Resource Sheet 2: Explore Wildlife Habitat Beneath the Surface

You have just begun your exploration of different underwater environments. It's now time to "meet" some of your aquatic neighbours in your imaginary dive into the depths of wildlife's watery worlds.

Freshwater Systems

Streams and Rivers

- **Fast-moving:** As soon as you enter a fast-moving stream or river, you will immediately understand the challenges faced by plants and animals that call this rushing world "home." Your neighbours will be organisms that have adapted to live with the currents. They either swim like mad, hide out in eddies, attach themselves to something solid, or "go with the flow." This environment offers particular benefits. Dissolved oxygen content tends to be high (which means you can breathe more easily), a steady stream of food is delivered by the current (which means there's a source of available food), and the bottom is often swept clean of mud (which means there's maid service), leaving rock crannies for shelter. And, if you wish to travel, the current will do most of the work — at least if you go downstream!
- **Trout:** Beautifully patterned brook trout are typical of the "swim like mad" creatures you might see in a fast-moving stream. They love the high oxygen content found here; it helps power their strong swimming muscles. Trout spend much of their time resting in slow-moving pools under stream banks. When hunger strikes, they can artfully play the currents, darting about from eddy to eddy to hunt for tasty snacks that the moving water delivers.
- **Plants:** The survival strategy differs for plants, such as algae, that stay put in the current by gluing themselves to underwater rocks. This method also works for the larvae of the notorious black fly. The young attach themselves to underwater rocks where they eat by filtering small bits of debris from the passing waters. Other animals, such as dragonfly larvae, stonefly larvae and crayfish are flat enough to slip into tight, calm spaces between and under rocks. These voracious predators lie in wait for organisms that prefer to go with the flow.
- **Zooplankton:** Some organisms, particularly young ones, drift downstream during a part of their lives. You won't likely see them without a microscope, but rotifers, a type of *zooplankton* (free-floating animal), can number up to 5,000 per litre in some freshwater habitats. They don't attach to rocks or other stationary objects, but mainly drift in the water column until they are eaten, reproduce or are carried back upstream in the belly, fur or feathers of a stronger creature.
- **Slow-moving:** When your stream or river reaches flatter land, it slows down and drops some of the soil it picked up on its travels. These slower waters suit animals that swim more slowly and allow an abundance of plants to take root in the muddy bottoms. Mud creates a totally different type of habitat for animals, too. Tiny, pale, thread-like worms called nematodes make up about 15 per cent of the living material here. Imagine how many there must be considering these roundworms are only a centimetre long and as thin as a hair on your head!

Lakes

If you drift long enough under the moving waters of a river or stream, you may come to one of Canada's estimated three million lakes. Lakes are classified as *lentic* (still water) ecosystems and scientists divide them into three main categories:

- **Oligotrophic:** *Oligotrophic* lakes (producing little food) are usually cold, rich in oxygen and poor in nutrients.
- **Eutrophic:** *Eutrophic* lakes (producing much food) are usually warm, low in oxygen and rich in nutrients.
- **Mesotrophic:** *Mesotrophic* lakes are somewhere in between the two other types.

The underwater area of lakes can be further subdivided into specific zones based on the amount of light that penetrates the water and how close it is to the shore or bottom.

- **Littoral Zone:** If you stay near shore in the shallow area where light can penetrate, you will likely be surrounded by rooted underwater plants. This is called the *littoral* zone. A lake's greatest number and variety of plants and animals, from producers to reducers, are found here. Swim here and you may brush fins with ferocious pike or muskellunge — metre-long, toothy torpedoes, waiting hidden among the plants to burst upon an unsuspecting frog, fowl or fish. Here you may also see aquatic insects. Diving water beetles, giant water bugs and water boatmen dart about looking for prey, but usually of a smaller size.
- **Pelagic Zone:** Keeping to the water column and floating farther from shore, you will find yourself in the *pelagic* (open water) zone. At first, you may feel quite alone. But, if you look very, very closely, you will find millions upon millions of tiny *phytoplankton* (literally, free-floating plants), *zooplankton* (free-floating animals) and *diatoms* (microscopic algae). Phytoplankton, being plants, are producers in the lake food web. They provide food for the primary consumers such as rotifers, protozoa, cyclops and other zooplankton, which, in turn, feed larger animals. In the open water of a cold, oxygen-rich lake you may even find yourself swimming alongside lake trout or char. These fast, sleek, carnivores live near the top of the food chain, eating smaller prey. In warmer lakes, your fishy neighbours might be bass, sunfish, suckers, catfish or even the exotic carp.
- **Benthic Zone:** As you move down the water column, you will eventually come to the *benthic* or bottom zone. Most creatures that find themselves on the bottom are poor swimmers. Molluscs, such as mussels and clams, favour this zone, filtering tiny organisms out of the water on a continual basis.
- **Profundal Zone:** In a really deep lake you may even descend to a *profundal* zone, an area where the light cannot reach. There isn't much variety or abundance of life in this zone. *Reducer* species, including *anaerobic* bacteria (bacteria that do not need oxygen) and some fungi are found here, doing their dreary but important work of decomposing those that have left the world of the living behind. Other organisms include blood worms, some fish and nematodes.

Canada's Aquatic Environments, at **www.aquatic.uoguelph.ca**, contains a collection of photos and detailed diagrams of different water bodies and information about wildlife that lives in them.

Brackish Waters

Estuaries: Where Freshwater and Saltwater Meet

During your imaginary dive, imagine swimming from freshwater into an area where freshwater and saltwater meet. Estuaries are where rivers spill into the ocean. While they have similarly diverse habitats as their freshwater counterparts — littoral, benthic and pelagic zones — there is a major difference: the presence of brackish (partially salty) water.

Estuaries come in all shapes and sizes and may be called bays, lagoons, harbours, inlets, fjords and sounds. Some of Canada's best-known estuaries are the St. Lawrence estuary, Strait of Georgia, James Bay and the Mackenzie River and Beaufort Sea and the Bay of Fundy between New Brunswick and Nova Scotia.

Many of the fish that you find in the open waters come just to dine. In fact, estuaries have been called grocery stores for marine life because of the abundance and amazing variety of food. Let's pick out a few of the stars.

- **Marine sturgeons:** That hulking, armoured fish that looks like it just swam out of the age of the dinosaurs is a marine sturgeon. This ancient fish has not changed much in 65 million years. Its elongated body is covered in large plate-like scales called scutes, and its vacuum-cleaner mouth, located on the underside of the head, enables it to suck up bottom-dwelling crustaceans, worms and small fish.
- **Clams, mussels and more:** Cruising along the bottom, you'll meet huge numbers of clams, mussels, snails, segmented worms and lugworms. Amphipods (small shrimp-like crustaceans) are so numerous that scientists have found up to 11,000 of them in a single square metre of Bay of Fundy mud!

- **Crabs:** Fiddler and hermit crabs, also crustaceans, take advantage of this productive habitat too. You'll recognize male fiddler crabs. They're the ones with one claw that is much bigger than the other. (Both claws of female fiddlers are about the same size.) Claws are used to manipulate food, for sexual display and for defence. So keep your distance! Hermit crabs, unlike other crustaceans, have soft abdomens that need protection. The hermit finds an abandoned mollusc shell and puts it on by backing into it. It then carries the shell on its back — a mobile home! When it grows out of one home, it simply finds a bigger one.

Saltwater Systems

Moving Saltwater

As we leave the estuary and head along the ocean coast, we find other special — and often turbulent — underwater environments. Be careful if you try to swim in the *intertidal zone*! The currents, tides and wind-driven waves make life along marine coasts challenging for even the best-adapted inhabitants. Many creatures firmly attach themselves to anything solid to prevent themselves from being washed away. This situation creates a high demand for rocky real estate. Hard-shelled mussels use sticky threads to permanently attach themselves to rocks, their own shells often providing a surface for plants such as algae and smaller creatures such as barnacles. In healthy habitat, you might encounter thousands of mussels, crowded shell to shell, and filtering out tasty plankton that is continually washed around them by currents. Still other shelled animals, such as limpets, cling tightly to rocks but move slowly about on a muscular foot in a daily search for food. No one seems to know how, but they manage to return to the same place on their rock every night.

Not all the creatures you meet along the coast have hard shells. Colourful sea stars and anemones use suction cups to stay plastered to the rock. The sea anemones' jelly-like bodies absorb the impact of crashing waves while their poisonous tentacles wave toward unsuspecting prey.

And not all creatures choose rocks for a home base. Thread-like nematodes dig into the mud and sand. Some free-swimming fish, such as sculpins, seem perfectly built for turbulent times. These bottom dwellers are pressed against the bottom as water flows over their large pectoral fins (fins on the side of the body). They are so committed to life on the bottom that, unlike most fish, they don't even have a swim bladder to help them float.

The Continental Shelf

Continue your imaginary dive out to sea from any of Canada's ocean coasts and you will see, stretched beneath you, the *continental shelf.* This is the area between the low tide mark and the open or deep ocean. These shallow waters (also called the *neritic zone*) receive sunlight, making them the most productive part of an ocean. When these ecosystems are healthy, you will see forests of seaweed, large schools of fish and a huge variety of other creatures, both in the open water and on the bottom.

Perhaps the most famous of Canada's continental shelves is the Grand Banks off Newfoundland and Labrador. This is a vast area, up to 150 metres deep and swept by the warm waters of the Gulf Stream. Coastal rivers deliver important minerals and the sun can penetrate to the seabed where seaweed can flourish. Tiny planktonic plants and animals can number more than 400 million in a single cubic metre. This all makes Canada's Grand Banks one of the world's richest continental shelves and one of the world's most important fishing grounds — for now.

Who are your neighbours beneath the waters of the continental shelf? Here, the scope runs from marine mammals (such as whales, seals and dolphins) through to reptiles (sea turtles), invertebrates (crustaceans), algae and, of course, fish. There are hundreds of fish species alone, but most noticeable might be fish such as cod, flounder, salmon, sharks, rays and skates.

There was a time when a trip below the surface of the Grand Banks would guarantee with a parade of countless schools of Atlantic cod. Sadly, this once abundant fish has become rare. Still, you may be lucky enough to see some, living near the bottom and eating almost any small fish, crustacean or other invertebrate that will fit in their mouths.

- **Anadromous Fish:** Anadromous fish, like you, are only visiting. They spend part of their lives in freshwater habitats (where they were born or hatched), part of their lives in saltwater habitats (where they feed and grow to adulthood) and then return to freshwater habitats to lay eggs. The most famous of the anadromous fish is the salmon. They can be found on the shelf of both the East and West coasts.
- **Bottom Dwellers:** Flounder are flat fish that, as adults, hide in the sand on the bottom. They start out life looking like other fish, with an eye on each side of the head. But, living with one side of their faces always pressed against the bottom, flounder have adapted in an interesting way. As a flounder matures, one eye appears to migrate so that *both* eyes are on the *same* side. There are both left eye and right eye species of flounder. Right eye flounders are found in all three oceans of Canada.

Other bottom dwellers include skates and rays. These relatives of sharks spend most of their time on the bottom. Like the sculpins, they do not have swim bladders to help them float. However, their skeletons are made of light, flexible cartilage that takes less energy than bone to support. Even the ferocious-sounding stingray eats mostly hard-shelled invertebrates. Its teeth are hard and flat to crush the shells of its prey. The spine used for stinging is a modified scale used for defence. It can be lethal, so it's best to keep your distance and shuffle through the shallows where they occur.

- **Worms:** You will see lots of creatures besides fish living here. Amphitrite worms hide in their tube dwellings buried just below the surface of the mud. When vibrations alert them to approaching food, they reach up from the tube opening and grab prey with their tentacles. If the approaching vibration indicates a predator, they quickly take refuge back in the tube.
- **Lobsters:** Lobsters are another well-known, yet intriguing, occupant of the shelf. These armoured aquatic crustaceans rumble along the bottom eating fish, invertebrates and plants. They live a long time — up to 100 years, some scientists think. A world-record specimen has been recorded at a very impressive 20 kilograms and more than a metre long.

The Deep Ocean

When you notice the relatively shallow continental shelf sloping away beneath you, you have reached the deep ocean. It can drop to staggering depths. How deep? Scientists have found a place nearly 11 kilometres deep in the Marianas Trench in the Pacific. This is deep enough to easily submerge our highest terrestrial mountains. Closer to home, we have the Gully, a two-kilometre deep underwater canyon that lies about 360 kilometres east of Halifax, Nova Scotia, in the ocean and then a rapid drop to over three kilometres and then down to some five kilometres in the abyssal plain.

The deep ocean is too complex to appreciate in a single glance so let's start near the surface and work our way down from there.

- **Epipelagic Zone:** The *epipelagic* zone extends down to around 200 metres from the surface of the ocean. It is where air-breathing marine life must live. Leatherback turtles, dolphins, porpoises, whales are found here. There is enough light in this zone to support photosynthesis. Tiny phytoplankton "harvest" light and form the foundation for far-reaching ocean food chains.
  As you descend, you might glance back up toward the light and be struck by how difficult it must be for creatures in this zone to conceal themselves from predators that lurk below. This is an ideal place for migratory carnivores such as basking sharks and mackerel sharks to cruise in search of food. The infamous white shark, the world's largest predatory fish, is found in both the Pacific and Atlantic oceans. The epipelagic zone is dangerous for all but the very big, the very small and the very fast!
- **Mesopelagic Zone:** The area between 200 metres and 1000 metres is the mesopelagic zone. It is often called the twilight zone because a minimum amount of light penetrates to this depth. Medium-depth species like dory, tuna and mackerel might swim around you. You can relax a little here because light levels are low enough to allow for concealment even from below.
- **Bathypelagic and Abyssopelagic Zones:** These zones are absolutely dark and may be described as follows:
  - Bathypelagic Zone (the area between 1000 to about 4000 metres in depth),
  - Abyssopelagic Zone at depths of 4000 to about 6000 metres, and the
  - Hadal Zone, which includes the trenches or fissures beneath the ocean floor.

  You'll join bizarre life forms here that have adapted to cold temperatures, intense pressure and darkness. No plants live here. Lantern fish are very successful (and very abundant) here in the deep. They make up for the lack of light by creating their own. Tiny "flashlights," called photophores, line their heads and bodies, attracting zooplankton, such as copepods and ostrapods, on which they feed. Lantern fish sometimes travel in such large schools that they can fool sonar equipment into thinking *they* are the ocean floor. Fearsome viper fish also live here. They have such long fangs that they don't even fit in their giant mouths — and their mouths open wide enough to swallow whole prey that is larger than them. Happily, they also have expandable stomachs to contain their rare but super-sized meals. Other creatures you may encounter are deep-sea jellyfish, brittle cucumbers, stalked crinoids, brotulides, tube worms, abyssal octopus, deep-sea eels and sea snails.

  While you are down here, visit a special deep sea environment that was recently discovered off Canada's West Coast: deep ocean hot springs known as hydrothermal vents or "black smokers." These vents can release water heated to 300° C. These large, black chimney-like structures can rise 15 metres from the ocean floor at depths of over 2,000 metres. There is no oxygen, no light and lots of sulphur. Up to 60 species have been identified here that are found in no other ecosystem in the world. How does life survive in such an inhospitable place? Bacteria take the place of plants as the producers in these food webs. In a process called *chemosynthesis* (not *photosynthesis*), they draw energy from a chemical called hydrogen sulphide and use it to grow. Other creatures graze on the bacteria while still others eat the bacteria-eaters. Eventually an entire food web develops.

The ocean floor itself is called the *benthic* realm. Here, you can join such creatures as sea spiders, half a metre wide and striding across the muddy ocean floor to prey on sea anemones. You can also share space with giant isopods, relatives of our small, terrestrial pillbugs. The hefty aquatic version looks more like an armadillo than a pill. Or you can hang out with sea cucumbers, octopuses and crabs.

Whew! It is time to head back to the surface and end our imaginary underwater adventure — for now. Do you know that you have only experienced a fraction of the amazing places and creatures that exist under the water? In fact, even scientists have seen only a small part of the underwater world that exists. It is truly a rich "frontier" for curious minds that wish to discover something never before seen by humans.

If you would like to continue the adventure, here are some websites to help:

- Visit the *Department of Fisheries and Oceans* website, *Big Blue Bus,* at **www.dfo-mpo.gc.ca/canwaters-eauxcan/bbb-lgb/index_e.asp** to get a great lesson plan, join a club or research your favourite creature.
- Also visit the *Centre for Marine Biodiversity* to view videos and photographs of marine life and habitat at **www.marinebiodiversity.ca**.
- Take a virtual field trip to an underwater ecosystem, do a stream study or carry out a benthic assessment at **www.epa.gov/owow/oceans/kids.html**.