FISH FOR OUR FUTURE!

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Contents

Just for Teachers

UNIT ONE

A L E V I N

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

S M O L T

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

S A L M O N

for High School Students

EXTRA RESOURCE SHEETS

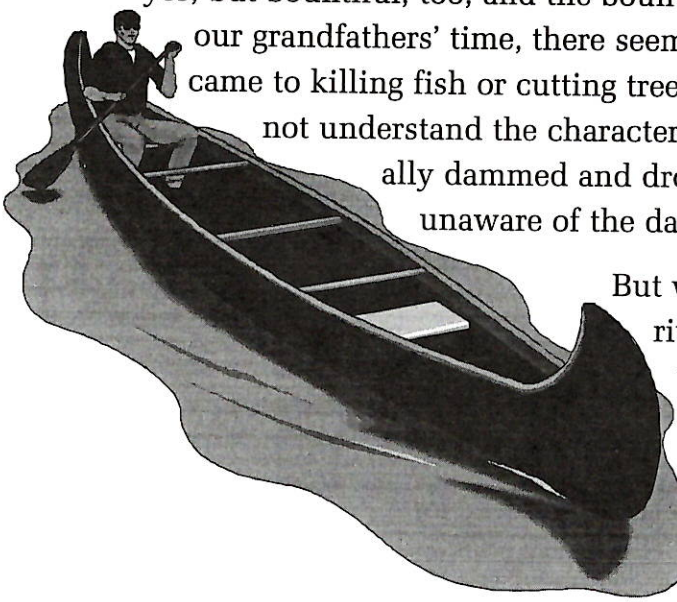
FISH FOR OUR FUTURE!

JUST FOR TEACHERS

"The rivers are our brothers. They quench our thirst. They carry our canoes and feed our children. So you must give the rivers the kindness you would give any brother."

- Chief Seattle, 1852

FOREWORD



Perhaps it was simply a case of plenty, but there is no doubt that our land has suffered in the two or three hundred years since Europeans arrived. The land was hard, yes, but bountiful, too, and the bounty must have seemed to be limitless. Even in our grandfathers' time, there seemed to be no need for self-restraint when it came to killing fish or cutting trees. Ignorance played its part too, for we did not understand the characteristics or needs of natural habitat, and casually dammed and drove streams and cut fields to streambank unaware of the damage being done.

But while all that was going on, our land, our rivers and forests, were entering our collective consciousness, our culture. The reason is perfectly natural - we were utterly dependent upon them for our survival. They were where we worked, and played. So it has come to be that in the way we think about ourselves, in our stories, poems, songs, paintings, in our history and in our current travels, truly "a river runs through it."

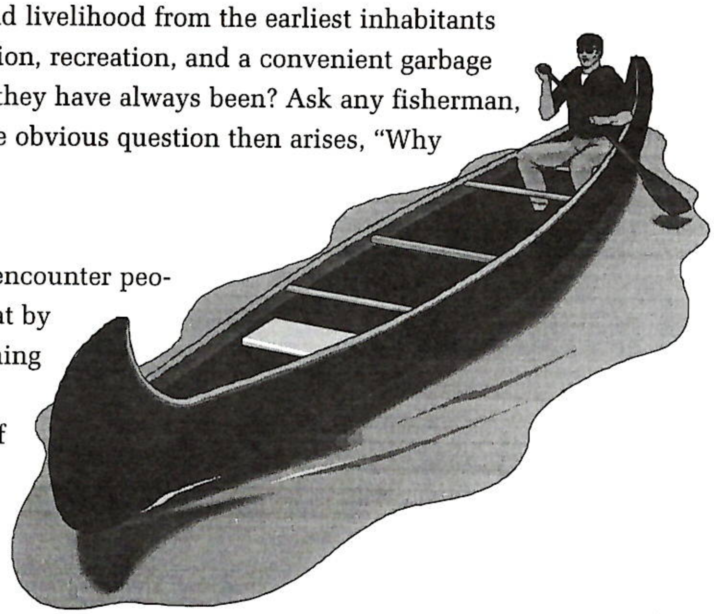
In the early days of the Keswick River Society a few years back I was pondering all this with my mother-in-law (a teacher and a good one) and suggested that we could use the Keswick River to teach science. She responded with characteristic enthusiasm: "Why not use the river to teach **everything?!**" It was this simple gem of an idea that Wayne Annis cultivated into the rivers program you have in your hands.

Wayne and his team, with the visionary support of School District No. 12, have created an imaginative cross-curricular tool for teachers and their students to bring our rivers back into the centre of our consciousness, where they deserve to be for our own sakes. It is only if we are aware of how much rivers and forests are part of our culture, a part of ourselves, that we will take care of them. And we must never forget that in saving them, we are really only saving ourselves.

David Olmstead, M.L.A.
Burtts Corner, N.B.
June 1997

INTRODUCTION

RIVERS . . . a part of Maritime life and livelihood from the earliest inhabitants through today. A source of food, transportation, recreation, and a convenient garbage disposal system. Are the rivers the same as they have always been? Ask any fisherman, and you'll soon realize the answer is no. The obvious question then arises, "Why not?"



It's interesting *(and not too unusual)* to encounter people who can regale you with river stories that by today's standards are hard to believe. Returning from fishing trips with hundreds of fish, the size of which are seldom seen today. Tales of the annual log drives, and attempts to straighten rivers to make log drives easier. Streams being stripped of their gravel, to serve as a base for roads and driveways. Such stories often end with *". . . you know, it's funny, but that river is different. The old swimming hole is all filled in, and there's hardly any fish now."* Is it any wonder? Is it too late: have we passed the point of no return? **NO!!!**

Through careful planning, evaluation and implementation of strategies, changes can happen. Regardless of how small or large projects are, or how much time you and your students can commit to restoration projects, every bit helps!

So what are habitat management, digger logs and rock deflectors? Why are they becoming important to teachers and students? This manual attempts to answer these and many other questions through student activities. It is divided into four units: Teachers Guide, Alevin & Fry (elementary), Smolt (middle), and Salmon (high). Although it contains a variety of material and activities from several different sources including Ontario's Ministry of Environment **Fishways** as well as various publications of the Department of Fisheries and Oceans, it is by no means the *"last word"* but rather a jumping-off point for you and your students. Have fun, keep safe, and remember, ***WE CAN MAKE A DIFFERENCE!***

SAFETY CONSIDERATIONS

FOR FIELD TRIPS . . .

- Wear gloves
- Wear sunscreen and a hat
- Be cautious of water depth

- Do not work around water during lightning storms
- Beware of slippery algae on rocks
- Work in pairs or groups - use the buddy system
- If using boats, wear life jackets
- Always have an emergency plan in place
- Keep a first aid kit near the worksite
- Make sure footwear is suitable

- Gain a basic knowledge of water safety and rescue
- Ensure adequate supervision

JUST FOR TEACHERS

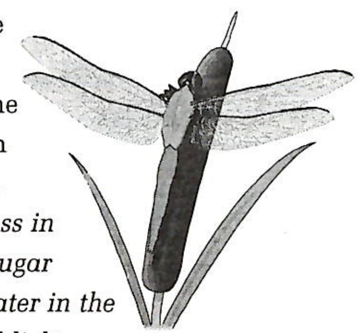
STREAMS AND RIVERS are local resources available for education, recreation and water supply. They are relatively safe, accessible and may provide a controlled area of study for students. Waterways played an important role in our developing civilization. They provided passage from ocean to inland villages, towns and cities. They were a means of importing goods and products, and exporting natural products such as timber.

Digger logs, rock deflectors, electro-seining, habitat reconstruction and anadromous species; are these foreign terms to you? If so, relax! They were to me too. The following section is a brief overview of the above, as well as hydrology, stream, ecology and other things you need to know to teach the lessons effectively. Let's begin with the basics: what types of water systems are there?

What Types of Water Systems Are There?

What are the differences between a pond, lake, river and stream? How do you classify a body of water as one or the other? If you look at current names, it could be quite confusing. Small bodies of water are sometimes referred to as rivers, larger bodies of water referred to as streams. Some bodies of water the size of lakes are referred to as ponds! Why? In the past, the designation of a body of water was dependent on who discovered it and what they decided to name it. In modern times, a body of water is classified by its characteristics. There are two general classifications: standing water and flowing water. A pond is an example of standing water. A stream is an example of flowing water.

STANDING WATER is characterized by little inflow or outflow of water and high concentrations of nutrients. This results in distinct populations of aquatic insects and plants. Because of the large numbers of plants, photosynthesis is the principle method of oxygen being "added" to the water. *(Photosynthesis is the process in which plant cells produce sugar from carbon dioxide and water in the presence of chlorophyll and light. Oxygen is released as a by-product.)*



FLOWING WATER is characterized by current or flow. Velocities vary between bodies of flowing water, and within a body of flowing water depending on the size, shape and gradient of the water channel, the roughness of the bottom, depth and recent amounts of precipitation. Plant life is sparse compared to standing water, and the oxygenation of the water occurs primarily through aeration; water rushing over rocks. The process of aeration also promotes evaporation which cools the water and helps maintain temperatures within the survival range of fish and aquatic insects.

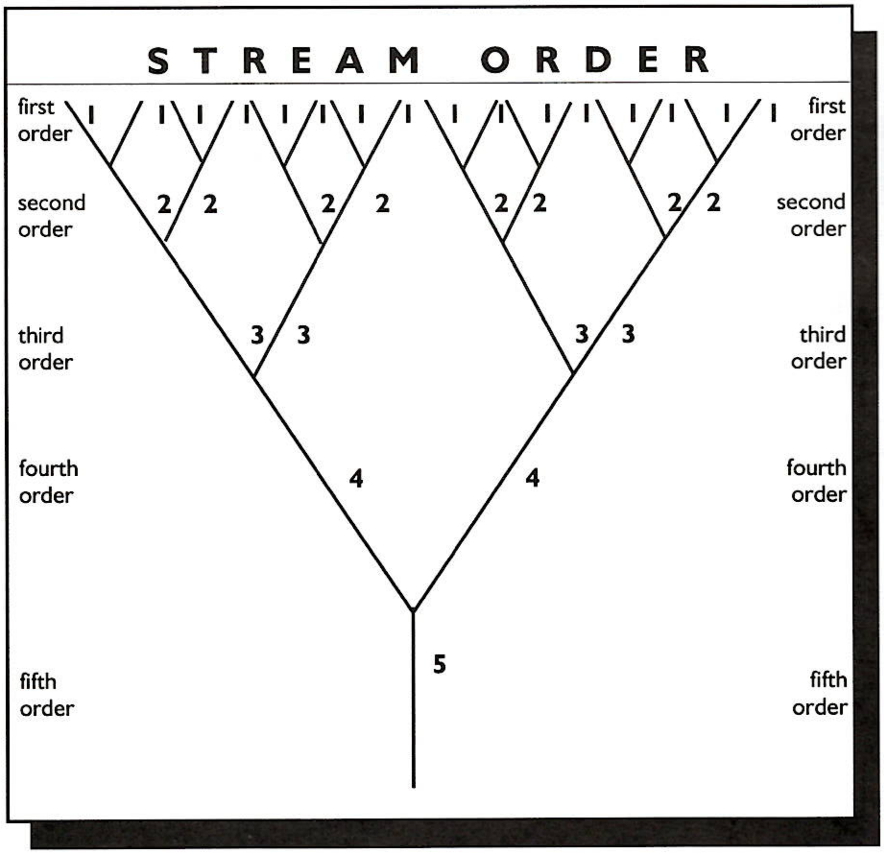
Hydrologic (or water) Cycle:

Water enters the atmosphere through evaporation and transpiration *(the loss of water through the pores of plants' leaves).* As the vapour cools and condenses, clouds form. When enough moisture collects in the form of clouds, precipitation falls. Some of this water runs along the surface of the ground and ends up in streams, lakes and rivers, carrying with it soil, silt, chemicals, etc. This is known as *surface runoff.* Other water is soaked up by the ground and gradually makes its way to the bedrock. The process of percolation removes many of the impurities in the water through much the same process as a filtration system. This water eventually reaches the water table, and makes its way into lakes, and other bodies of water that may be fed by underground springs. Some of the water absorbed by the ground is utilized by plants through capillary action, much the same way a paper towel soaks up water. Most plants obtain their hydrogen and oxygen through this process.

Stream Order:

Streams and rivers are made up of many different parts. When looking at a river with all of its feeder streams or tributaries, the shape of a branching tree may be seen. Each small stream is a branch or tributary of the larger body of water that it joins. *(See Figure 1)* Streams with no tributaries are called *first-order streams. Second-order streams* are formed when two first-order streams meet. When two second-order streams meet, a *third-order stream* is formed. The lower the order of stream, the cooler it tends to be. This is due to greater shading of the water by vegetation, cooling by evaporation and natural springs, the source of many small streams. All of the land drained by a river system either through direct entry into the river or its tributaries is that river's watershed.

FIGURE 1



NOTE: *When a tributary is of a lower order than that of the receiving stream, it does not change the order of the receiving stream. For example, if a first-order stream joins a fourth-order stream, it does not change the order of the fourth-order stream. The fourth-order stream becomes a fifth-order stream only when it meets another fourth-order stream.*

Water as a Transporter:

Low-order streams generally have greater velocity than high-order streams. This allows for the constant removal of gravel, sediments and silt which build and maintain a natural meander pattern in the stream. This continual *"flushing"* leaves boulders and cobble; ideal spawning ground for many species of fish and excellent habitat for aquatic insects such as caddisfly larvae, stone fly larvae, etc. As water flows to the mouth of the stream or river, its velocity decreases, and it thereby becomes incapable of carrying materials of decreasing size. This results in materials being dropped: coarse gravels, fine gravels, then coarse and fine sand. Eventually the stream enters another body of water and there deposits finer material that it carried, forming a delta.

Human activities frequently result in erosion. Although small erosion sites may seem isolated and insignificant, they collectively impact on waterways. Increased material in streams and rivers heighten existing erosion problems downstream, acting like sandpaper. This is particularly evidenced after significant rainfalls. The water may turn a rust colour, as increased water flows carry with them more and more materials. This impacts on banks and erosion sites downstream, making the channel wider and shallower. Over time, pools fill in and aquatic habitat vital to the survival of fish and insects disappears. The end result may be the total destruction of habitat for specific species, and the eventual extinction of those species within that waterway.

Meandering:

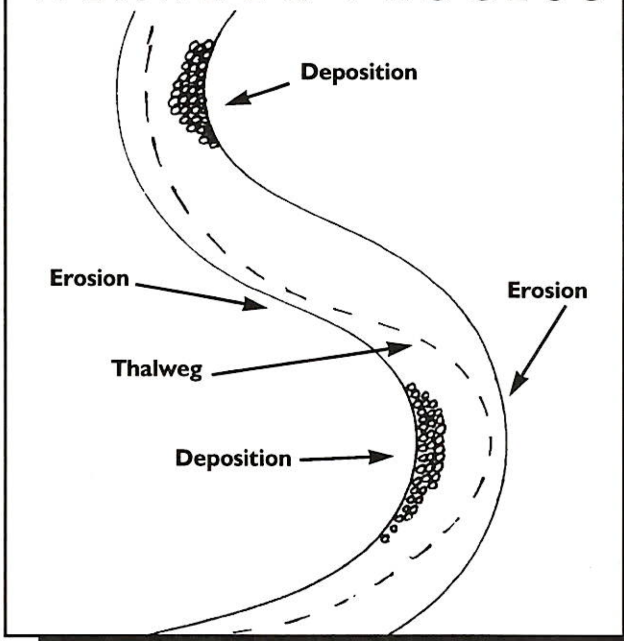
According to scientists, the gravitational pull of the moon has an impact on any body of water; the greater the body of water, the greater the impact. This applies to an ocean or your bathtub. Streams and rivers are affected by gravity. Gravity causes water to move downstream and gives it speed. As the moon's gravity pulls at the water, it draws the water up the river bank as far as it can. When it can *"pull"* no higher, the mass of the water causes it to fold under, and flow toward to the other bank, thus creating the meander pattern in streams and rivers. As the water folds under, it has the effect of digging. This creates pools and riffle areas. *(See Figure 2)* Unimpacted water systems are capable of maintaining themselves in this pattern forever, if left undisturbed. A healthy stream channel adjusts to change naturally without changing its basic shape and form.

Stream channels are also influenced by friction between the water and the stream bed and banks. Friction creates a turbulence which slows down the flow. When water flows over large materials such as rocks, boulders and debris, friction increases. As water levels rise, the friction on the bottom and sides has less and less influence on slowing the water flow. The velocity of the water and the rotation of the earth also combine to create a sloshing or pulsing pattern that slows the stream down. You can observe this effect by watching water run down a chute or a trough. All of the forces described above help to create the physical features of a stream and the shape of a channel.

Throughout the years, we have impacted most streams and rivers through forestry practices and farming. This has resulted in a greater sediment load to the streams and rivers, and the elimination of pools and fish habitat in many waterways. Streams and rivers become wide and shallow, excellent ice-making *"machines"* in the winter months. Waterways in this condition typically freeze to the bottom, creating great sheets of ice removed with the spring freshet. Not only does heavily silted water impact on the downstream banks and curves, but now thick ice sheets are added to the equation. On some rivers, this results in an annual loss of many acres of valuable agricultural and silvicultural land.

FIGURE 2

MEANDER PROCESS

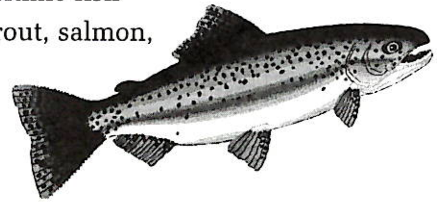


Through careful planning and reconstructive projects, these impacts on a stream or river may be reversed. The first step is the completion of a stream survey. The information is then compiled and forwarded to the Department of Fisheries and Oceans, who will assess the area and make recommendations on what habitat restoration techniques are required and where.

Stream Inhabitants

When you begin investigating a stream or river, you will be amazed at what you find! There are many reasons for insects and fish to live in a stream. A stream's water is continually mixed from top to bottom. This brings a supply of oxygen to all life-forms within the stream. A stream's temperature remains fairly constant, compared to standing bodies of water. Another advantage is food. With rainfall or wind, insects fall from trees and surrounding banks into the water, providing a food source for fish. In addition, food materials from decaying plant and animal matter provide nourishment to fish and insects.

Common Maritime fish species include trout, salmon, bass, American eel, perch, etc.



You may also find dace, stickleback, burbot, crayfish and sculpin! *(Yes, sculpins do exist in fresh water!)* With approval, some of these species may be kept in an aquarium for further short-term study. Insects can provide hours of fascinating study as well. Many insects such as mosquitoes, etc. may be hatched easily in a classroom setting. All that is required is a sample of pond water and time. It is very difficult to successfully raise frogs or toads in the classroom, particularly from the tadpole stage onward. This is due to their food and water requirements, etc. You will have greater success, higher survival rates, and far less work if frogs and toads are examined at their various life phases for brief periods, then released.

Land Usage

How adjacent land is used can greatly affect a stream, river or lake. Poor ploughing practices, the trampling of stream banks by livestock, poor drainage designs and loss of stream bank vegetation can reduce water quality by importing materials from the land during snow melt and run-off caused by precipitation. These materials may take the form of fine silt, fertilizers, manure, pesticides, etc. To combat this problem, a minimum of six metres of healthy vegetated fringe should be left on each bank. This will reduce runoff and decrease the likelihood of it entering the stream. Carefully designed drainage systems can also decrease deposits of soil and associated material.

Although adult fish can live in heavily silted water for brief periods of time, their eggs cannot. If sedimentation occurs when there is only moderate rainfall, eggs may be smothered and food buried. Since the eggs of many trout and salmon lie in the gravel from late fall until early spring, it is critical that excessive amounts of sediment be prevented from entering the stream near spawning sites particularly during that period.

Pollution

Water quality is commonly affected by two inter-related pollution problems: enrichment and chemical toxins. Enrichment is the fertilizing of a stream through waste-water input from municipal sewage treatment plants, septic systems, barnyard drainage and fertilizers washed in from farm fields and storm sewers.

A normal healthy stream has clear water washing over rubble and rock, occasionally flowing through beds of rooted aquatic plants. A stream that has enrichment problems quickly develops excessive algae growth on rocks. These trailing strands tend to choke river channels, eventually crowding themselves out of food and space, then dying. Oxygen is removed from the water by the respiration of bacteria that feed on the decaying vegetation.

Pollution is the introduction of noxious chemicals, herbicides, pesticides and heavy metals, which actually poison life-forms in the stream. Chemicals such as dioxin, DDT, PCB and mirex, or heavy metals such as cadmium, zinc and lead, as well as many petro-chemical distillates, can poison aquatic life immediately if released in sufficient quantities. The effects are equally serious if the chemicals are released in small amounts over a period of time, since they accumulate in the food web.

Land Usage

Space for fish can be described as the physical features that make up the stream's character. These features are commonly called **riffles, pools, runs** and **flats.**

A **riffle** is a swift, shallow portion of a stream or river where the flow of water is broken. Rocks often protrude through the surface of the water. The bottom is usually gravel, rubble and/or rock.

A **pool** is a slow, deep portion of a river or stream, usually following a riffle or run. Although pools vary in depth, they are usually the deepest areas of the stream or river. The bottom may be gravel, rock, boulders, silt, or a covering of logs.

A **run** is a swift, deep portion of a river. Although the flow of water in a run may be as swift as in a riffle, the water depth is proportionally greater. Runs can range in depth from 20 cm to 2 m, depending on the stream size. The bottom is usually rock, rubble and/or boulders.

A **flat** is a shallow, slow portion of the stream, usually located where it widens. It can be as shallow as a riffle, but is not exposed to the full speed of the current.

The pattern in which these features occur is dependent on soil types, gradient, amount of flow and the natural hydraulic properties of flowing water. Normally there is a repeating sequence of riffles and pools at regular intervals. This frequency may be calculated with a fair degree of accuracy by multiplying the average natural width of the river or stream by 6. *(For example, if a stream is 1 m wide, you may expect to find a pool every 6 m on that stream.)*

The best bottom for trout and salmon is a mixture of gravel, rubble, rock and boulders, with a generous sprinkling of sunken logs and stumps. The gravel and rock found in riffles and runs offers the best habitat for aquatic invertebrates upon which trout and salmon feed.

These fish have very specific space requirements at the various stages of their life cycle: nursery, feeding, hiding and spawning. If the type of space that these fish require at a particular stage is not available, the development of the population will become disjointed and eventually collapse. For example, fingerlings do not live where the larger fish live because they would soon be eaten. They prefer the quiet margins of riffles, where rocks, logs and plant materials offer cover. Here, they are safe from the large predators found in deeper water.

After about a month, they move into the swifter portions of the stream, still in the very shallow areas. In these areas they require structures like rocks and logs to break the current. When they are about one year old, they move into deeper water. Larger fish require more water overhead to serve as protection from predators, since the larger they get, the slower and less maneuverable they become.

Older fish prefer to live in runs at the head of pools, where they are close to food-gathering areas, but still feel secure. Riffles are important for two other reasons: the majority of food that trout and salmon rely on is produced in riffles, and riffles are where spawning takes place. Pools provide winter refuge for many species of fishes including trout and salmon. In addition, they provide excellent hiding places for larger fish.

Shelter

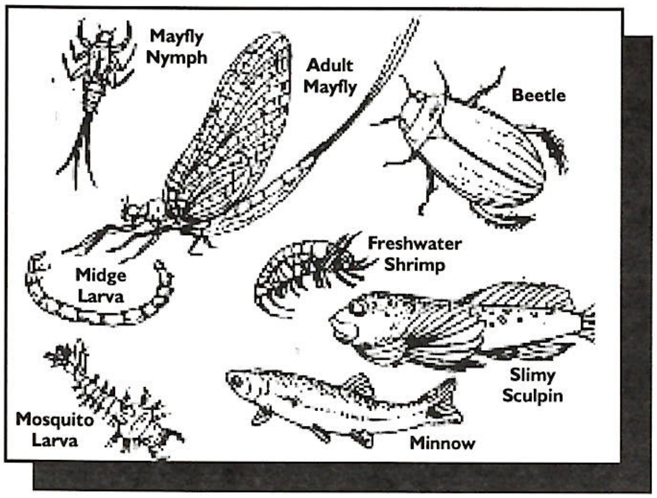
Shelter areas are vital to the survival of trout and salmon. Shelter requirements vary with the size of the fish. Trout like to be protected on three sides. This often means top, one side and the bottom *(an example of this would be an undercut bank).*

A shelter also provides protection from strong currents. Rather than living in strong, heavy currents, trout prefer to "lounge" in the slower water created by the water flow around a rock or log. This requires them to exert far less energy than if they continually stayed in the strong current. Even within the roughest, fast-flowing rapids, there are *"dead spaces"* as long as there is a structure such as a rock or log to act as a buffer against the current.

Shelter is also provided if the water surface is riffled and broken. This makes it difficult to see fish that are within the water. Beds of aquatic plants can also provide cover for young and adult trout and salmon.

Food

The final requirement for trout and salmon is food. The food required is often dependent on the size of its predator. In general, most trout will eat anything that will fit in their mouths. There are a number of factors, however, that tend to determine the selection of food items.



Trout that are less than 30 cm in length feed primarily on invertebrates, both terrestrial and aquatic. These include mayflies, caddisflies, stoneflies, crayfish, midges, beatles, grasshoppers, etc. The active feeding of trout seems to be determined by two things: how much food there is, and how easy it is to get the food. Even if there is an abundance of a particular type of insect, a trout will not attempt to eat it if it swims too quickly or is inaccessible. When invertebrates are emerging or trapped in the surface film, they are immobilized for a brief moment and therefore easily caught by the trout. Insects that fall into the water are also easily caught because they have difficulty getting out of the water.

Most of the aquatic invertebrates that fish feed on are bottom-dwellers. The most important area where they live is riffle areas. Riffles provide well-aerated water and lots of food, shelter and space for invertebrates. The space and shelter occur because of the jumbled nature of the stream's bottom.

Food for invertebrates comes from a number of sources. Sunlight encourages diatoms and other simple organisms to grow on the rocks. These organisms are eaten by bugs that scrape the rocks for food. In the fall, leaf litter provides a major source of food for invertebrates. Riffles collect and store these soggy leaves on the upstream side of the rocks where they are accessible to invertebrates. The other areas of a stream also produce invertebrates, but not in the same variety or numbers, nor over the same time period as a riffle.

As trout reach and exceed 30 cm in length, their diet shifts toward larger food items, such as minnows. Fish work on a *"calorie budget"* expending as little energy as possible in the pursuit and capture of food. Capturing and eating one minnow usually expends less energy than catching an equivalent amount of invertebrates. If invertebrates are abundant and easy to capture, however, even large trout will feed on them.

Larger trout rarely eat smaller ones because the different sizes are generally found in different locations, depending on their shelter and space requirements. Minnows, however, are less shelter-oriented and are far more likely to be eaten.

The habitats of trout and salmon are complex and dynamic, affected by both natural and human influences. By studying the components of aquatic habitat, we gain a better understanding of the way in which brook trout and other species interact with their environment. It can also help us learn how we may correct and manage the problems we cause.

INDICATORS OF HEALTHY/UNHEALTHY HABITATS

HABITAT requirements are the things a life form needs to exist. Habitat requirements differ, just as plant and animal species differ; for example some require pristine water, while others thrive in water qualities far below standards for human consumption. Some prefer water with low oxygen levels and little water current, while others require high oxygen levels and swift flowing water. Generally, habitat requirements are a combination of four components: water, food, space and cover.

Water

Factors to be considered include: water quality, water chemistry, water temperature and the diversity of life forms.

WATER QUALITY: One of the first criteria commonly associated with water quality is its appearance. If a stream's water is discoloured or turbid (cloudy), we assume water quality is low. Turbidity is generally caused by suspended solids in the water such as particles of clay and soil, organic materials, or excessive amounts of plankton, etc. These reduce the transparency of the water. Water transparency is measured by using a secchi disk.

WATER CHEMISTRY: Vast differences in water chemistry occur between standing and flowing water, and between different sites within the same waterway. Factors commonly measured are pH, oxygen and nutrients.

pH: When you measure the pH of water, you are measuring the water's acidity. pH ranges on a scale of 0 to 14, with 7 being neutral. pH readings less than 7 are said to be acidic, greater than 7 base. This means that the lower the pH reading, the more acidic the water is. Most fish prefer a pH range of 6.7-8.6, and develop breathing problems when the pH is not within this range. pH levels also affect plant growth, by affecting their consumption of nutrients. If pH levels range beyond reasonable bounds, plants will eventually stop growing and die. pH is usually measured with litmus paper and a colour chart or a pH metre. With the heightened problem of acid rain, the waters of some rivers, particularly in Nova Scotia, appear "crystal clear" but their pH level is such that most life-forms cannot exist within that water.

O_2: Oxygen levels are vital to the survival of plants and animals. Different species require various amounts of oxygen. Some organisms such as trout, salmon, caddisfly larvae, etc. require great amounts of oxygen, while other species such as sludge worms and mosquito larvae prefer reduced oxygen levels.

NUTRIENTS: All living things require nutrients in order to sustain life. Among these are nitrogen and phosphorus. Nitrogen is found in all proteins, therefore it is present in all living things. It exists in a variety of forms, including ammonia and nitrate. Think back to the smell of an outhouse or a chicken barn. Few would not recognize and remember the smell of ammonia! Ammonia enters a waterway through many sources: incorrectly installed sewage systems, decaying plant and animal matter and runoff from agricultural operations. Within a short period of time, most of it turns into nitrate, a "fertilizer" that can be used by plants such as algae. Nitrate is also an ingredient of chemical fertilizers. Surface run-off after rains, etc., may also add great quantities of fertilizer to waterways.

Like nitrogen, phosphorus is a natural part of each living cell, where it plays a part in the storage of energy. Phosphorus enters a water system through the same means as nitrogen, as well as from the decay of organic materials, faecal matter and detergents. Many detergents, particularly those used in dishwashers have high phosphorus content. Like nitrogen, increased levels of phosphorus coupled with higher water temperatures commonly experienced in summer months lead to excessive algal bloom.

Water Temperature

Fish, like most aquatic vertebrates and invertebrates, are cold-blooded, which means their body temperature is that of their surroundings. Body temperature affects body processes such as metabolism. The warmer the temperature, the faster the metabolism, and therefore the greater the requirement for oxygen. With cooler temperatures, metabolism slows. The problem is that as water temperatures increase, oxygen content decrease.

Salmonoids *(fish such as trout and salmon)* require cooler water than perch, bass, gaspereau or suckers, not only to sustain life, but for growth and reproduction. Fish will only lay their eggs within specific temperature ranges. Most salmonoids prefer the warmer temperatures of mid- to late spring. Water temperature is also a major factor in the timing of fish migrations.

Water temperatures of a stream or river are regulated by springs, shading, stream width and depth. If a stream or river is well-shaded, narrow and deep, its large volume of water is slow to heat up or cool down; the temperature does not vary much during a day or even over a span of several days. If a stream is wide and shallow, it will heat and cool quickly, resulting in great temperature fluctuations within short periods of time. Although most streams begin as springs bubbling out of the ground or the bottom of lakes, dry hot summers bring lower water levels and reduced flows, resulting in an increase in water temperatures.

If temperatures range between 30-35° C for extended periods of time, most salmonoids, especially young ones, will become seriously stressed and may die. Young trout and salmon prefer water temperatures no greater than 15-18° C. If water temperatures rise above 22° C for periods extending beyond several consecutive days, brook trout will die; brown trout and rainbow trout cannot withstand temperatures above 24° C.

Diversity of Life Forms

Healthy streams and rivers have a wide diversity of both plant and animal life-forms within them including: algae, bacteria, fish and invertebrates.

ALGAE: It is normal to find algae growing in streams and rivers. As water temperatures increase and water quality decreases, algae growth may become excessive. The bottom of a small stream may appear virtually choked with strands of algae, or a lake's water may appear green. This is referred to as *algal bloom* and has the effects of changing the chemical composition of the water through decreased oxygen, etc.

BACTERIA: Bacteria serve many functions, from the process of making cheese and yogurt, to breaking down compounds in a stream or river, thereby supplying nutrients to other organisms. Still other forms decompose organic matter, and in the process release nutrients. This may create difficulties within the stream or river because many of the nutrients produced have a low pH level, and the increased plant life encouraged by heightened quantities of nutrients greatly reduce oxygen levels. Other forms of bacteria feed on living organisms, and produce diseases. These types of bacteria are referred to as pathogens. Increased levels of pathogens may render water unfit for drinking or swimming.

FISH: Well-known fish species such as trout and salmon usually require cool, clear, well-oxygenated water for survival. Increased numbers of sunfish, catfish, etc. may suggest low oxygen levels and deteriorated habitat, perhaps the result of pollution. This is true particularly if other species were at one time dominant in that location.

INVERTEBRATES: Healthy streams and rivers contain a great variety of aquatic invertebrates. Some are found on vegetation, others on the stream bottom among and under rocks. Invertebrates that live in fast well-oxygenated water tend to be those that require great amounts of oxygen, and have adaptations that allow them to exist in turbulent conditions. These adaptations may include type and number of appendages, body shape and movement. Stoneflies, caddisflies and mayflies, when found in reasonable numbers, are generally indicative of good water quality. When water quality is poor due to pollution or other causes, invertebrate life-forms may be limited to sludge worms, midgefly larvae, etc. These organisms require low oxygen levels and are adapted to water with little or no flow.

Food

Just as living organisms have specific habitat requirements, many have specific food requirements. Aquatic vertebrates and invertebrates, as well as terrestrial invertebrates that fall into the water or are washed in by the rain, provide a food source to many fish species.

Certain species of fish feed on selected species of insects, and are then a food source for specific species of birds or terrestrial vertebrates, etc. It is therefore essential to maintain the natural balance of species within an ecosystem to ensure the survival of all dependent life-forms. Left to nature, this balance is naturally maintained.

When a body of water is impacted through human activity, etc., the natural balance of species may no longer be stable. For example, if a stream's habitat is changed so that it no longer supports certain insects, the fish that depend on that food source may cease to exist in that river. This in turn affects other fish, terrestrial animals and birds that rely on salmonoids as a primary food source. These species then become endangered, or move to other locations where food supplies are more plentiful. This again impacts on the stream by the proliferation of other insects, fish species and animals. The long-term effect is a marked change in the ecosystem of the area.

Space

All organisms need a certain amount of space in which to live. This amount of space may vary with stages of life, size of the organism and activity levels. Many fish and insects begin their life as an egg, attached to a rock, or buried beneath coarse, well-oxygenated gravels. If this habitat is destroyed, the impact on the organism is obvious. Once hatched, these organisms live their lives in and around rocks and cobble on the stream or river bottoms. Again, if their habitat disappears, the organisms cease to exist.

The disappearance of living spaces can be attributed to many factors including siltation, water course alteration, erosion and pollution.

Cover

CLOSELY related to living space is cover, or *"hiding areas."* In-stream cover is generally provided in five ways:

- **UNDERCUT BANKS:** areas where water has eroded the material under a stream bank. The upper portion has not slipped into the water because the root systems of trees, shrubs, grasses and other vegetation have held the soil in place.
- **ROCKS, STONES AND BOULDERS:** in a stream or river they provide protection from predators, weather and other factors. Rock size, shape and location affect what species use it for cover. Many species prefer irregular-shaped and sized rocks and boulders. Even in fast moving water, fish find refuge in the relatively calm water found on the downstream side of rocks and boulders.
- **LOGS AND TREES:** are essential in streams to assist in the development of pools, cleaning the stream bottom and stabilizing the watercourse. The proper amount of large material can make the difference between poor and excellent fish habitat in many streams. Logs and stumps, although sometimes a nuisance to boaters, provide overhead cover for fish species to escape from predators or fast-flowing water. Like any good thing, too much can be a problem. If log jams develop, they can divert water over a stream bank and cause serious erosion problems. In such cases, the log jam may be removed once proper permission has been obtained.
- **LOW OVERHANGING GRASSES AND BUSHES:** these provide overhead cover under which fish can hide. This is particularly important for trout. In addition, insects that live on this plant material frequently fall into the water, or are washed in by the rain and provide an important food source to many fish.
- **WATER DEPTH, POOL COLOUR AND SURFACE TURBULENCE:** these factors assist in hiding fish from terrestrial predators. The deep waters of pools hide adult fish, while the broken water surfaces of riffles hide younger fish, particularly trout and salmon.

NEGATIVE IMPACTS ON HABITATS

A COMMON agricultural practice was to rinse out crop sprayers in a nearby river or stream. Similarly, used automobile oil was frequently dumped behind garages. Foresters cut to the edge of streams and rivers, as did farmers, in an attempt to maximize profits. Little thought was given to the contamination of soils and waterways. As time progressed, problems became increasingly evident. This, coupled with the rise of *"environmental awareness,"* led to an increased awareness on the part of individuals as well as corporations.

The problem, however, is far from solved. It is beneficial therefore to briefly examine human activities that impact on stream or river habitat.

Humans directly or indirectly affect stream or river habitat through:

- **sand and small gravel**
- **fine silt and gravel**
- **municipal and private sewage and septic tanks**
- **forestry operations**
- **farming operations**
- **mining operations**
- **contamination from pesticides, herbicides and road salt**
- **urban sprawl and industrial activities**
- **dams and diversions**
- **acid rain**
- **bridge and road construction**
- **invasion of non-native plants**
- **pollution**

IT IS SOMETIMES difficult to see the effect of some of these activities in larger streams and rivers because the larger volumes of water hide the problem, or make it harder to identify. It is important to remember that small brooks join streams, and streams join rivers, and each in turn gives its problems to the receiving body of water, ultimately affecting coastal waters and wetlands. ***All water systems are connected and interrelated.*** Let's briefly look at a few of the above points, and how they affect habitat.

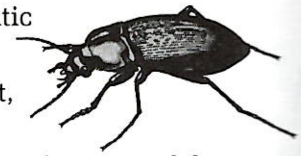
Sand and small gravel:

Sand and bits of gravel are pushed along by the water's flow, bouncing and rolling along the stream bottom. As they move downstream, they fill in the spaces in the bottom gravel *(interstitial spaces)* and have the effect of plugging up a sieve or strainer. Big spaces are filled up first, then smaller and smaller ones, until water can no longer pass through the gravel. This destroys spawning areas, reduces habitat and impedes insect production. In severe cases, entire pools may fill in and the watercourse eventually becomes wide and shallow. Once this happens, the chances of the stream or river naturally rehabilitating itself become slight.

Fine silt and clay:

These materials are smaller than sand, and tend to stay suspended (or hanging) in the water. The turbulence or movement of water accompanied by a negative electrical charge keeps these particles suspended. This results in *"cloudy"* water that may not settle until it reaches a lake or pond. In freshwater, suspended solids may not settle for several weeks (i.e. a lake). When freshwater meets saltwater, the freshwater looses its charge and the silt rapidly drops to the bottom. This silt material, rich in nutrients, may also carry with it heavy metals, pollutants, pesticides and herbicides.

Cloudy water also makes it difficult for fish to see their food and to breathe. In addition, insects are scoured from rocks. Aquatic plants may become covered and receive less light, thereby reducing their growth and the production of oxygen. If the stream bottom has already been partially *"plugged"* by silt, additional loadings will seal the bottom tight. ***It is not natural for a stream or river to turn a muddy colour after it rains!***



Municipal and private sewage and septic tanks:

Canada is far behind many other countries when it comes to treating our waste sewage. Each day, millions of litres of treated and untreated sewage are pumped into our water systems. This is compounded by other substances people commonly dispose of through their sewage system including: detergents, solvents, paints, oil and other household chemicals. ***Few realize that a single litre of oil can contaminate up to two million litres of water!*** Clearly each of us must do our part by becoming part of the solution, not the problem.

Forestry operations:

Forests play a vital role in regulating stream flows and the maintenance of water quality. In a natural setting, up to 99 per cent of nutrients in a stream or river come from the forest ecosystem. Although trees and other plants use large amounts of water, they benefit streams and rivers by stabilizing surrounding soils with their roots.

Fallen leaves and decaying vegetation on the forest floor cushion the impact of rain and slow the flow of water over the land, thus reducing erosion. In addition, the shading effect of the forest slows snow melt, thus reducing spring flooding.

Maritime history is laced with stories of the log drives; fortunes made and lives lost. With roads yet undeveloped, rivers served as the principal method of transporting logs to the mill or coast. In some cases, horses were used in streams to pull ploughs along the streambed to straighten the water course to make log-driving easier. In later years, bulldozers were used for the same purpose. This destroyed untold amounts of aquatic habitat.

In general, forestry practices have greatly improved over the years. This heightens productivity, as well as protects resources. Problems being addressed within the forest industry include:

- **LARGE-SCALE CLEAR CUTTING:** The removal of all the trees in an area allows heat to penetrate the soil and thereby raise the temperature of the ground water and air. Evaporation increases, reducing water flow in surrounding brooks, streams and rivers. In the winter, frost may go much deeper and freeze springs, reducing winter water flows in streams and rivers. Frequently the building of bush roads and trails impacts on streams and rivers, providing corridors for silt and sand run-off. With the snow melting faster in the spring, heavier flows off the land bring increased flooding. This causes streams to widen, become shallower, and pools to move or disappear.

- **CUTTING TO THE STREAM EDGE:** According to law, a greenbelt or uncut area must be maintained along the waterway. This area is known as a ***riparian zone.*** Although this may appear as wasted or unproductive area, it is quite the opposite. The root systems of deeply-rooted trees, grasses and shrubs stabilize banks much like steel reinforces concrete. In addition, they provide some shade to the water, thereby reducing water temperatures. Riparian zones also provide habitat for many species of insects and animals, necessary parts of the ecosystem. With the removal of riparian zones, water temperatures increase, less organic materials are added to the aquatic ecosystem by the forest, and banks become unstable and erode more easily.
- **THE DUMPING OF SLASH AND DEBRIS IN STREAMS AND RIVERS:** Slash or leftover materials such as tree limbs and tops are sometimes dropped into streams. These wash downstream, and "jam up" creating dams which cause blockage of fish passage, diversions and erosion. As this material decays, it uses up vast amounts of oxygen and overloads the stream with organic materials.

Farming operations:

MOST farms were and are built near water to ensure a good water supply. Unfortunately, the following farm practices resulted:

- ***run-offs into the waterway of natural and commercial fertilizers:*** this heightens algae growth in streams, reducing oxygen levels
- ***removal of vegetation along the waterway*** (for implications see *cutting to the stream edge* above)
- ***ploughing to the water's edge and fall ploughing:*** fall rains coupled with no residual plant material after harvesting heighten soil erosion
- ***channelization and dredging of the stream for irrigation and flood control purposes:*** results in significant habitat loss and the destruction of natural stream features such as pools
- ***livestock walking in and crossing streams, trampling and eroding banks, as well as adding "nutrients:"*** results in heightened erosion problems, increased algae growth and bacterial counts from faecal materials

Contamination from pesticides, herbicides and road salt:

During the 1950's, vast forested areas were sprayed with the pesticide DDT to control infestations of the spruce budworm. In addition to budworms, many fish, birds and insects were killed. Others were affected by lowered birth rates, thinned shells and poisoned food supplies. Although DDT is now a banned chemical, it is unclear what long-term effects may still be present. Similarly, the long-term effects of chemicals that we presently use are still unknown.

Invasion of non-native plants:

Many of the plants now commonly found along rivers, streams, in forests and flower gardens are not native to New Brunswick. Some, although very appealing to the eye, are very destructive. One example is the ***purple loosestrife.***

This attractive plant is of little or no use to wildlife, and tends to crowd out other plant life. Loosestrife can take over an entire wetlands area. One mature plant can produce 2.5 million seeds each year. In fact, the leaf of one plant can root and generate another whole plant! As other species of plants are crowded out, the animal species that depended on those plants either die off or go elsewhere seeking food.

The only way to eradicate this plant is to carefully remove it and burn it. Care must be taken not to leave any leaves or root fragments in the ground because the plant will continue to grow.

HABITAT RESTORATION WHERE/HOW TO BEGIN

How do we get started?

Establish the scope of your project. Plan on starting small, with an area or project easily managed. To begin with, why not adopt a particular section of a stream? Your project can easily expand as you and your students become comfortable with field work and restoration methods. It's best to not *"bite off more than you can chew."*

Where are we at now?

Before beginning any restoration work, it is essential to know the degree to which the body of water has been impacted. Is there a significant erosion problem? What are the habitat conditions of the stream? What species of plants and animals are presently there? What plants and animals were historically there? Does the river have historical significance? These and other questions help to ascertain how the river was and is impacted, and to what degree. *(Sample forms are found in units 3 and 4.)* The Department of Fisheries and Oceans may also assist with determining the habitat conditions of the stream or river.

What can we do?

Once a stream or river is assessed, the information may then be forwarded to the Department of Fisheries and Oceans Habitat Management Branch for their evaluation. They may inspect the site, and make recommendations on possible reconstructive work. While you are waiting for this to happen, there are other things that may be done, such as garbage cleanups and the establishment of community partnerships. In addition, if you intend for your students to do work around the stream or river, a ***watercourse alteration permit*** is required. The application for this permit is included at the back of this resource text.

Who can help us?

There are many individuals and organizations that may be of assistance. It is important to include community members, parent volunteers, service groups and organizations and local businesses. Some may participate actively in habitat reconstruction, others through financial contributions, or assisting with field trips, school activities, student projects, etc.

The following pages contain information on specific habitat reconstructive techniques. These and others are covered in greater detail in the curriculum units.

Check before doing watercourse alterations

Spring days bring out a winter's worth of home improvement dreams. Maybe it's a new sunroom overlooking the lake, or a footbridge over a backyard brook. Whether you do it yourself or hire someone to help, perhaps there is a third party you will need to talk to.

A network of lakes and waterways provides 300,000 New Brunswickers with safe drinking water, and gives a home to fish and wildlife. To help protect that resource from the effects of building and landscaping activities, the New Brunswick Department of the Environment administers the Watercourse Alteration Regulation program.

The program has been in place for 20 years now, but many of us are still not clear on when a home improvement project crosses the line into watercourse alteration. Before you do any clearing, excavation, construction or landscaping activities within 30 metres of a watercourse, check to see whether the Watercourse Alteration program applies to you.

Simply put, the permit program applies to all open channels that hold or carry water. Lakes, ponds, rivers, streams and brooks are clearly watercourses. Two kinds of permits are issued under the program. The "standard" permit applies to those projects large enough to involve a professional engineer: major bridges, dams or large culvert installations, for example. As a homeowner, your planned work should need only the much simpler "provisional" permit.

When you apply for your permit, you'll be asked to describe the project: what you plan to do and where. Department staff will take note of your location and the details of your plan, and consider how the project can best be carried out without causing any harm downstream.

If this seems a bit overprotective, take a minute to consider the consequences.

When we clear away trees and shrubs, dig up the ground or compact it with heavy equipment, the earth loses its ability to soak up water. Excess water then runs across the surface, washing away the top layers of soil. If fertilizers, pesticides or other substances are present in the soil, they are likely to travel with it, and when eroded soil enters a river, lake or stream, it can change the form and flow of the waterway, ruining fish habitats or clouding a favourite swimming spot with weeds and algae.

If a watercourse is part of a watershed that gives your community its drinking water, environmental problems can become a human health hazard. Once a watershed is damaged, bringing it back to good health is a complicated business, often expensive and not always completely successful.

The simpler your project, generally, the simpler the process of applying for a permit, and by contacting your local Environment office, you may, in fact, find out that you don't need a permit for the project you have planned. If you do, any office of the Department of Environment can give you an application form, and all the advice you'll need to fill it out. The forms are also available at all Service New Brunswick Centres.

Often, you will be able to provide all the information needed, while in other cases, an inspector may be required to visit the site. For small-scale construction, you may be asked to submit a map of your area and a hand-drawn sketch of your plan, or perhaps a simple scale drawing.

While a small job is likely to get prompt approval, more ambitious plans can take up to two months. So when should you apply for your watercourse alteration permit? As soon as home improvement fever hits!

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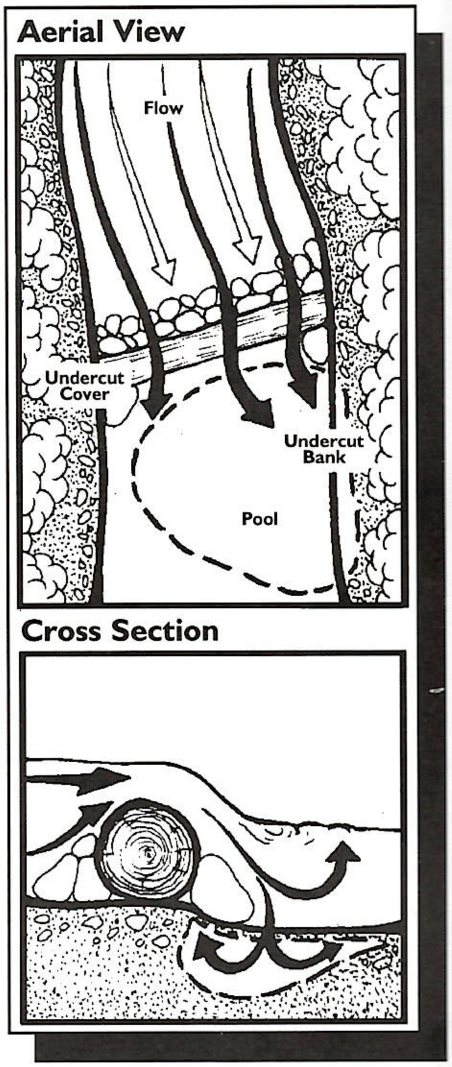
Teacher:

HABITAT RECONSTRUCTION

SHEET 1

OVERVIEW: Once a stream survey has been completed and the site evaluated by the Department of Fisheries and Oceans, habitat reconstruction, if needed, may begin. Two of the most common habitat reconstructive devices are digger logs and rock deflectors.

DIGGER LOG



Purpose:

To dig a pool below the log, deepen the water and provide cover under the log and the banks. Spawning gravel will become exposed and finer materials sorted to the stream's sides.

Materials:

- One 8" - 10" log of sufficient length to span the width of the stream
- Rocks
- Chicken wire
- Rebar (3 pieces per log)
- Hand tools.

Method:

1) Move rocks to allow the log to sit on the bottom of the streambed at a 30 degree angle to the stream.
2) Wedge both ends of the log securely into the stream banks.
3) Secure chicken wire horizontally along the top surface of the log, wrap the upstream side, and extend the wire upstream of the log. This will serve as a foundation for the ramp.
4) Build a rock ramp on the upstream side of the log. Make it extend upstream to a distance four times the height of the log.
5) It is strongly recommended that the log be further secured by drilling at least three holes in the log, and driving rebar through the log into the stream bed. Bend the top of the rebar over, so its tip is pointing downstream. This ensures that it will not be a navigational hazard.

PLEASE NOTE: *Habitat reconstructive structures may only be installed under the direction of the Department of Fisheries and Oceans.* ***Improperly placed habitat reconstructive structures will do more harm than good!***

Teacher:

HABITAT RECONSTRUCTION

SHEET 2

Purpose:

To narrow and deepen the stream channel, providing deeper, cooler water.

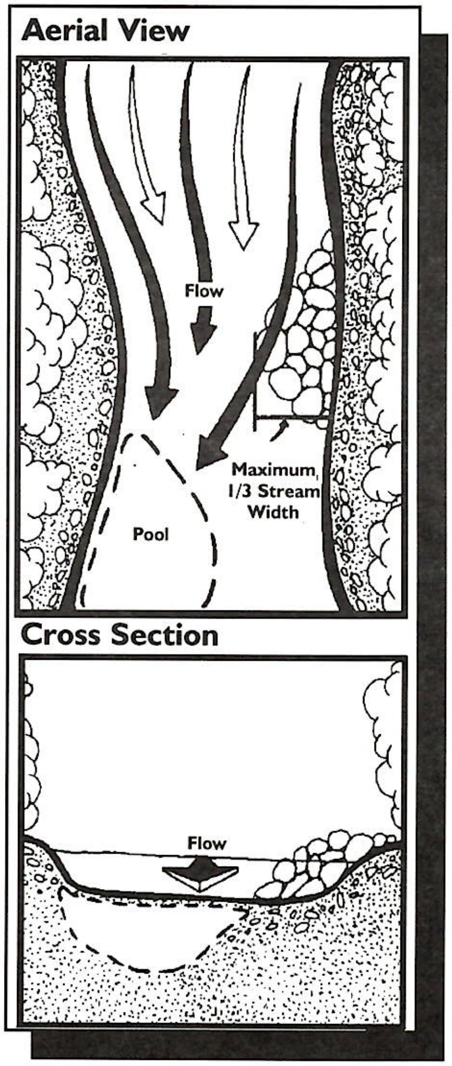
Materials:

- Rocks

Method:

1) Using rocks from the stream bed, form a triangle of rocks no more than one-third the width of the stream.
2) Move large rocks from the channel and place as part of the deflector.
3) Place largest boulders on the outer edges, especially the upstream edge.
4) Rocks should be piled low along the two edges of the triangle adjacent to the water, sloping to bank height on the edge adjacent to the bank. This gives the deflector a pyramid shape, and helps to deflect high flows of water back into the stream. Over time, material will be deposited below the deflector (on the same side), and gradually reshape the stream's natural meander pattern. The deflector will also assist in the forming of a pool downstream on the opposite bank.

ROCK DEFLECTOR



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Teacher:

HABITAT RECONSTRUCTION

SHEET 3

Purpose:

To centre the water flow and narrow the stream channel providing deeper, cooler water.

Materials:

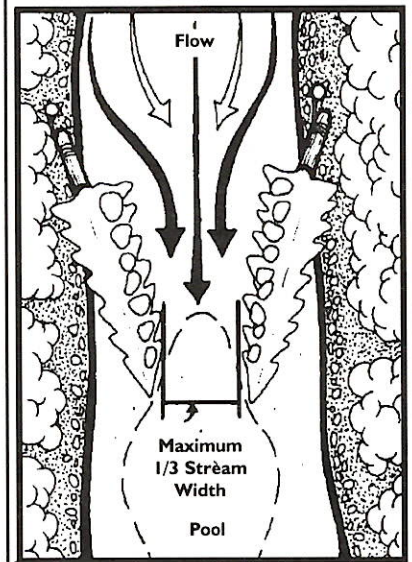
- Bushy softwood trees greater than 30 cm (12") in diameter
- Rocks
- Rope

Method:

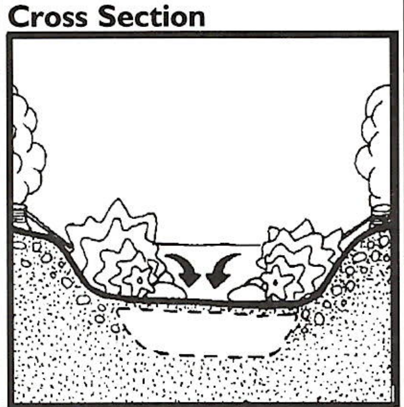
1) Fell or place trees angling downstream with tops no more than one-third of stream width out from the streambank.
2) Tie butt ends of trees to stable structures on bank with rope.
3) Reinforce deflectors with rocks taken from the centre of the stream channel. Place rocks along the boles of the trees.

DOUBLE TREE DEFLECTOR

Aerial View



Cross Section



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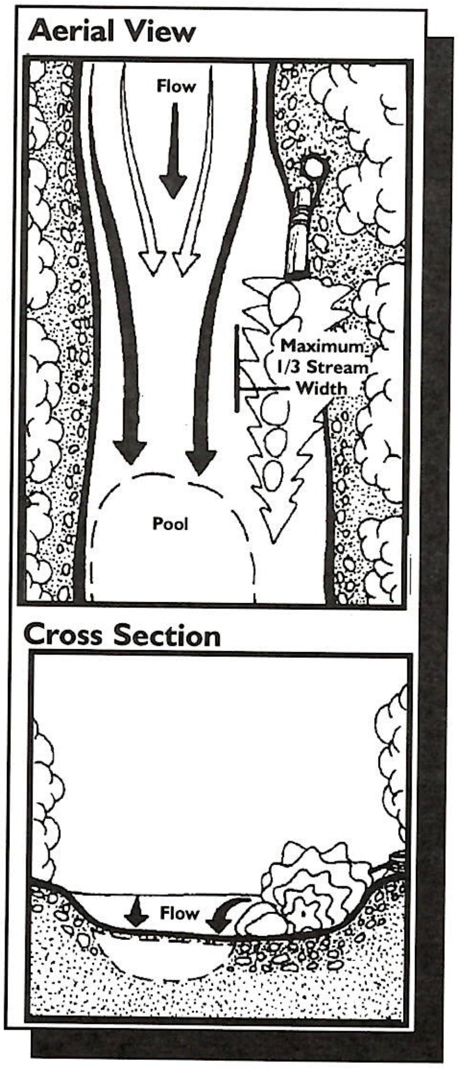
Teacher:

HABITAT RECONSTRUCTION

SHEET 4

SINGLE TREE DEFLECTOR



Purpose:

To deflect water and trap slash and silt. This will form a fast run of water beside the tree, and a pool downstream.

Materials:

- Bushy softwood tree greater than 30 cm (12") in diameter
- Rocks
- Rope

Method:

1) Fell or place the tree angling downstream with its top no more than one-third of stream width out from the streambank.

2) Tie the butt end of the tree to stable structure on the bank with rope.

3) Reinforce deflector with rocks taken from the centre of the stream channel. Place rocks along the bole of the tree.

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Teacher:

HABITAT RECONSTRUCTION

SHEET 5

Purpose:

To dig a pool below the debris dam and deepen water above the dam, as well as to provide cover.

Materials:

- Logs (preferably hardwood greater than 20 cm (8") in diameter
- Rope

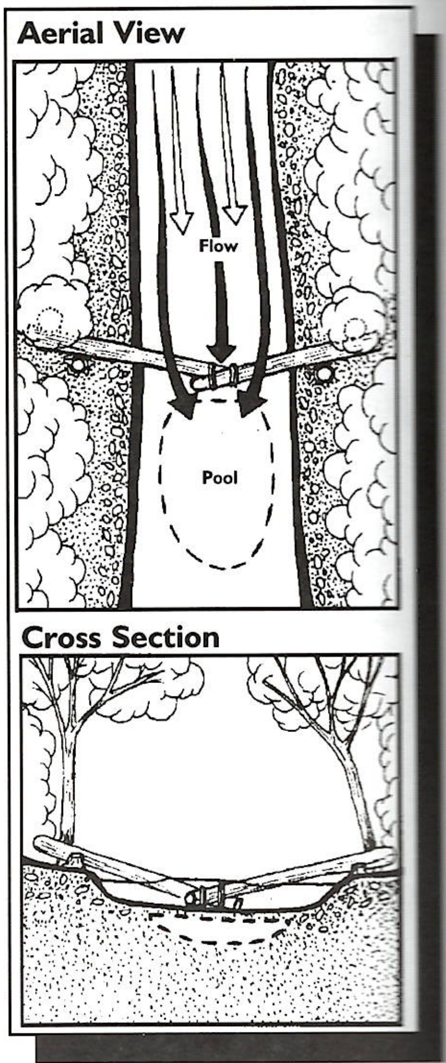
Method:

1) Cut two trees and place each one leading from the streambank across the stream to meet in the centre of the streambed.

2) Tie the butt ends of the trees to stable structures on the stream-banks or wedge the ends between high stumps or trees on the banks and tie the ends. This will stop the logs from twisting downstream.

3) More logs and brush can be placed behind the large logs to help direct most of the water flow over the debris for digging a pool. Leave some gaps for flow in low water conditions.

DEBRIS DAM



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Teacher:

HABITAT RECONSTRUCTION

SHEET 6

Purpose:

To narrow and deepen the stream channel, providing deeper, cooler water.

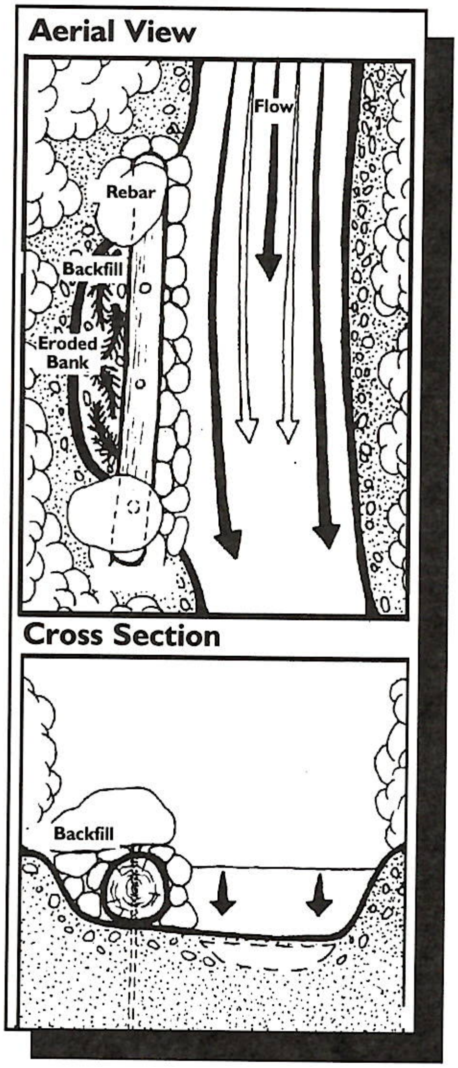
Materials:

- Log or logs (preferably hardwood greater than 30 cm (12") in diameter
- 5' lengths of 3/8" rebar
- Rocks
- Brush

Method:

1) Place log(s) to form new streambank.
2) Reinforce the log with large rocks from the stream channel, especially at the ends of the log.
3) Tie the log down. Use either a rebar pounded down through the log, or wire around the log with rebar on either end into the streambed.
4) Backfill the washed out area with available brush, place rocks on top, or pack down by running machine on top of brush.
5) Make sure that the top of both the log and the backfill is level with the streambank at both ends.
6) Make sure the backfill is stable and well-packed so that high water cannot dig material out from behind the log.

LOG BANK STABILIZER



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FISH FOR OUR FUTURE!

UNDERSTANDING FISH

UNDERSTANDING FISH

*T*O fully appreciate fish as a living organism and *not just another fish* it is helpful to consider some "fish features."

Eyes and Sight:

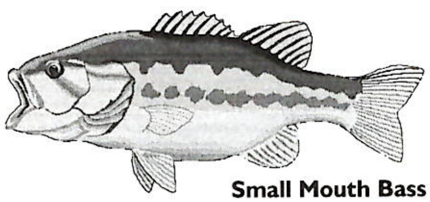
As with other animals, a fish's eyes serve a number of purposes: to find food, watch for enemies and other dangers, and perhaps to navigate. Unlike most animals, the pupil bulges outwards, allowing a wider field of vision. Although the eyes are located on the sides of the head, they have stereoscopic vision in a forward direction. The lens of a fish eye can move in and out, like a camera lens, allowing the eye to focus. Some fish, such as trout and salmon, appear to have the ability to see into the air for significant distances.

Nostrils and Smell:

Yes, fish smell!!! Actually many fish have a well-developed sense of smell which allows them to recognize the chemical characteristics of their home stream. In addition, it may assist them in avoiding predators. Fish do not breathe through the nose, but through the mouth and gills.

Gills:

A fish gill has two parts, the cover and filaments. The gill cover protects very delicate threads or filaments. When the fish's mouth closes, water is forced through the gills and out through the open gill covers. When the mouth opens the gill coverings close. As the water passes over the gills, the gill filaments, rich with blood vessels, pick up oxygen out of the water. In addition, the filaments release carbon dioxide as a waste product. As physical activity and/or metabolism increases, oxygen requirements increase. This results in an increased opening and closing of the mouth and gill covers.



Small Mouth Bass

Mouth:

The mouth is used to catch and hold food. Food is not chewed before being swallowed.

Fins:

*M*OST fish have two sets of paired fins (pelvic and pectoral), and four single fins (dorsal, caudal, anal and adipose).

- The pelvic and pectoral fins are used for horizontal or lateral balance and resting.
- The dorsal and anal fins are used for maintaining vertical balance and achieving quick changes in direction.
- The caudal or tail fin is the most important fin since it propels the fish through the water by the flexing of strong muscles along the sides of the body. The caudal fin is also used by female salmonoids to move gravel and scoop out the redds into which the eggs are then deposited.
- The adipose fin is small and fleshy on trout and salmon. It is unclear what purpose it serves. This fin is often clipped off by fishery biologists to identify certain stocks of fish, etc.

Scales:

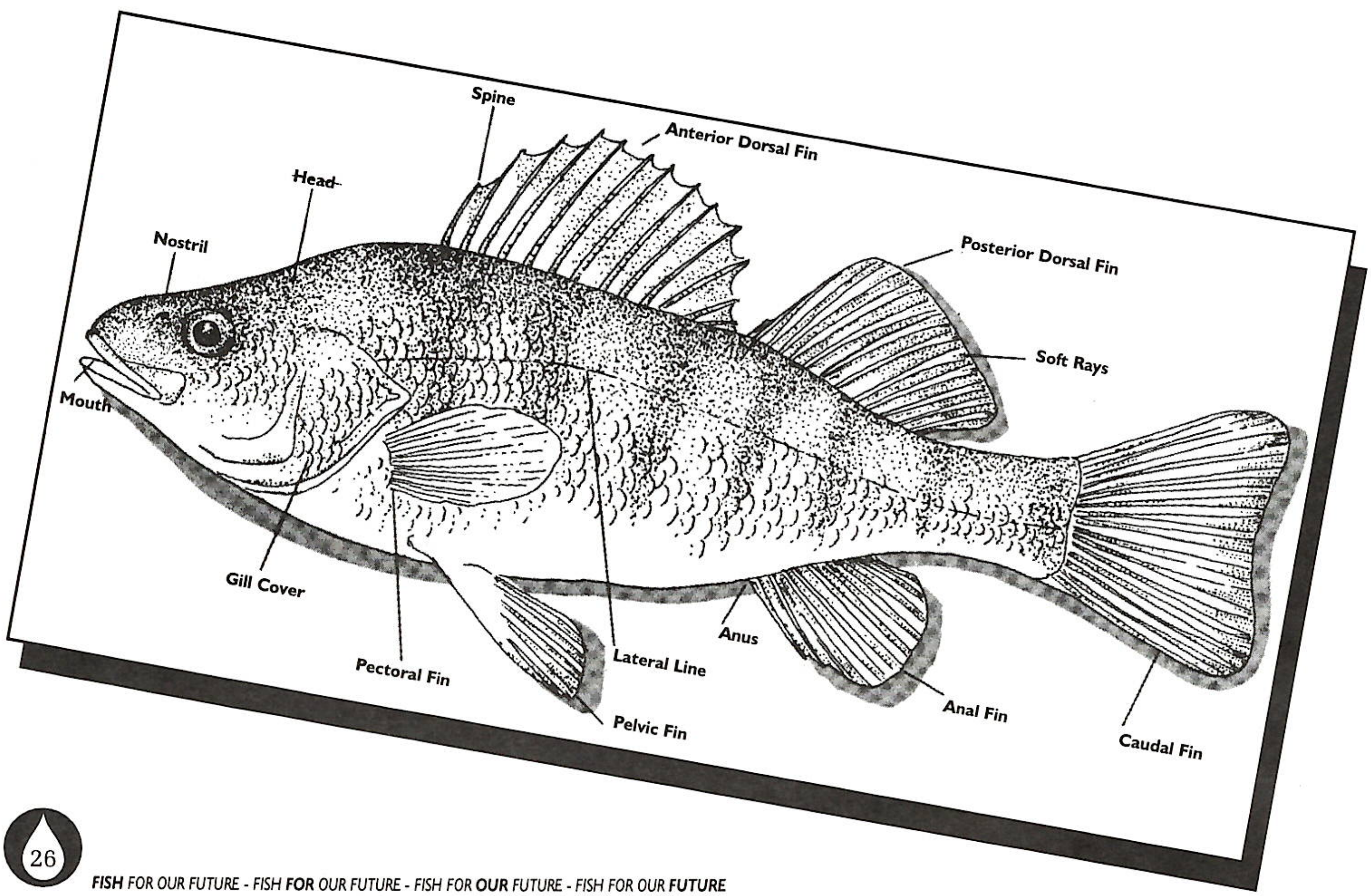
The surface skin of the fish, except for the head and fins, is protected by overlapping scales. Each scale grows in a regular pattern, and is coated on the outer side by mucus which protects the fish from disease. The mucus also makes it easier for the fish to swim through shallow areas while moving upstream to spawn. Scale growth is continuous and occurs around the perimeter of each scale. Growth is more rapid in the summer, therefore the summer rings are wider than the winter rings, allowing for age calculations. When fish spawn, scales are often damaged. This damage leaves permanent marks on the scales, and allows for calculating how many times the fish has spawned, and at what age.

Ears:

Fish do not have external ears but they can detect sound with an inner ear and labyrinth which function as organs of balance as well as hearing.

Lateral Line:

Along the side of the fish, there is a row of special scales with small holes. These scales, slightly different in colour, are called the lateral line. This system of scales is connected to a series of nerve endings which can detect changes in pressure, sound and movement. The lateral line also helps to warn the fish of the approach of predators and prey.



ATLANTIC SALMON

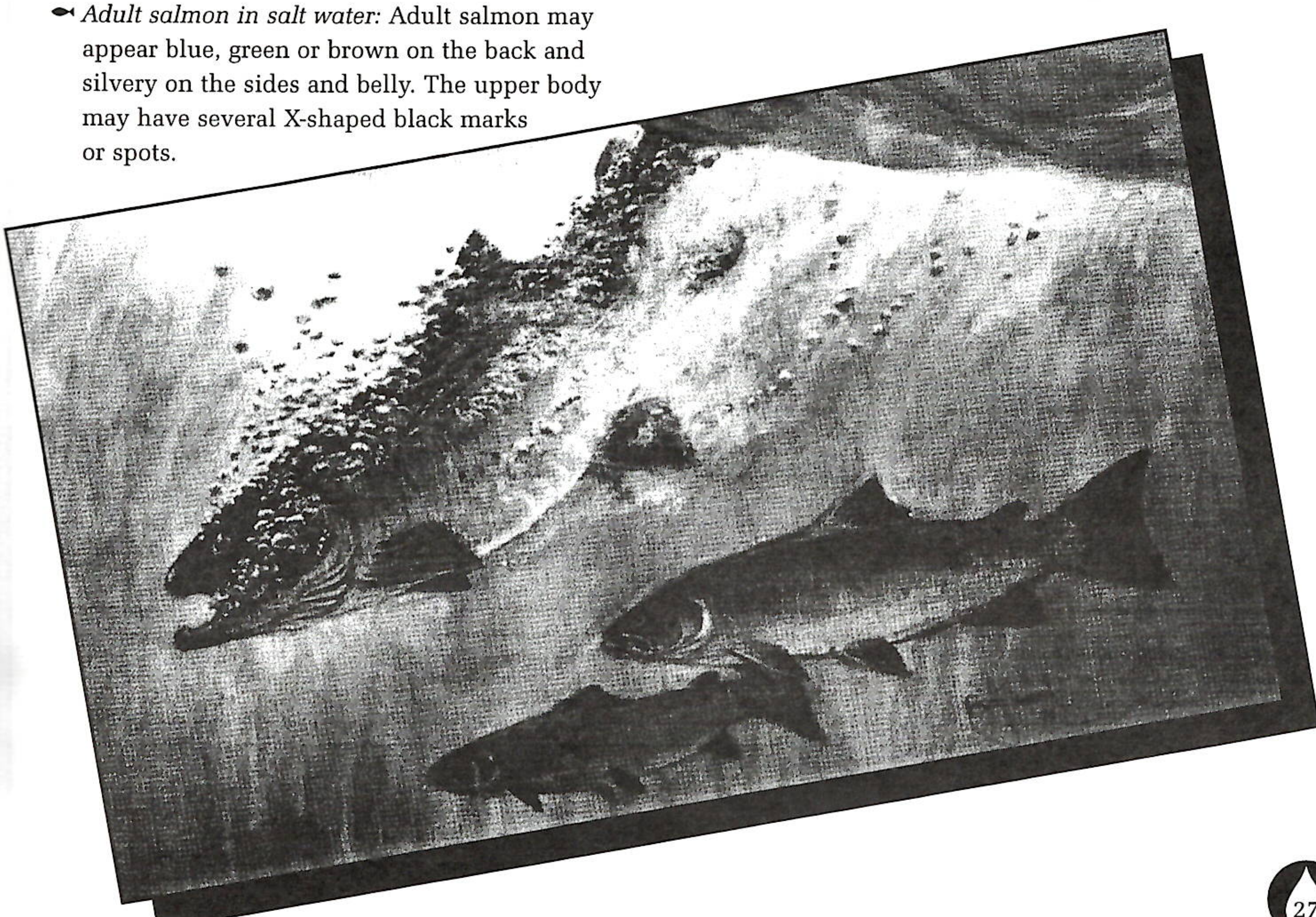
Distribution

ONE of the best known members of the salmonoid family, the Atlantic salmon is native to the North Atlantic Ocean and coastal rivers, including parts of Russia, Portugal, Iceland and Greenland. In North America, they are found from Northern Quebec and Labrador to the Connecticut River. Overfishing and destruction of habitat have greatly reduced populations. Landlocked populations of Atlantic salmon exist in some lakes of eastern North America, particularly Newfoundland, Labrador and Quebec.

Physical Characteristics

Salmon may vary in colour depending on the water they're in, and their age. There are so many different physical looks in the life of a salmon that it can be confusing. The following are some of the common characteristics:

- *Young salmon in fresh water (parr):* Salmon at this stage have 8-11 dark bars on each of their sides, with a red spot between each one. These markings may be referred to as "parr marks."
- *Young salmon leaving fresh water (smolts):* As parrs "smoltify" (get ready to live in salt water), they lose their parr marks, becoming silvery in colour.
- *Adult salmon in salt water:* Adult salmon may appear blue, green or brown on the back and silvery on the sides and belly. The upper body may have several X-shaped black marks or spots.
- *Adult salmon in fresh water:* Adult salmon may appear bronze-purple in colour with occasional reddish spots on the head and body.
- *Spawning males:* Spawning males develop a hooked lower jaw, which easily distinguishes them from females.



Fishy Facts

- The name *salar* comes from the Latin *"salio"* which means to leap. The Atlantic salmon can leap 3.7 m high and 5 m long.
- In the wild, about 1 in 10 young salmon survive to become smolts. In many rivers fewer than 1 in 25 will return to spawn. Some salmon may live to the ripe old age of 11 years!
- You can "read" scales to determine how old the fish is, how many years it spent in fresh water, how many years it spent at sea, and at what ages it spawned.
- Sea-run salmon can be as big as 1.5 m and 36 kg but most are 9 kg or less. The biggest known salmon ever caught in Canada was 25.1 kg, and was caught in Quebec.
- When salmon are in their smolt stage, and migrating to their winter ocean feeding area, they "imprint" or remember the smells that they encounter. When it is time to return to spawn, they remember the smells in reverse order, and "smell" their way home to their place of birth!
- After one winter at sea, a salmon usually weighs 1.4 - 2.7 kg. After two winters, 2.7 - 6.8 kg.

Life Cycle

The Atlantic salmon spends much of its adult life feeding and growing during long migrations in the sea, returning to reproduce in the freshwater stream or river where it hatched. Atlantic salmon that are ready to spawn move up rivers from spring through fall, each river having a fairly consistent period when the fish "run." Salmon populations that ascend rivers in the spring are commonly referred to as the "spring run," those that wait until fall the "fall run."

Salmon may travel long distances upstream before arriving at their spawning location (as much as 500 km!). During their journey, many obstacles are met and overcome, including small waterfalls, etc. In addition, salmon do not eat until they return to the ocean, although they rise readily to an artificial fly. Although the exact reason for this is still a mystery, it may be that salmon are irritated by the artificial fly, and therefore respond.

Spawning occurs during October and November, usually in the gravel bottom at the head of a riffle or the tail of a pool. The female looks for places where the water seeps down into clean gravel, thereby providing the eggs with a sufficient supply of oxygen.

Atlantic salmon spawn in the early evening and at night. The female digs a nest (redd) 15 - 35 cm deep in the gravel by turning on her side, flipping her tail upward and pulling the gravel up until a hole is excavated. After the female and male spawn in the redd, the 5 - 7 mm eggs are buried with gravel by the female. The whole process is repeated several times until the female has shed all of her eggs. Females produce an average of 1500 eggs per kg of body weight. After spawning, the adults usually drop downstream to rest in a pool.

After spawning, some adults return to sea before the onset of winter. Others remain in the river all winter, living off accumulated body fat. When spring comes, these salmon (black salmon), now lean, dark and much more lifeless return to the sea.

Salmon eggs develop over a period of approximately 110 days. In most rivers, the eggs survive quite well and are protected from freezing or silt. The eggs usually hatch in April, and the young salmon (alevins) remain buried in the gravel for up to 5 weeks while they absorb the large yolk sac attached to their stomach. Many fish are killed during this period as silt and sand shift, trapping the young fish. Those that make it through this stage emerge from the gravel in May or June, and are approximately 2.5 cm in length.

During this freshwater phase before they migrate to sea they are known as parr. They are territorial and feed during the day, their diet consisting mainly of water insects. Salmon parr are eaten by many kinds of predators including trout, eels, other salmon, mergansers, kingfishers, mink, otters, etc.

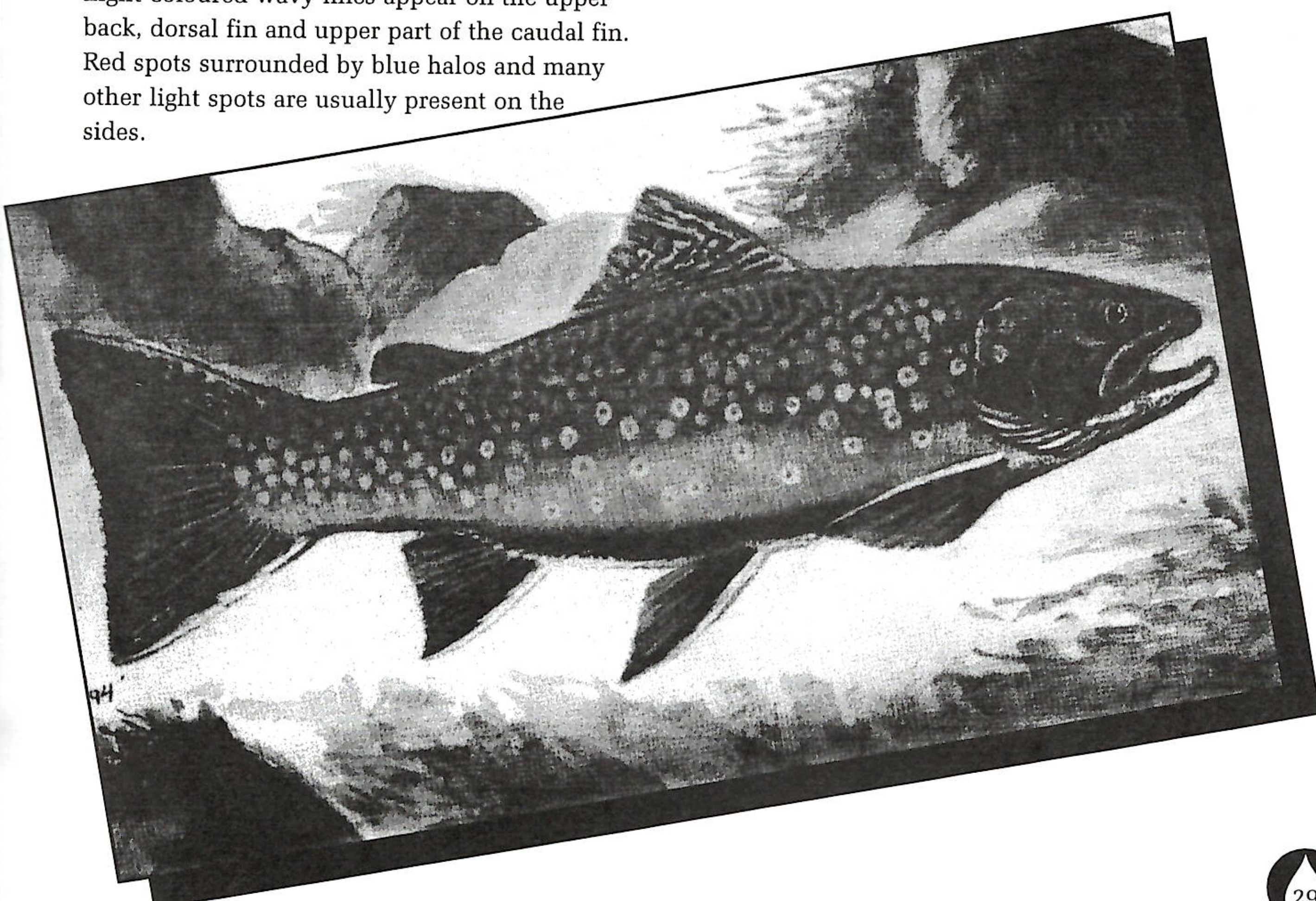
SPECKLED TROUT

Distribution

THE speckled trout is native to eastern North America from the Atlantic seaboard to Massachusetts, south along the Appalachian Mountains, west to Minnesota and north to Hudson Bay. It is found in many types of water systems, from small ponds to large rivers, lakes and saltwater estuaries. Because of its popularity as a sport fish, it has been introduced throughout the world. The speckled trout is our most sought-after freshwater fish.

Physical Characteristics

- Their colour varies depending on the water they are in and their sexual activity.
- The belly of the speckled trout is white to yellow in females, and reddish in males. The leading edges of the lower fins have a bright white border followed by a black border and reddish coloration.
- During spawning, colours intensify and males often become a deep orange-red on the belly.
- *Adult in freshwater:* Appearance may be green to dark brown and black on the back and sides. Light-coloured wavy lines appear on the upper back, dorsal fin and upper part of the caudal fin. Red spots surrounded by blue halos and many other light spots are usually present on the sides.
- *Adult in saltwater:* In saltwater, the speckled trout appears silvery on the sides and dark blue or green on the back. Pale red spots may be visible on the sides as well as the white leading edge of the fins. When returning from the sea, these trout regain their freshwater colours.



Life Cycle

Brown trout prefer cool clear rivers and lakes with temperatures of 12-19° C. They are wary and elusive fish that look for cover more than any other salmonoid. In running water they hide in undercut banks, in stream debris, surface turbulence, rocks and deep pools. They also take shelter under overhanging vegetation.

Brown trout are carnivorous (meat-eaters). They eat insects from water and land, and take larger prey such as worms, crustaceans, mollusks, fish, salamanders and frogs as their size increases.

Brown trout spawn in the fall and early winter (October to February) around the same time as speckled trout or later.

They return to the same stream where they were born, choosing spawning sites that are spring-fed headwaters, the head of a riffle, or the tail of a pool. Selected sites have good water flows through the gravel bottom. The female uses her body to excavate a redd in the gravel. She and the male may spawn there several times. A 2.3 kg female produces about 3400 golden-coloured eggs that are 4 to 5 mm in diameter. Females cover their eggs with gravel after spawning and the adults return downstream. The eggs develop slowly over the winter, hatching in the spring. A good flow of clean, well-oxygenated water is necessary for successful egg development.

After hatching, the alevins (newly hatched fish) remain buried in the gravel and take nourishment from their large yolk sacs. By the time the yolk sacs are absorbed, water temperatures have warmed to 7-12° C. The fry (young fish) now emerge from the gravel and begin seeking food.

Brown trout fry are aggressive and establish territories soon after they emerge. They are found in quiet pools or shallow, slow-flowing waters where older trout are absent. They grow rapidly, and can reach a size of 16 cm in their first year.

Yearling brown trout prefer cobble and riffle areas. Adults are found in deeper waters and are most active at night. They are difficult to catch and are best fished at dawn or dusk. Brown trout living in streams grow to about 1.8 kg, but lake dwellers and sea-run fish grow larger. They mature in their third to fifth year and many become repeat spawners.

In sea-run populations, brown trout spend 2 to 3 years in freshwater then migrate downstream to spend 1 to 2 growing seasons in coastal waters near river mouths and estuaries. There they feed on small fish and crustaceans. Most return to their home streams to spawn, but some straying occurs. Brown trout live up to 14 years and can spend as long as 9 years in the ocean.

CHAIN PICKEREL

Distribution

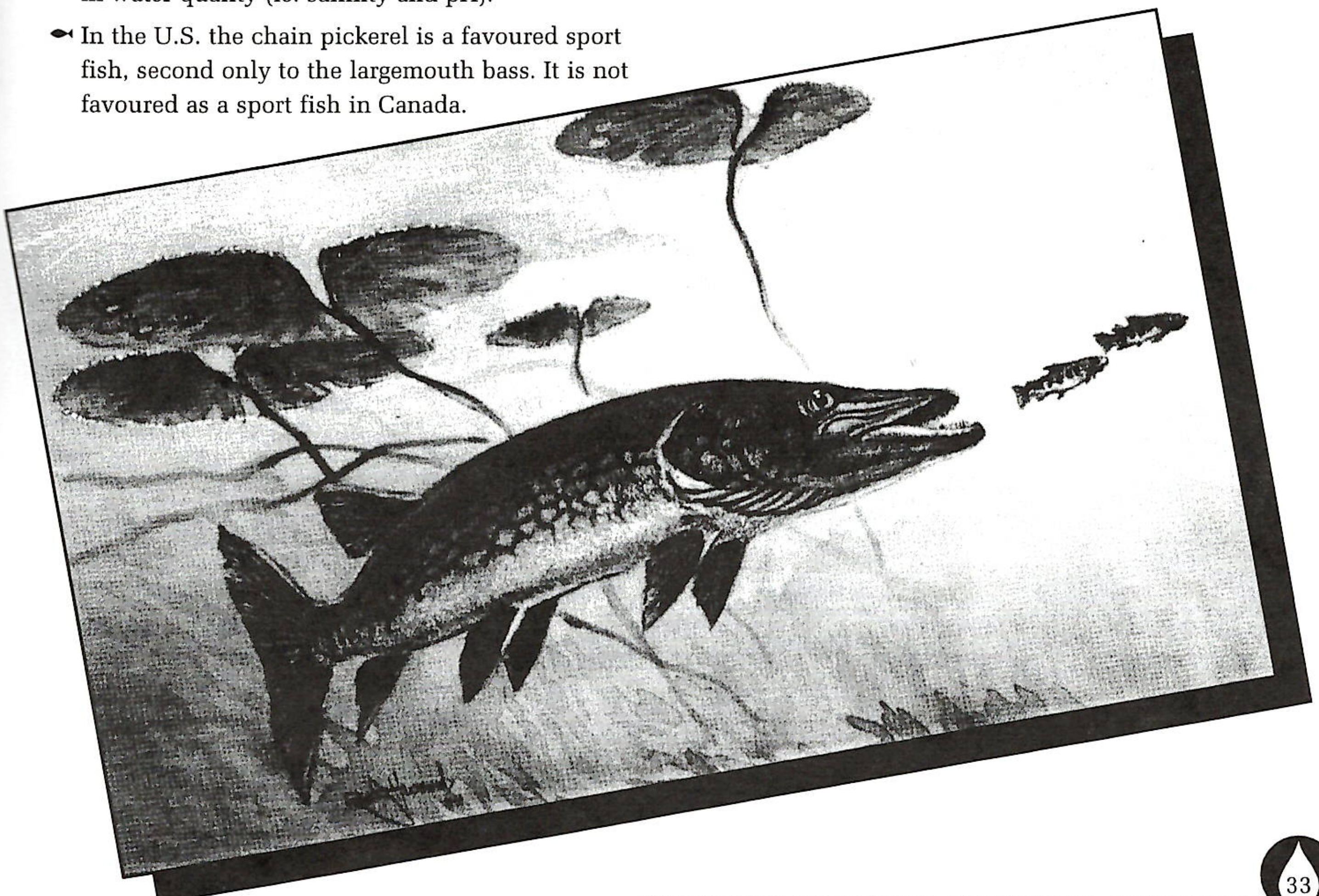
CHAIN PICKEREL are found only in eastern and south-central North America. In Canada they are found only in western New Brunswick, Nova Scotia and the eastern townships of Quebec, south of the St. Lawrence River.

Physical Characteristics

- Chain pickerel get their name from the chain-like pattern on their sides.
- They have a long, narrow body.
- Adults may appear bright green, through olive-green to nearly brown on the back and upper sides. The sides are marked by yellow-green to yellow areas broken by dark, interconnecting marks resembling links of a chain.
- The mouth is large, with small hook-like teeth set in the roof of the mouth and with larger teeth at the sides of the mouth.
- The pupil of the eye is yellow.

Fishy Facts

- The largest known chain pickerel caught was 74.93 cm long and weighed 4.05 kg. It was caught near Homerville, Georgia, U.S.A.
- Chain pickerel are able to tolerate large changes in water quality (ie. salinity and pH).
- In the U.S. the chain pickerel is a favoured sport fish, second only to the largemouth bass. It is not favoured as a sport fish in Canada.
- The flesh of chain pickerel is white, flaky and tasty. In the summer though, a weedy taste may be present. It is best to remove the skin before cooking as this may contribute to the bad taste.



Life Cycle

Chain pickerel spawn mainly in the spring, shortly after the ice melts. The adults enter spawning areas, which include the flooded areas of streams, lakes and ponds. Spawning takes place at depths of 1 to 3 metres. Unlike salmon and trout, the chain pickerel does not build a redd. During spawning, a single female and one or two males swim slowly around over the flooded vegetation. Periodically throughout the day, they roll inward and sharply flex their bodies so that the eggs and milt are shed at the same time. With a lash of their tails, the eggs are spread out over the bottom. Spawning generally lasts no longer than 7 to 10 days.

The eggs are 2 mm in diameter and are light yellow in colour. Like with some other fish, the eggs are slightly sticky, allowing them to fasten to vegetation. One female may lay from 6,000 to 8,000 eggs. No care is given to the eggs, and hatching occurs within 6 to 12 days, depending on the temperature of the water.

The newly hatched pickerel sink to the bottom, where they attach themselves to vegetation by a sticky gland on the tip of the snout. There they remain for a period of about one week, gaining nutrition from remaining egg yolk. In areas of high concentration, a considerable amount of cannibalism may occur.

Maturity is reached in the third or fourth year. The average life span is 3 or 4 years, with a maximum of 8 or 9 years, depending on conditions and growth rate. The chain pickerel is a solitary fish, establishing territories in the summer and hiding motionless in the vegetation most of the time. It mainly inhabits sluggish streams or heavily vegetated lakes, rivers and ponds. In the winter, they move to deeper water and stay active, taking food under the ice.

The pickerel is born a hunter, with physical characteristics allowing it to swim quickly. It is equipped with teeth for quickly grabbing prey. They mainly eat other fish, but may also eat amphibians, snakes, small birds and small rodents.

Young chain pickerel are eaten by bass, grebes, frogs, loons, yellow perch, mergansers, herons, kingfishers and ospreys.

LAKE WHITEFISH

Distribution

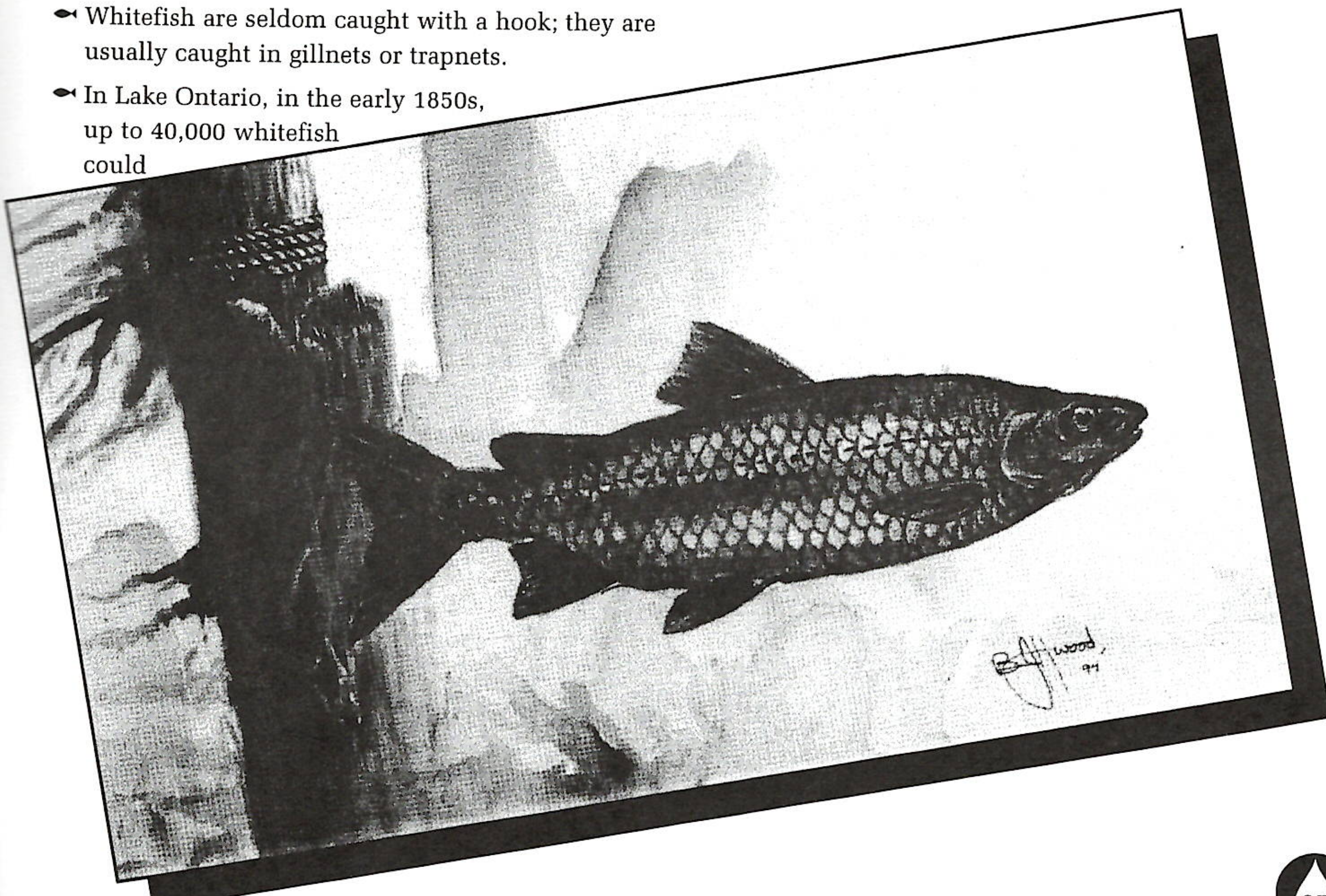
LAKE WHITEFISH may be found in freshwater from the Atlantic coast across Canada and the northern United States. It is distributed throughout the Territories in most large lakes and rivers.

Physical Characteristics

- It has an elongated body, averaging a length of 38.1 cm.
- Its colour is mostly silvery; its back is a pale greenish brown or light brown and sometimes dark brown to almost black, with silvery sides. Fins are usually clear or only lightly pigmented.
- A heavy layer of mucus or slime overlays the scales, causing whitefish to feel slimy.

Fishy Facts

- Whitefish has an exceptionally fine flavour. Its eggs are prepared and sold as caviar.
- Whitefish are considered to be one of the most valuable commercial freshwater fish in Canada. Catches have been reduced due to environmental deterioration and depletion of stocks.
- Whitefish are seldom caught with a hook; they are usually caught in gillnets or trapnets.
- In Lake Ontario, in the early 1850s, up to 40,000 whitefish could be caught in a single night in the fall using a seine net 3 metres deep and 91 metres wide.
- Historically, lake whitefish grew to weights of 8 kg in the Great Lakes. The largest known whitefish weighed 18.9 kg, and it was caught off Isle Royal, Lake Superior, about 1918.



Life Cycle

Whitefish usually spawn in November and December, but this may vary. Spawning occurs in shallow water at depths of less than 7 or 8 metres, often over a hard or stony bottom. Occasionally, spawning may occur over sand.

The number of eggs released varies, increasing with the size of the female. Counts have shown a range of 8,000 to 16,000 eggs. The eggs, measuring 2.3 mm in diameter, are deposited randomly in the spawning area. Within 24 hours, the eggs have increased in diameter to 3.0 to 3.2 mm.

The eggs develop in the spawning ground until April or May.

Young whitefish usually move into deeper waters by early summer. Their growth varies from lake to lake, but generally is rapid. Males mature at a younger age than females, and die earlier.

Adult whitefish are bottom feeders, eating a wide variety of invertebrates and smaller fish. Their food varies from region to region, but aquatic insect larvae, mollusks and amphipods are their primary foods. Small whitefish often fall prey to a number of predatory fish.

Major predators of the whitefish include: lake trout, chain pickerel and even whitefish themselves, when they consume their own eggs.

Whitefish are also host to many parasites. Parasitized whitefish are prevented from entering the market by restricting fishing in infected lakes, rigid inspection of fish and candling of fillets. Candling is a process where fish flesh is held up to a background light to see if any parasites are present.

STRIPED BASS

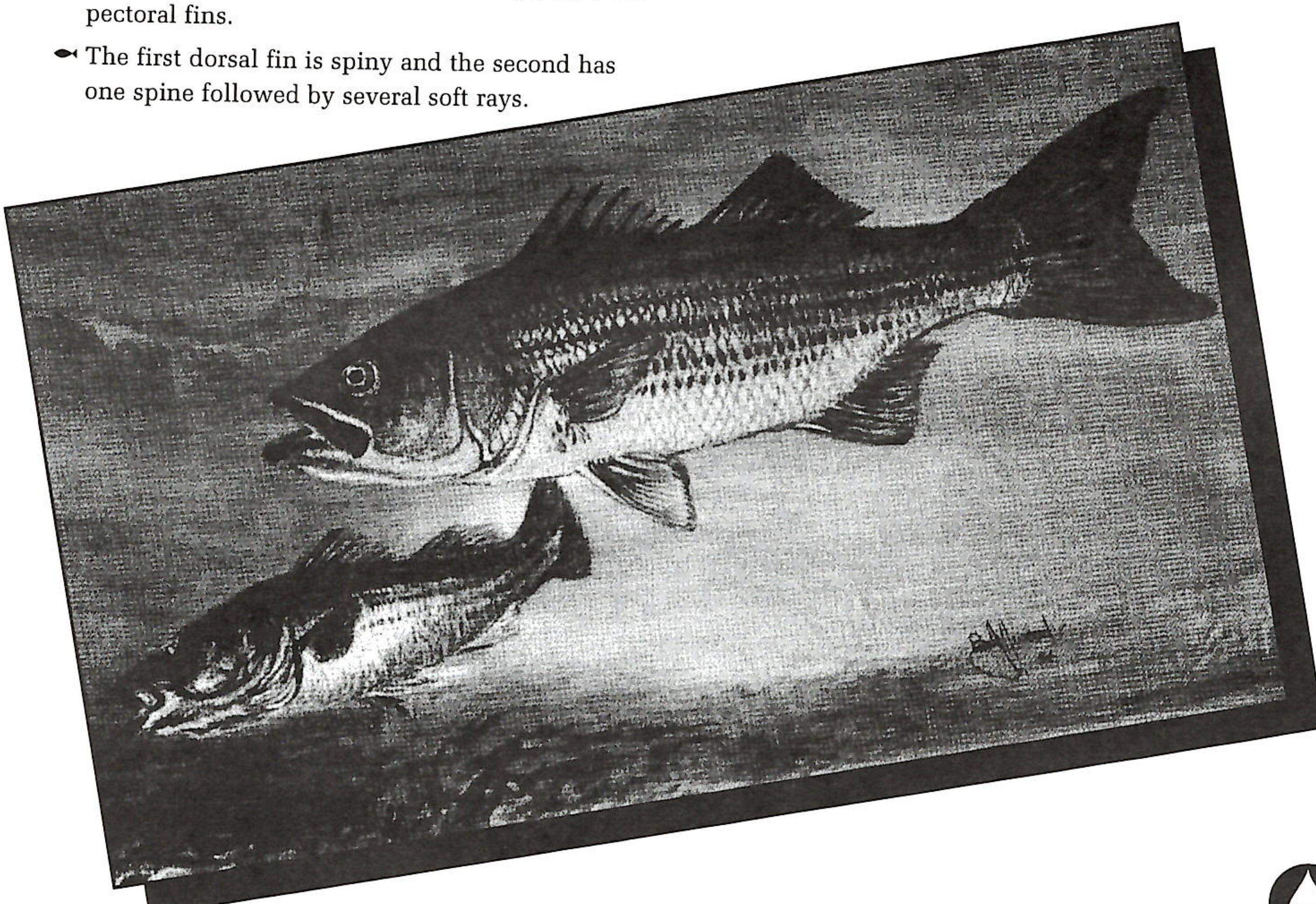
Distribution

THE STRIPED BASS is a coastal species found in rivers, estuaries and inshore waters of eastern North America from the St. Lawrence River and southern Gulf of St. Lawrence to northern Florida, as well as the Gulf of Mexico. It was introduced on the Pacific coast of North American over 100 years ago, where it now ranges from California to southern British Columbia. Striped bass have been introduced and become established in some landlocked lakes in the southern and central U.S.A.

Striped bass have been introduced to parts of Europe and Asia.

Physical Characteristics

- It has a long, laterally compressed body, reaching 34-53 cm in length at maturity.
- Its colour is olive green to blue or black on the back; the sides are pale or silvery with a white belly.
- The mature bass has 7-8 horizontal stripes on the sides, while the young often have 6-10 dusky bars instead.
- The eyes and mouth are both relatively large and the lower jaw protrudes.
- The pelvic fins sit forward on the body below the pectoral fins.
- The first dorsal fin is spiny and the second has one spine followed by several soft rays.
- A single spine lies at the front of each pelvic fin and three short spines precede the anal fin.
- Young often lack stripes.



Fishy Facts

- Striped bass have been recorded as large as 56.7 kg in North Carolina in 1891. Most striped bass are 13.6 kg or less.
- A striped bass weighing 28.6 kg was caught in the Saint John River in New Brunswick in 1979.
- A striped bass tagged and released in the Saint John River, New Brunswick was recaptured 36 days later in Rhode Island - 805 km away!
- After fertilization, striped bass eggs swell to a size of 3.6 mm, about 3 times their original diameter.
- The striped bass is a popular sport fish and can be caught by casting, trolling, jigging and fly fishing.

Life Cycle

Striped bass live in the saltwater and return to freshwater to spawn, making them anadromous. During their saltwater life, many striped bass make long sea migrations. Not all fish migrate however, some remain in the estuary of their home rivers.

Striped bass spawn in May and June in steady-flowing rivers that have large estuaries and water temperatures between 14 and 22° C. They spawn near the surface in water and produce many eggs - an average of 100,000 eggs is typical of bass in our rivers - with a 50-lb. female being recorded as producing three million eggs!

The eggs are semi-buoyant due to having a large oil globule and are carried along by the current which prevents them getting silted over and smothered on the bottom.

The eggs may hatch in 2-3 days depending on the temperature, and are about 5.5 mm long. After absorbing the yolk sac, they feed on zooplankton.

Striped bass feed mostly after sunset and before dawn and feed on a variety of insect larvae, marine worms and crustaceans, as well as many kinds of schooling fishes.

Canadian striped bass grow rapidly and normally mature between 3 and 6 years of age, males maturing a year earlier than females and not living as long. Striped bass can live to 31 years.

Adult striped bass have few predators except man, while the small striped bass are preyed on by Atlantic tomcod, Atlantic cod, silver hake and larger striped bass.

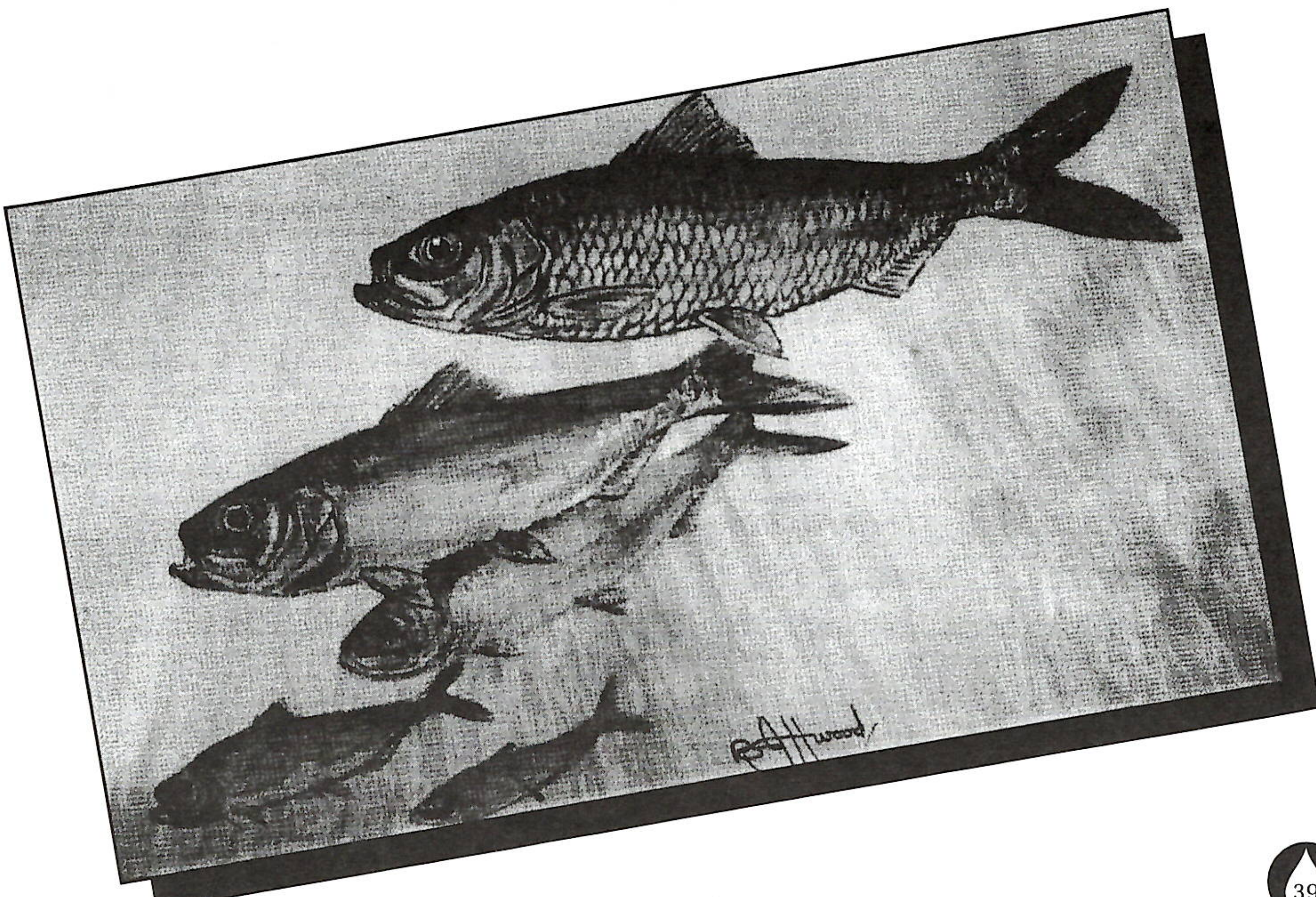
ALEWIFE (GASPEREAU)

Distribution

THE ALEWIFE is commonly found in rivers and lakes along the eastern coast of North America. Adults live in coastal marine waters from 56 to 110 m deep. Landlocked populations exist in several Ontario and New York lakes. Since the Welland Canal was built in 1824, the alewife has spread throughout the Great Lakes.

Physical Characteristics

- The alewife is a member of the herring family and has a slender body, coloured greyish green on the back and silvery on the sides and belly.
- When gaspereau enter freshwater, they often have a copper colour.
- Gaspereau have a single black spot on each side, just behind the head.
- Each eye is large and has an eyelid.



Fishy Facts

- The alewife has a row of scales, known as scutes, forming a sharp edge along the midline of the belly, which is how some came to call the alewife "sawbelly."
- Alewife eggs, or roe, are canned and sold as a delicacy.
- Despite the many thousands of eggs laid by the spawning alewife, very few offspring survive. In some populations, as few as three migrate downstream for each female that has spawned.
- During the spawning runs, commercial fishermen set large trap nets or enclosures called weirs in coastal rivers and estuaries to catch migrating alewives. This is commonly seen on the Miramichi and Saint John rivers.
- The catch is used for fish meal, lobster bait, pet food, or is smoked, canned, salted or pickled. Although tasty, alewives are not favoured locally for human consumption.

Life Cycle

In the Maritimes, the alewife spends most of its life growing in saltwater, feeding on zooplankton. Beginning in early spring, large runs of adult alewives migrate up coastal rivers to spawn in freshwater lakes, ponds and streams. Like trout and salmon, alewives use their sense of smell to return to the streams and lakes where they hatched. Migration into freshwater occurs only during daylight hours. Spawning, however, occurs at night and can occur in lakes or in slow-moving or fast mid-river water. A single female can lay as many as 200,000 eggs. After spawning, many alewives die. Those that survive return to sea within a few days.

Alewife eggs are about 1 mm in diameter, and are left to lie on the bottom or float with the current. Depending on water temperatures, the eggs hatch in about a week. After the yolk sac is absorbed, the tiny larval fish stay near the spawning grounds preferring shallow, warm and sandy areas. During this time, they feed on tiny zooplanton.

From August to October, the young alewives, now 32 to 152 mm in length, migrate downstream in large schools to live in estuaries and coastal areas. Adults overwinter at sea in George's Bank, the Gulf of Maine or Nantucket Shoals.

Alewives can live at least 10 years. They are eaten by many species of fish and birds including: striped bass, salmonoids, smallmouth bass, eels, perch, bluefish, weakfish, terns, eagles, ospreys , great blue herons and gulls.

WHITE SUCKER

Distribution

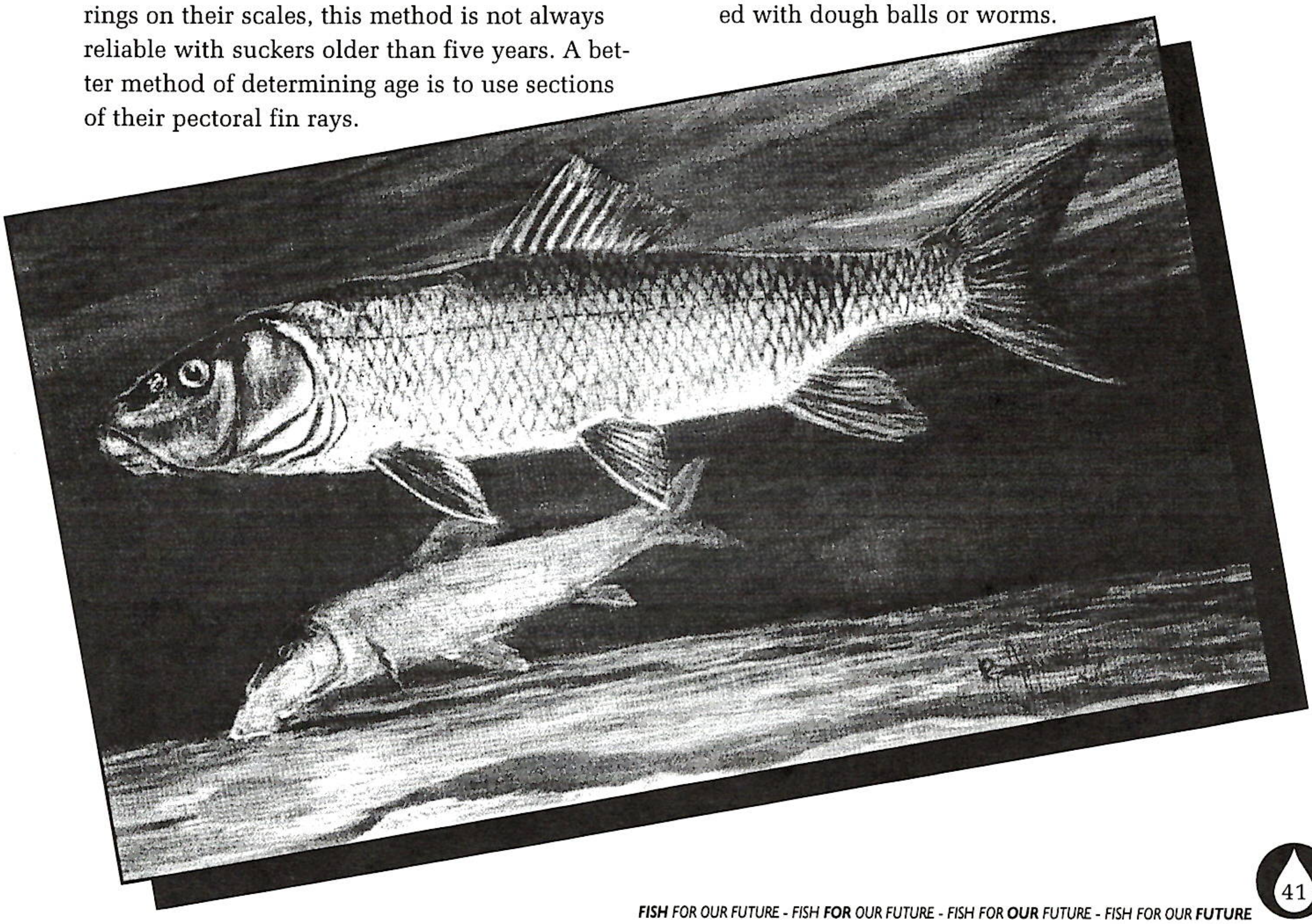
THE WHITE SUCKER is found in the freshwater streams and lakes of Labrador, south to Georgia, west to Colorado and north through Alberta and British Columbia to the MacKenzie River delta. In Canada, they are absent from Newfoundland, eastern Labrador, Prince Edward Island, southwestern British Columbia and much of the far north.

Physical Characteristics

- The white sucker is torpedo-shaped, and has a sucker-like mouth located on the underside of its blunt, rounded snout.
- Its colour varies from gray to coppery-brown to almost black on the back and upper sides, becoming lighter on the lower side to white on the belly.
- White suckers have large scales, one dorsal fin, one adipose fin, and the lateral line is complete.
- Young white suckers (5-15 cm long) usually have three large dark spots on their sides.

Physical Characteristics

- Spawning migrations of white suckers can be numerous and very dense. One observer recorded 500 swimming upstream past a single point over the course of five minutes.
- Although most fish may be aged by counting the rings on their scales, this method is not always reliable with suckers older than five years. A better method of determining age is to use sections of their pectoral fin rays.
- The flesh of white suckers is bony, but can be very tasty, especially when hot-smoked.
- Suckers used as bait should never be used in lakes that have no suckers. They can be caught on wet flies, small spinners and small hooks baited with dough balls or worms.



Life Cycle

The white sucker can adapt to a wide range of habitat conditions; however, it prefers the warm shallow waters of lakes and quiet rivers, where water temperatures may reach 24° C. In stream areas, they are most abundant where there is ample underwater debris, streamside vegetation and water depth to provide cover.

In lakes they are most commonly found in the upper 6.2-9.2 m of water, moving to shallow areas to feed. They browse along the bottom, sucking in aquatic insects, small clams and snails. As they eat, they spit out inedible objects such as sand and gravel. Feeding usually occurs at dawn and dusk.

White suckers spawn in the spring, usually during the months of May and June. The main factor influencing when spawning occurs during this time period is water temperature. When it reaches the range of 10-18° C, white suckers migrate upstream to spawning areas.

Shallow gravel riffle areas where the water is up to 30 cm deep and where the flow is moderate is typical spawning habitat for white suckers. Lake populations with limited access to streams will occasionally spawn on gravel shoals where there are waves. Although some spawning may occur during daylight, most takes place at sunrise and sunset. One female usually spawns with several males. Females normally produce 20,000 to 50,000 eggs, but can produce up to 139,000 eggs. Suckers do not build a nest, rather they scatter their eggs, which stick to the bottom or drift downstream and attach to a rock or underwater debris somewhere else.

Hatching takes place within 8-11 days, depending on water temperature. The young remain in the gravel for one or two weeks. When they emerge, they migrate downstream. Sometimes only 3% of white suckers survive this stage.

Young suckers in lakes are found along shorelines with sand or gravel bottoms. In streams they prefer sand and gravel shallow areas with moderate currents.

In the early stages of their lives, white suckers do not feed on the bottom. Their mouth is at the end of their snout and they feed near the surface of the water on plankton. As they grow, their mouths shift to the underside of the head and they begin taking food from the bottom.

White suckers grow rapidly during their first year. Growth rates vary considerably in different areas, but in all populations females grow more rapidly than males, reach larger sizes and live longer. Maturation occurs between the ages of 5 to 8, with males maturing a year earlier than females. Suckers have been known to live up to 17 years.

Although there is evidence that suggests that white suckers can compete for food with other sport fishes, they can be a major food item in the diet of other fishes such as Atlantic salmon, brook trout, pike and bass. They are also eaten by birds and mammals.

RAINBOW TROUT

Distribution

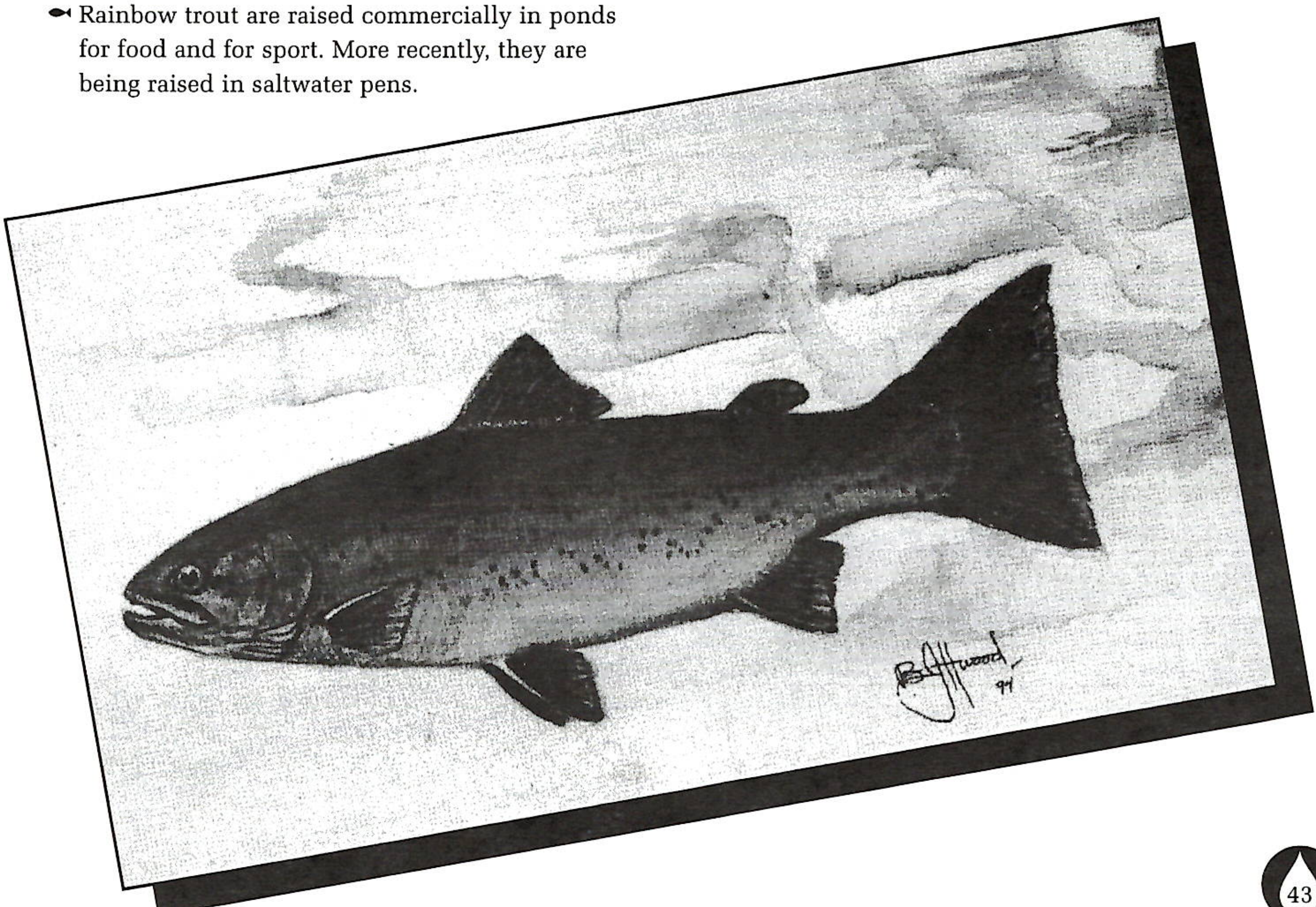
RAINBOW TROUT are native to the Pacific Ocean and freshwater systems of western North America. Despite this, they have been widely introduced throughout the world. Rainbow trout were first introduced to Atlantic Canada in the late 1800s.

Physical Characteristics

- Adults in freshwater will vary in colour from metallic blue to green or yellow-green to brown on the back, with silvery sides and a light belly.
- Numerous black spots are found on the head, back, sides and fins. Spots on the tail are in obvious rows. Mature fish have a distinctive rosy stripe along the side from the gill cover to caudal fin.
- Adults in seawater, also known as steelheads, are more silvery in colour and may lack the rosy stripe. There may also be less spotting.

Fishy Facts

- The largest known rainbow trout was caught in Alaska and weighed 19.10 kg.
- The rainbow trout is fished with wet and dry flies, lures or natural bait.
- Rainbow trout are raised commercially in ponds for food and for sport. More recently, they are being raised in saltwater pens.



Life Cycle

Different populations of rainbow trout have different life patterns. Some rainbow trout may live in lakes or ponds, while others may be stream dwellers, or may be anadromous, spending part of their lives at sea before returning to freshwater to reproduce.

Spawning usually occurs in the spring, in small tributaries of a river, or in the inlet or outlet of a lake. Spawning may also occur in the late fall or early winter. Like the Atlantic Salmon, rainbow trout usually return to the stream where they were hatched.

When a female is ready to spawn, she finds a shallow riffle area with a gravel bottom. There she uses her body to dig a redd in the gravel. One or two males will spawn with her in the redd, then she will bury the fertilized eggs. She then repeats this process until all her eggs are laid. Most female rainbow trout produce between 1000 and 4000 eggs.

The eggs are between 3 to 5 mm in diameter, and will hatch in 4 to 7 weeks, depending on water temperature. In another 3 to 7 days the young fish absorb the yolk sac and emerge from the gravel.

Young lake-dwelling fish may move into the lake by the end of their first summer. Young rainbow trout seek cover, preferring slow-moving shallow stream areas where they can find shelter under rubble, rocks, instream debris and undercut banks. Older trout move into faster and deeper stream waters.

Anadromous rainbow trout spend from 1 to 4 years in freshwater before they transform into smolts to prepare for life in saltwater. In the process of smoltifying, they lose their parr markings and become silvery. They migrate to sea in spring and remain there for a few months to several years before they return to freshwater.

Rainbow trout are an aggressive fish, and will eat a wide variety of food. In freshwater this includes: insects, crustaceans, snails, leeches and other fishes. At sea, they mainly eat fishes, crustaceans and squid.

The growth rate of rainbow trout varies widely, depending on their habitat, diet and life pattern. Fish that go to sea or live in large productive lakes generally grow to be the largest and live the longest. Rainbow trout may live as long as 11 years, and many will spawn repeatedly.

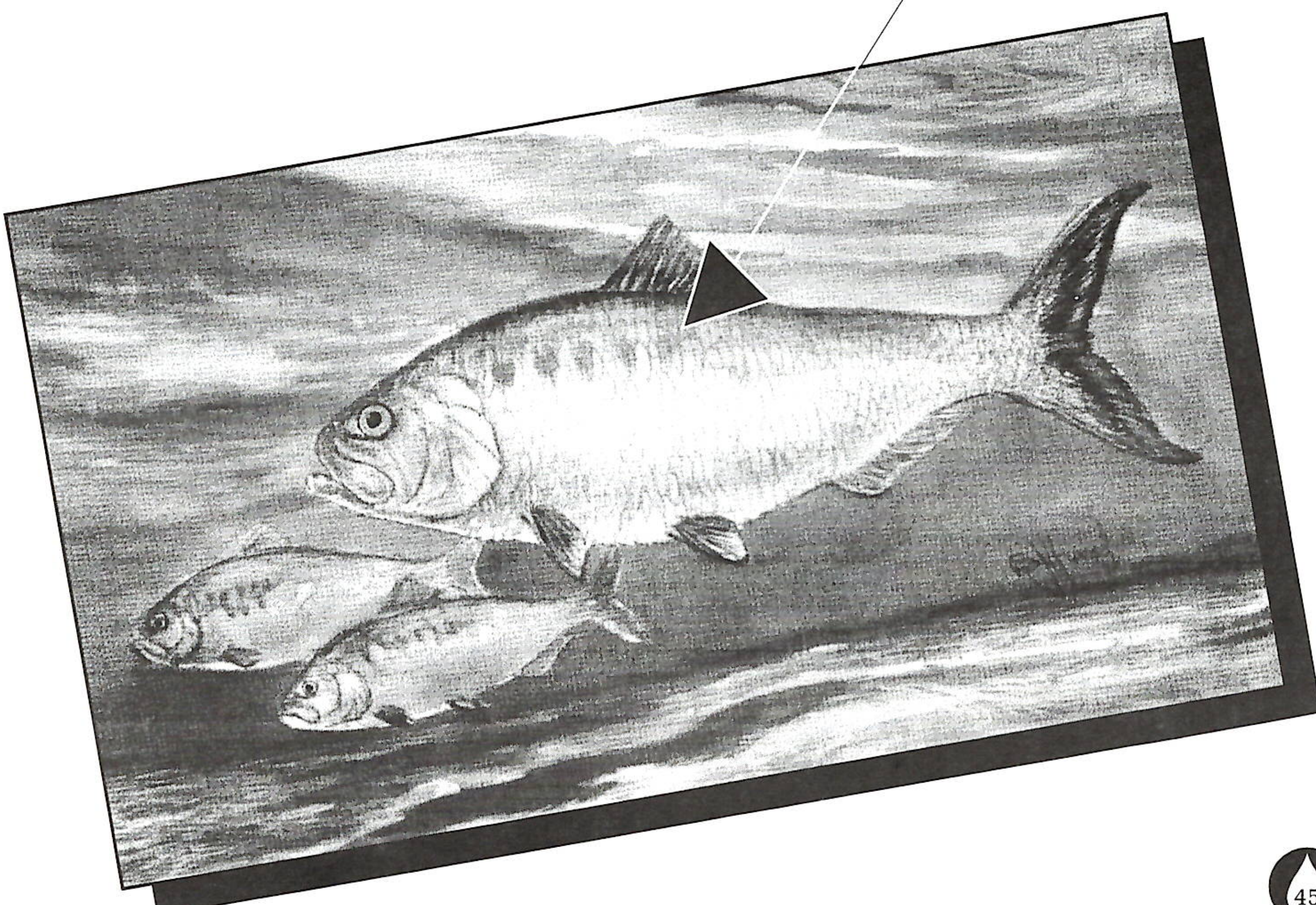
AMERICAN SHAD

Distribution

AMERICAN SHAD are anadromous fish, and are found along the Atlantic coast of North America from Newfoundland to Florida. Large spawning runs used to occur in the Saint John and Miramichi rivers.

Physical Characteristics

- The American shad, like the alewife, is a member of the herring family and has a slender body, coloured a blue-green metallic hue on its back.
- Shad have a series of black spots on their sides, beginning just behind the head.
- Like the gaspereau, shad have a row of scales known as scutes, forming a sharp "sawbelly" edge along the midline of the belly.
- There is no lateral line.



Fishy Facts

- American shad can grow to 76 cm and weigh 6.8 kg; however, adults found in Canadian rivers are usually 45-50 cm long and weigh from 1.4 - 2.7 kg.
- Some shad can migrate up to 3,000 km in one season!
- The flesh of shad is very tasty. The scientific name for shad comes from the Saxon word "allis", meaning "most delicious."
- Scientific studies show that shad from all eastern U.S. rivers spend some time in the Bay of Fundy.
- During the 1800s a thriving shad fishery existed along the Atlantic coast supporting an annual catch as high as 23,000 tons. Today, numbers of shad have greatly declined due to over-fishing and changes in our rivers. Dams often block access to vast areas of spawning habitat. Even where fishways provide access, many young shad may not survive the downstream migration.
- Shad are fished commercially in rivers during their spawning runs. The eggs (roe) are considered valuable, so large numbers of females are taken. The flesh is sold fresh and salted. Shad are angled and considered a fine game fish.

Life Cycle

The American shad lives for several years at sea before returning to spawn in the stream or river where it was hatched. Shad avoid cold temperatures, preferring to stay in water that is 8° C or warmer. Migration and behaviours are determined in part by water temperature and currents.

Each spring, schools of shad use their sense of smell to migrate up coastal rivers and tributaries. This generally occurs in June and July, when water temperatures reach 13-20° C.

Spawning occurs in mid-water areas of rivers during the night. Laid over a wide range of bottom types, the eggs are about 3 mm in diameter, and drift with the current. Hatching occurs in 8-12 days, depending on the temperature of the water.

A female can produce from 60,000 to 600,000 eggs, although the average is about 130,000 eggs. Many shad in the Maritimes are repeat spawners, while southern populations of shad die after spawning.

Young shad spend their first summer in the river feeding on insects and crustaceans. They swim near the bottom of the water, as deep as 3.7 - 4.9 m, but at night are found near the surface. By the fall, they have grown to a size of 7.5 - 12.5 cm and migrate to the sea as water temperatures in the river drop.

At sea, shad live in schools, moving to areas where bottom temperatures range from 7 - 13° C. They stay near the bottom during the day, dispersing during the night to all depths. Immature and spawned-out adults remain offshore in areas like the Bay of Fundy until winter, when they move farther out to sea in order to stay in preferred water temperatures. At sea they eat zooplankton, crustaceans and occasionally small fishes. Most shad mature at age 4 or 5 and may live up to 13 years.

Although not a major food source to other animals, shad are eaten at sea by seals, sharks, blue-fin tunas, kingfishers and porpoises. Young shad in freshwater are eaten by bass, American eels and birds.

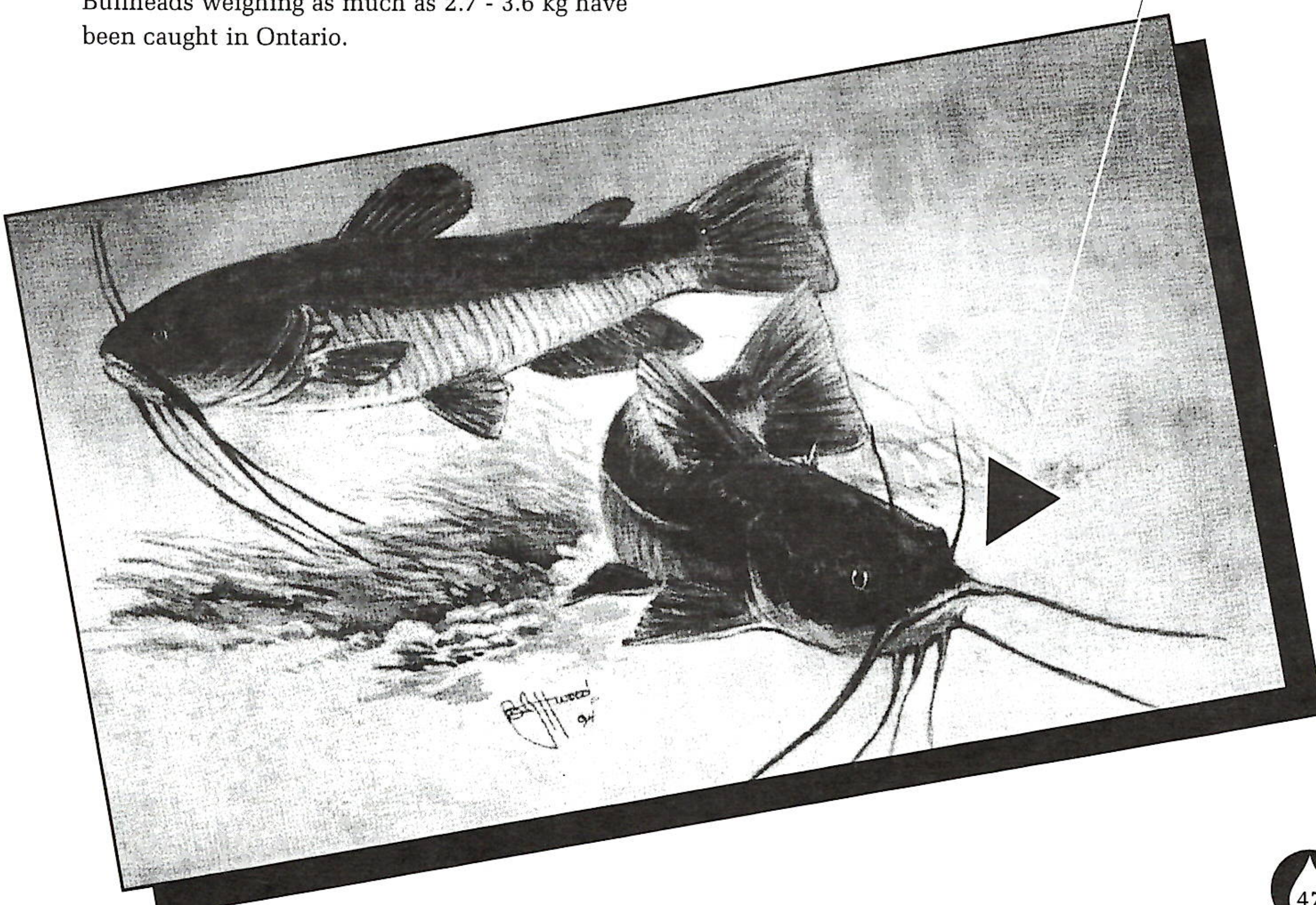
BROWN BULLHEAD

Distribution

THE BROWN BULLHEAD, also known as catfish or bullhead catfish, is found in the freshwaters of eastern and central North America, from the Maritime provinces to Florida, and westward to southern Saskatchewan, Missouri and Texas. In Atlantic Canada the brown bullhead is found only in New Brunswick and mainland Nova Scotia.

Physical Characteristics

- The bullhead is easy to identify with its distinctive sets of whisker-like formations around the mouth. These features are called barbels.
- Bullheads have thick rounded bodies, heaviest around the front, with broad, large flattened heads.
- The bullhead has no scales but the skin has many taste glands.
- In the Atlantic region, bullheads seldom grow more than 30 cm long and 0.5 kg in weight. Bullheads weighing as much as 2.7 - 3.6 kg have been caught in Ontario.



Fishy Facts

- The spines at the base of the dorsal and pectoral fins can be "locked" into an erect position. This is thought to help protect the bullhead against predators by making it much harder to swallow.
- Brown bullheads take many types of bait and are easily caught by anglers. They are best fished using worms at dusk.
- The flesh of brown bullheads is very tasty. They are raised commercially in the southern United States.
- Brown bullheads can live in extremely polluted water, where other fish would die.

Life Cycle

Brown bullheads usually live on the bottom of lakes or large slow-moving streams. They prefer shallow, weedy, muddy areas and can tolerate higher water temperatures and lower oxygen levels than many other fish species.

Feeding usually occurs at night, using their barbels to search for food. They eat a variety of food including insects, fish eggs, leeches, mollusks, worms, algae, plants and small fishes.

Bullheads spawn in the late spring, when water temperatures approach 21° C. One or both fish excavate a shallow nest in a protected area of mud or sandy bottom. Several thousand cream-coloured eggs are deposited in the nest. The parents care for the eggs by fanning them with their fins and physically stirring them up.

After hatching, the young catfish are jet black and resemble tadpoles. They swim in a school and are protected by their parents for several weeks until they are about two inches long. Young bullheads feed mainly on insects and plankton.

Bullheads usually reach maturity at age 3, and live for 6-8 years. They are eaten by chain pickerel and other members of the pike and perch families.

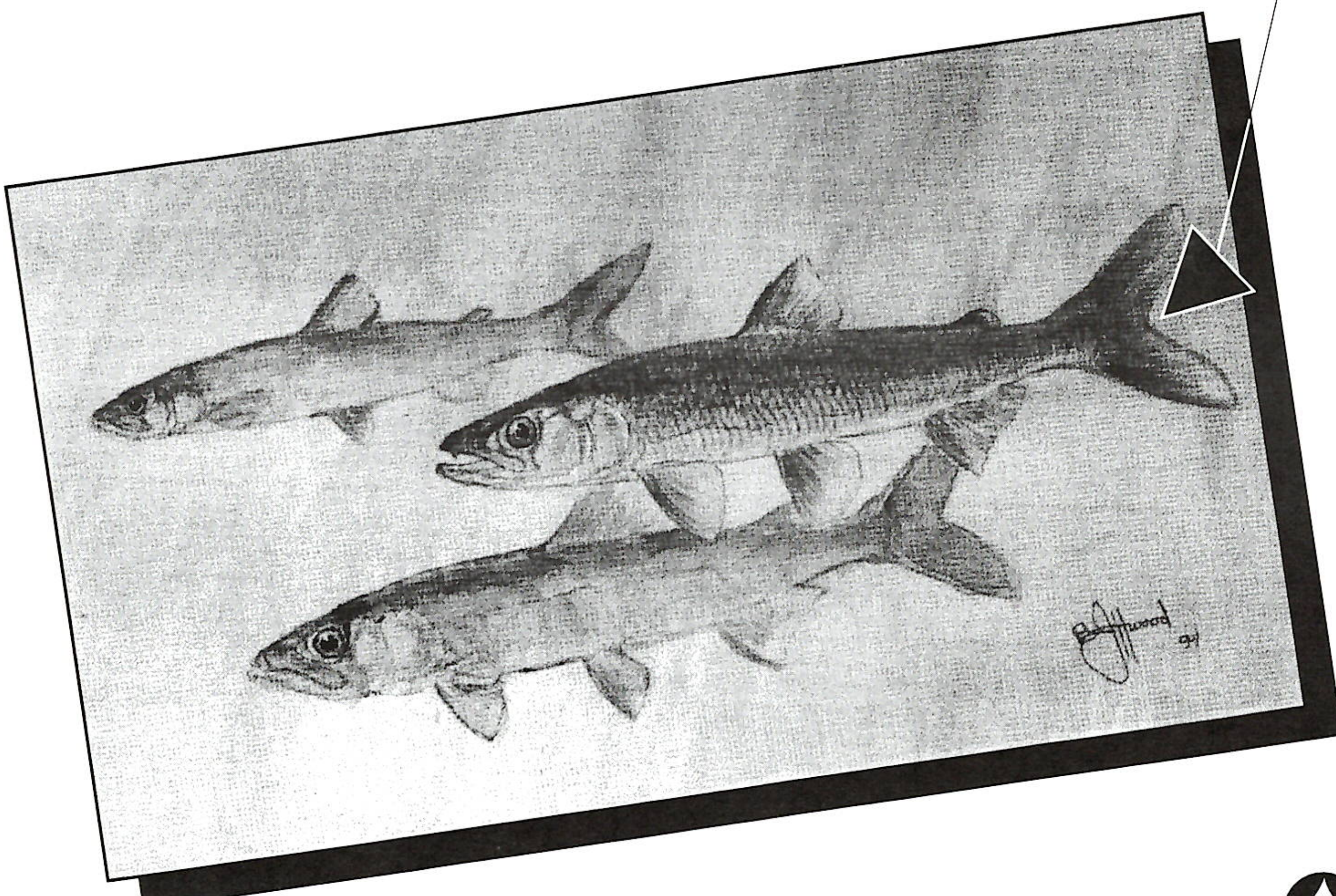
RAINBOW SMELT

Distribution

RAINBOW SMELT are found in rivers and coastal areas of eastern North American from Labrador to New Jersey. They are found on the west coast from Vancouver Island to the Arctic Ocean.

Physical Characteristics

- The rainbow smelt is a small slender fish that grows about 25 cm long.
- Smelt are olive-green on the back and lighter on the sides.
- The sides have a purple, pink and blue iridescence, especially when freshly caught.
- Smelt have a relatively large mouth with fang-like teeth and a protruding lower jaw.
- The caudal (tail) fin is deeply forked.
- When in fresh water, smelt become darker; almost black on the back.



Fishy Facts

- Smelt are fished commercially and for sport. Winter fishing for smelt is a popular sport. Anglers take them on lines through the ice, using worms as bait. In spring, anglers dipnet or seine them in spawning tributaries.
- The largest Maritime fishery occurs in the Miramichi estuary. Smelt are sold fresh or frozen and are very tasty.
- Freshly caught smelt smell very much like cucumbers. This odour disappears after preservation or freezing.
- Male smelt are more abundant than females in spawning areas. This is probably because they can spawn up to 8 consecutive nights, but females can spawn only 3 or 5 nights.

Life Cycle

Rainbow smelt are anadromous and live in schools. They grow and mature in shallow coastal waters and migrate up freshwater streams to spawn. Smelt move into estuaries in the fall and to streams after the spring thaw.

Spawning occurs from February to June, usually when water temperatures are between 4-10° C. They do not necessarily return to the stream of their birth to spawn, especially if there are nearby streams available. Smelt in land-locked lakes swim up tributary streams or in some cases spawn along the shoreline. Spawning occurs at night, in fast-moving water.

Each female may produce as many as 93,000 eggs. The fertilized eggs become sticky and attach to the bottom, sometimes forming a thick layer.

After spawning the adults return to the estuary during the day but may return upstream to spawn again on subsequent nights. Some fish die after spawning. Those that survive leave freshwater to spend their summer in coastal waters.

Smelt eggs are 1 mm in diameter and take 11 to 29 days to hatch, depending on water temperatures. Smelt fry are 5 to 6 mm long when they hatch and drift downstream to brackish water.

Young smelt use water depth for cover and feed near the surface at night. They feed on plankton and may grow to 5 cm by August.

Older smelt eat larger invertebrates and other fish. Smelt grow rapidly in their first year and tolerate increasing amounts of saltwater as they get older. They prefer temperatures of 6 to 14° C and stay close to shore, hiding in eelgrass beds or in the mud.

Smelt in the Miramichi average 13.9 cm at age 2 and 20.6 cm by age 5. Maturity is usually reached within their second year. Smelt have been known to live as long as 17 years! Females tend to live longer and grow larger than males.

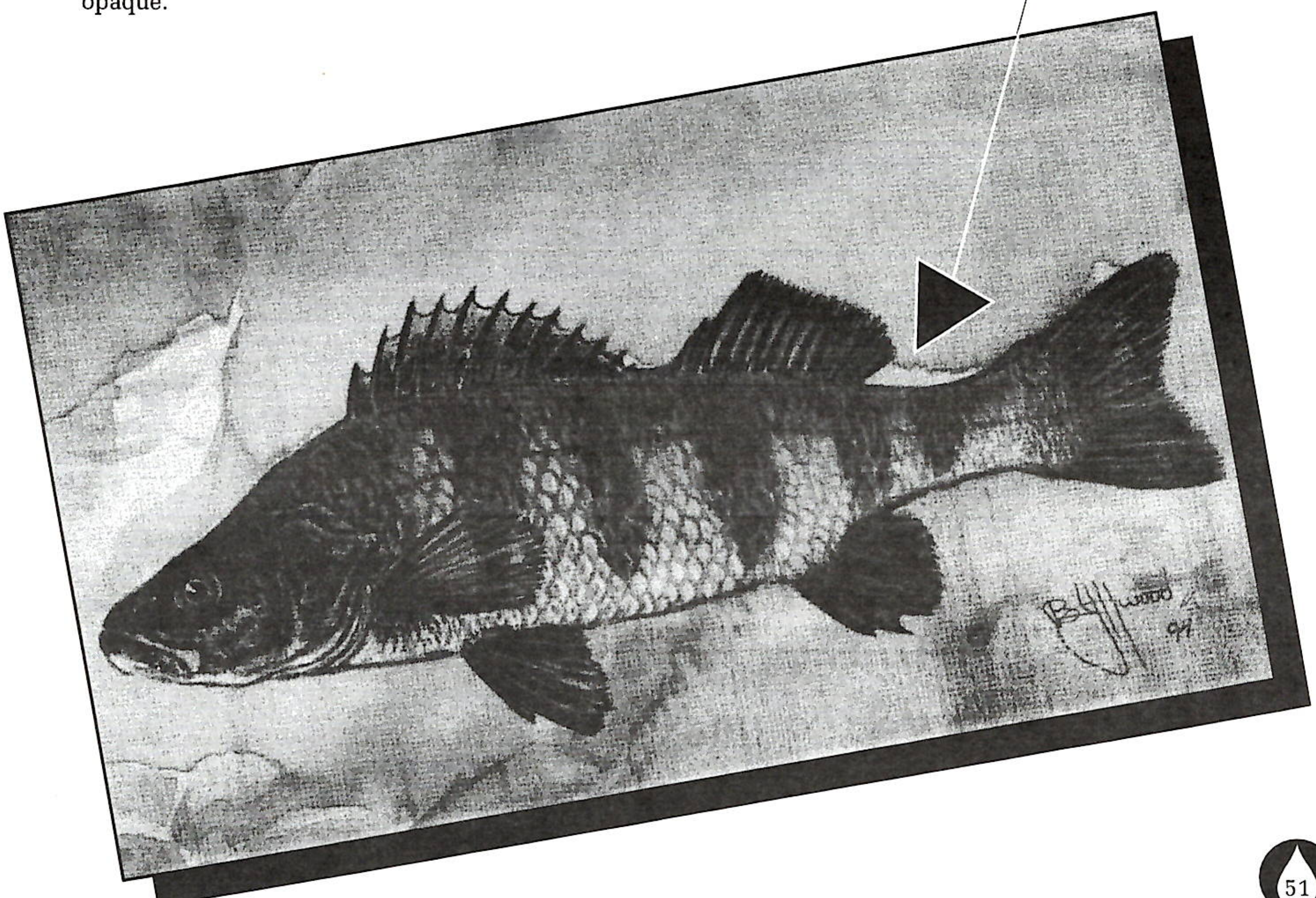
YELLOW PERCH

Distribution

YELLOW PERCH may be found in the freshwaters of North America from Nova Scotia south along the Atlantic coast to Florida, west to Pennsylvania and Missouri, northwest to Montana, north to Great Slave Lake, southwest to James Bay and east to New Brunswick and Nova Scotia. It has been introduced in the southern and western United States and has spread to southern British Columbia. Yellow perch are not found in Prince Edward Island, Cape Breton or Newfoundland. They are occasionally found in brackish water along the Atlantic coast.

Physical Characteristics

- Yellow perch range in colour from black-green to olive to golden-brown on the back, extending down the sides in tapered bars.
- The rest of the sides are yellowish, with a white to grey colour on the belly.
- There are two dorsal fins, the first one having 13 to 15 sharp spines, the second one having only one spine followed by soft rays.
- The pectoral fins are amber-coloured and transparent; the pelvic fins are yellow to white and opaque.



Fishy Facts

- Occasionally yellow perch are found with the unusual colouring of grey-blue or red and the absence of dark bars on the side.
- Students studying the anatomy of bony fish most often use the yellow perch.
- The yellow perch is fished both for sport and for food. They are readily caught using worms. Yellow perch have been fished commercially in other areas of Canada for over a hundred years and are sold both fresh and frozen. The flesh is white and tasty.
- Yellow perch are sometimes infected with the broad tapeworm *(Diphyllobothrium latum)* that can be transmitted to humans if the flesh is improperly cooked.

Life Cycle

Yellow perch live in schools in shallow water. They can adapt to a wide variety of warm or cool habitats. They may be found in large lakes, small ponds or gentle rivers, but are most abundant in clear, weedy lakes that have muck, sand or gravel bottoms. They prefer summer temperatures of 21 - 24° C. Yellow perch feed on aquatic insects, crustaceans and a variety of fishes and their eggs.

Spawning occurs from April through July when water temperatures range from 9 to 12° C. The adults move into shallow areas of lakes or up into tributary streams. Males are the first to arrive and the last to leave. Spawning takes place at night or in the early morning, usually in areas where there is debris or vegetation on the bottom.

Females shed their eggs in long jelly-like spirals or accordion-folded strands. Several males fertilize the eggs during spawning. Some egg masses can be as much as 2.1 m long, 51 to 102 mm wide and weigh 0.9 kg!

Females produce an average of 23,000 eggs, but have been known to produce up to 109,000 eggs. The egg masses are semi-buoyant and attach to vegetation or bottom material. They receive no care and can be found washed up onshore after storms. They may also be eaten by predators.

Yellow perch eggs are 3.5 mm in diameter and hatch within 8 to 21 days, depending on water temperature. Newly hatched yellow perch are about 5 mm long.

Young perch grow rapidly, remaining near the shore during their first summer. There they swim in large schools that often include other species.

Adults join schools farther offshore. They move between deep and shallow water in response to changing food supplies, seasons and temperatures. Perch feed in the morning and evening, taking food in open water or off the bottom. At night, they rest on the bottom.

Yellow perch remain active and feed during the winter. They can outbreed and outfeed speckled trout or other fish in the lake. This can sometimes lead to an overpopulation of small, stunted perch.

Yellow perch are eaten by other fish such as chain pickerel, smallmouth bass and lake trout. They are also eaten by birds like mergansers, loons, kingfishers and gulls.

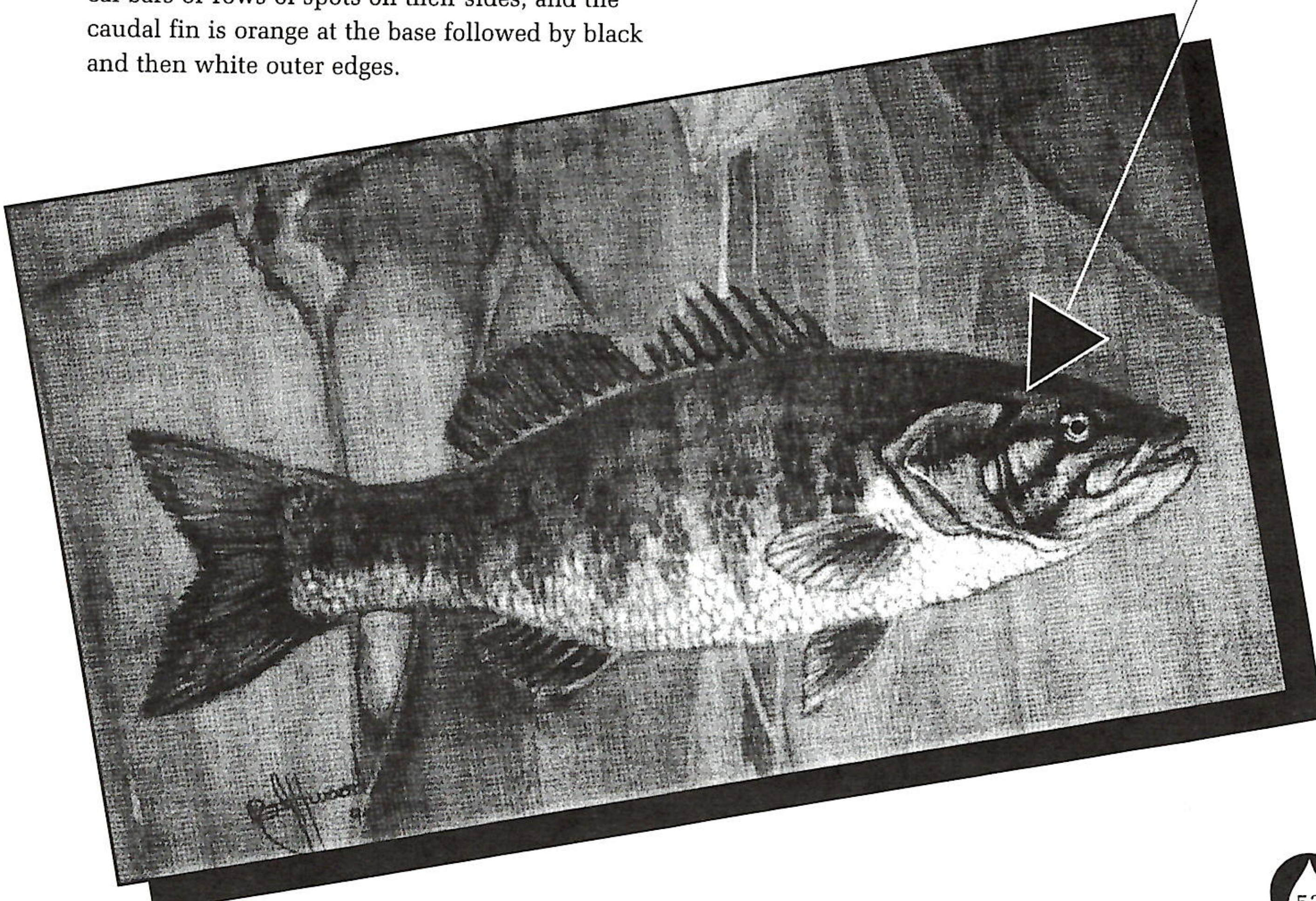
SMALLMOUTH BASS

Distribution

THE SMALLMOUTH BASS is a freshwater fish, originally found in lakes and rivers of eastern and central North America. Through widespread introduction, it is now found from south and central Nova Scotia and New Brunswick south to Georgia, west to Oklahoma, north to Minnesota, west to North Dakota and east from southern Manitoba to Quebec. It is also found in a few areas of western North America and has been introduced to Europe, Asia and Africa.

Physical Characteristics

- Smallmouth bass range in colour from brown, golden-brown, olive to green on the back, becoming lighter to golden on the sides and white on the belly.
- There are 8-15 narrow vertical bars on its sides and dark bars on the head that radiate backwards from the eyes.
- Its head is fairly large, with large red, orange or brown eyes.
- Young smallmouth bass have more distinct vertical bars or rows of spots on their sides, and the caudal fin is orange at the base followed by black and then white outer edges.



Fishy Facts

- Some male smallmouth bass return to the same nest year after year. Over 85% of them build their nest within 138 m of where they nested in earlier years.
- Smallmouth bass have been seen "sunning" in pools with water temperatures of 26.7° C.
- Smallmouth bass have been a popular sport fish since the early 1800s. This popularity led to widespread introductions and the culture of smallmouth bass. It was harvested commercially until the 1930s but overfishing led to its restriction as a sport fish.
- Smallmouth bass can be caught with wet or dry flies, trolling or by casting with bait or lures.

Life Cycle

Smallmouth bass prefer clear quiet waters with gravel, rubble or rocky bottoms. They may be found in mid-sized gentle streams that have deep pools and lots of shade, or in fairly deep, clear lakes and reservoirs with rocky shoals. They tend to seek cover and avoid the light by hiding in deep water, behind rocks and boulders and around underwater debris and crevices. Smallmouth bass prefer water temperatures of 21-27° C. When temperatures fall, they become less active and seek cover in dark, rocky areas. They do not eat during the winter, remaining inactive on the bottom, near warm springs when possible.

Spawning occurs from late May to early June in shallow, protected areas of lakes and rivers. The male prepares a nest in a sandy, gravel or rocky bottom by cleaning an area 0.3 to 1.8 m in diameter. He then defends the nest from other males and attracts a series of females into the nest to spawn. Each female usually produces between 5,000 and 14,000 eggs, depending on the size of the fish. After spawning, the female leaves and the male remains to guard the nest and fan the eggs. The eggs are 1.2 - 2.5 mm in diameter and are found sticking to stones in the bottom of the nest.

Hatching occurs within 4 to 10 days, depending on water temperatures. Hatching success varies. Sudden changes in temperature or water level can cause the eggs to die from shock, or cause the male to abandon the nest, leaving it open to predators. The male protects the young as they absorb their yolk sacs. He continually guards them for 3 to 4 weeks until they begin to leave the nest.

Young smallmouth bass stay in shallow quiet areas where rocks and vegetation are plentiful. At first they feed on plankton, switching to larger prey, like water insects, amphibians, crayfish and other fishes as they grow.

Older bass prefer rocky shallow areas of lakes and rivers, retreating to deeper water when water temperature becomes excessive. Most bass do not travel very far, and those in streams spend all season in the same pool.

Maturity is reached between the ages of 3-6 years. Males usually mature a year earlier than females. They have been known to live 15 years!

Smallmouth bass are eaten by yellow perch, catfish, white suckers and turtles.

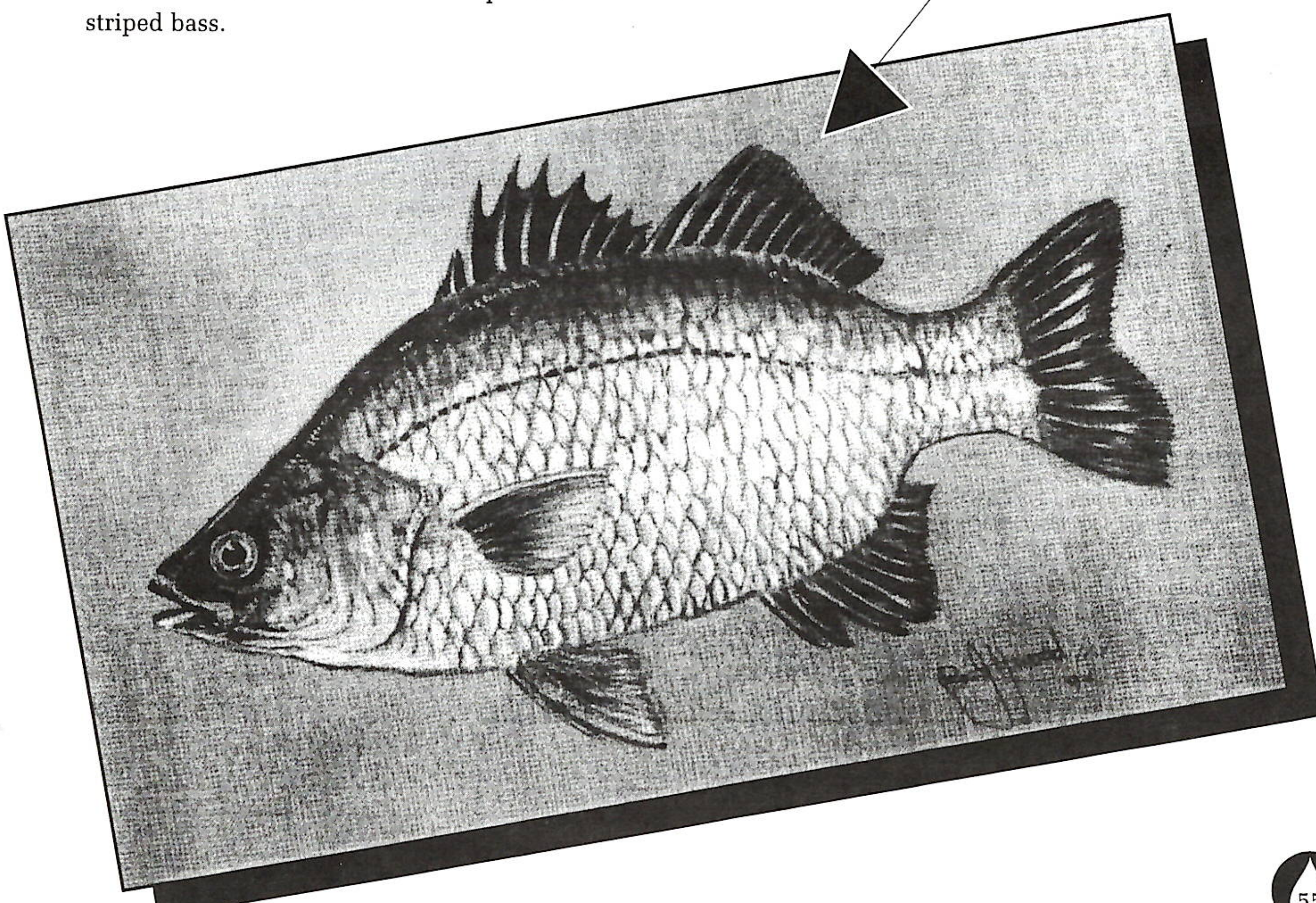
WHITE PERCH

Distribution

WHITE PERCH are found in fresh and brackish waters along the Atlantic coast from the southern Gulf of St. Lawrence to North Carolina and inland along the upper St. Lawrence River to the lower Great Lakes. They are found in all three Maritime provinces.

Physical Characteristics

- White perch have deep thin bodies that slope up steeply from the eye to the beginning of the dorsal fin.
- Colours can be olive, grey-green, silvery-grey, dark brown or black on the back. The sides are lighter green and the belly silvery-white.
- Like all members of the bass family, there are two dorsal fins on the back and the pelvic fins sit forward on the body below the pectoral fins.
- White perch have many small, sharp teeth.
- Although it is similar in shape to the striped bass, the white perch has a deeper, less rounded body, and lacks the 6 to 10 horizontal stripes found on striped bass.



Fishy Facts

- The oldest known white perch lived for 17 years.
- The world record for white perch is 2.15 kg, caught in Messalonskee Lake, Maine, in 1949.
- The white perch has very tasty flesh, and when large enough, they are a popular sport fish.
- White perch are fished commercially in Chesapeake Bay, U.S.A. and in the lower Great Lakes.

Life Cycle

White perch live in both fresh and saltwater. They prefer summer water temperatures of 24° C. In the Maritimes, they are usually found in freshwater lakes and ponds. There are sea-run populations in some coastal rivers and estuaries.

Spawning takes place in the spring, when water temperatures range from 11 to 16° C (usually during the months of May and June). Males and females each spawn several times, over many kinds of stream or lake bottom. A 25 cm female can produce 247,700 eggs.

The eggs are 0.9 mm in diameter, and become sticky after fertilization. Then they become attached to vegetation and bottom materials. The length of time before eggs hatch varies, depending on water temperatures. When the water temperature is 15° C, hatching may take 4 - 4.5 days. Water temperatures of 20° C will allow hatching within 30 hours.

Growth rates of white perch vary among regions and populations. Most perch in the Maritimes are less than 15 cm long. Maturity is usually reached in 3 years, and the expected lifespan is 5 to 7 years.

White perch feed during both the day and night. Fresh and saltwater populations move to the surface (or inshore) waters at night, retreating to deeper water during the day.

When they are small, their diet consists of aquatic insect larvae. As they grow, many kinds of fishes such as smelt, yellow perch and other white perch are eaten. They are eaten by smallmouth bass, chain pickerel and large trout.

FISH FOR OUR FUTURE!

APPENDICES

. . . BECAUSE IT FEELS SO GOOD!

By Mike Flewelling, "Facilitator" Woodstock Middle School

ADOPTING the role of "facilitator" of a group of middle school students attempting to complete a year-long project that will culminate in two major events within two weeks of each other is a bit like the man in an oft told joke. When asked why he repeatedly hit himself in the head with a hammer, he replied, ". . . *Because it feels so good when I stop.*"

Being a facilitator in any situation is more applicable in some cases than others. However, if you are involved in an enterprising project like we are, it is the essence if your project is to be a success. There are "tons" (tonnes) of books written on the subject, very few of which I have read. Instead of dwelling on the text book techniques, this article will outline an experience - one that a Grade Seven class at Woodstock Middle School and myself undertook some months ago.

For us the process began with an effort to sell the students on the idea of *Enterprise*. If students are not convinced that they have already initiated enterprising type experiences in their lives, they will not buy into the idea that you, as a teacher, will merely facilitate their problem solving, brainstorming, construction, bartering, buying and fuming in their attempt to leave a legacy for others. They will sit back and whine the old refrain, "I can't do this!" (Sing along with me.) Whether it be fixing a bike, building a treehouse, or marketing a craft to earn Christmas money, almost every student has, at one time, been enterprising.

Next came some *input* on my part. Students usually need some parameters before they begin a large project. A few teachers had thrown around the idea of doing some sort of habitat enhancement at a local stream just above the town landfill site. Environmental projects are not the only ones that can be easily facilitated by teachers, but they have some built-in motivators; environmental projects are fashionable, they take place outside when the weather is nice, and kids like to sense that they are doing something that will matter. The clincher for our project was taking the students to the site and doing some stream assessment. You might say that it gave them a chance to "get their feet wet." (But that's another story.)

Once the students were sold on the idea that they could be enterprising and that they had some basic working knowledge of how waterways work and what problems might exist, it was time to brainstorm ideas. We plastered the blackboard with dozens of ideas, some of them very good and some of them pretty wacko. The key here is that all the ideas went on the board. One of the students served as recorder and our "MacQuarrie Brook" file was born that day.

Next, came the *sorting out of ideas* and, for us, it boiled down to what interested the kids. I saw some super ideas bite the dust that day and it was hard for me not to overrule and push these ideas to the top of the list, but this project had to belong to the students and I knew they'd be more easily motivated if the ideas were theirs. Besides, some of my ideas were heard and adopted by many of the kids. Some might point out that this wasn't "true facilitating" on my part, but the teacher / student relationship has to be a bit more fluid than that. The kids saw my involvement in the project as being just like theirs and my ideas throughout the year carried equal weight as we worked through a number of snags. Young kids especially, can get really bogged down if we don't nudge or yank them out of the rut they can sometimes fall into.

We eventually settled on five ideas: two models, a community presentation, an activity box based on trees, and a few days of habitat restoration work at the now adopted MacQuarrie Brook. This is where facilitation skills really come in handy. The class was now divided into four groups and I could no longer "control" the discussion. To keep a finger on the pulse of each of these groups, I had the students spend a lot of time carefully outlining what they hoped to accomplish, how they would go about doing it, what each group member would be responsible for, drawings, budgets, etc. This enabled me to hold students accountable during the times in class that we worked on the project. I could easily access the file for each group and check on their progress regularly. For the facilitator, this is *working smarter not harder.*

The winter months saw me helping the kids move the project forward. At times they were tremendously motivated. At times they needed the old "you've made a commitment and have a responsibility to see it through" routine. I won't go into the fine points of this; most teachers know it well. As the time drew close for the kids to present their finished projects, some groups were further along than others. Here is where I decided to *get help*. Other teachers, parents and members of the community had skills and expertise that the students and I didn't have. We began to create a list of possible resource people who could help us overcome some of these potentially serious problems. Together we contacted various folds and "amazingly" every need was met.

Once the projects were completed, it was time to *celebrate the kids' work.* We did it by holding a night for parents and public, showing off student accomplishment. What does this have to do with facilitating? I mention it only because it allowed me to test whether any real learning had taken place.

Listening to students explain their projects and what they represented confirmed more than I had expected. Learning had definitely taken place. Celebrating the kids' work and sitting back to watch them strut their stuff is the acid test in this whole business of facilitating learning.

There is likely much more to be said on the subject but the hope is that anyone who embarks on an enterprising project will be able to read between the lines for the finer details. I would encourage all teachers to step outside their comfort zone and risk an attempt at playing the facilitator in the classroom.

Above are Woodstock Middle School students and their facilitator, Mike Flewelling, who helped build a model of a Deflector - used to narrow stream channels, raising water levels and creating beneficial pools that fish need to survive. Below is the model of a Digger Log also constructed by students at Woodstock Middle School. These models are part of their Enterprise Youth Project that is focused around waterway restoration in part of the area's watershed system.

With a bit of planning, some hard work, a lot of patience and a sense of humour, you may be pleasantly surprised by the results. Oh yes, there is one more reason to serve as a facilitator for a major classroom project. It feels so good when it's done.

ADDITIONAL RESOURCES

AND WHERE TO FIND THEM

VIDEOS

TITLE	AVAILABLE FROM	COST
Fish Habitat "A Resource in Peril"	Habitat Management Division, D.F.O.	None
The Sackville River "We Can Make a Difference"	Habitat Management Division, D.F.O.	None
"The Future is in Your Hands"	Atlantic Salmon Federation	None
"The Southwest Brook Project"	Wayne Annis	Loan Only
"Revive Our Rivers"	School District No. 12	$5.00

Other videos are available through the National Film Board including: Atlantic Salmon, Rivers to the Sea, Trout.

POSTERS

TITLE	AVAILABLE FROM	COST
"Recreational Fish of Canada"	Department of Fisheries & Oceans	None
"Atlantic Canadian Species"	Department of Fisheries & Oceans	None
"The Scotian Shelf"	Department of Fisheries & Oceans	None
various other posters	Department of Fisheries & Oceans	None
"Trout in Atlantic Canada"	Atlantic Salmon Federation	*$5.00 Each
"The Atlantic Salmon's World"	Atlantic Salmon Federation	*$5.00 Each
"Atlantic Salmon Rivers of North America"	Atlantic Salmon Federation	None
"Fish"	Ontario Forestry Association	$2.50
"A Healthy Lake Ecosystem"	Federation of Ontario Naturalists	$2.50 + s & h
"Freshwater Fishes of Manitoba"	Manitoba Department of Natural Resources	None

* *These posters are available in pamphlet size in quantities at no cost.*

BOOKS

TITLE	AVAILABLE FROM	COST
The Wild Gulf Almanac	Chewonki Foundation	
A Guide for Fish Habitat Improvement in New Brunswick	Department of Fisheries & Oceans Gulf Region	None
Adopt-A-Stream Program (Nova Scotia)	Habitat Management Department of Fisheries & Oceans	Available to groups in N.S. at no charge
Investigating Aquatic Ecosystems	Prentice-Hall	
Investigating Terrestrial Ecosystems	Prentice-Hall	
Atlantic Fishes of Canada	University of Toronto Press	

HELPFUL Groups/Organizations

NAME / CONTACT	RESOURCES / ASSISTANCE
Habitat Management Branch **Department of Fisheries and Oceans** P.O. Box 550 Halifax, N.S. B3J 2S7 **Phone: 902•426•4612** **Fax: 902•426•1489**	- assistance in evaluating aquatic habitat conditions - supply posters for classroom use - provide technical support for aquatic habitat restoration - Adopt-A-Stream manual, for Nova Scotia groups
Gulf Region **Department of Fisheries and Oceans** P.O. Box 5030 Moncton, N.B. E1C 9B6	- A Guide for Fish Habitat Improvement in New Brunswick
The Atlantic Salmon Federation P.O. Box 429 St. Andrews, N.B. E0G 2X0 **Phone: 506•529•1072**	- ***Fish Friends*** program for elementary school - various posters - manual for stream-side tanks
Ontario Forestry Association 150 Consumers Road Suite 209 Willowdale, Ontario M2J 1P9	- "Fish" poster, $2.50 each

NAME / CONTACT	RESOURCES / ASSISTANCE
Ministry of Environment 135 St. Clair West Toronto, Ontario M4B 1P5 **Phone: 416•325•4000**	free catalogue of resources
Federation of Ontario Naturalists 355 Lesmill Road Don Mills, Ontario M3B 2W8	"A Healthy Lake Ecosystem" poster available for a small charge
Manitoba Department of Natural Resources *Public Information Services* 1495 St. James Street, Box 22 Winnipeg, Manitoba R3H 0W9	"Freshwater Fishes of Manitoba" poster
New Brunswick Department of Natural Resources and Energy P.O. Box 6000 Fredericton, N.B. E3B 5H1	Technical assistance for habitat restoration projects
Department of the Environment *Mr. Michael Sprague, Manager* Water Resource Monitoring P.O. Box 6000 Fredericton, N.B. E3B 5H1	Information on water quality Information on riparian zones
Corey Feed Mills *Mr. Terry Drost* 136 Hodgson Road Fredericton, N.B. E3B 5W6 **Phone: 506•444•7744**	Fish food Feeders Aquaculture supplies

WAT-ER THESE?

ABIOTIC
Characterized by the absence of living organisms.

ACID PRECIPITATION
Rain or snow which contains acids, usually nitric or sulphuric, formed from the interaction of certain forms of air pollution and water, often termed "acid rain."

ADAPTATION
The occurrence of genetic changes in a population or species. A result of new or altered environmental conditions.

ADIPOSE FIN
A fleshy fin situated on the back of certain fishes behind the dorsal fin. Found only in trout, salmon, whitefish, smelt and catfish.

AGE GROUP
All fishes of one species born in the same year; also known as *"year class."*

ALEVIN
Stage of development of the salmonoid embryo from hatching to absorption of the yolk sac. The yolk sac is used as the sole source of food for the newly hatched fish.

ALLOCATION
Assignment of aquatic resources for fish production and other water uses. This includes providing sufficient numbers of fishes to escape harvest to perpetuate the fishery as well as assigning a portion of the annual allowable yield to a group or individual.

ANAL FIN
The fin situated behind the anus or vent of a fish.

ANGLER
A person who fishes for sport with a hook and line.

AQUACULTURE
The commercial cultivation of aquatic organisms for sale.

AQUATIC INSECT
An insect that requires an aquatic habitat to complete one or more stages in its life cycle.

AQUATIC INVERTEBRATE
All animal forms that inhabit an aquatic environment and that do not have backbones. This term is commonly used as a general term to describe stream-dwelling insects.

AQUATIC PLANT
A plant found growing in the water. Aquatic plants may grow above the water line, below the water line, or may float on the surface of the water.

BARBEL
A long hair-like projection, usually in the mouth area used to feel for food in bottom sediments.

BIOSPHERE
The life zone of the earth, including the lower parts of the atmosphere, the hydrosphere, soil and parts of the lithosphere (to a depth of about 2 km.).

BIOTIC
Of or pertaining to live and living organisms.

BUFFER CAPACITY
The ability of some natural systems to absorb acid rain without a marked increase in overall acidity.

BUFFER STRIP
A narrow strip of natural vegetation used to moderate the effects of surface run-off.

CADDISFLY LARVAE
The mobile aquatic phase of the caddisfly. Caddisfly larvae build cases from leaves, gravel, sand, bark, twigs, grass or other debris that they drag about with them. A basic food for many fishes.

CAMOUFLAGE
A method of concealing oneself from a predator by appearing to blend in with the natural background.

CARRYING CAPACITY
The maximum average number of a given organism that the aquatic habitat can maintain at any particular season of the year. The carrying capacity is commonly measured as weight per unit of area, such as grams per square metre.

CATCH LIMIT
The legal number of fishes that may be taken by a fisherman on a particular day or longer period of time.

CATCH-AND-RELEASE
A form of sportfishing whereby fishes are carefully released alive after being caught.

CAUDAL FIN
The tail fin of a fish.

CAVIAR
The pickled roe or eggs of certain fishes.

CLOSED SEASON
The time of year when a given species of fish cannot be legally caught.

CONSERVATION
The wise management of renewable resources in such a way to ensure their continuing quality and availability to current and future operations.

CONSERVATION OFFICERS
Highly trained professionals who spend most of their time preserving and protecting our natural resources. Their prime role is to enforce game and fish laws, but they also carry out resource management and public information duties.

CONSUMERS
Heterotrophic organisms, mainly animals, that ingest other organisms or organic matter.

DAILY MOVEMENT
A typical pattern of movement which occurs every day, for example from near the surface at night to deeper water during the day, or from near shore to offshore areas.

DECOMPOSERS
Heterotrophic organisms (including bacteria and fungi) that break down the complex compounds, absorb some decomposition and release substances usable by producers.

DEGRADATION
Refers to the decline in quality of habitat.

DIVIDE
The height of land separating two watersheds.

DORSAL FIN
A fin on the back of a fish, usually central in position supported by rays or spines.

DRAGONFLY NYMPH
The mobile aquatic phase of the dragonfly. A source of food for many fishes.

ECOSYSTEM
An interacting system of living organisms (plants and/or animals), soil and climactic factors all linked by the flow of energy and nutrients.

ENHANCEMENT
Improvement of habitat capabilities. Commonly used in reference to in-stream structures such as the improvement of spawning beds or the improvement of in-stream cover.

ENVIRONMENT
The prevailing conditions that reflect the combined influence of climate, soil, topography and biology (other plants and animals) present in the area. Environmental factors are extremely important in determining how well a particular species will grow in a given area.

EROSION
The weathering of the earth's surface by the action of winds, water, gravity and ice.

EUTROPHICATION
A change in water quality caused by a marked increase in the amount of nutrients (largely nitrogen and phosphorus) in a body of water.

EXOTIC
A term to describe a species that is introduced (deliberately or accidentally) to an ecosystem where it does not naturally occur. Also known as "introduced species."

FILLETS
Slices of fish flesh of irregular size and shape that have been removed from the carcass of a fish by cuts made parallel to the backbone.

FINGERLINGS
Refers to a young fish, usually late in its first year.

FISH CULTURE STATION
A hatchery that usually raises fishes from eggs to fingerling sizes to supplement the supply of naturally reproducing fishes or to create new fisheries, where natural reproduction is not possible.

FISH SCALE
A chitinous covering plate on a fish. By counting the annual growth rings on a scale, the fish's age may be determined.

FISHWAY
A passageway constructed around a barrier to allow for fish passage.

FLOODPLAIN
The land periodically flooded by a river.

FOOD CHAIN
Chain of organisms through which energy is transferred. Each link in the chain feeds on or obtains energy from the one preceding it and it in turn is eaten by and provides energy for the one following it.

FOOD WEB
The interrelation of food chains in a community.

FRY
Young fishes after they have used up their yolk sacs and begun active feeding.

GENES
Units of genetic material located in the chromosomes. They control the various traits of an organism.

GILLS
Organ used by fishes and other aquatic animals to transfer dissolved oxygen from water to their blood.

GILL ARCH
Bone-line arches which support the gill filaments and rakers.

GILL FILAMENT
Feathery part of gills where actual oxygen/carbon dioxide exchange occurs.

GILL RAKER
Projections from the gill arch which keep food and other debris from moving through the gill filaments.

GROUND WATER
Water found underground in porous rock strata and soils.

HABITAT
The local environment in which a plant or animal lives; includes the food, water, space and shelter necessary for survival.

HABITAT RESTORATION
The restoration of degraded fish habitat to its former condition so that fishes and other animals can survive and reproduce in it.

HETEROTROPHIC ORGANISMS
Organisms that derive nourishment from outside themselves.

IN-STREAM COVER
Objects such as logs or boulders in or added to a stream that provide shelter for fishes.

JUVENILE
Young fishes older than fry but not yet mature enough to spawn.

LATERAL LINE
An organ running along the sides of fishes which senses low frequency vibrations; often used to detect predators or food.

MAYFLY NYMPHS
The mobile aquatic phase of the mayfly. Food for many fishes both in the nymph stage and when they hatch as adults.

MIDGE LARVAE
The worm-like aquatic phase of the midge (also known as no-see-ums). An abundant and significant fish food.

MIGRATORY FISH SPECIES
Fish species that migrate from a larger body of water to a stream or river to spawn.

NICHE
An environment where an appropriate combination of conditions exists for a species to thrive.

NUTRIENT LOAD
The total input of nutrients (largely nitrogen and phosphorus) into a water body.

OLIGOTROPHIC
Waters having few nutrients, and often little plant or animal life.

OPEN SEASON
The period of time when fishes may legally be caught.

PARTICULATE MATERIAL
Small, solid bits of rock or debris that are often suspended or carried in water.

PECTORAL FINS
The most anterior or uppermost of the paired fins.

PELVIC FINS
A pair of ventrally situated fins located in some species below the pectoral fins or in other species between the pectoral fins and the anal fin.

PHYTOPLANKTON
Small, generally microscopic life that floats free in the water and carries out photosynthesis.

PISCIVORE
An organism that eats fishes.

PLANKTON
Small, generally microscopic plant life (phytoplankton) or animal life (zooplankton) that floats free in the water. Plankton is used as a food by some fishes.

POOL
Water of considerable depth in proportion to the size of the stream. Pools generally have slowly flowing water and a smooth surface, but they can often have a swift turbulent area where the water enters them.

PREDATOR
An animal that kills and eats other animals.

PREY
An organism that is killed and eaten by animals.

PRODUCER
An organism that manufactures its own food (any of the green plants).

QUOTA
The maximum allowable catch of a certain species based on a sustained harvest.

REDD
The gravel nest of trout or salmon.

REHABILITATION
The restoration or rebuilding of degraded or impaired fish habitat and/or water quality.

RESPIRATION
The processes by which tissues and organisms exchange gasses with their environment.

RESPONSE THRESHOLD
The level of some factor, below which an organism begins to show physiological or behavioural change.

RAPID
Shallow water with a rapid current and with surface flow broken by gravel or cobble.

RIP-RAP
A foundation or wall made of broken rock or logs commonly used to stabilize shorelines and reduce erosion. The wall created can be either of an irregular or pre-determined design.

RUN
Water with moderate to rapid current flow in deeper, narrower channel than a riffle. Flow is less turbulent than a rapid.

SEDIMENTATION
Deposition of eroded soil material in a water body.

SMOLT
Life stage in trout and salmon occurring at 1 to 3 years of age when the fish has turned silvery and is prepared to migrate out of a stream or river to the sea.

SOFT RAYS
Analogous to supporting fin structures that are often branched, and are not sharp at the tip.

SPACE
The physical area required by fishes to move around in and search for food, shelter and the necessary water quality and quantity. This requirement varies among species and development stages.

SPAWNING
The act of depositing eggs or discharging milt (sperm).

SPECIES
A group of genetically similar individuals which actually or potentially interbreeds.

SPINE
Straight or curved sharp fin rays or other structures.

STAKE HOLDER
Any individual or group of people with a vested interest in a fishery and any decision affecting the fishery.

STOCK
A group of fish of the same species which are genetically similar and can normally interbreed.

STREAM VELOCITY
A speed or velocity measurement recorded as distance travelled over time; metres per second.

STRESS
A stimulus or succession of stimuli that, if of sufficient magnitude, will tend to disrupt the stability of a system.

SUSTAINABLE BENEFIT
Something that satisfies present and future human needs and aspirations, such as high quality environment, wholesome food, employment and income and recreational activity.

SUSTAINABLE DEVELOPMENT
Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

SWIM BLADDER
A gas-filled sac in the dorsal portion of the body cavity of most fishes which aids in buoyancy and in some cases respiration.

TAGGING
The attachment of a permanent identification marker to a fish and then releasing it with the intention of gathering information.

TRIBUTARIES
Smaller streams which feed into larger streams or rivers.

WATERSHED
The area of land drained by a particular stream or river.

WATERSHED MANAGEMENT
A system approach to freshwater resources management that recognizes the interconnection of fish and insect with their environment and each other. Important considerations include water quality, pollution, forestry and agricultural practices.

WING DEFLECTOR
A triangular deflector made of rock, logs or cribbing that forces water out toward the centre of the stream. Used to control erosion and narrow the stream thus increasing the current.

YEAR CLASS
All fish of one species born in the same year, also known as age class.

ZOOPLANKTON
Free-floating microscopic animal life.