FISH FOR OUR FUTURE!

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JUST FOR TEACHERS

UNIT ONE — ALEVIN — for Elementary Students

An ALEVIN, such as a newly hatched salmon or trout, (pronounced 'ALE VIN) remains buried in the streambed gravel until the attached yolk sac is absorbed. When the young fish emerges from the gravel and begins to feed, it is called a "fry."

UNIT TWO — SMOLT — for Middle School Students

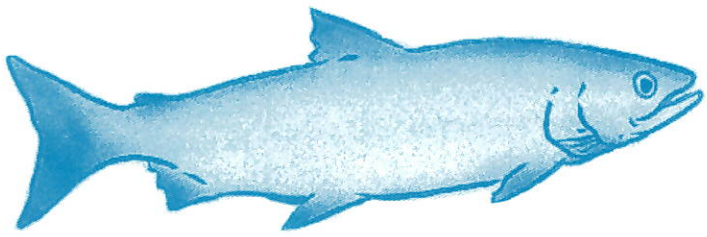
A young salmon (or sea-going trout) is called a "SMOLT" when it is ready to leave fresh water for the sea. Smolts have lost the dark "parr" markings on their sides and turned silvery

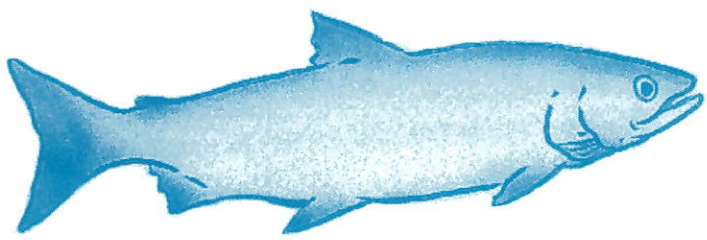
UNIT THREE — SALMON — for High School Students

EXTRA RESOURCE SHEETS

FISH FOR OUR FUTURE!

SALMON





TEACHER: WAT-ER IN THESE SAMPLES?

Overview:

Students will use water chemistry testing procedures to analyze the chemical composition of a stream or river and to predict whether or not various fish species could live in that body of water.

Objectives:

Students will be able to:

- demonstrate an understanding and concern for human influence on aquatic ecosystems
- analyze water samples for various chemical properties
- use their water chemistry data to predict whether or not certain fish could live in particular bodies of water

Subject Links:

- science
- geography

Time:

Classroom: two hours (one hour before and one hour after field trip)
Field Trip: three hours

Materials:

- water testing kits
- topographic map
- student resource sheet
- boat (optional)
- thermometers
- student worksheet
- chest waders (if no boat)

Background:

THE chemical composition of water may be used in determining if proper habitat conditions are present for the support of many species of plants and animals. This can vary greatly between bodies of water, and within water systems such as streams or rivers. Differences in physiology allow some animal species to live in conditions that would be fatal to others.

Fisheries biologists conduct water chemistry analyses to measure the chemical conditions of a body of water to determine what plant and animal species the water can support, and what can be done to improve water quality and habitat conditions. Students can perform similar tests to become familiar with the sampling techniques for the following components:

Dissolved Oxygen: Dissolved oxygen is the oxygen available to aquatic organisms derived primarily from air mixing with water by turbulence (commonly referred to as aeration) and photosynthesis. The amount of dissolved oxygen in a body of water may vary, depending on a number of factors, one of which is temperature. As the temperature of oxygen increases, it becomes less soluble in water. The solubility of oxygen is greatest at water temperatures near 0° C. When measuring levels of dissolved oxygen, it is therefore important to also measure the temperature of the water. Because of the dependence aquatic organisms have on oxygen for survival, testing for dissolved oxygen levels, along with temperature readings, is perhaps the most important water quality test.

One way oxygen is utilized is through respiration. During respiration, animals use oxygen to "burn up" organic matter, thereby releasing energy needed for life processes. Another way oxygen is used is decomposition. As organic matter decomposes, it provides a food source to fungi and bacteria. They inturn remove oxygen from the water. The greater the amount of organic material in the water, the greater the populations of fungi and bacteria. Organic pollutants can significantly reduce the amount of oxygen present in a body of water. Increased amounts of other gases such as carbon dioxide or methane also restrict the water's capacity to "hold" oxygen.

pH: pH is a measurement of the hydrogen ion concentration in a water sample, measured on a scale of 0 to 14.0. A pH value of 7.0 (pure, distilled water) is neutral; below 7.0 is acidic, above 7.0 is basic. pH is measured on a logarithmic scale, which means that every unit of change represents a tenfold change in the quantity of hydrogen ions. For example, water with a pH of 5.0 is ten times as acidic as that with a pH of 6.0 and one hundred times more acidic than waters with a pH of 7.0.

Fish generally prefer a pH level between 6.0 and 8.0. Most fish can tolerate pH values slightly beyond this range for short periods of time, and some for indefinite periods. Few species, however, can tolerate pH levels lower than 5.0 or greater than 9.0. In such extremes, fish experience difficulty exchanging gases across gill membranes and may die if the conditions persist. Acid precipitation, the result of smelters, coal-burning power plants, etc. reacts with water vapour in the air to form sulphuric acid, nitric acid and other toxic substances. As this falls to the ground and runs off the land into bodies of water, it decreases the pH level in that body of water. The lakes and rivers that have little natural buffering ability may suffer serious damage to their fish populations, as exemplified in many lakes and rivers in Nova Scotia.

Alkalinity: The alkalinity of water is the measure of its ability to neutralize acids. In water bodies, alkalinity is a result of dissolved carbonates, bicarbonates and hydroxides derived from the decomposition of limestone bedrock. (Other sources of these ions include rain, groundwater, as well as domestic and industrial sources such as lye and baking soda.) Alkalinity is a fairly reliable measure of how well a body of water can support life. A productive body of water has lots of living organisms that produce carbon dioxide during respiration. The carbon dioxide then reacts with the water to form carbonate and bicarbonate ions. Bodies of water that are productive then tend to have high alkalinity. Productive waters in areas with limestone may have readings of 200 mg/L or more. Readings below 50 mg/L are considered low.

Phosphates: Phosphates are nutrients that play an important role in life processes such as energy conversion and in the actions of enzymes and buffers. Common sources of phosphates include fertilizers, detergents and water softeners. Phosphates also enter water systems through natural processes such as: the decay of organic matter, sewage, manure and soil particles. In moderation, they constitute an important nutrient for many organisms. In excessive amounts, phosphates can destroy fish habitats because their presence promotes the growth of algae. The more algae that is present, the less oxygen is available for other species. As a result, some fish species that cannot tolerate reduced oxygen levels will die out. Phosphate concentrations of 0.015 mg/ℓ or greater are considered unsuitable for fish habitat.

Ammonia: Nitrogen is found in protein, and is therefore present in all living things. As such, it is an important part of the natural ecosystem. In water, nitrogen exists as a component of ammonia and nitrate. Ammonia enters the water through the decay of organic matter, including the decay of sewage. In addition, ammonia in fertilizers is dissolved in rainwater, some of which ends up in rivers and lakes during heavy rains. A concentration of ammonia in excess of 0.5 mg/ℓ can be lethal to some species of fish.

Nitrate: Through a chemical reaction, ammonia converts into nitrate, thus the source of nitrate is the same as ammonia. Increased levels of nitrate trigger excessive algal and plant growth, with an additional effect of reduced dissolved oxygen as the plants eventually decompose. Nitrate levels should not exceed 0.3 mg/ℓ in fish habitat.

Chloride: The most common chloride in water is sodium chloride, or salt. Chlorides occur naturally in freshwater ecosystems, however levels may become excessive from street runoff when roads are salted in the winter, or from sewage. A concentration of chlorides in excess of 50 mg/ℓ can impair fish habitat.

Advance Preparation:

1. Scout local streams or rivers for suitable worksites. Be sure to check for any dangerous features, and obtain permission from landowners.
2. If possible, secure topographic maps of the selected sites *(see Appendix for contacts)*, or prepare a sketch of the study area.
3. Set the date for the field trip. Advise students to wear appropriate clothing and boots.
4. ***If it is not possible to take a field trip:*** you may wish to bring samples from the sites to the classroom for analysis by your students. The following factors should be considered:
    a. Oxygen levels and water temperatures should be taken at the site. The samples may then be reassessed in the classroom and differences noted.
    b. Ammonia concentrations must be measured within 48 hours.
    c. Phosphates change within 5 minutes of sampling, but total phosphorus remains constant and can be measured normally.

Process:

PART ONE: IN THE CLASSROOM

1. Have students test a water sample from an aquarium or drinking fountain to practice the test procedures they will be using at their worksites. Students should be reminded to carefully follow the instructions contained in the kits. Discuss with students the importance for each test and what parameters they might expect to find in the body of water they will be sampling on their field trip.

2. If possible, use several sample sites on the lake or river.

Lake: Using the topographic map, select three or four stations. Possible stations include: near any inlet, near any outlet, and a bay isolated from the main body of water, or the deepest portion of the lake. *(Note: Try to ensure that no station is where there is movement of water such as directly in an inlet or outlet. Such locations will reflect the characteristics of the inlet/outlet rather than those of the lake.)*

Stream/River: Possible site locations: the headwaters, mid-reaches, and the mouth. The station at the river's mouth should be positioned where there is no influence from the receiving body of water. If possible, sequence stations from the mouth to the source. An idea for the mid-reach stations is to locate one below and one above any feature that might affect water quality such as a tributary, agricultural drainage, etc.

3. Using maps, have students identify the locations of all known or potential human impacts (storm sewers, sewage treatment outfalls, industrial influences, agricultural drainage) and their relationship to the sampling sites. Refer to these locations during analysis.

PART TWO: THE FIELD TRIP

1. At the beginning of the outing, discuss safety guidelines with students. If a boat or canoe is to be used, make sure there is adequate supervision and each person in the boat wears appropriate safety equipment, particularly life jackets.
2. Distribute student worksheets and water test kits to groups of students. If time and equipment are limited, reduce the number of test sites.
3. Have each group conduct three trials for each chemical tested, then average the results before recording on their student worksheet. The tests need not be conducted in any particular order, but students should ensure that all water samples are taken from specific sites.
4. Ask students to note the temperature, time and weather conditions under which the tests were conducted, as well as the nature and appearance of the lake or stream surveyed. It would also be beneficial for them to note the various types of aquatic plants and insects sighted. ***(Don't forget to look under rocks on the stream bottom!)***

PART THREE: ANALYSIS

1. Have students work in the same groups as during the field trip. Their task now is to analyze the water chemistry data. Have group members pool their data so that all class members have a complete set.
2. Distribute a copy of the Student Resource Sheet, to assist students with their analysis. Have each group prepare a brief report that includes answers to the following questions:
    a. Account for the results of each chemical test. For example, if you found an increase in dissolved oxygen as you moved from the mouth to the headwaters of a stream, explain what might cause this.
    b. Explain the effect of each measured chemical factor on the quality of fish habitat for a number of fish. For example, if you found a pH level of 4.5, what effect would this have on which fish species the water system could support? What insects would the water support? How do you know?

Evaluation:

Have students work individually to predict what species of fishes the lake or stream sampled could support. If possible, invite a fisheries biologist to visit the classroom to discuss the students' findings with them.

Possible Extensions:

1. Predictions as to probable fish populations could be compared with actual population data from the Department of Natural Resources and Energy, or Fisheries and Oceans. *(See Appendix)* An interesting addition would be to find historical records indicating what species were once within the body of water, and compare with current predictions. What are the differences/similarities? Why?
2. Depending on results, problems with habitat may be identified through the water quality analysis exercise. Depending on class interest, time, etc., some habitat improvements may be made. Contact the Department of Fisheries and Oceans if you wish to explore this idea.
3. If there is a lake or stream that is thought to be incapable of sustaining fish populations, have students perform a water chemistry investigation to identify limiting factors. Students may then prepare a plan to correct the problem. This may be followed by presenting their plan to the Department of Fisheries and Oceans as well as the Department of Natural Resources and Energy for their input and approval.

STUDENT RESOURCE SHEET: WAT-ER IN THESE SAMPLES?

FISH	TEMPERATURE RANGE**	OPTIMUM	OXYGEN*	pH**
RAINBOW TROUT	5-20° C	15° C	4.6 mg/ℓ	5.5 to 8.2
SMALLMOUTH BASS	2-32° C	27-29° C	4.0 mg/ℓ	5.5 to 8.2
YELLOW PERCH	4-32° C	20° C	5.7 mg/ℓ	4.8 to 8.2

* These are the ***response thresholds,*** or the levels below which fish begin to show some behavioural or physiological change.

** Range within which fish is known to live.

Site Information:

Name of body of water _____

Sampling Station Number _____

Description of Site: _____

_____

_____

_____

_____

_____

Date: _____

Time: _____

Wind Speed: _____

Air Temperature: _____

Sky: _____

Nature of Shore: _____

Appearance of Water: _____

Type of Bottom: _____

STUDENT RESOURCE SHEET: WAT-ER IN THESE SAMPLES?

Sketch of Site:

Test Results:

VALUES: trials 1, 2, 3 & A (average)

Chemical Parameters	Station 1 1 2 3 A	Station 2 1 2 3 A	Station 3 1 2 3 A	Station 4 1 2 3 A
OXYGEN				
pH				
Phosphates				
Alkalinity				
Ammonia				
Nitrate				
Chloride				
Temperature				

TEACHER: THE STOCKING QUESTION

Overview:

It is often hard to find solutions to many pressing problems, such as the reduction of fish stocks due to overfishing or deteriorating habitat conditions. Many times such decisions are reached through the process of discussion, consultation and debate. Through the following activity, students will role-play such a process by considering if the possible construction of a fish culture station is the best way to enhance fish populations in their geographic area.

Objectives:

Students will be able to:

- identify some of the issues involved in stocking fish and factors involving fish populations
- prepare a viewpoint with respect to a particular issue
- understand that fisheries management decisions must take into account both biological facts and social concerns
- present their case in an orderly manner
- consider the views of others in the resolution of a problem

Subject Links:

- science
- language arts

Time:

two and one-half hours, including some work at home

Materials:

- student resource sheets
- name tags
- evaluation forms (optional)

Background:

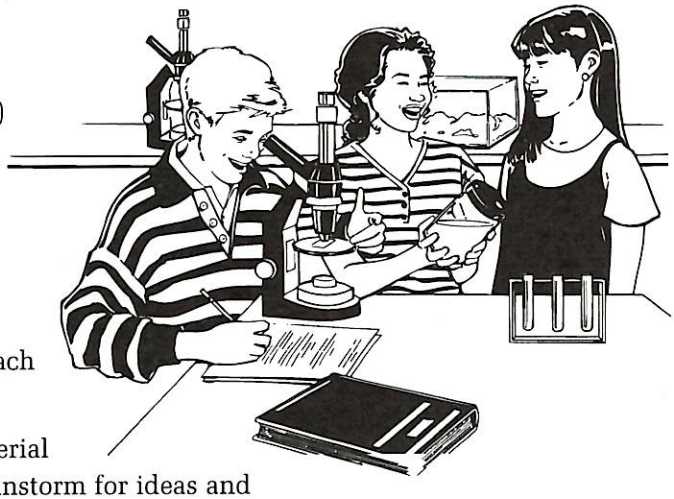
SOMETIMES when a specie of fish is having problems reproducing or when fish have been over-harvested, fisheries managers need to step in and apply the tools of their trade: research, rehabilitation, regulations and sometimes stocking with fish raised in a fish-culture station.

Stocking along will not bring back good fishing, especially if the real problem is pollution, inadequate shelter for young or mature fish, or damaged spawning habitat. If any or several of these conditions are present, habitat rehabilitation may be required. *(See habitat reconstruction, in the Teacher's Resource Guide.)* Special harvesting regulations may need to be enacted, such as restricting fishing to certain areas, limiting the season, number of fish taken or allowable capture size. Programs such as catch and release angling or increasing the bag limit on species that are readily available but less favoured by anglers may also be beneficial.

Stocking is expensive, with a cost of more than $1.00 to raise each hatchery fish. The longer the fish is held prior to release, the greater the cost to produce that fish. Although it is costly, it is considered by some biologists to be an effective way of rejuvenating* depleted fish stocks.

(Not all biologists prefer stocking; they prefer habitat reconstruction, with the mind-set that if the correct habitat conditions are present, fish populations can heighten naturally. "If you build a subdivision, people should eventually move in.")

Process:



1. Divide students into the following groups:
   - Tourist camp operators (fishing outfitters)
   - Fisheries biologists
   - Chamber of Commerce
   - Local fishing club
   - Government Commission
2. Hand out the appropriate resource sheet to each group.
3. Provide class time for groups to read the material provided, search out additional material, brainstorm for ideas and perhaps interview individuals who would have an interest in a fish-culture station, should one be developed locally. Each group should then prepare a presentation to the Government Commission. Students in the Government Commission should use this time to decide on their decision-making process.
4. Set a date for submitting presentations to the Government Commission, and another date, at least four days later, when the Commission will hear the presentations in public.
5. On the day assigned, proceed as follows:
   - Introduce the various groups
   - Indicate the order of speakers
   - State the ground rules: the presenter speaks, the Commission members ask questions for clarification or information, then members of the audience add their comments.
   - After the last presentation give each group two minutes to comment on the briefs presented by the other interest groups.
   - Have the Commission "withdraw" to discuss what should be done and make a decision. (They may discuss the issues in front of the rest of the class, who may listen but have no input.)

Evaluation:

1. Have students rate their own participation by filling out a form with a 0 to 5 scale. Factors to be considered include:
   - whether all group members carried an equal share of the work load
   - did the group complete its assignment on time
   - the quality of the work done
   - how well the group functioned as a team
2. Have students research and present an alternate resolution for the situation, taking into account the concerns of all the client groups involved.

Possible Extensions:

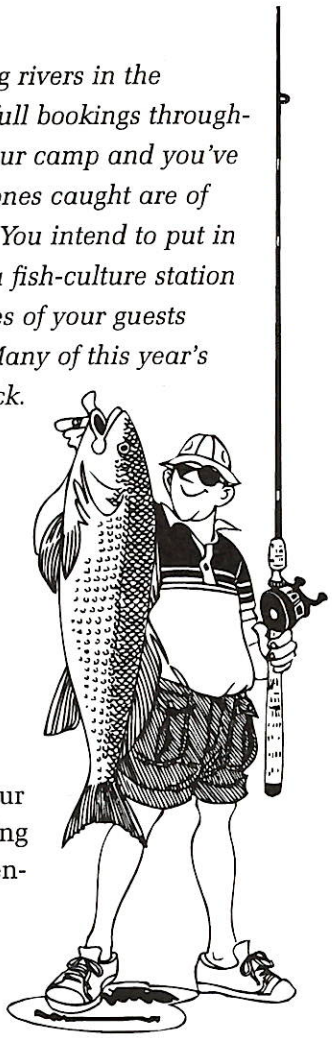
1. If possible, visit a provincial or federal fish-culture station before completing this lesson. If a visit is not possible until after the lesson, prepare a class list of questions on the issues raised during the simulation. Interview station staff and record their views.
2. Invite a local tourist camp operator and a local fishing club member to present the class with their views on the stocking issues raised during the simulation lesson.

STUDENT WORKSHEET ONE: THE STOCKING QUESTION

GROUP A: TOURIST CAMP OPERATORS

Background:

SEVERAL years ago you bought a tourist camp along one of the best salmon fishing rivers in the province. The first year you operated your camp, fishing was excellent; you had full bookings throughout the summer. Over the last two seasons bookings have dropped considerably at your camp and you've noticed that your guests are catching fewer and fewer salmon, although most of the ones caught are of good size. Obviously there has been a problem with reproduction over several years. You intend to put in a proposal to the Government Commission to approve funds for the development of a fish-culture station in your area as a means of increasing fish populations. This will increase the chances of your guests catching fish each time they go out, and therefore increase bookings at your camp. Many of this year's guests have indicated that if fishing is not improved by next year, they will not be back.



Assignment:

1. Prepare a group presentation for the Government Commission outlining your recommendations and reasons. Your presentation should address the following questions:
   - How much money will your proposal cost initially and annually?
   - How will it affect the existing local sport fishery?
   - How will it benefit the local community?

   Include any charts or audio-visual material you need to support your proposal. (You may want to get help from people owning sportfishing camps in your area.) Select one of your members to make the presentation to the Commission.

Helpful Arguments for the Presentation:

GOAL: To make profit and bring more money into the town and area.

1. The more fish to be caught, the more guests we have in our camps, therefore the more local people we can employ.
2. The more guests, the more money they spend in the local community buying gasoline, fishing tackle, restaurant food, groceries, gifts, repairs to vehicles, etc.

STUDENT WORKSHEET ONE: THE STOCKING QUESTION

GROUP B: THE FISHERIES BIOLOGISTS

Background:

YOU have worked on many salmon rivers in the province over the past three years. You believe the local salmon population is declining because of a combination of factors, mainly overfishing, poaching and the construction of a hydro dam on the largest river in the area. The construction of the power dam raised the water level four metres and severely damaged prime spawning areas.

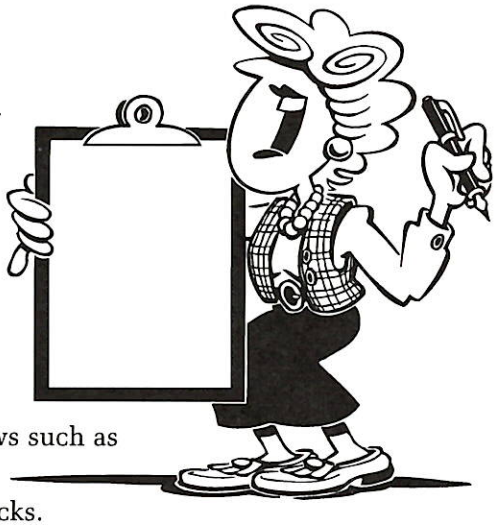
You want the Government Commission to grant funds for spawning bed rehabilitation, to support closed seasons on some lakes and to introduce fishing regulations to protect spawning fish. You also think that some funds should be set aside for publicizing the proper techniques of hook and release angling. You believe that hatchery stocking is not an effective way to improve local salmon stocks.

Assignment:

1. Prepare a group presentation for the Government Commission outlining your recommendations and reasons. Your presentation should address the following questions:
   - How much money will your proposal cost initially and annually?
   - How will it affect the existing local sport fishery?
   - How will it benefit the local community?

   Include any charts or audio-visual material you need to support your proposal. (You may want to get help from fisheries biologists in your area.) Select one of your members to make the presentation to the Commission.

Helpful Arguments for the Presentation:



GOAL: To produce strong fish stocks and increased fishing opportunities over the long-term through:

1. Spawning bed reconstruction, rehabilitation and the transfer of sexually mature adult fish to the area. This seems to have worked in other areas to make local fisheries self-sustaining in test-sites in other countries. These ideas would also save money for government by requiring fewer expensive fish culture stations.
2. The introduction of changes to the fishing and hunting laws such as closed seasons, closed areas, catch size limits and fly fishing only on some rivers would help protect salmon stocks.
3. The introduction of prizes for catch and release of trophy fish to help increase reproduction numbers.
4. Increased community involvement through projects to reconstruct spawning beds and the protection of spawning beds at spawning time through carefully regulating water levels.
5. The encouragement of angling for under-used species of fish to reduce the pressure on salmon (for example, perch, smallmouth bass, burbot, etc.)
6. The formation of a "River Watch" committee to ensure that local residents follow established fishing regulations, thereby protecting fish stocks and potential spawning fish.

STUDENT WORKSHEET ONE: THE STOCKING QUESTION

GROUP C: CHAMBER OF COMMERCE

Background:

AS AN ORGANIZATION, you are continually looking for ways to make your community attractive to visitors. Because you believe it will improve fishing on local rivers as well as provide an additional place for tourists to visit, you want the Government Commission to decide to build a fish-culture station.

An additional consideration is that if the station is built, it would create six new jobs in the area, thus having a positive effect on the local economy.

The annual operating cost of the facility would be $100,000. Most of this money would be supplied by the federal and provincial governments, but the town would have to supply part of the grant as an incentive to build within the area. As an organization, you believe that the increased money brought into the local community will more than offset the costs incurred. You are aware that good fishing brings many visitors who spend money on food, gasoline, lodging, gifts, guides, tackle, etc.

Assignment:

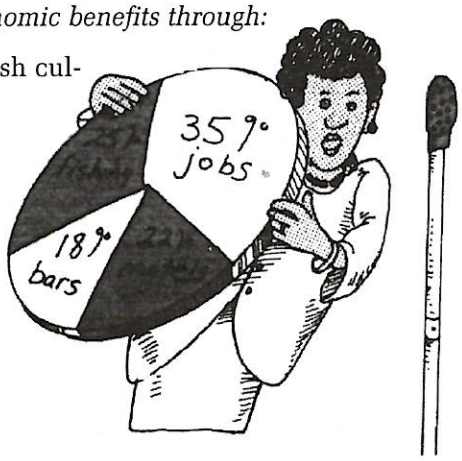
1. Prepare a group presentation for the Government Commission outlining your recommendations and reasons. Your presentation should address the following questions:
   - How much money will your proposal cost initially and annually?
   - How will it affect the existing local sport fishery?
   - How will it benefit the local community?

   Include any charts or audio-visual material you need to support your proposal. (You may want to get help from a member of the Chamber of Commerce in your area.) Select one of your members to make the presentation to the Commission.

Helpful Arguments for the Presentation:

GOAL: To increase sustainable tourist industries and local economic benefits through:

1. Government grants available to build and operate the fish culture station in its first five years of operation.
2. The sale of some of the fish to local fish farms and offshore cages, which would bring in revenue and make the operation economically self-sustaining.



STUDENT WORKSHEET ONE: THE STOCKING QUESTION

GROUP D: FISHING CLUB

Background:

AS THE DIRECTORS of a local fishing club, it is your job to present the views of your 52 club members to the Government Commission. Your club members feel that the main problem is the overfishing of some species, particularly salmon and brown trout. They also believe that fish stocks will successfully rebound if some fishing pressure is transferred to other species such as smallmouth bass. Many of your members think that the number of anglers from outside your province should be reduced by requiring all non-residents to stay at tourist resorts and to fish with a guide.

Assignment:

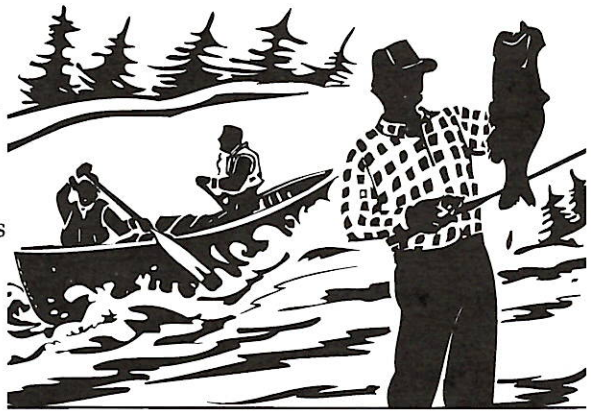
1. Prepare a group presentation for the Government Commission outlining your recommendations and reasons. Your presentation should address the following questions:
   - How much money will your proposal cost initially and annually?
   - How will it affect the existing local sport fishery?
   - How will it benefit the local community?

   Include any charts or audio-visual material you need to support your proposal. (You may want to get help from members of a local sport fishing club in your area.) Select one of your members to make the presentation to the Commission.

Helpful Arguments for the Presentation:

GOAL: To obtain more and better fishing opportunities without depleting the availability of fish through:

1. Additional Conservation Officers to enforce fishing laws within the area and to protect fish populations from poachers.
2. Establishing the fishing club as the organization to coordinate the management of the area's fish, working with fisheries biologists, the Chamber of Commerce and local tourist camp operators.
3. Stocking two lakes in the area with rainbow trout as part of a "stock, grow and take" fishery. This would add to the fishing opportunities available in the area and take fishing pressure away from the salmon and other fish species in the river.



STUDENT WORKSHEET ONE: THE STOCKING QUESTION

GROUP E: GOVERNMENT COMMISSION

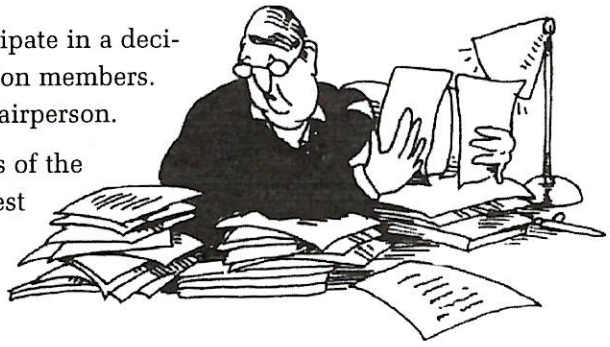
Background:

AS GOVERNMENT COMMISSION MEMBERS you are to listen to the arguments of the various groups and make a decision whether to establish a fish-culture station or use funds to increase fish populations through alternative means such as habitat restoration. The Government Commission has a different role than the other groups . . . its work is to hear the arguments for and against the proposal and make a ruling. That's the main reason why they don't have an "assignment" section. They determine how they will proceed and reach their conclusions.

Suggested Activities:

AS A COMMISSION MEMBER, YOUR TASKS ARE AS FOLLOWS:

1. To be familiar with the background material provided to each group and all fisheries management terminology.
2. To hold a meeting of Commission members to determine a process for evaluating ideas presented by different groups on whether or not a fish-culture station is needed.
3. To be familiar with the main points being made by each group in their written presentations. Prepare questions for each presenter, requesting clarification on points and requesting additional related information if necessary.
4. When the appointed day arrives, to participate in a decision-making session with other Commission members. One student will serve as Commission chairperson.
5. To make a decision based on the strengths of the arguments presented by the various interest groups and your knowledge of fisheries across the province, using the process you have already determined in (2) above.



TEACHER: FISH-ER WORTH IT!

Overview:

When considering any issue, it is useful to examine it from a number of different perspectives. In the following exercise, students will examine different values and perspectives related to New Brunswick's fish stocks.

Objectives:

Students will be able to:

- identify and distinguish between economic and non-economic values of fish
- develop and demonstrate skills in locating and extracting information from a story, recording information in an organized fashion, and summarizing.

Subject Links:

- science
- math

Time:

one hour

Materials:

- student resource sheets 1 and 2

Background:

MANY TIMES, the value that people put on a resource is in direct relation to how much they use it. People who do not make their livelihood from the fisheries or wildlife may tend to view them as less important, or if considered important, for other reasons. These differences in values and perspectives occasionally result in conflict.

An example of this is the recreational fishery, which generates millions of dollars to the economies of the Maritime provinces. As well, native peoples rely on fish as a protein source during certain periods of the year. Others, who do not depend on fish for either food or recreation, may view fish as important from the stand-point of knowing the fish are there to see and enjoy. The value of fish can be measured in terms of what people are prepared to pay or give up in order to have fish.

In addition to direct dollars generated by the intrinsic value of fish, numerous economic spin-offs also occur. Some of these include: increased sales by business establishments (i.e. boats, motors, fishing equipment, fish dinners, motel unit rentals, fuel and bait), an increased number of business enterprises catering to anglers (i.e. hotels, motels, bait shops, restaurants) and better markets for locally produced commodities.

The importance of healthy fish populations within stable aquatic communities is harder to define in economic terms. Few people are "fish watchers" as the resource is not nearly as accessible as, for example, birds or some mammals. Other values are often cited:

- Fish are viewed as environmental indicators of the health of aquatic ecosystems.
- Fish play an important role in transferring energy throughout the food web in aquatic ecosystems. Whether fish are prey or predators, they require food energy in the form of phytoplankton, zooplankton, small crustaceans or other fish. Fish are considered central to the maintenance of ecological stability.
- Fish have intrinsic value simply by being living things that are part of the native, natural order.

Process:

1. Ask the class why fish are important to the province. Divide the class into groups of three or four students. Give each group a copy of Student Resource Sheet 1. Have each group itemize and assess the costs incurred by the angler in the story.
2. Have each group report to the class their total cost in dollars for the angler in the story. Have the class average the various costs and establish a range of total costs incurred by anglers.
3. Distribute a copy of Student Resource Sheet 2 to each group. Have students examine the story and list the fisheries' values. The list should include economic and recreational (non-consumptive values - i.e. ecological, environmental, aesthetic). Students should be able to justify the value they assign to each.
4. Have students draw conclusions based on the values presented on the Student Resource Sheets. Students should separate and acknowledge the differences between long-term and short-term investments or benefits.

Evaluation:

1. Have one student role-play an uninformed non-angler who values the resource for "what it is" and another student play an avid fisherman. Have them interact by discussing their values relating to the resource, identify where those values conflict, and try to find resolutions that may satisfy both parties.
2. Develop an interview questionnaire designed to determine people's understanding of the value of fish. If time permits, assign each student the task of interviewing several community members, then compile the results.

Possible Extensions:

1. Have students identify as many personal, communal, global values of fish as they can. What priorities can they identify when considering economics, the environment, etc.?
2. Have students contact local businesses in their area to determine the economic benefits and value of the local fishery.
3. Have students determine the cost per kilogram of fish from one of their own fishing trips. They should include costs of travel, food, gasoline, oil, bait, lodging and fishing equipment, etc. This may then be compared with the price of fish at the local market or grocery store. Which is cheaper?
4. Invite a local member of an angling club or a fishing guide to discuss the importance of angling to the local economy.
5. As a method of teaching consensus decision making, give students a question such as: are all types of fishing (recreational, commercial, native) valid activities in the modern world? In consensus, all parties should feel that their points of view have been considered, and they can live on each type of fishing. They could build a decision-making framework based on the alternatives considered and the criteria used to rate each alternative.

STUDENT: FISH-ER WORTH IT!

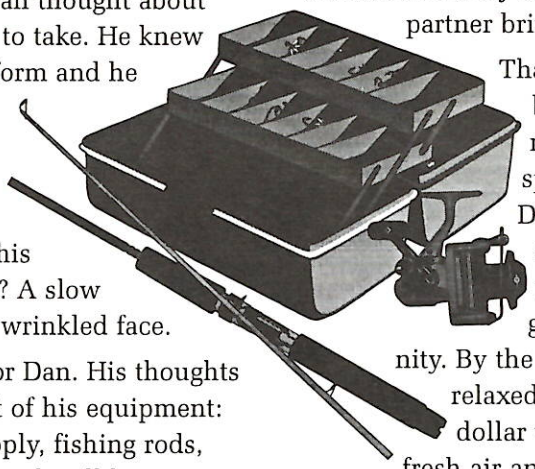
A DAY OF FISHING

Instructions:

FROM THIS STORY, make a list of the angling equipment and all other expenses for a day of sport fishing. Add up the figures to get a total estimate. By the end of this story, you should be able to give several reasons why people fish.

DAN just sat down to supper when the phone rang. He had been expecting it. His friend Bill sounded excited. "There are rumours that the fishing is hot and you should get up here as fast as you can," he urged.

As he finished his supper, Dan thought about what equipment he would need to take. He knew his boat and motor were in top form and he had already purchased his fishing licence. He realized though, that he had gained a few more pounds over the winter; how could he forget with a wife like his who constantly "reminded" him? A slow smile worked its way across his wrinkled face.



Things had not come easy for Dan. His thoughts wandered as he checked the rest of his equipment: paddles, anchor, bailer, food supply, fishing rods, tackle and jacket. Yes, it seemed to be all here. Where had the years gone?

A few last-minute purchases would complete the preparations: a 100-metre spool of line, sunglasses and ice for the cooler. Time for that in the morning.

Darkness still blanketed the land as Dan finished his breakfast. He always tried to be on the road by 4 a.m. After a quick survey to ensure he had not forgotten anything obvious, he started on the two-hour drive to the lake. Along the way he stopped only once - to buy the items he listed yesterday, and gas up the car and outboard motor tank.

As he topped the hill over the bay, he could see the beautiful blue horizon over the lake. The view was spectacular, as usual, and made the early morning start worth it. At the dock he paid a five dollar launch fee and impatiently waited for Bill to arrive.

Their day started slowly with only one good fish, a trout weighing over 1 kg. Not a bad eating size! The two anglers constantly altered their technique, adjusting the depth of their lines and changing tackle. Still the fish did not seem eager to bite. Maybe he should have invested in a fish-finder, he mused. With the continuation of their unlucky streak, both men decided it was time to head to shore to eat their lunches and plan their strategy for the afternoon. By the way, don't ever let your fishing partner bring egg sandwiches!

That afternoon, they had lots of nibbles but no bites. The day had not been a total loss though. In spite of the lack of fishing action, Dan and Bill had enjoyed joking and laughing, as they shared memories of other trips and growing up in the same community. By the end of the day, both anglers felt relaxed and content. It's hard to put a dollar value on a good time, but the fresh air and companionship in such surroundings made the trip rewarding.

On the way home, Dan tried to occupy his mind with a quick calculation of the total cost of a day of fishing. As he calculated the numbers, the total seemed a little embarrassing, especially since only one fish had been caught, and even at that a fish that had been raised in a hatchery, judging from its clipped fin! Other costs came to mind: hatchery operating costs, fish food for one and one-half years, transportation to the release site, and periodic patrols by Conservation Officers to ensure that fish are not subjected to illegal fishing methods or environmental hazards due to pollution.

As he neared home, Dan knew that in spite of all the costs, fishing was worth it, at least for him. He began to plan for his next trip.

STUDENT: FISH-ER WORTH IT!

NATURE'S FREE SHOW

Instructions:

AFTER reading this story, give four reasons why people value fish.

IT was late October and the rivers were high and wild with the fall rains. As I stood by the river, I watched in awe. It seemed that the smell of the river excited the spawning fish as they charged the falls by the hundreds. The show was thrilling and continuous - large salmon, shimmering silver in the afternoon sun, leapt from the pool, trying to navigate the falls. I almost felt like cheering them on, especially when they got so close to the top, only to fall back into the pool below. Some did make it, disappearing into the river above, on their way to spawning grounds.

Watching the fall run of fish is a favourite activity of mine. The experience was further heightened by wearing my polarized sunglasses. They make it possible to see right into the water.

I moved further upriver to watch the adult salmon prepare to lay their eggs. As I watched, the females dug the redds and deposited their eggs. The males then fertilized the eggs and the eggs were then buried in clean gravel. It was thrilling to watch this process over and over again. When spawning was completed, some of the fish left on their return trip to the ocean.

What a noble animal! Returning to the location of its birth, and travelling thousands of kilometres to do so! And then the perils of the ocean, especially the seals, fish nets and other dangers.

As I stood near the river, I noticed a Department of Fisheries and Ocean technician by his pick-up truck with the D.F.O. decal on the door. I went over to him and asked about the ever-increasing pollution problems in the river. He explained to me that contaminants in many rivers are creating greater and greater challenges. The contaminants accumulate in the food web and top predators contain the highest levels, requiring human consumption of some fishes to be limited. Fish can be used to monitor contaminant levels in some areas.

As I left the river, I was replaced by a couple of teenagers who were as thrilled as I'd been to see these large fish. I hope there will still be large fish there when they reach my age.

STUDENT RESOURCE SHEET: FISH FLOWCHART

Below is a list of equipment, goods, supplies and services a commercial fisher would be required to provide in order to conduct a business. Using a flowchart with the fisherman at the centre of the page, construct a diagram to demonstrate the fisherman's overall role in the community. Include people and businesses the fisherman would be involved with in the pursuit of fishing.

LIST

domestic steel tug, 300 hp

refrigerated truck

vessel insurance

rental costs for boat or other equipment

twine and net repair

business and truck insurance

building maintenance

licences for fishing, radio, truck

net anchors, weights and floats

trucking and freight costs

food and provisions for crew

vessel repairs and maintenance

truck repairs and maintenance

safety gear

crane charges

accounting fees

taxes for municipal, provincial and federal governments

loans from institutions

diesel electronic depth sounder

Loran

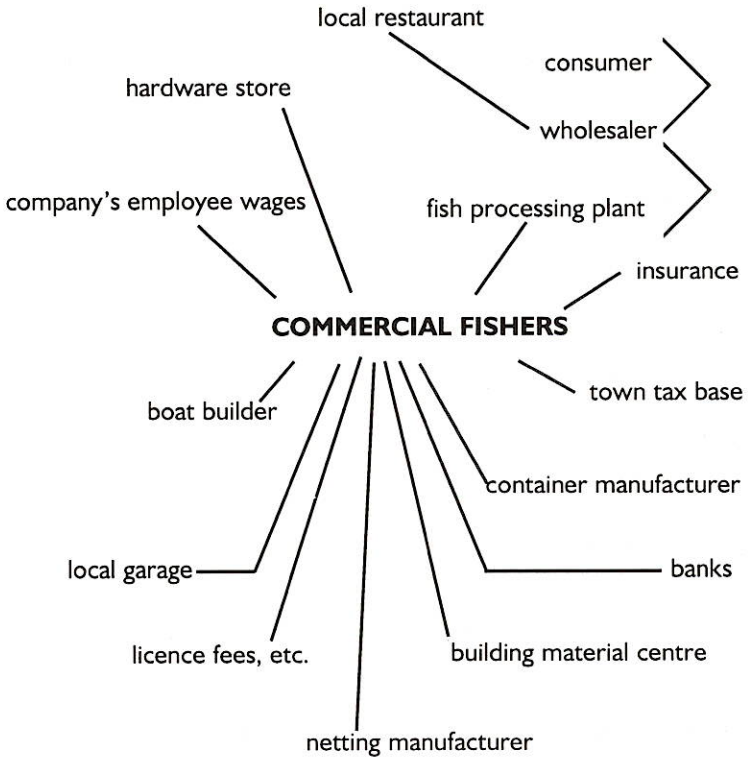
radio

radar

winches

net lifter

FLOWCHART EXAMPLE



TEACHER: SUPPORT YOUR LOCAL CRITTERS

Overview:

Many human activities impact on their local watershed. Seemingly insignificant activities, when combined with others, serve to create significant problems. This activity will give students opportunity to consider the issues of habitat loss and the laws needed to protect animals and their habitat.

Objectives:

Students will be able to:

- express how governments use laws to protect wildlife and the environment
- identify an illegal act done by persons that harms animals or their habitat
- identify one local, habitat-related issue, describe how it affects wildlife, and defend a particular stance on that issue

Subject Links:

- science
- language arts
- environmental science

Time:

one and one-half hours to two hours, not including optional field trip

Materials:

- Student Resource Sheets

Background:

CANADA'S wildlife may be referred to as a renewable resource. This resource is the livelihood of many people both directly and indirectly through guiding, outfitting or trapping and as additional revenue to local businesses.

Most people do not automatically recognize the value of wildlife's habitat. It's relatively easy to gain public support to preserve a popular beach or local tourist area, but another issue when seeking support to preserve a marsh, bog or pond. Such features are often seen as a nuisance; a mere breeding place for mosquitoes and other pests. Their loss would have both economic and social implications, with the potential endangerment of various species of flora and fauna. ***Yes, even mosquitoes are important!***

Wildlife habitats are vital assets to Canadians, almost like money in the bank. They are essential to the survival of wildlife, and represent the foundation of economic sectors and our way of life. They are as essential to us as topsoil is to farming.

One of the difficulties is that certain habitat conditions may be wiped out without much visible evidence of destruction. For example, the eggs of a salmon or trout cannot survive just anywhere; they must be laid in streams where there is a bed of clean gravel. Take away the gravel, or cover it over with silt or sand and the stream will flow as before on the surface, but it will cease to be a spawning stream.

Trout and salmon eggs require fast-running, well-oxygenated water to survive. If the water becomes dammed, they may be lost. Reduction of forest cover without careful planning also significantly reduces wildlife habitats.

Laws and regulations are very important in the protection of wildlife and their habitats. The Federal Fisheries Act, for example, dates back to Confederation. This law provides for the protection of fish and environments necessary to the lives of fish species in all of Canada. The Fisheries Act defines fish habitat as "spawning grounds and nursery, rearing, food supply and migration areas on which fish depend, directly or indirectly, in order to carry out their life processes."

Provinces also have Fish and Wildlife Acts and regulations, which govern the care and protection of wildlife and their habitats within the province.

The examination of all federal and provincial laws relating to wildlife and their habitats would be an activity far greater than what could be completed by this lesson. For the sake of time and simplicity, sections of the Federal Fisheries Act will be examined. If students are interested in other aspects of wildlife management or regulation, additional resources are named in the appendix.

Common Threats to Fish Habitat:

- removal of sand or gravel from beaches, riverbanks or stream banks
- toxic industrial and municipal waste discharges
- stream diversions
- dredging
- silt, contaminants and other pollutants
- land clearing to provide for agricultural or urban development
- improper use of pesticides
- construction of electric power installations
- building of causeways, wharves, marinas and reservoirs
- logging and log storage
- pipelines, power transmission lines, road and rail construction

Avoid Negative Impacts By:

- not disturbing rooted aquatic plants
- don't remove rubble or boulders from the shallows
- avoid dredging and filling
- build a floating or pipe dock to minimize bottom disturbance
- bring in rock for cribbing. Don't take it from the shore or shallows
- if metal drums are used for floatation, ensure that none of their former contents are left in them
- preserve the natural setting of the shoreline - observe setbacks and minimize shoreline clearing. *Trim branches, not trees!*
- where possible, replant low growing shrubs instead of grass on the shoreline
- stabilize eroding banks by planting vegetation or installing gabion baskets or riprap on dry land ***(A permit is required.)***

Advance Preparation:

1. Collect several weeks' worth of local newspapers.
2. Field preparation (optional, in conjunction with students):
   - Determine the location and extent of the area at issue. If possible, visit it ahead of time. ***Be absolutely sure*** to check sites for any dangerous features. Obtain any necessary permissions.
   - Find topographic and/or road maps of selected sites if possible, otherwise prepare a sketch of the study area.
   - Choose the week and date of your trip in consultation with students and other staff to reduce conflicts. Advise students about clothing and boots required for the trip.
   - Arrange for adult helpers.

Process:

PART 1: HABITAT LOSS

1. Review the concept of habitat, including the need of all living things for water, food, shelter and space.
2. Pass out the Student Resource Sheet. Explain that each picture represents a human activity that could result in habitat and wildlife population loss. Have them determine what is going on in each picture, and how it might affect various aspects of fish habitat.

PART 2: LOSSES AND LAW

1. The following are answers to the Student Resource Sheet:
   1) Fish are not able to get up a stream to spawn because of an obstruction or a dam.
   2) Pollution from a factory is dumped in a stream where fish live.
   3) A construction project is destroying fish habitat.
   4) A project results in sediment being washed into a lake, destroying habitat.
   5) Aerial spraying of pesticides on orchards falls into fish habitat.
   6) An oil rig spills hazardous materials into the water.
2. Ask if there's any way that they would involve themselves in any of these actions. Follow this by asking them if they might be involved in any of these activities. Draw the connection between the pictures and their lifestyles by asking them if they:
   I. Use electricity from hydro dams
   II. Use manufactured products such as steel, chrome, plastic, leather, etc. *(factories often produce significant effluent)*
   III. Use products resulting from activities that may increase sedimentation in streams and lakes, such as pulp and paper products or food processing, pesticides
   IV. Use agricultural products on which fertilizers or pesticides have been used
   V. Use oil products such as gasoline and plastics
3. Depending on time and the interests of students, a discussion of laws and penalties found under the Federal Fisheries Act (Teacher Resource Sheets) may prove enlightening and interesting.

PART 3: LOCAL APPLICATIONS

1. Have students find out what is happening locally that might relate to wildlife protection or loss. Recent issues in local newspapers would be a good place to start. Any new waterfront developments would provide an obvious focus. If there are no local issues, those of other areas or potential issues might be addressed.
2. In small groups, have students choose and follow up on related issues, or choose one issue for the class to explore. If the issue has "sides" or different perspectives, invite proponents of each to come and talk to the class about their point of view and how they accommodate or plan to accommodate the law.
3. *OPTIONAL:* Organize a field trip to the local aquatic habitat affected by the issue to see if any laws appear to have been broken. Examine the on-site problems related to the issue, and evaluate how the law has been accommodated.

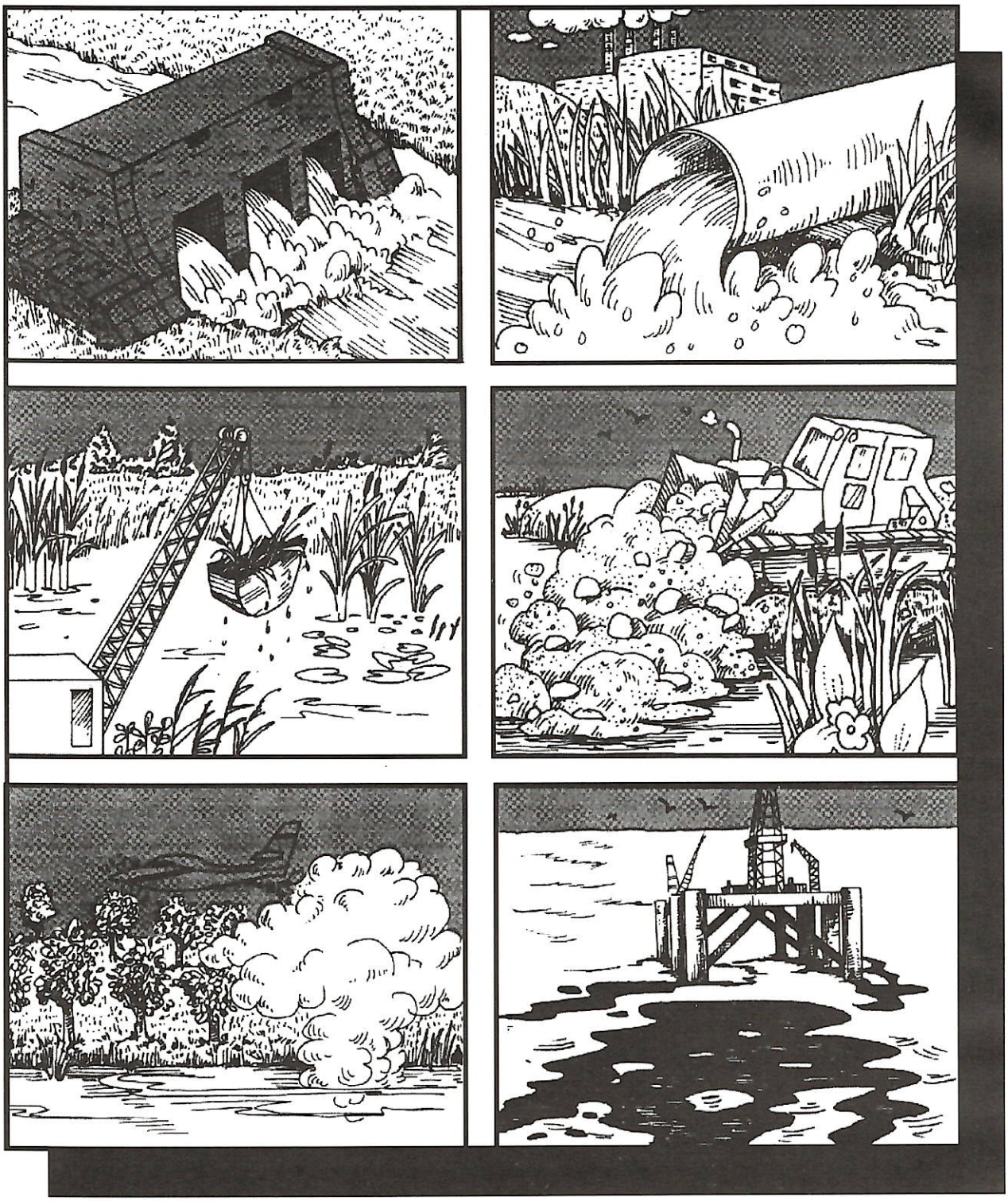
Evaluation:

1. Have students write a letter to the editor of the local paper supporting some aspect of the issue examined, and justify their support with facts.
2. Have students search for actual or potential wildlife habitat problems not being addressed, and develop a plan of action around their perspective and that of their community.
3. Have students refine an old section of a law so that it better deals with one of the local issues examined. An alternate to this is to have students draft a new law, if current laws do not address local issues.

Possible Extensions:

1. Ask a local fisheries officer to discuss fisheries law enforcement with the students.
2. Create a bulletin board display of stories covered in newspapers about wildlife habitat laws or regulations being broken.

STUDENT RESOURCE SHEET: SUPPORT YOUR LOCAL CRITTERS



TEACHER RESOURCE SHEET: SUPPORT YOUR LOCAL CRITTERS

Canada's Fish Habitat Law

THE Federal Fisheries Act is a long document, difficult to understand. Some of the material is interesting, and can lead to good discussion. The following are excerpts from the Fisheries Act, and relate only to the protection of fish habitat. A complete copy of the Act may be obtained by inquiring through your local fisheries office.

Definitions:

CANADIAN FISHERIES WATERS: In this Act, "Canadian fisheries waters" means all waters in the fishing zones of Canada, all waters in the territorial seas of Canada and all internal waters of Canada.

FISH: "Fish" includes all shellfish, crustaceans, marine animals and the eggs, spawn, spat and juvenile stages of fish, shellfish, crustaceans and marine animals.

FISH HABITAT: "Fish habitat" means spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes.

DEPOSIT: "Deposit" means any discharging, spraying, releasing, spilling, leaking, seeping, pouring, emitting, emptying, throwing, dumping or placing, whether or not any act or omission resulting in the deposit is intentional.

DELETERIOUS SUBSTANCE: "Deleterious substance" means:

- any substance that, if added to any water, would degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man of fish that frequent that water, or
- any water that contains a substance in such quantity or concentration, or that has been so treated, processed or changed, by heat or other means, from a natural state that it would, if added to any other water, degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man of fish that frequent that water.

The Need for Safe Fish Passage

SECTION 20(1): Every obstruction across or in any stream where the Minister determines it to be necessary for the public interest that a fish pass should exist, shall be provided by the owner or occupier with a durable and efficient fish-way, or canal around the obstruction, which shall be maintained in a good and effective condition by the owner or occupier, in such place and of such form and capacity as will in the opinion of the Minister satisfactorily permit the free passage of fish through it.

SECTION 20(2): Where it is determined by the Minister in any case that the provision of an efficient fish-way or canal around the obstruction is not feasible, or that the spawning areas above the obstruction are destroyed, the Minister may require the owner or occupier of the obstruction to pay to him from time to time such sum or sums of money as he may require to construct, operate and maintain such complete fish hatchery establishment as will in his opinion meet the requirements for maintaining the annual return of migratory fish.

SECTION 20(3): . . . after the fish-way is completed and in operation the owner or occupier of any obstruction shall make such changes and adjustments at his own cost as will in the opinion of the Minister be necessary for its efficient operation under actual working conditions.

SECTION 20(4): The owner or occupier of every fish-way or canal shall keep it open and unobstructed and shall keep it supplied with a sufficient quantity of water as the Minister considers necessary.

SECTION 21(1): The Minister may authorize the payment of one-half of the expense incurred by such owner or occupier in construction and maintaining any fish-way or canal . . .

SECTION 21(3): Where an unused obstruction or a thing detrimental to fish exists, and the owner or occupier thereof does not, after notice given by the Minister, remove it, or if the owner is not resident in Canada, or his exact place of residence is unknown to the Minister, the Minister may, without being liable to damages, or in any way to indemnify the said owner or occupier, cause the obstruction, or thing detrimental to fish to be removed or destroyed and, where notice has been given to the owner or occupier, may recover from the owner or occupier the expense of the removal or destruction.

SECTION 22(3): The owner or occupier of any slide, dam, or other obstruction shall permit to escape into the river bed below the said slide, dam or other obstruction, such quantity of water at all times, as will, in the opinion of the Minister, be sufficient for the safety of fish and for the flooding of the spawning grounds to such depth as will, in the opinion of the Minister, be necessary for the safety of the ova deposited thereon.

SECTION 66: Every owner or occupier of an obstruction across or in any stream who refuses or neglects to provide and maintain a fish-way or canal in accordance with section 20, to install and maintain fish stops or diverters in accordance with subsection 21(4) or to provide for the sufficient flow of water and the free passage of fish in accordance with section 22 is guilty of an offence punishable on summary conviction and liable, for the first offense, to a fine not exceeding two hundred thousand dollars, and, for any subsequent offence, to a fine not exceeding two hundred thousand dollars or to imprisonment for a term not exceeding six months, or to both.

Protection of Fish in or Near Fish-Ways

SECTION 27: No one shall:

a) damage or obstruct any fish-way or canal built, constructed or used to enable fish to pass over or around any obstruction;

b) do anything to stop, impede or hinder fish from entering or passing the fish-way or canal or to stop, impede or hinder fish from surmounting any obstacle or leap; or

c) fish in any manner within twenty-five yards downstream from the lower entrance to any fish-way, canal, obstacle or leap.

SECTION 29(1): No one shall erect, use or maintain in any of the Canadian Fisheries waters, whether subject to any exclusive right to fish or not, any net, weir, or other device that unduly obstructs the passage of fish.

SECTION 29(2): The Minister or any fishery officer may order the removal of or remove any net, weir, or other device that, in the opinion of the Minister or any fishery officer, unduly obstructs the passage of fish.

Destruction of Fish

SECTION 32: No person shall destroy fish by any means other than fishing except as authorized by the Minister or under regulations made by the Governor in Council under this Act.

Destruction of Fish by Explosives

SECTION 28: No one shall hunt or kill fish or marine animals of any kind, other than porpoises, whales, walruses, sea lions and hair seals, by means of rockets, explosive materials, or explosive projectiles or shells.

Destruction of Fish Habitat

SECTION 35(1): No person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat.

SECTION 35(2): No person contravenes subsection 35(1) by causing the alteration, disruption or destruction of fish habitat by any means or under any conditions authorized by the Minister or under regulations made by the Governor in Council under this Act.

Penalty:

SECTION 40(1): Every person who contravenes subsection 35(1) is guilty of:

a) an offence punishable on summary conviction and liable, for the first offence, to a fine not exceeding three hundred thousand dollars and, for any subsequent offence, to a fine not exceeding three hundred thousand dollars or to imprisonment for a term not exceeding six months, or to both or:

b) an indictable offence and liable, for a first offence, to a fine not exceeding one million dollars, and, for any subsequent offence, to a fine not exceeding one million dollars or to imprisonment for a term not exceeding three years, or to both.

Pollution of Fish Habitat:

SECTION 36(3): Subject to subsection 36(4), no person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish or in any place under any conditions where the deleterious substance or any other deleterious substance that results from the deposit of such deleterious substance may enter any such water.

SECTION 36(4): No person contravenes subsection 36(3) by depositing or permitting the deposit in any water or place of waste or pollutant of a type, in a quantity and under conditions authorized by regulations applicable to that water or place made by the Governor in Council under any Act other than this Act . . .

Obligations of Proponents:

SECTION 37(1): Where a person carries on or proposes to carry on any work or undertaking that results or is likely to result in the alteration, disruption or destruction of fish habitat, or in the deposit of a deleterious substance in water frequented by fish or in any place under any conditions where that deleterious substance or any other deleterious substance that results from the deposit of that deleterious substance may enter any such waters, the person shall, on the request of the Minister or without request in the manner and circumstances prescribed by regulations made under paragraph 3(a), provide the Minister with such plans, specifications, studies, procedures, schedules, analysis, samples or other information relating to the water, place or fish habitat that is or is likely to be affected by the work or undertaking as will enable the Minister to determine

a) whether the work or undertaking results or is likely to result in any alteration, disruption or destruction of fish habitat that constitutes or would constitute an offence under subsection 40(1) and what measures, if any, would prevent that result or mitigate the effects thereof: or

b) whether there is or is likely to be a deposit of a deleterious substance by reason of the work or undertaking that constitutes or would constitute an offence under subsection 40(2) and what measures, if any, would prevent that deposit or mitigate the effects thereof.

Powers of the Minister:

SECTION 37(2): If, after reviewing any material or information provided under subsection 37(1) and affording the persons who provided it reasonable opportunities to make representations, the Minister or a person designated by the Minister is of the opinion that an offence under section 35 or 36 is being or is likely to be committed, the Minister or a person designated by the Minister may . . .

a) require such modifications or additions to the work or undertaking or such modifications to any plans, specifications, procedures or schedules relating thereto as the Minister or a person designated by the Minister considers necessary in the circumstances, or

b) restrict the operation of the work or undertaking, and, with the approval of the Governor in Council in any case, direct the closing of the work or undertaking for such period as the Minister or a person designated by the Minister considers necessary in the circumstances.

Duty to Report:

SECTION 38(4): Where, out of the normal course of events, there occurs a deposit of a deleterious substance in water frequented by fish or a serious and imminent danger thereof by reason of any condition, and where any damage or danger to fish habitat or fish or the use by man of fish results or may reasonably be expected to result therefrom, any person who at any material time

a) owns the deleterious substance or has the charge, management or control thereof, or

b) causes or contributes to the causation of the deposit or danger thereof, shall, in accordance with any regulations applicable thereto, report such occurrence to an inspector or such other person or authority as is prescribed by the regulations.

Penalties:

SECTION 40(3): Every person who

a) fails to provide the Minister any material or information requested pursuant to subsection 37(1) within a reasonable time after the request is made,

b) fails to provide or submit any material, information or report that is to be provided or submitted under regulations made pursuant to subsection 37(3),

c) fails to make a report that he is required to make under subsection 38(4),

d) carries on any work or undertaking described in subsection 37(1)

I) otherwise than in accordance with any material or information relating to the work or undertakings that he provides to the Minister under subsection 37(1),

II) otherwise than in accordance with any such material or information as required to be modified by any order of the Minister under paragraph 37(2)(a), or

III) contrary to any order made by the Minister under subsection 37(2),

is guilty of an offence punishable on summary conviction and liable, for a first offence, to a fine not exceeding two hundred thousand dollars and, for any subsequent offence, to a fine not exceeding two hundred thousand dollars or to imprisonment for a term not exceeding six months, or to both.

Provisions for Discard of Miscellaneous Materials

SECTION 36(1): No one shall

a) throw overboard ballast, coal ashes, stones or other prejudicial or deleterious substances in any river, harbour or roadstead, or in any water where fishing is carried on,

b) leave or deposit or cause to be thrown, left or deposited, upon the shore, beach or bank of any water or upon the beach between high and low water mark, remains or offal of fish, or of marine animals; or

c) leave decayed or decaying fish in any net or other fishing apparatus.

SECTION 36(2): Remains or offal described in subsection (1) may be buried ashore above high water mark.

Penalties:

SECTION 40(2): Every person who contravenes subsection 36(1) or (3) is guilty of

a) an offence punishable on summary conviction and liable, for a first offence, to a fine not exceeding three hundred thousand dollars and, for any subsequent offence, to a fine not exceeding three hundred thousand dollars or to imprisonment for a term not exceeding six months, or to both.

General Penalties:

SECTION 72(1): Where a person is convicted of an offence under this Act, the court may, in addition to any punishment imposed, order that any thing seized under this Act by means of or in relation to which the offence was committed, or any proceeds realized from its disposition, be forfeited to Her Majesty.

SECTION 72(2): Where a person is convicted of an offence under this Act that relates to fish seized pursuant to paragraph 51(a), the court shall, in addition to any punishment imposed, order that the fish, or any proceeds realized from its disposition, be forfeited to Her Majesty.

SECTION 78: Except as otherwise provided in this Act, every person who contravenes this Act or the regulations is guilty of

a) an offence punishable on summary conviction and liable, for the first offence, to a fine not exceeding one hundred thousand dollars and, for any subsequent offence, to a fine not exceeding one hundred thousand dollars or to imprisonment for a term not exceeding one year, or to both: or

b) an indictable offence and liable, for a first offence, to a fine not exceeding five hundred thousand dollars, and for any subsequent offence, to a fine not exceeding five hundred thousand dollars or to imprisonment for a term not exceeding two years, or to both.

Recovery of Costs Incurred by the Crown:

SECTION 42(1): Where there occurs a deposit of a deleterious substance in water frequented by fish that is not authorized under section 36 or a serious and imminent danger thereof by reason of any condition, the persons who at any material time

a) own the deleterious substance or have the charge, management or control thereof, or

b) are persons other than those described, in paragraph (a) who cause or contribute to the causation of the deposit or danger thereof, are, subject to subsection (4) in the case of persons referred to in paragraph (a) and to the extent determined according to their respective degrees of fault or negligence in the case of persons referred to in paragraph (b), jointly and severally liable for all costs and expenses incurred by Her Majesty in right of Canada or a province, to the extent that such costs and expenses can be established to have been reasonably incurred in the circumstances, of and incidental to the taking of any measures to prevent any such deposit or condition or to counteract, mitigate or remedy any adverse effects that result or may reasonably be expected to result therefrom.

SECTION 42(2): All such costs and expenses are recoverable by Her Majesty in right of Canada or a province with costs in proceedings brought or taken therefor in the name of Her Majesty in any such right in any court of competent jurisdiction.

Civil Liabilities for Loss of Income by Fishermen:

SECTION 42(3): Where, as a result of a deposit that is not authorized under section 36, a deleterious substance enters water frequented by fish, the persons who at any material time

a) own the deleterious substance or have the charge, management or control thereof, or

b) are persons other than those described in paragraph (a) who cause or contribute to the causation of the deposit, are, subject to subsection (4) in the case of the persons referred to in paragraph (a) and to the extent determined according to their respective degrees of fault or negligence in the case of the persons referred to in paragraph (b), jointly and severally liable for all loss of income incurred by any licenced commercial fishermen, to the extent that such loss can be established to have been incurred as a result of the deposit or of a prohibition to fish resulting therefrom, and all such loss is recoverable with costs in proceedings brought or taken therefor in any court of competent jurisdiction.

SECTION 42(4): The liability of any person referred to in paragraph 42(1)(a) . . . is absolute and does not depend on proof of fault or negligence but no such person is liable for any costs and expenses pursuant to subsection (1) or loss of income pursuant to subsection (3) if he establishes that the occurrence giving rise to the liability is wholly caused by

a) an act of war, hostilities, civil war, insurrection or a natural phenomenon of an exceptional, inevitable and irresistible character; or

b) an act or omission with intent to cause damage by a person other than a person for whose wrongful act or omission he is by law responsible,

SECTION 42(5): Nothing in this section limits or restricts any right of recourse that any person who is liable pursuant to this may have against any other person.

TEACHER: CONTROLLING THE CRITTERS

Overview:

From time to time it is necessary for biologists to control, or attempt to control, one species of plant or animal to ensure the survival and viability of other species. Students will explore this issue by considering the lamprey eel and its impact on fish stocks.

Objectives:

Students will be able to:

- develop an awareness of the life cycle and biology of the sea lamprey and how its characteristics relate to potential control methods.
- develop thinking skills such as constructing a decision-making framework, identifying, extracting, interpreting, evaluating, recording and summarizing information.

Subject Links:

- science

Time

two hours

Materials:

- Student Resource Sheets
- student worksheet
- purple loosestrife pamphlet

Background:

THE issue of limiting the population of a species to allow others to gain density and increase viability has long been contentious. The coyote has long been a suspect in where responsibility lies for declining deer populations. In other situations, links are easier to identify.

An example of this is the purple loosestrife. This eye-catching purple flowering plant was first introduced to North America by European settlers. This plant species is particularly suited to live in our climate; virtually indestructible. Tall, bushy and long-lived, they reproduce through seeds, cuttings, leaves that may fall to the ground, etc. A five year old plant, for example, will have produced approximately 2 700 000 seeds! When identified, they must be carefully pulled from the ground, burned and the area checked to ensure that no leaves or plant parts remain.

This plant species, once established, quickly proliferates to the point that vast numbers of them will grow within areas, effectively crowding out other plant species. The animals that depend on those species must then find alternate places to live, or die off. Unfortunately, there are no native animal species that use this plant as a food source, and few plants that will compete with it. This creates a dilemma for scientists: the purple loosestrife is an introduced species. There are a few insect species native to Europe that do feed on the plants, but what are the implications of introducing a new insect species to our ecosystem?

Another "nuisance" species is the sea lamprey. It brings no significant positive contribution to the ecosystem, causing more harm than good. What is the extent of the problem, and the costs of attempting to control this species, both in economic terms and others? Many questions remain unanswered.

Process:

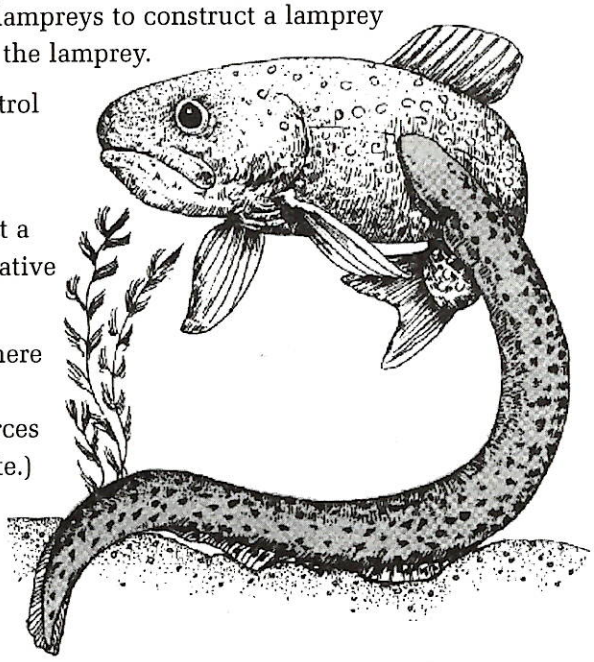
1. Read and discuss the life of the sea lamprey with students. Outline potential needs for the control of sea lampreys.
2. Have students use the matrix provided on the Student Worksheet to set up a chart of alternative methods of control and the factors to consider. Information about alternative methods of control can be found on Student Resource Sheet 2.
3. Have students use the decision-making matrices to evaluate the various methods of control with respect to the factors listed. They should use ranking scales to determine the acceptability of the control measure (i.e. use 0 for unacceptable, 5 for most acceptable).
4. Discuss the matrix and complete it as a class. Encourage students to arrive at a decision on the best overall method of lamprey control.

Evaluation:

Have students develop and justify a cost-effective combined method of lamprey control.

Possible Extensions:

1. Have students use their knowledge of sea lampreys to construct a lamprey barrier that allows all fish through, except the lamprey.
2. Have students find out if any lamprey control measures are currently being used in the province.
3. Depending on student interest, etc., dissect a lamprey with students as part of a comparative anatomy class.
4. Consider a field trip to a river tributary where lampreys are known to spawn. (The local office of the Department of Natural Resources and Energy may assist you in locating a site.)

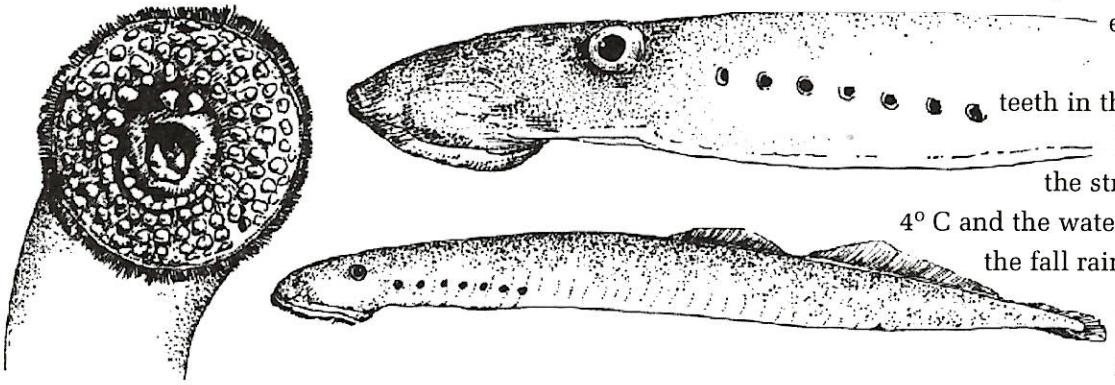


STUDENT RESOURCE SHEET: CONTROLLING THE CRITTERS

Sea Lamprey: Life History

MANY fishermen consider the sea lamprey the most hated fish parasite, commonly preying on the Atlantic Salmon.

Although the lamprey has a leech-like appearance, it is actually more closely related to fish, particularly the shark. Like the shark, the lamprey has a skeleton of cartilage and gill slits rather than a gill cover. Unlike the shark however, the lamprey does not have paired gills or true jaws. It is, however, a very capable predator. With its large tooth-lined sucking disk, the lamprey attaches to its prey and rasps a hole in the side of its victim. It then feeds on blood and other body fluids. If the prey is able to survive the attack, it must deal with the loss of blood, which continues because of the anti-clotting chemical injected by the lamprey. In addition, the development of infection is common in the wound area.



The parasitic stage of the sea lamprey's life cycle is actually very short. The life cycle starts in the spring, when the water in the stream has warmed to 4° C. The sexually mature adults migrate upstream to spawn in shallow, gravel-bottom riffles. There they dig a nest using their sucking mouth. Both sexes prepare the site by moving small rocks and pebbles to form a C-shaped nest.

Spawning initiates when the stream temperature reaches 14° C. Females produce an average of 61 500 eggs, which drift across the nest and then lodge securely among the stones in the nest's rim. Adults die after spawning. Once hatched, the young larval lampreys, called ammocetes, now less than 1000 in number, wriggle free of the gravel and move to the slower reaches of the stream.

At this stage the lampreys are not predatory. The larvae live in the bottom mud in U-shaped burrows and come to the surface to filter-feed on minute plant and animal material.

After a period of three to fourteen years, the sea lamprey reaches a mid-summer transformation stage. The worm-sized larvae begin to transform into a miniature version of the predatory adult - eyes emerge, fins enlarge and the ring of teeth in the mouth develops. By late October, the stream has cooled to 4° C and the water levels rise with the fall rains. The pencil-size young lampreys, called transformers, begin their migration to the sea. The young sea lamprey will live and grow on the fish of the ocean for the next one to one and a half years, then return in the spring to the stream to spawn. The adult sea lamprey now measures up to 45 cm and upon entering its stream of origin, it spawns and completes its life cycle.

STUDENT RESOURCE SHEET: CONTROLLING THE CRITTERS (PART 2)

Sea Lamprey Control Measures:

1. LAMPRICIDE

The chemical compound 3-triflouromethyl-4-nitrophenol (TFM) appeared to be the solution to the sea lamprey problem when it was discovered in 1958. This lampricide was very effective at controlling sea lamprey larvae in streams. The incidents of sea lamprey attacks decreased throughout the 1960s and 1970s as TFM was applied to test streams in Ontario.

While sea lampreys are most susceptible to TFM, other species of fish are also affected. Other fish species have tolerance levels only slightly above those of the sea lamprey and occasionally a fish kill may result. In order to minimize the risk to other species, fish are tested prior to application to determine the correct concentration of TFM. The stream is also monitored throughout the application and the treatment can be altered if the need arises.

There is concern over the potential continued release of lampricide chemicals into the environment. Lampricides do break down, but they persist for several months under laboratory conditions. Scientists are hesitant to release any chemical in the environment. TFM has been tested thoroughly on animals and has not produced injury to the animals or their young at the dosages used in the field studies.

American biologists have determined that some young larval lampreys (ammocetes) survive every lampricide treatment and some streams become infested every four years. The sea lamprey larvae that remain may benefit from the reduced competition; the increased survival of these somewhat tolerant individuals may more than compensate for the numbers killed by the TFM application. The sea lamprey that survive may eventually give rise to a strain of TFM-tolerant sea lampreys.

Lampreys that spawn in large rivers are also difficult to control using lampricides because of the water volume.

The control of sea lampreys by chemicals is also very expensive in terms of employee costs and chemical costs. It would also involve cooperation between federal and provincial governments, achieved through negotiations.

2. BARRIERS

Stream barriers can be an effective means of sea lamprey control. The barriers are a one-time major expenditure with a yearly cost for maintenance. While effective at controlling sea lampreys, they also present a problem for some migratory fish and for watercraft navigating the river. The sea lamprey can get over some barriers during times of flooding.

3. CHEMICAL REPELLENTS AND ATTRACTANTS

Pheromones are chemicals secreted by many animals including lampreys, that may be useful for controlling them. Pheromones are being studied as potential attractants to trap sea lampreys or as repellants to keep sea lampreys from entering large rivers, which are hard to control by barriers or lampricide.

4. HABITAT MANIPULATION

The sea lamprey is thought to have existed in Maritime rivers prior to the arrival of humans. In the unstressed ecosystem, sea lamprey populations were held in check, but logging and agriculture disrupted the ecosystem, removing stream-side cover and elevating water temperatures. In so doing, river habitats were altered, making them unsuitable for species such as the Atlantic Salmon, while enhancing sea lamprey populations. Replanting stream-side trees and cover, as well as the installation of habitat reconstructive devices, lowers stream temperatures, removes silt and denies the sea lamprey spawning and rearing habitat.

5. BIOLOGICAL CONTROL

It is unfortunate that the sea lamprey is prey to very few organisms. During spawning, the adult is vulnerable to predators such as raccoons, mink and heron. When the lamprey is in its parasitic stage, however, nothing seems to eat it.

Europeans favour the sea lamprey as a great delicacy, but the varieties found in Maritime rivers are less appetizing than the European river sea lamprey. Predation by humans, while desirable as a possible control method, seems unlikely in the Maritimes.

The sea lamprey is one out of nine species of lampreys in Canada. Six species of lampreys are non-parasitic and could be of value as competitors to control sea lamprey abundance and growth. Unfortunately, if chemical controls were to be used on sea lampreys, they would also kill the non-parasitic species.

6. STERILE MALE METHOD

Sea lamprey numbers may be controlled by sterilizing males, using chemical sterilants or radiation. First, migratory males would need to be captured. Once sterile, these males would be released into the stream to mate with fertile females. The infertile eggs would not hatch.

7. TRAPS

When barriers are placed early in the attempts to control sea lampreys, it becomes possible to trap the adults as they attempt to migrate upstream. It is also feasible in small streams to trap transformers as they make their way to the ocean from their rearing areas. The use of attractants make trapping a more effective control method. Traps can be used to obtain males and to determine sea lamprey abundance.

STUDENT WORKSHEET: CONTROLLING THE CRITTERS

Decision-Making Matrix

Alternatives / Factors to Consider	Lampricide	Barriers	Chemical Repellents-Attractants	Habitat Manipulation	Biological Control Method	Sterile Male	Traps
Biomagnification							
Cost							
Effectiveness of Control							
Long-term Environmental Damage							
Habitat Destruction							
Effect on Migratory Fish							
Toxicity to Humans							
Public Acceptance							
Total							

TEACHER: "OH GIVE ME A HOME"

Overview:

To fully understand an organism it is important to become knowledgeable about its habitat. Through the following exercise, students will learn about the habitat requirements of brook trout, then design an ideal trout stream. ***It is strongly recommended that students go on a field trip to a stream with good fish habitat before completing this activity.***

Objectives:

Students will be able to:

- demonstrate their understanding of the role habitat plays in the survival of salmonoids
- develop skills in: reading critically to derive pertinent information from resource materials, reading a map and producing a map of a stream, detailing salmonoid habitat
- students will be able to describe the habitat requirements of salmonoids

Subject Links:

- science

Time:

minimum of one hour

Materials:

- Student Resource Sheet
- Student Worksheets
- Teacher Resource Sheets

Background:

THIS activity addresses one of the major problems facing Canada's fish populations: habitat degradation. Before attempting to make changes in habitat, people must understand the habitat needs of the species in question.

All animals have certain needs that must be met in order for them to live. Those needs may be referred to as ***habitat requirements.*** When those needs can no longer be met in a particular area, the species in question will disappear from that area, either through death, or finding somewhere else to live.

Increasing attention is being focused on the habitat requirements of trout and salmon. These *salmonoids* are favoured as sportfish by fishermen world-wide. Both trout and salmon are presently disappearing from our streams and rivers. One of the main reasons is human impact on fish habitats. Increasing energy and financial commitments are being expended to prevent their disappearance.

The first step in this process is to understand the habitat needs of salmonoids. These are described in some detail on the Student Resource Sheet.

Process:

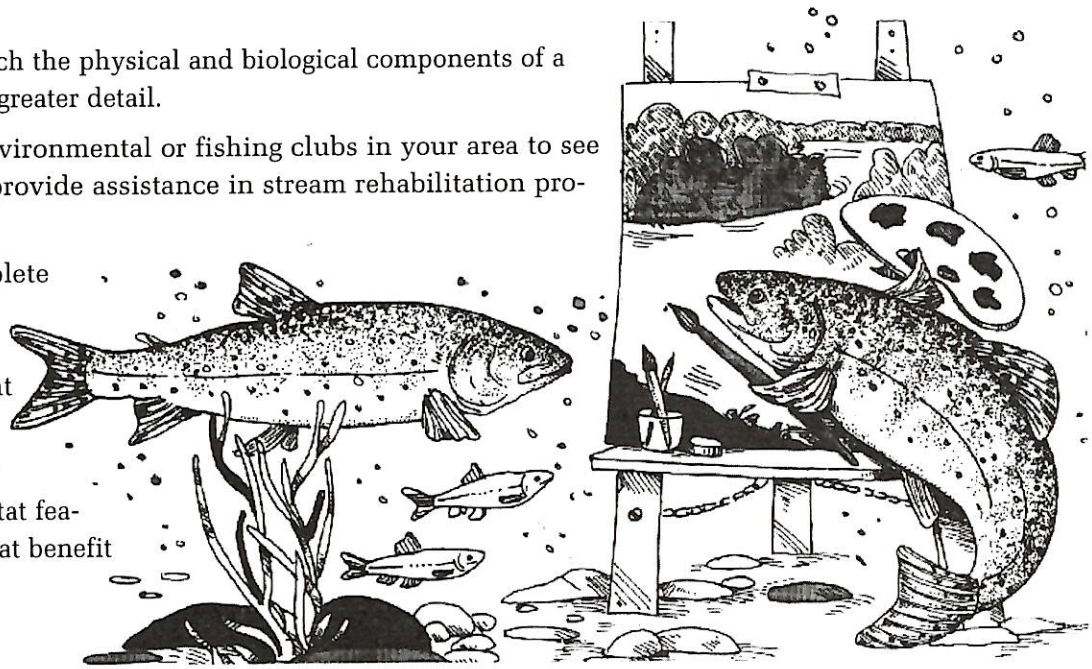
1. Assign the Student Resource Sheet on Salmonoids and Salmonoid Habitat as homework or a classroom reading assignment.
2. Discuss as a class or in small groups, the importance of good habitat for salmonoids.
3. Work through an example of a sketch of a stream section as illustrated on the Teacher Resource Sheet, noting such trends as pools following runs or riffles, sediment collecting in slow areas, etc.
4. Have students complete the mapping and question activity found on the Student Worksheet. Although their maps will vary, they should contain some of the following elements:
   - **a spawning area** that is at the head (top) or tail of a pool, in a riffle or spring area (moving water with high oxygen levels), and with a gravel bottom.
   - **sufficient shelter** for brook trout of all ages. This means the presence of undercut banks, logs, large boulders or weed beds for the larger fish. Branches, twigs and smaller boulders near riffle areas provide shelter for the young fish (fry).
   - **food sources** found in riffle areas and overhanging vegetation. Dense vegetation that completely prevents the sunlight from penetrating along the entire length of the stream section is counter-productive.
   - **water temperature control features** such as a spring, some overhanging bank vegetation and generally narrow, swift areas rather than wide, slow areas.
   - a balance of riffles, pools, runs and flats.
   - the absence of roads, agriculture or other developments nearby, or at least buffered from the stream through riparian zones.
5. Discuss the students' designs and the habitat features they contain that may benefit salmonoids.

Evaluation:

Provide students with Worksheet 2 and have students assess the map and rate it for its salmonoid habitat. What is missing? What stages of fish might survive there? A sample assessment is provided on Teacher Resource Sheet 2.

Possible Extension:

1. With assistance from the students, design a field trip to carry out an actual stream assessment on a section of a local stream. Have students sketch maps of the stream and identify features that create or prevent good habitat for fish.
2. Have students research the physical and biological components of a stream ecosystem in greater detail.
3. Check with local environmental or fishing clubs in your area to see if your class could provide assistance in stream rehabilitation projects.
4. Have students complete the mapping and question activity found on the student worksheet.
5. Discuss the students' designs and the habitat features they contain that benefit salmonoids.

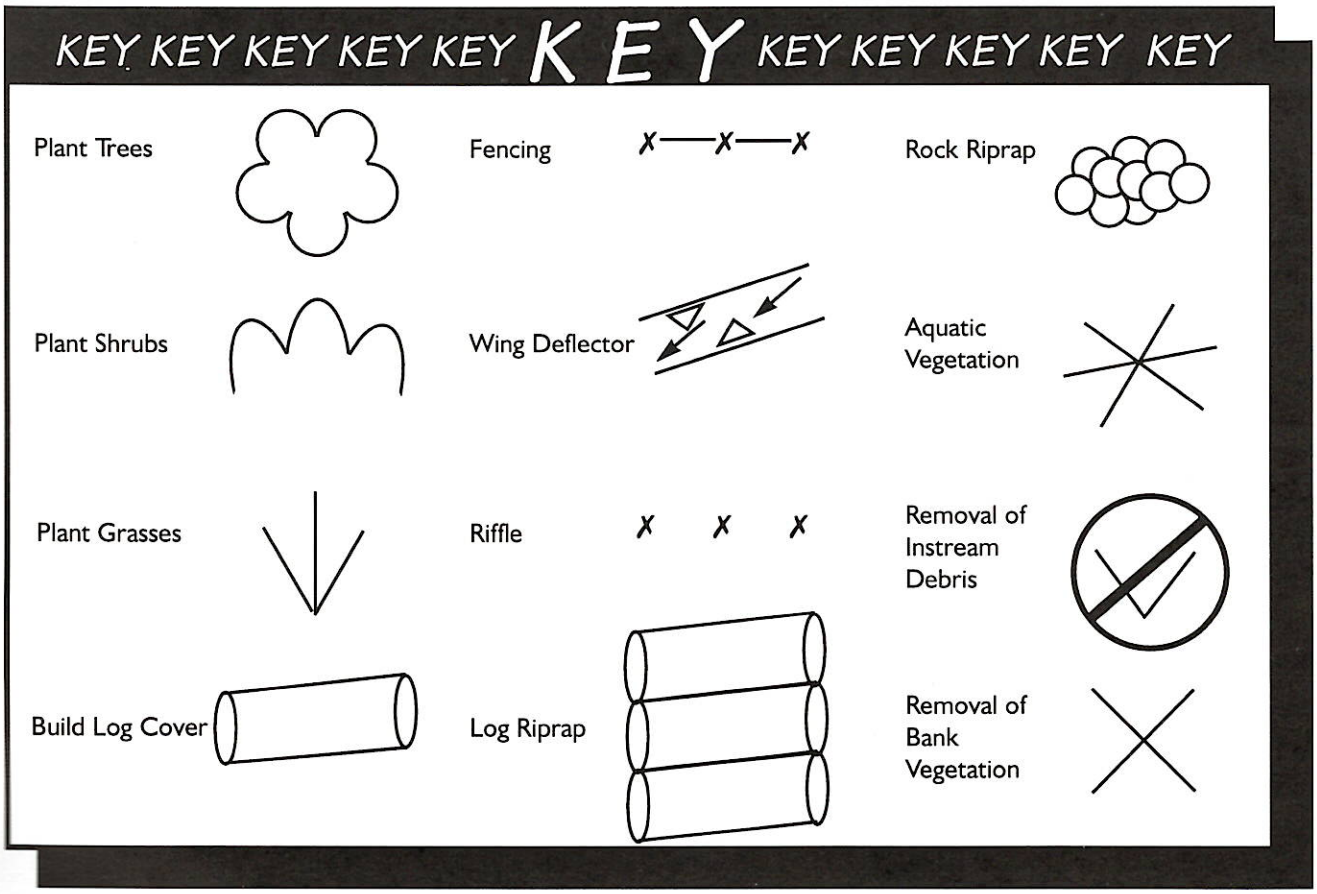


STUDENT WORKSHEET 1
"OH GIVE ME A HOME..."

Instructions:

In this activity, you will have an opportunity to design a trout or salmon stream (or at least a section of one).

1. Read Student Resource Sheet *"Oh Give Me a Home . . ."*
2. Using the key below, sketch a map of a section of an ideal trout or salmon stream that provides a spawning area, cover for various age groups, good water quality, food, etc. Use a scale of approximately 2.5 cm to 10 m.
3. Indicate the site of your map that offers the best spawning site for trout or salmon. Describe what it offers in the way of suitable features.
4. Describe the features of your stream that would help to control water temperature during prolonged summer heat.
5. Describe the features of your stream that would help to provide shelter for adult brook trout.
6. Where, in your stream, would you spend the most time as a young brook trout under 30 cm? What features would attract you to this spot?



STUDENT RESOURCE SHEET: "OH GIVE ME A HOME..."

Salmonoids and Salmonoid Habitat

ALL animals, including fish, have a certain set of needs that must be met in order for them to live and grow. These can be summarized into four categories: food, water, space and shelter. Together, these items describe an animal's habitat. A combination of things from each category provides the preferred habitat for each species. Even within species, different combinations are required for nursery areas, feeding, spawning, etc.

Water:

Water quantity and quality are important requirements for fish. It has been said that a stream is only as healthy as the valley through which it flows. Extensive use of the valley without regard for the stream will quickly spell the end of fish communities.

One of the most limiting factors regarding fish habitat is water temperatures. Stream temperatures are regulated by springs, shading and channel width. Most streams begin as springs bubbling out of the ground. The water from these springs comes from snow melt and rainwater that has percolated through the soils of the surrounding hillsides during the previous week, month or year. Human impacts and developments may reduce the opportunity for rainwater to percolate into the soil and thereby limit the replenishment of the water table. As springs dry up, stream flow decreases in the summer and water temperatures rise. Water quality and quantity are diminished.

Springs help to regulate water temperatures throughout the year; maintaining cool water temperatures in the summer and relatively warm temperatures in the winter. They also provide a haven for fish such as trout and salmon when summer temperatures become limiting.

Shading:

Bank vegetation prevents erosion and also provides shade. This also helps regulate water temperature; critical for mid-summer when temperatures begin to soar. Too much shading in a stream, however, will reduce production of aquatic invertebrates and ultimately result in less food for trout and other species. Too little shading will encourage solar heating of the stream's water.

The percentage of shading suitable for an optimal balance of cool water temperatures and food production varies from stream to stream and depends on several factors such as: the amount of spring water available to cool the stream, the stream's width, development and human activity along the stream. In general, the more shading along the stream the better. A narrow river channel also maintains cooler water temperatures. Where width greatly increases, so does the water surface susceptible to solar heating. A narrower, deeper, swifter stream with its lower ratio of water surface to depth will experience a sharply reduced amount of warming.