. The release will coincide with the emergence of fry and potential food sources in the natural environment. This is determined by monitoring the water temperature of the stream.

In consultation with the ASF representative, determine the best way to transport the fish to the release site. This will probably be done in one container with water from the classroom aquarium. Individual students can then be given a few fish in a plastic bag to release on their own.

You will have to make the necessary arrangements for transportation to and from the site. Make sure the students are dressed properly, expecially with suitable footware.



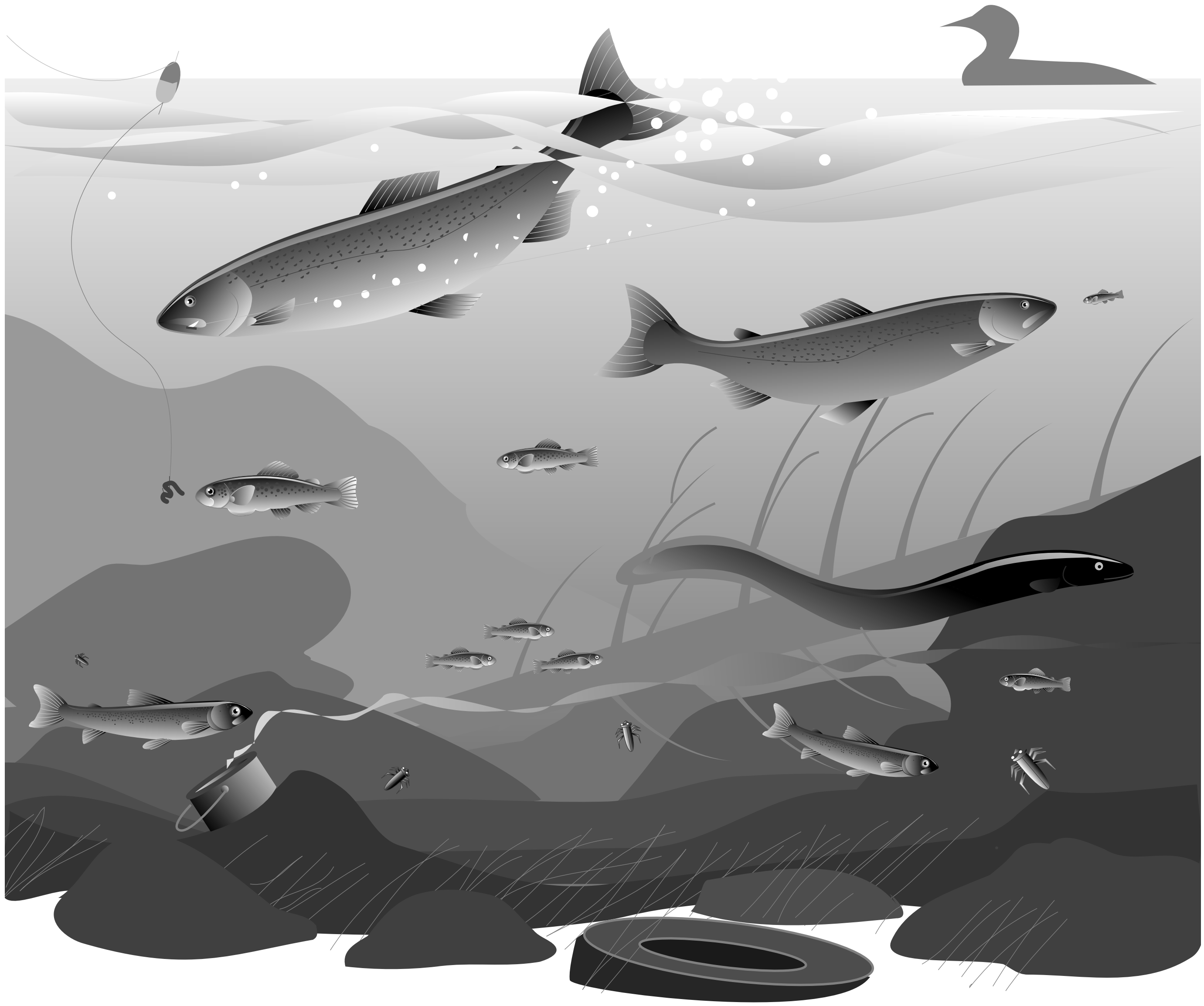
Now would be a good time for the students to prepare another newsletter.

Background

Atlantic salmon have a survival rate of about .03% -. 04%.

Oct/Nov ....7500 eggs are laid
April/May...................................4500 hatch
May/June ....650 reach fry stage
Over 2 to 4 years ....200 survive as parr
Next spring ....50 migrate to sea as smolt
A year (or more) later.................2 or 3 adults return to spawn

Brave New World



Your fish will soon be living in a stream that looks something like this.

Here are some questions for your group to discuss:

- How is this stream different from the aquarium?
- What new challenges will the fish have?
- In what ways can people damage a stream?
- How can people help a stream?

Use Your Imagination!

You are a fry being sloshed around in a bucket of water. Suddenly you are turned upside down and poured into a stream. You tumble over and over and over again. Finally you come to a stop, open your eyes and...

Appendix

Bug Dial • Side 1

Photocopy all four parts of the Bug Dial

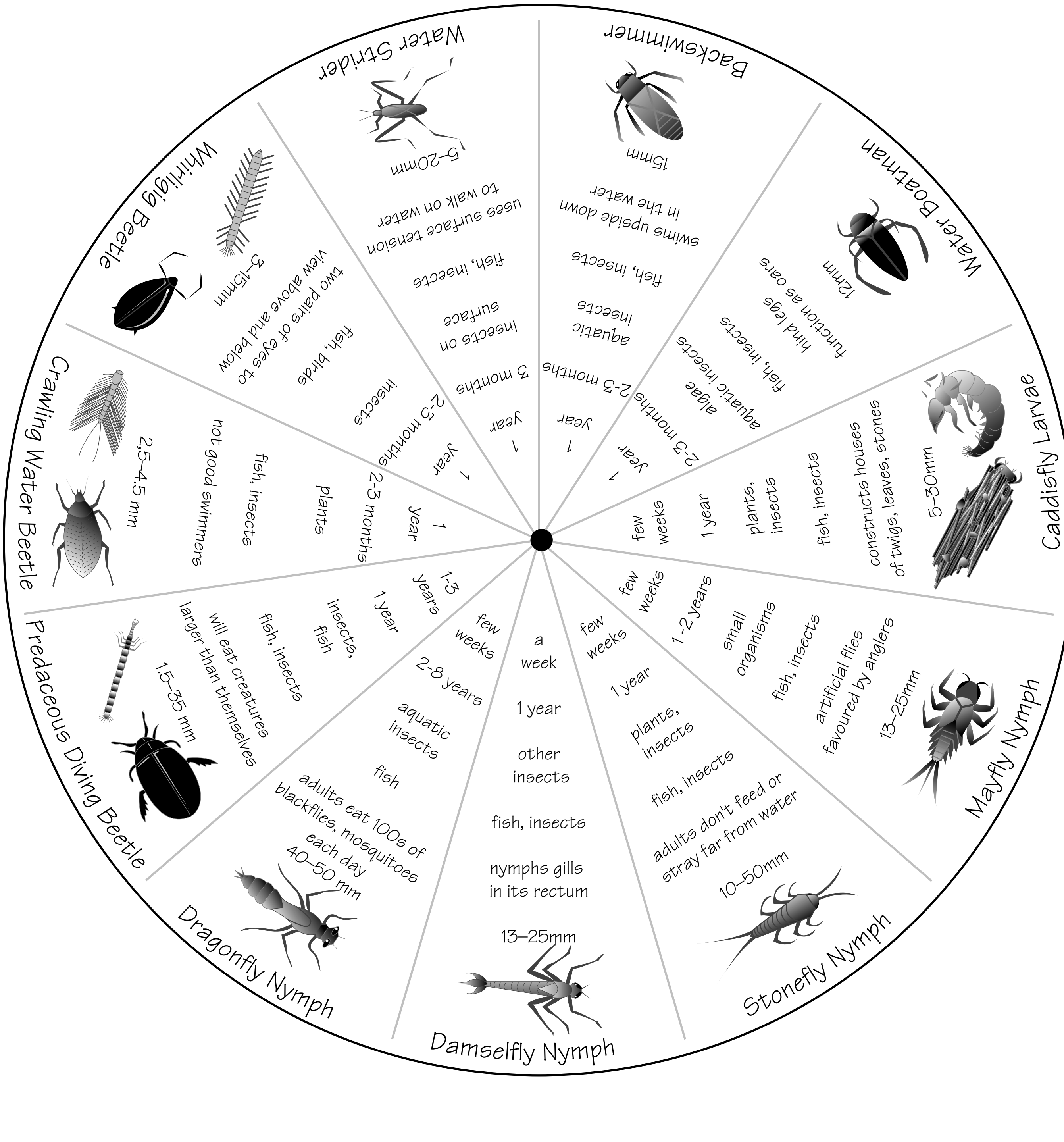
Glue them to Bristol board or other light cardboard and cut them out.

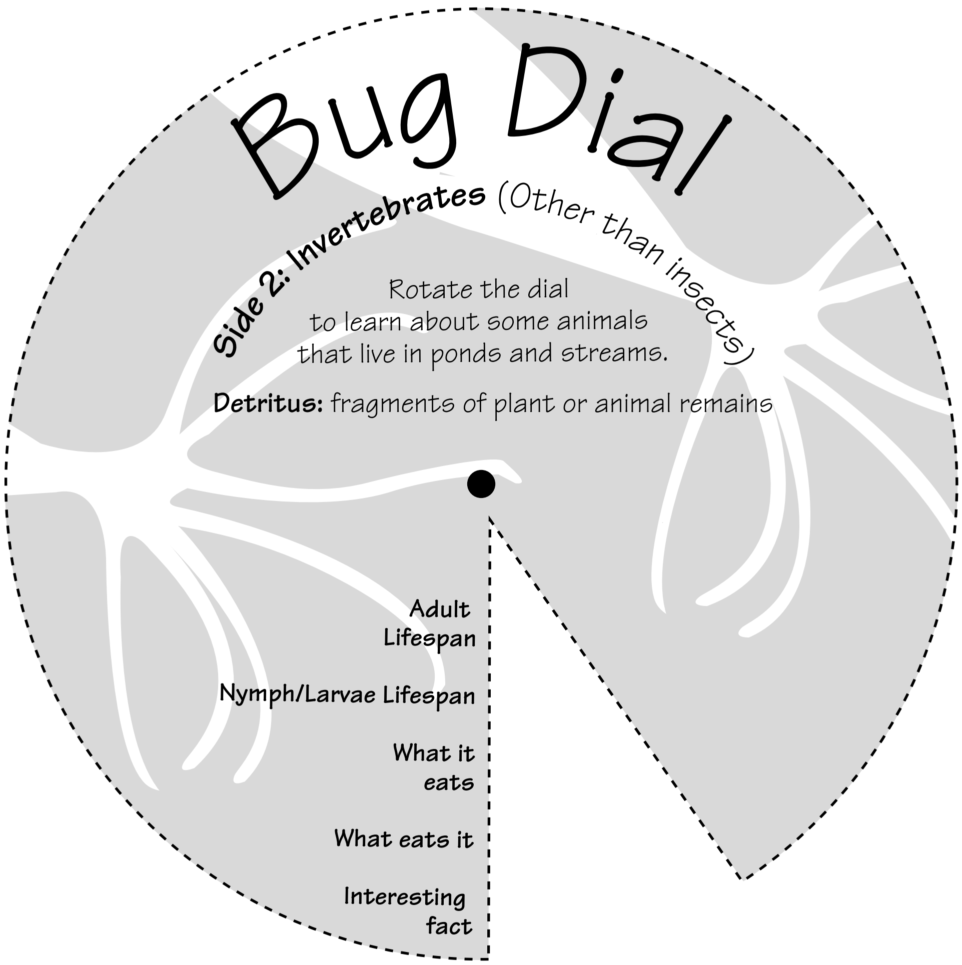
Center the small dials on the corresponding larger ones and punch a small hole through the center black dot.

Use a paper fastener to attach all four together, with Side 1 and Side 2 back-to-back.

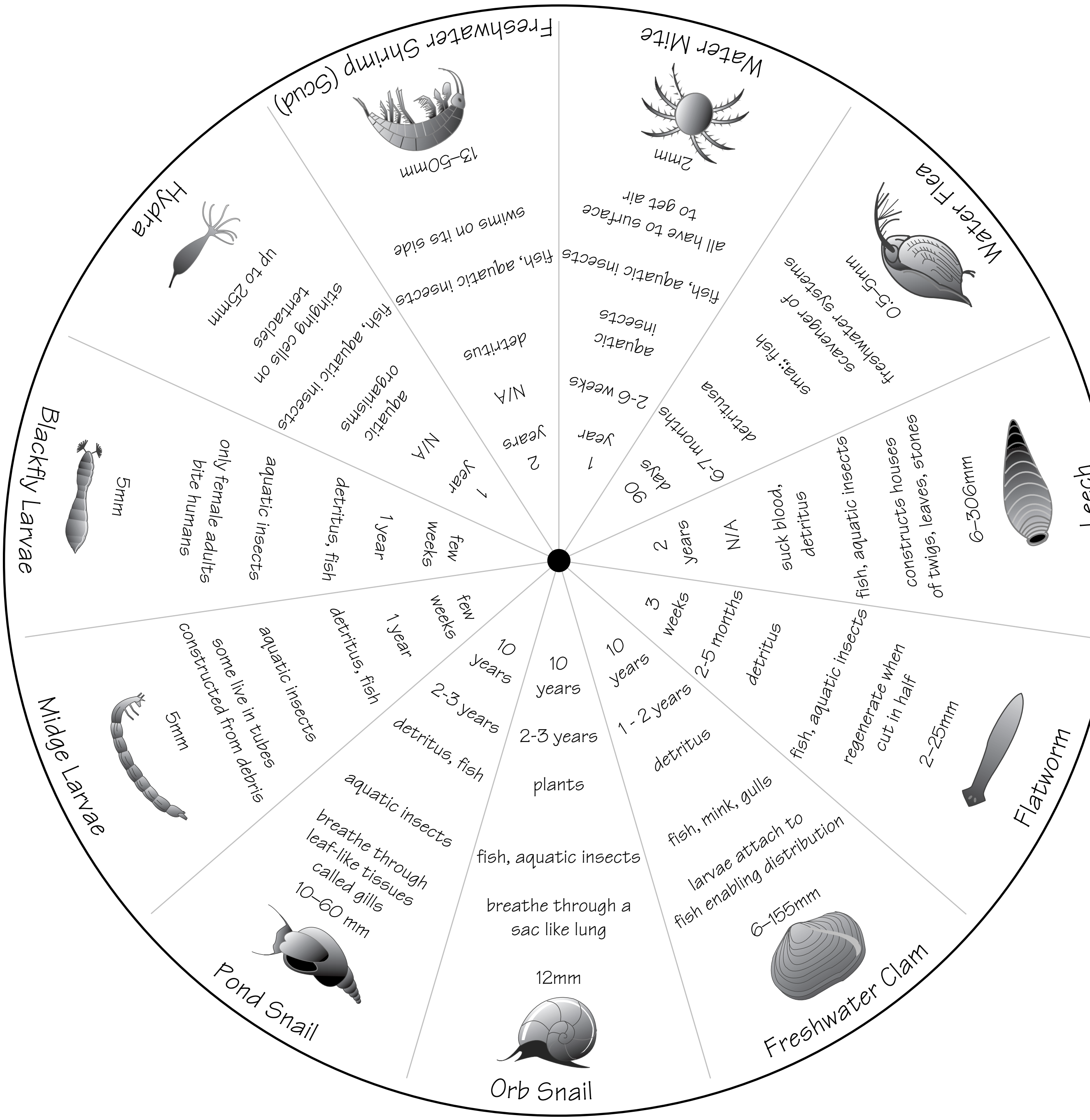
Rotate the small dials to learn about various animals that live in freshwater.

Bug Dial • Side 1




Bug Dial
Side 2: Invertebrates (Other than insects)
Rotate the dial
to learn about some animals
that live in ponds and streams.
Detritus: fragments of plant or animal remains
Adult Lifespan
Nymph/Larvae Lifespan
What it eats
What eats it
Interesting fact

Bug Dial • Side 2



Credits

Sources used in the development of this edition are:

An earlier draft of *Fish Friends* by the Huntsman Marine Science Centre, St. Andrews, New Brunswick

Page 4: Activity adapted from *Earth Child*, Kathryn Sheehan and Mary Waider, 1991, Council Oak Books, Oklahoma

Pages 10, 30, 35: Adapted from *Salar: The Story of the Atlantic Salmon.* Gary Anderson & Ann Brimer

Page 19: Adapted from *The Diversity of Life,* Edward O. Wilson, published by W. W. Norton & Co., Inc.

Pages 19, 42, 73, 74: Adapted by *Project Wild Activity Guide* 1993, sponsored by the Canadian Wildlife Federation

Pages 32, 38, 39, 48, 49: Adapted from various publications by the Nova Scotia Department of Fisheries

Pages 40, 48: Contributed by M.N. Robinson

Page 43: Adapted from *Keepers of the Animals,* Michele Caduto and Joseph Bruchac, Fifth House Publishers, Saskatoon

Page 64: Adapted from a series of articles by Bob Bancroft in *Eastern Woods & Waters* and *Atlantic Beef*

Page 68: Adapted from *World Resources,* a report by the World Resources Institute and *Developing a Cooperative Framework for Sustainable Development Education* by the National Round Table on the Environment and the Economy.

Page 70: Adapted from *Developing a Cooperative Framework for Sustainable Development Education* by Learning for a Sustainable Future

Page 76: Adapted from *Salmon Enhancement,* David Snow, the Salmon Association of Eastern Newfoundland

Resources

Many audiovisual and printed resources support *Fish Friends.* Check with your regional representative or ASF Communications in St. Andrews, NB for up-to-date materials.

In addition, several special resources are recommended:

1. The Atlantic Salmon Federation *Fish Friends* sub-website has updated information on the program, troubleshooting, extra resources and contacts - at http://www.asf.ca/fishfriends/

2. The main ASF website is changed every few days, offering the latest information on issues impacting Atlantic salmon throughout its North American range, and in Europe. - at http://www.asf.ca

3. Schools using the *Fish Friends* curriculum are encouraged to share their experiences with other schools. Send stories and digital images to asfweb@nbnet.nb.ca - In addition a listing of schools involved with the program is posted on the ASF Fish Friends website at http://www.asf.ca/fishfriends/schools/

4. **Note for Teachers:** There may be special resources made available in future via email. Teachers involved are strongly encouraged to submit a contact e-mail address to: asfweb@nbnet.nb.ca