## Irishtown Nature Park

# Middle School

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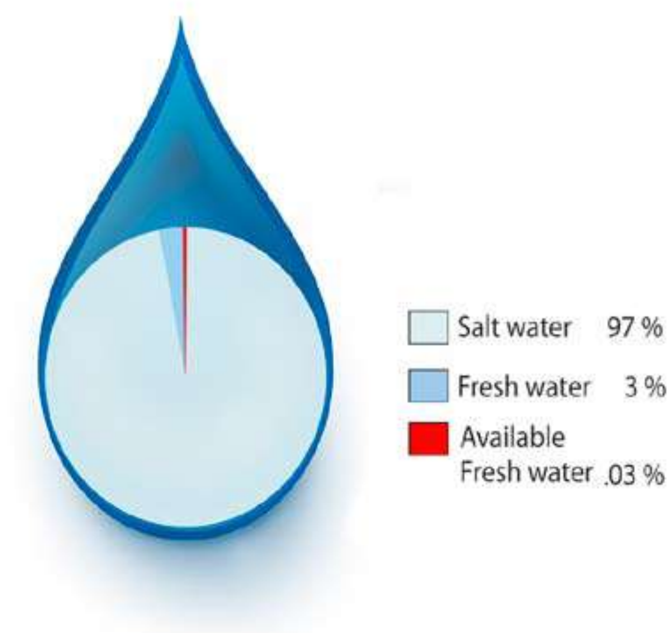
## Who are we?

The Petitcodiac Watershed Alliance (PWMG-GSBP Inc.) is a non-profit environmental science and education organization that promotes sustainable use of the Petitcodiac River and its tributaries. In addition, since 1997 the group has been involved in a monitoring program of established sites in Petitcodiac tributaries of concern or interest. These sites are verified through the following stream health indicators: temperature, dissolved oxygen, total coliforms, E. coli, Nitrates, Phosphorous, sediment and pH. More information about the groups activities can be found on the following web-site: www.petitcodiacwatershed.org

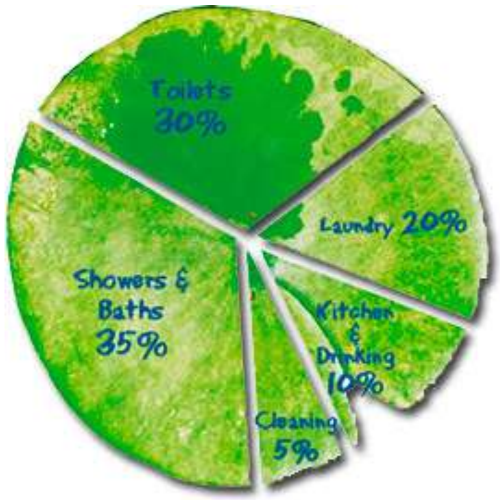
New Nouveau Brunswick
Be... in this place • Ici on peut... Être

## Water, water, everywhere…

Without water there would be no life on earth. Every day you need about **2 L** of water just to cover the basic functions like sweating, breathing, and going to the bathroom. Although there are some other planets that have a bit of water, it is a unique feature of our planet earth. It's water that gives our planet its characteristic blue appearance from space! You might look at a map and think there's plenty of water to go around, but **only 3%** of the earth's water is freshwater, and the other **97%** is salt water. Of the 3% that is freshwater only a fraction of it is available for people to use. Much of the freshwater on our planet is stored up in glaciers, snow capped mountains and contained in deep water reservoirs that are very hard to get at.




Given what a small fraction of the earth's total water is available for our use, conservation is extremely important. **Conservation** is taking care of something to make sure it will last. In order to conserve water we must make sure we protect our water sources from pollution and other contaminants, and not waste the water we have. Canadians currently use an average of **329 litres** of water per person, per day - second only to the United States in the developed world, and more than twice as much as Europeans!




This is a chart showing us what percentage of water is used where around the house. Below is a breakdown of how much water we use doing some of those daily activities.

| | |
|---|---|
| Flushing a toilet | 6-20 litres |
| Letting the water run while brushing teeth | 12 litres |
| Shower | 20 litres per min |
| Cooking three meals | 30 litres |
| Cleaning house | 30 litres |
| Washing dishes for three meals | 40 litres |
| Washing clothes | 80-120 litres |
| Watering a lawn | 120-160 litres |
| Taking a bath | 120-160 litres |
| Washing a car | 120-160 litres |
| Running a hose | 400 litres |

EXERCISE: Can you figure out how much water you use in an average day?

None of the water we use is "new". Even the glass of water you drink straight from the tap may have been used years ago to flush a toilet, or millennia ago to refresh a Tyrannosaurus Rex! Water is recycled via the hydrologic cycle, or water cycle, changing its state as it moves through it.

**States of Matter**

Before we talk about the Water Cycle, let's talk about the different forms water can take, or the different **states** it can occur in. States of matter are the different physical ways matter can be found in. This is caused by **atoms and molecules** (tiny, tiny bits of matter that make up everything in the world) being arranged in different ways. The three main states are solids, liquids, and gases.

**Solids** are matter that has tightly packed together atoms or molecules, making them very resistant to changes in shape and volume, meaning it's very difficult to bend or stretch them. If all the kids in your class pretended to be atoms making up a solid, you'd all be squished together in a big group hug and not able to move much! Some solids you see every day include rocks, tables, doors, hockey pucks, and your grandmother's fruit cake no one will eat. When water is in its solid form, it is called ice.

**Liquids** are matter that has loosely packed together atoms or molecules, making it very easy to change its form. If the kids in your class pretended to be liquid atoms, you'd be able to reach out your arms and touch each other, but still have plenty of space to move around freely. You can't change the volume of a liquid, but you can change the shape of it. Liquids take the shape of whatever container they're in, and if they aren't in a container, they'll stretch across whatever surface they're on. Some liquids you might see often are milk, juice, soda pop, and the ocean. The liquid state of water is probably the state you think of most for this substance.

**Gases** are matter with spaced out atoms or molecules, with no definite shape or volume that move around randomly. If the kids in your class were gas atoms, you'd be really spread out, able to run around and not touch each other. Some important gases include oxygen, which we need to breathe, nitrogen, which makes up most of the Earth's atmosphere, and carbon dioxide, which we breathe out. You may have heard of ozone before. Ozone is a gas in the upper atmosphere that blocks some of the sun's harmful ultraviolet rays (UV rays). Without it, the earth would heat up too much; this is called global warming. The gaseous state of water is water vapor, which makes up clouds in the sky.

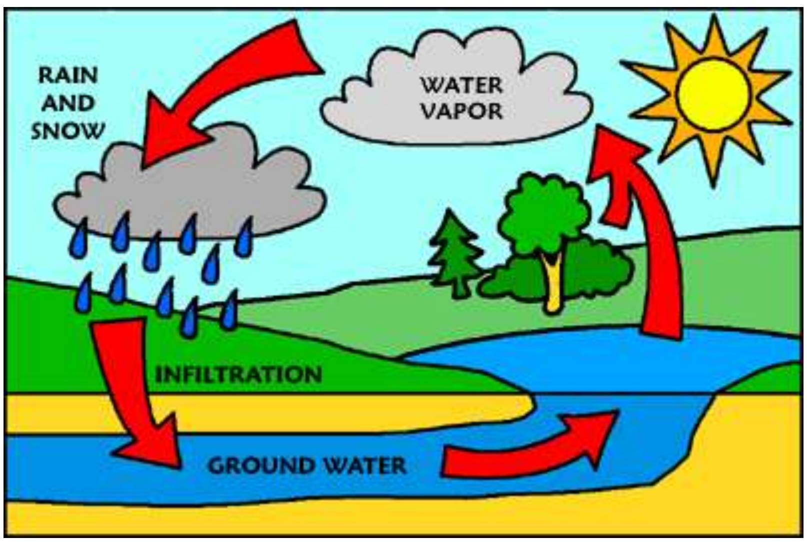
Changes in **temperature** and **pressure** cause a substance to change states. For example, when it is cooled below 0$^{o}$C, water freezes and changes states into a solid. When it is warmed up to between 0$^{o}$C and 100$^{o}$C water melts and changes into a liquid. Heated above 100$^{o}$C, liquid water boils and evaporates, changing states into a gas.

EXERCISE: Make water change states by freezing water mixed with food colouring together in an ice cube tray. Then have a glass of water with your ice and watch it melt, changing into coloured water. You can also boil a pot of water and (very carefully!) hold the pot lid or a large metal cookie sheet over top of it. You'll be able to see the water boil and change into vapor, which will collect on the metal tray (or **condense**) as water and fall back into the pot.

## Water Cycle



Let's start with our heads up in the clouds! Clouds are made up of water vapor, the gaseous state of water. When this vapor is cooled, it **condenses**, or comes together, into heavy rain droplets that fall to the earth. If it's cold enough, it might even turn into snow. Some snow might collect in mountain regions as ice caps or glaciers, which can store frozen water for thousands of years. When these and other snow deposits melt, the melted water flows over land as **snowmelt.** Most rain falls back into the oceans, or onto land where it flows over the ground as **surface runoff**. Some runoff will flow into rivers and lakes; however much of it is absorbed into the ground as **infiltration**, much like a sponge soaks up water. Some of this becomes **ground water**, or water located beneath the ground surface. Overtime **streamflow** in rivers and lakes will move water to the ocean, where the sun beats down on it and heats it. This leads to **evaporation**, which is when liquid water changes states into gaseous vapor. **Transpiration**, or the release of water vapor from plant leaves, adds to the vapor in the atmosphere. Once in the sky water vapor collects as clouds, and our water cycle starts all over again.




EXERCISE: Make a Water Cycle Jar using moss. Get a large (8 ounce) jar and layer the bottom with small rocks/gravel, then sand, and finally a layer of soil on top. The jar should be about a third full at this point. Add a living moss plant, and water gently. Place a bottle cap or shell full of water in the soil as well. Close the lid on top, place in a sunny spot, and watch the water cycle occur!

**Pollution**

At each stage in the water cycle the water can be polluted. **Water pollution** is when things that shouldn't be in the water get in it and make it have a lower quality. There can be direct pollution of a lake or river, such as when garbage or chemicals are dumped into it. Also, surface runoff can pick up contaminants on the ground and carry them into a body of water where they can build up. Toxic substances in the atmosphere can combine with water vapor to produce acid rain. As well, pollutants can soak into the ground and get into the ground water supply. Water pollution is extremely dangerous as all life on earth depends on clean water. Plants that absorb polluted water can pass on the pollutants to any animal that consumes it, which in turn pass on the dangerous substances to any predator animals that kills it for food.

EXERCISE: Make an experiment to see how pollutants in the water affect plants. Place a stalk of celery in a glass of water that has been mixed with food colouring. After several days, watch what has happened to the leaves on the celery. What does this tell you about the effect of contaminated water on plant life?

## Habitats and Ecosystems

A **habitat** is an animal or plant species' home and where it spends its time. For example, your habitat is where you live, and also your school and the places you play at. As well, if you took a walk through the park, you might see a beaver habitat, which would be the beaver's dam and the pond he lives in, or a squirrel habitat, which would be the trees the squirrel runs around in. Organisms of the same type, like a family of deer, can share a habitat, as long as the habitat is able to provide the animals with everything they need to survive – **food, water, shelter,** and **adequate space**.



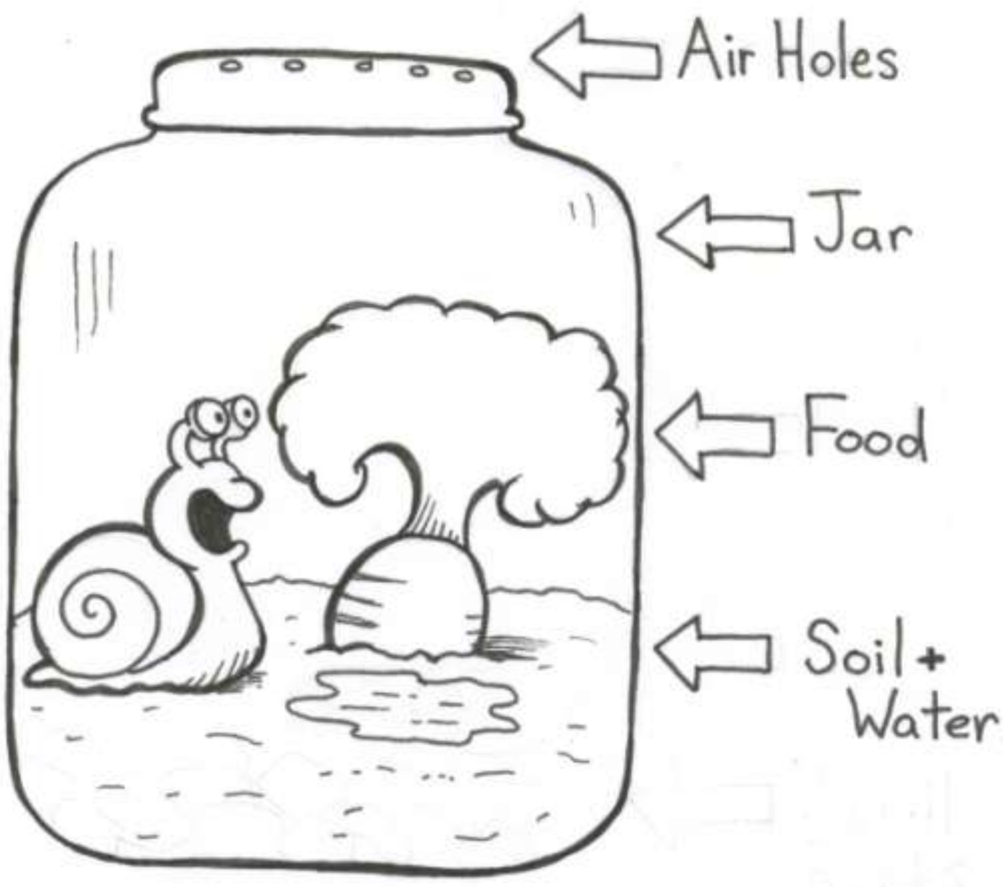
EXERCISE: Choose an animal or plant found in the watershed (use the pictures at the back of the manual for help). Describe its habitat, and where it finds food, water, shelter, and space.



An **ecosystem** is all the different organisms living in a certain area, including their different habitats. For example, if you were to visit a wetland, the ecosystem you'd see would include the marsh, all the animals in the marsh, all the insects, all the plants, all the fish, and all the single celled organisms you'd need a microscope to identify.

We will be looking at a local freshwater aquatic ecosystem today in Irishtown Nature Park. It is just one small component of a much larger system, known as the Petitcodiac Watershed.

EXERCISE: Create a snail habitat in your classroom! Find a large, clean jar, and put about two centimeters of dirt on the bottom. Add enough water to make it moist, and cover it with vegetables (carrots, lettuce, etc). Punch a few holes in the lids, and then add some snails found around the lake. Make sure to keep adding enough water to keep the soil moist, and have enough vegetables for the snails to eat. You can also add large shells or rocks to act as shelter.

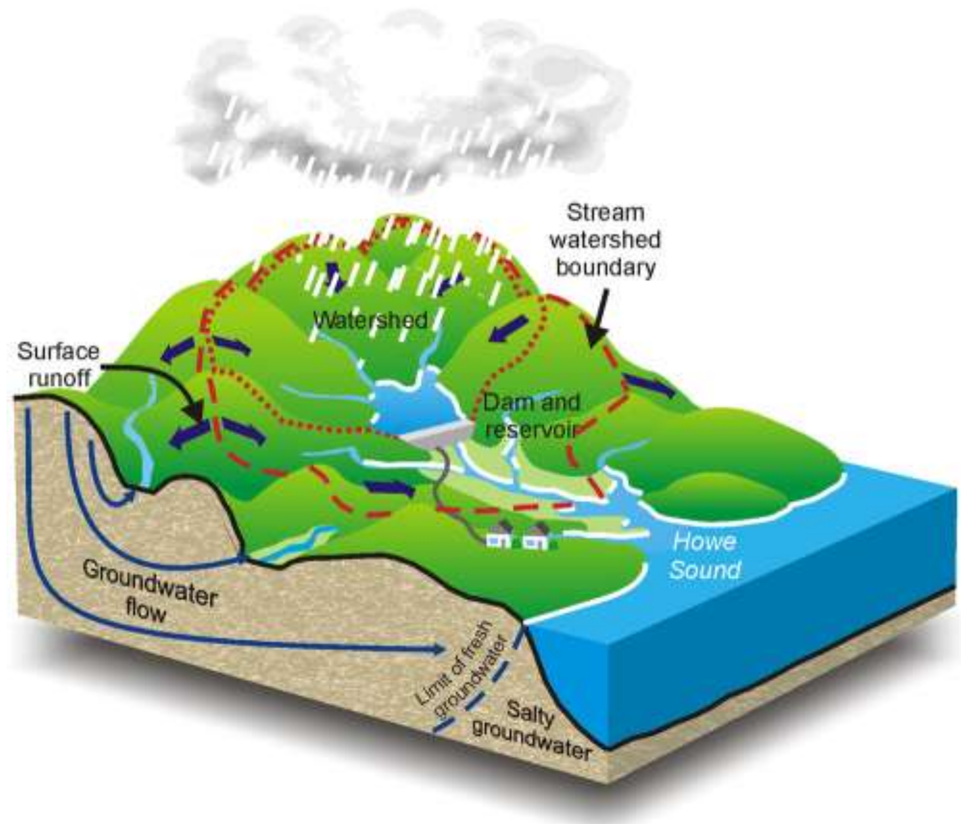


## Petitcodiac Watershed



**Watersheds**

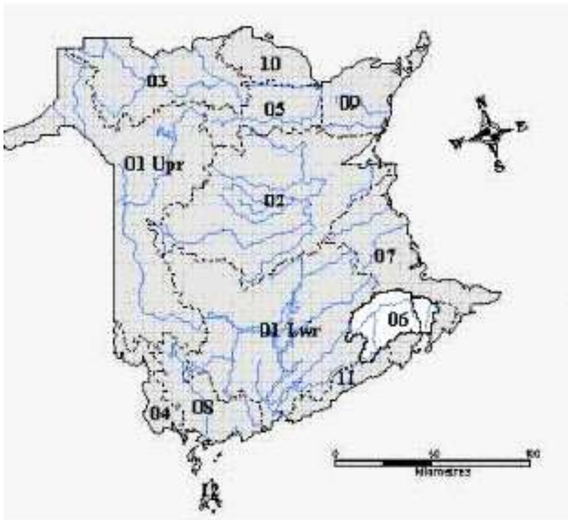
A **watershed** is a geographical area that acts as a sink. It collects all the runoff as it moves downhill into a body of water like a river, lake, or estuary. Eventually, most watersheds drain




into the sea. The watershed includes all the rivers and streams that carry the water as well as all of the land surfaces from which the water is drained. All watersheds are separated from each other by some kind of geographical barrier such as a hill or a mountain.

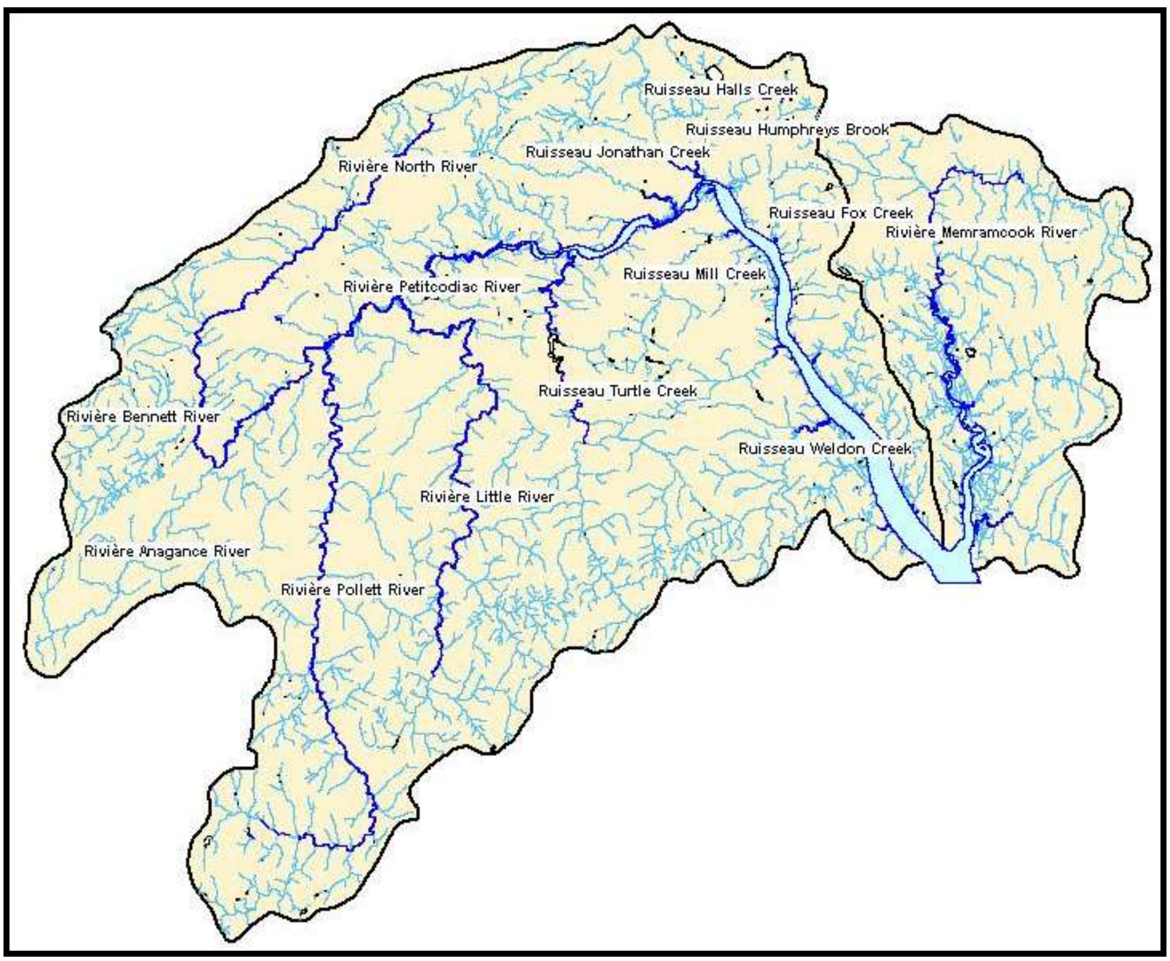
Water supports the life of all organisms found within the watershed. Everything – all the people, plants, and animals – in the watershed depend on it having clean water so they can live. If the water is polluted in one spot, that polluted water will flow downstream and affect all the other areas past it in the watershed. This is why it’s so important to look after all the different areas of the watershed.

A topographical map of our local watershed is shown on the following page.




**(Left) Map of New Brunswick, with the Petitcodiac Watershed highlighted and indicated by the number 06.**

**(Below) Enlarged map of the Petitcodiac Watershed.**



The Petitcodiac Watershed covers an area of 2400km$^2$. This area stretches from the Village of Petitcodiac to the Village of Dorchester, including all of Greater Moncton. The watershed is surrounded by **Acadian forest**, a mix of conifers (trees with needles) and deciduous trees (ones with leafy foliage). The Acadian forest region is where trees from the north mingle with trees from the south. So far 23 species of trees have been found in the park. The forest consists of pure softwood stands (which are over 60% softwood), pure hardwood stands (which are over 60% hardwood), and a variety of mixed stands. Each year 1223.2 mm of precipitation falls on the watershed. Approximately 111,000 people live in our watershed.

EXERCISE: Based on the data listed above, calculate the total **volume** of precipitation that falls on the Petitcodiac Watershed in a year.

**Irishtown Nature Park**

The Irishtown Nature Park is one of the largest urban parks in Canada, with an area of 9km$^2$. Its main feature is a large (1.20 km$^2$) lake that acted as Moncton's first water supply in the 1800s. The park offers a wide variety of habitats to explore including Acadian forest, wetlands, and aquatic/terrestrial environments. This picturesque nature park consists of 2,200 acres of forest and 250 acres of water.


**Map of the Irishtown Nature Park. The sampling site is marked with a white star.**

Unfortunately for our former reservoir, its water quality has not been the best the last few years. There have been blooms of **blue-green algae**, resulting in some temporary closures of the lake. The main species of the algae found at the lake, *Anabaena smithii*, and *Micocystis wesenbergii*, are not dangerous to people, but a very similar looking but toxic algae can grow in the same conditions, and can be dangerous to animals and humans.

The next section will look at water quality control, with water quality control testing being carried out at the Irishtown Nature Park.

**The Irishtown Resevoir**

## Water Quality Testing

**Water quality** is defined as the physical, chemical and biological characteristics of water. It's important to monitor water quality for different reasons. We may want to make sure it's safe to drink, or that it's safe to swim in, or that it's healthy enough to support the surrounding ecosystem. For Irishtown Nature Park, we are most concerned with the last two assessments.

Water quality testing is a scientific process, and relies heavily on **observations**. An observation is any information you obtain through any of your five senses. So anything you see, hear, taste, touch or smell is an observation, and can tell us a lot about the quality of the water at the park. We won't be doing any tasting, but we will be making plenty of observations as we do experiments on the water. As we make observations and write down the results from tests, we will be following a version of **The Scientific Method**.

### *The Scientific Method*

Before you start an experiment, you usually make a hypothesis about what the result will be. A **hypothesis** is basically a predication of what you think might happen in an experiment, or a possible explanation for something you observe. For example, you might observe a glass of water you leave out in the sun contains less liquid at the end of the day, and you might hypothesize that some of the liquid evaporated in the heat. You could test this hypothesis by monitoring the glass throughout the day and measuring the difference in volume that occurred.

The **experimental design** details what you used in your experiment, and what procedures and methods you did. This is very important in case anyone wants to carry out your study again. An example using the previous water evaporation study would be listing what size glass was used, what temperature it was at the time of the experiment, and how you calculated the volume of water in the glass.

The **results** section is where you put all the data you collected. You might use graphs or charts to present it, or you might write a description of what happened.

For each **parameter**, or characteristic of the water, tested in Irishtown, you will be given background information and a chance to make a hypothesis on how the water will test for it. You will also be given space to record your results.

## *Parameters*

### Escheria Coli (E. coli) and Total Coliformes (TC)

E. coli is a bacterium found in the lower intestine of warm blooded animals. While most strands are harmless to humans, some can cause serious food poisoning. The harmless varieties are actually quite good for their host, producing Vitamin K and preventing harmful bacterium from becoming established. E. coli bacterium can survive for brief periods of time outside their host's body, and this makes them a good indicator of the presence of fecal contamination, or animal wastes, in waterways.

E. coli can enter a waterway in a number of ways. Runoff from nearby farms might carry the bacterium into a lake, improper disposal of sewage waste, or a faulty septic line could all lead to the presence of E. coli.

HYPOTHESIS: Based on observations around the lake, do you expect to see any E. coli bacterium present? Why or why not?

____________________________________________________

______________________________________________________________________________

______________________________________________________________________________

EXPERIMENTAL DESIGN:

*At the lake:*

Use the **pre-labeled autoclaved bottle** for the site you're sampling. Wade into the stream to get away from the shoreline. Carefully unscrew the cap. Be sure not to touch the inside of the cap, nor the inside of the bottle at any time during the collection of the water sample because it should remain sterile. With the cap off the bottle, turn the bottle upside down and place the open end into the column of water (avoid collecting any water from the water surface). With the bottle upside down in the water column, turn the bottle to face upstream. Let the bottle fill with stream water. Bring the bottle back out of the water. Empty a little portion of water so the water level is below the neck of the bottle (this allows for some air exchange in the bottle). Screw the cap back on. Place the bottle on ice as soon as you're done sampling the site. Samples should reach the lab within 8 hours from the time the first sample is taken.

***Materials***

*At the lake*

- 1 pre-labeled autoclaved bottle
- Hip waders or boots

*At the lab:*

- Quanti-Tray Sealer
- 1 SNAP PACK
- Pre-labeled Quanti-Tray 2000
- Incubator
- UV Light

*At the lab:*

*There are four main instruments you'll be using at the lab: The* ***Quanti-Tray Sealer****, which operates almost like a fax machine, the* ***Incubator****, which is the box with the door on the front, the* ***Quanti-Trays****, pictured below after they have been incubated, and the* ***UV Light****. Make sure you have all these supplies, plus* ***Snap Packs****, before getting started.*

1. Turn the Quanti-Tray Sealer on and check if the incubator is at 35$^{o}$C.
2. Take an autoclaved bottle from the cooler and pour the stream water out until you're left with just a little more than 100 ml (there's a black line marking 100ml). Be sure not to touch the inside of the bottle or the mouth of it with your hands to avoid contamination.
3. Add contents of one SNAP PACK to the 100 ml in the sterile bottle.
4. Put the cap back on and shake until dissolved. Be careful not to contaminate the inside of the cap or the bottle with your hands or any other instruments.
5. Pour mixture into a pre-labeled QUANTI-TRAY 2000. To keep the Quanti-Tray 2000 sterile, open it using the tab and force the package to open by squeezing it from side to side using you're index finger and thumb. DO NOT touch the inside of the Quanti-Tray 2000 when pouring the mixture.
6. Seal in the Quanti-Tray Sealer by placing the package up side down on the orange rubber tray and pushing the tray delicately into the mouth of the sealer.
7. Place the sealed tray in the incubator at 35$^{o}$C for 24 hours.
8. 24 hours later, read the E. coli results with the UV light. All florescent wells are positive for E. coli. Look for fluorescence with a 6-watt, 365-nm light within 5 inches of the tray in a dark environment (use a cardboard box). Also read the Total coliforms results by simply using room light to find yellowish wells. **All yellow tinted wells** are positive for Total coliforms.
9. To analyze the E. coli and total coliforms data use the IDEXX MPN Generator 3.2 program on the office computer.

**Quanti-Tray**

RESULTS:

Total Coliforms:______________________

E. coli: ____________________________

**Dissolved Oxygen, Conductivity, Salinity and Water Temperature**

Dissolved oxygen (DO) is the amount of oygen that is dissolved in water. Conductivity refers to how well a water sample is able to conduct electricity. Salinity is the saltiness or dissolved salt content of a body of water. This is high for oceans, but should not be for freshwater sources. Water temperature is simply how hot or cold the water is in degrees Celcius. There is a relationship between temperature and DO: the hotter the water, the less DO there is.

HYPOTHESIS: Based on observations around the lake, do you expect the DO to be high or low? What about conductivity? Salinity? Temperature?

________________________________________________________________________________________

________________________________________________________________________________________

________________________________________________________________________________________

EXPERIMENTAL DESIGN:

For testing these parameters we will be using a YSI. To make sure we get accurate data and that you are comfortable using one, we are going to run through some important information for using it.

Using a YSI

**Always keep the probe in the chamber when not using**. If you look into the chamber you should notice a small round sponge in the bottom of the chamber. Make sure to wet the sponge with clean water, put the probe back in the chamber and turn the instrument over to allow any excess water to drain out. The sponge, that should always be wet, creates a 100% water saturated air environment for the probe, which is ideal for dissolved oxygen calibration.

**Calibrating the YSI for Dissolved Oxygen:**

YSI

The altitude for Moncton is 0.

1. Ensure that the sponge inside the chamber is wet. Insert the probe into the calibration chamber.
2. Turn the instrument on by pressing the ON/OFF button.
3. Press the MODE button until Dissolved Oxygen is displayed (in mg/L or %). Wait for the dissolved oxygen and temperature readings to stabilize (can take up to 15 min.).
4. Use 2 fingers to press and release both the UP and DOWN ARROW buttons at the same time.
5. The LCD will prompt you to enter the local altitude in hundreds of feet. Moncton is 0 feet so you just have to press the ENTER button once.
6. The instrument should now display CAL in the lower left of the display. The calibration value should be displayed in the lower right of the display and the current % reading (before calibration) should be on the main display. Make sure that the current % reading (large display) is stable at 100%, then press the ENTER button. The display should read SAVE then should return to the Normal Operation Mode.

*Materials*

- YSI
- Hip waders or boots
- Pen and paper

Each time the YSI 85 is turned off, it may be necessary to re-calibrate before taking measurements. All calibration should be completed at a temperature which is as close as possible to the sample temperature. Readings on the YSI are only as good as the calibration.

*At the lake*

Walk into the stream with the **YSI** so you're away from shore. Press the ON/OFF button; the instrument will activate. Take the probe out of the chamber and drop it in the water column no further then 33cm (to the tape mark on the probe). Using the UP ARROW you can go from the DO in %, to DO in mg/L, Conductivity, Specific Conductance, to Salinity. The temperature should appear on the bottom of all screens. You need to take the following measurements: Temperature, DO in mg/L only, Specific Conductivity (not the first conductance reading) and Salinity. The DO should be taken as soon as the temperature is stable. You also need to continuously stir the water column with the probe while taking the DO and the specific conductivity readings. Rinse the probe with distilled water when all readings are recorded on the sampling data sheet.

RESULTS:

Dissolved Oxygen: ______________________________________________

Salinity: ___________________________________________________

Conductivity: _______________________________________________

Temperature: ________________________________________________

**The Mystery (and Chemistry) Behind Portable YSI Meters**

This experiment is pretty easy. A device that fits into your hand does all the work for you! But what exactly is it doing?

We use the YSI for measuring dissolved oxygen (DO), conductivity, salinity, and temperature. DO is the first parameter we measure with the YSI. This one is also the one we need to **calibrate** the machine for before heading into the water. Calibrate means to make adjustments to a device in order to ensure accurate results are measured. In order to do this, we need a sample solution with a known DO concentration.

We have already provided instructions for calibrating the YSI, this is how it works. By placing the electrode into the storage chamber with the sponge inside moistened, you provide an air environment that is 100% **saturated** with water, perfect for air calibration of the dissolved oxygen probe. When you saturate something with water, you fill it to the very maximum it can hold with water. To begin calibrating, place the probe inside the chamber and turning the YSI on. Press the MODE button until you see "% DO" on the display screen. If the number displayed on the screen is not 100% or close to it, then the YSI has to be recalibrated. We know that the air inside the chamber is sealed at 100% saturation, and since warm air will hold more water than cold air, you will need to re-calibrate the YSI with every change in temperature. You also need to know what altitude you're at because DO decreases with decreasing atmospheric pressure; as you get higher in altitude, the atmosphere contains less oxygen, as do water bodies. With the correct altitude, the YSI will be able to calibrate properly. Since we are very close to sea level here in Atlantic Canada, 0 is the right number and to accept it you need to press the enter button. The YSI will then display the current DO percent saturation. You need this number to be as close to 100% as possible. You will notice that the numbers are constantly changing on the YSI screen; you simply need to press enter when the numbers stop moving up or down. The YSI will then be calibrated at 100% and ready to use. This can take up to 15 minutes.

To test the calibration of the YSI, make a 100% oxygen saturated solution of water and test for saturation using the directions in the Exercise box below.

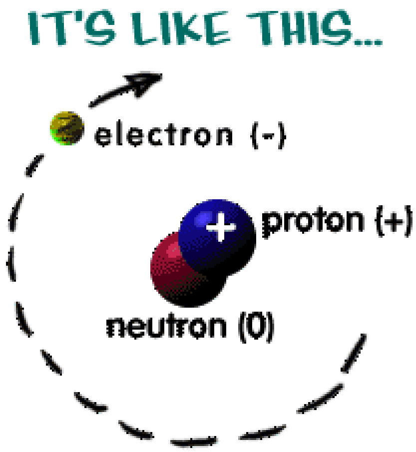
EXERCISE: Make your own saturated solution for testing the YSI! Pour 500mL of water from one beaker to another 10 times. This should completely saturate a water sample. You can test the accuracy of the YSI by measuring the DO in the oxygen saturated water; it should be close to 100%. Compare this to the reading you get from another beaker filled with 500mL of stagnant water. Why are the numbers different?

Think about the DO levels obtained at the Irishtown Reservoir. Knowing what you know about dissolved oxygen and water, can you explain why DO levels in the reservoir may sometimes be low?

The DO sensor has a membrane that blocks all substances except oxygen. It covers an electrolytic cell consisting of a positive and negative electrode. The membrane acts as a barrier, preventing potentially damaging substances in the water from reaching electrodes. If the calibration is done correctly, the electrodes will be able to obtain an accurate reading of the DO when placed in the sample.

The next parameter we measure is conductivity. The conductivity of a water sample is determined by the ion concentration of the solution. To talk about ions, we have to talk small. How small? Ions are so small that 50 million of them would fit into one centimetre! **Ions** are neutral atoms (the basic unit of all matter) that have either lost or gained electrons to become charged particles.

Confused? Atoms are like very tiny solar systems. The **nucleus** is like the sun at the center, and contains positively charged **protons** and neutrons, which have no charge. The **electrons** are like the planets that orbit the sun, and have a negative charge. Normally, the positive charges balance out the negative charges. However, by losing or gaining an electron, the atom’s charges are no longer balanced, and it becomes an ion.




**Ions** are free to move within the water body, making them capable of carrying a current. The greater the ion concentration is, the higher the conductivity is. Conductivity is highly dependent on temperature, varying as much as 3% for a one degree change in temperature. For this reason, the YSI allows you to record conductivity in either raw or temperature compensated form. For drinking water purposes, a conductivity of 0 - 800 µS/cm is ideal.

Because conductivity is determined by the ion concentration of the water, it is often used as a measure of salinity. Remember that salinity is the amount of salt in the water; salt is primarily made up of chloride and sodium ions. However, there can be other ions not related to salinity in the water. Phosphate, nitrate and ammonium ions may all be present, especially if the waterway is contaminated with fertilizers, and affect the conductivity reading. The YSI takes this into consideration, and therefore salinity is determined automatically from the conductivity readings according to specific mathematical formulas. Temperature is simply obtained from a temperature sensor in the probe.

**Nitrates and Phosphates**

Nitrates are commonly found in the soil, either put there by the use of farmyard manure or fertilizers, as well as occurring naturally as a result of the breakdown of natural materials by bacteria. While many nitrates in soil are used by plants, some are leached out by runoff and make their way into the water system.

Phosphate is also commonly found in fertilizers. Like nitrate, it can leach into ground water and runoff and end up in a water system.

Nitrates and phosphates in the water are not always a bad thing; we only need to worry about them when there's too much. They are not wanted in drinking water, and excessive nitrates can also be damaging to certain plants. As well, excessive nitrates and phosphates in the water can lead to **overenrichment** of the water, causing them to become eutrophic, or high in nutrients.

The original condition of most bodies of water is **oligotrophic**, meaning it is LOW in nutrients, especially phosphate or nitrogen compounds. A healthy waterway is low in nutrients? Yes, as strange as that may sound. Most nutrients cycle through from the soil to trees to dead organic matter and back to the soil, with very little leeching out into waterways. Water that is low in nutrients is clear, allowing sunlight to reach the bottom and support the growth of underwater plants. Plants are important for releasing oxygen into the water via photosynthesis, which supports all a variety of shellfish and fish.

**An example of a eutrophic lake.**

**Eutrophic** waterways are nutrient-rich. This is NOT a healthy waterway. Nutrient enrichment allows tiny phytoplankton to grow and multiple very quickly, which increases the cloudiness (or **turbidity**) of the water. This prevents the sun's rays from reaching the underwater plants. These plants die off, and stop releasing oxygen into the water. The loss of dissolved oxygen leads to a loss of aquatic animals, who become suffocated.

HYPOTHESIS: Based on observations around the lake, do you expect high levels of nitrates and phosphates or low? Explain.

________________________________________________________________________________________

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EXPERIMENTAL DESIGN:

For these tests we will be using the **YSI 9500 Photometer**. It's a cool instrument, but in order to get the most accurate results, make sure you are familiar with how to use it first.

## Using the YSI 9500 Photometer

Spills and moisture should be wiped off right away with a dry cloth. Avoid solvents or abrasive materials to clean the instrument. Keep it in its case to avoid any dirt or deposit in the test chamber. Always cap the test tube you're using. Always wipe test tubes with a clean tissue to remove drips or condensation before placing in the photometer. Don't leave tubes standing in the photometer test chamber. Also keep the 10 ml glass test tubes in the case to avoid any scratching.

**YSI 9500 Photometer**

Before you use the photometer each time, a **blank tube** is needed. This sets the YSI automatically and compensates for any natural color in the test sample.

The blank tube is a test tube filled ONLY with the stream water being tested, without any nitrate or phosphate reagents added. It is important to use a sample from the body of water being tested to provide a true comparison for the test results. The term **sample tube** is used to describe the tube containing the stream water AND the REAGENTS, which have been added.

*At the lake*

Use the correct **pre-labeled 500 ml bottle** for the site you're sampling. Wade into the stream to the designated sampling mark. With the cap of the bottle, turn the bottle upside down and place the open end into the column of water. With the bottle upside down in the water column, turn the bottle to face upstream. Let the bottle fill with stream water. Bring the bottle back out of the water and secure the cap back on. The nitrates need to be analyzed immediately and so it needs to take place at the lake.

### *Materials*

- 1 prelabelled 500 ml bottle
- Hip waders or boots
- YSI 9500 Photometer
- 1 blank 10 ml test tube
- 1 20 ml test tube
- Nitratest Powder
- 1 Nitratest tablet
- 2 10 ml test tube
- 1 Nitrocol tablet
- Crushing stick
- 1 Phosphate No 1 LR tablet
- 1 Phosphate No 2 LR tablet

Nitrates:

1. Fill the **20 ml test tube** with stream water to the 20 ml mark.
2. Add one level spoonful of **Nitratest Powder** (Zinc powder) and one **Nitratest tablet**. Do not crush the tablet. Place screw cap on and shake tube well for one minute (or until the tablet has dissolved).
3. Allow tube to stand for about one minute then gently tap the side of the tube to speed up the settling of anything floating in the tube. Allow tube to stand for two minutes or longer to make sure there is complete settlement. The water should be mainly clear now.
4. Remove screw cap and wipe around the inside of the top of the tube with a clean tissue.
5. Carefully pour some of the clear water into a **10 ml glass test tube**, filling to the 10 ml mark.
6. Add one **Nitrocol tablet**, and crush it with the **crushing stick**. Place screw cap on and mix to dissolve.
7. Let this sit for 10 minutes to allow full color development.
8. Press the ON key (green) on the **Photometer** and the instrument will display the test menu.
9. With the Arrows, choose test **PHOT 023** and press the OK key.
10. The photometer will display the following: "Insert Blank". Place the **blank 10 ml test tube** in the chamber, place the light cap over it and press the OK key. "BLANKING…" will appear on the screen.
11. When the screen displays "Insert Sample", take the blank tube out of the chamber and replace it with the sample tube, place the light cap over it and press the OK key.
12. The first screen will show result for N in mg/l. You only need the results for NO3. Use the down arrow and the next screen will display results for NO3 in mg/l.
13. Record the results.

Phosphates:

1. Fill the **10 ml test tube** with stream water to the 10 ml mark.
2. Add one **Phosphate No 1 LR tablet**, crush with crushing stick, and mix to dissolve.
3. Add one **Phosphate No 2 LR tablet**, crush with crushing stick, and mix to dissolve.
4. Let the test tube stand for 10 minutes to allow full color development.
5. Press the ON key (green) on the **Photometer** and it will display a menu of items to test on the screen.
6. With the Arrows, choose test **PHOT 028** and press the OK key.
7. The photometer will display the following: "Insert Blank". Place the **blank 10 ml test tube** into the chamber, place the light cap over it and press the OK key. "BLANKING…" will appear on the screen.
8. When the screen displays "Insert Sample", take the blank tube out of the chamber and replace it with the sample tube, place the light cap over it and press the OK key.

9. The first screen will show result for $PO_4$ in mg/l.
10. Record the results.

RESULTS:

Nitrates:_____________________________________________

Phosphates:__________________________________________

**The Mystery (and Chemistry) Behind Nitrate and Phosphate Testing**

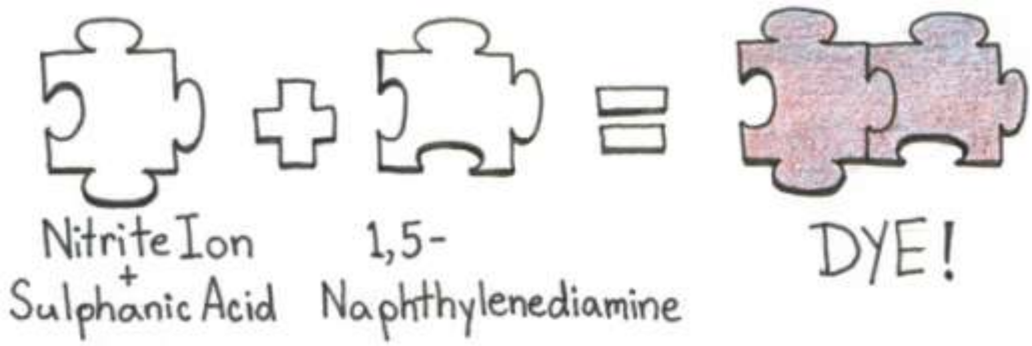
For nitrate and phosphate testing, all you need to do is crush up some tablets and your work is pretty much done. Pretty simple procedure, but what's going on in that test tube? And how does the photometer make sense of it?

The nitrate test uses something called a **colorimetric technique**. It works like tagging your friend at paintball; nitrate is colourless in our water sample to begin with, so we want to "tag" it with a bright dye we can see. This is done with a series of chemical reactions, resulting in a pink colour. The brighter the pink dye, the more nitrates there were in the water sample. Its then placed in the photometer, and a light is shone through the water. The more dye in the sample, the more light is prevented from passing through, or **absorbed** by the sample. The amount of nitrate in the sample is determined by comparing how much light can pass through the substance with a calibration chart.

The first step for the nitrate test involves adding zinc powder and a Nitratest tablet. Zinc powder acts to reduce nitrate ions ($NO_3^-$) into nitrite ions ($NO_2^-$). The nitrate must be reduced since nitrite ions react to the tablets that are added and are easy to identify, but nitrate does not. This has to do with nitrite having one less oxygen than nitrate, making it more reactive.

The Nitratest tablet contains ammonium chloride, which helps to settle the zinc powder to the bottom of the beaker quickly. It is very important for this to happen. Any suspended zinc will affect the results, usually with the amount of nitrate present being underestimated.

A sample of clear solution is then taken, and a Nitricol tablet is added. These tablets contain sulphanilic acid and 1,5-Naphthylenediamine. The main thing you need to know about these chemicals is that the nitrite ions react to the sulphanilic acid to form a compound. This compound then reacts to the 1,5-Naththylenediamine to form a bright dye. Think of it as the nitrite ions reacting with the sulphanilic acid to form one half of a puzzle piece. This puzzle piece is able to lock into another puzzle piece – the 1,5-Naphthylenediamine – to form a reddish purple dye. The amount of dye indicates how much nitrate there was at the beginning.




To determine how much dye is present, the sample is placed in the photometer. Blue-green light is shone through the sample, and the amount of nitrate is calculated based on how much light is absorbed and how much passes through.

The phosphate test involves crushing up a No 1 LR and a No 2 LR tablet in the sample. These tablets contain different chemicals that react to make a blue dye. The phosphate in the sample reacts with ammonium molybdate and antimony potassium tartrate trihydrate from the tablets to form phosphomolybdic acid. Think of it like chocolate phosphate chunks (what we're really interested in!) combining with flour and sugar to make chocolate chip cookies. This "cookie" then reacts with ascorbic acid from the No 1 LR tablet to form a bright, easy to see blue dye (think of it as the cookie baking and releasing a strong delicious smell you can identify right away). This dye is known as molybdenum blue, which is measured by the photometer. Red light is passed through the solution and absorbed by the blue dye, with the amount absorbed depending on the concentration of phosphate present.

## pH

pH is the measure of acidity or basicity of the water. This is determined by the concentration of hydrogen ions in the water. **The more acidic the solution, the lower the pH; the more basic, the higher the pH**. Things that are acidic include lemon juice and vinegar; these would have a low pH. Things that are basic include baking soda and milk; these would have a high pH. As the pH falls and the solution becomes more acidic, many chemicals are more easily dissolved in the water, making them available for plants and animals to absorb them. This can be damaging if those substances are toxic in certain amounts, such as iron, lead, chromium, ammonia, mercury or other elements that may be in the runoff from farms. A range of pH 6.5 to pH 8.2 is ideal for most aquatic organisms to live.

HYPOTHESIS: Based on observations around the lake, do you think the pH will fall within an ideal range?

________________________________________________________________________

________________________________________________________________________

EXPERIMENTAL DESIGN:

Fill the **10 ml test tube** to the black mark with water. Add 10 drops of **WR Ind. Reagent**. Cover the test tube with your thumb (so that it's sealed) and shake. Insert the tube in the **color range boxes** and compare colours by holding the boxes up to the light. Whichever colour the test tube most closely resembles in the box is its pH. Record the reading on the sampling data sheet. Rinse test tube twice with stream water when you are finished.

*Materials*

- 1 10 ml test tube
- 10 drops of WR Ind. Reagent
- pH colour range boxes
- Pen and paper
- Hip waders or boots

RESULTS:

pH:____________________________________________

**WR Ind. Reagent, test tube, and pH colour range box**

## The Mystery (and Chemistry) Behind pH

In this test, we add a few drops of indicator to a water sample, shake it around, and it magically changes colour to show us what pH it is. How does this happen? And what is the secret behind the indicator?

A pH indicator is something known as a **halochromic chemical compound.** A halochromic chemical compound is just something that changes colour at different pH levels. The different colours it changes to makes it easy to see what pH the sample has.

The type of indicator we use in the lab is known as a **universal indicator**. It is composed mostly of water, methanol, propan-1-ol, phenolphthalein sodium salt, methyl red sodium salt, bromothymol blue monosodium salt, and thymol blue monosodium salt. These ingredients are the key to revealing pH to us. **Phenolphthalein** is colourless in acidic solutions, and pinkish-purple in basic ones. **Methyl red** is red in pH under 4.4, yellow in pH over 6.2, and orange in between. **Bromothymol blue** is used to indicate a weak acid or base, otherwise known as a neutral solution. Finally, **thymol blue** is red-yellow at pH 1.2-2.8, and yellow-blue at pH 8.0-9.6.

Thus, the colours indicating the pH of a solution, after adding universal indicator are:

0-3. Strong acid - Red
3-6. Acid - Orange/Yellow
7. Neutral - Green
8-11. Alkali - Blue
11-14. Strong Alkali – Purple

### EXERCISE: MAKE YOUR OWN INDICATOR

You don't need to be in a lab to test a solutions' pH. Everything you need to indicate an acid or a base can be found in your kitchen at home! First, take a RED CABBAGE and chop it up into small pieces, until you have 2 cups worth. Place the cabbage in a large glass pitcher and cover it with boiling water. Wait ten minutes for the colour to leech out of the cabbage. Filter out the cabbage pieces so you are left with a red-purple-bluish coloured liquid. This liquid is at about pH 7, depending on the pH of the water you added. Pour about 50 - 100 mL of your red cabbage indicator into different smaller glasses. Into each glass, add a different solution until you notice a colour change – try mixing baking soda, cream of tartar, antacids, lemon juice, vinegar or milk with water and adding it to your cabbage indicator. Red cabbage contains a pigment molecule called flavin that changes colour in different pH levels. The corresponding pH for each colour is shown in the table below.

| pH | 2 | 4 | 6 | 8 | 10 | 12 |
|---|---|---|---|---|---|---|
| Colour | Red | Purple | Violet | Blue | Blue-green | Green-yellow |

### Turbidity

Turbidity refers to the cloudiness or haziness of the water caused by small particles (**suspended solids**) that are generally invisible to the naked eye, similar to smoke in air. As we talked about in the Nitrate and Phosphate section, turbidity may be caused by the growth of phytoplankton. Increased turbidity stops the sun's rays from reaching the bottom of the water, thus preventing the growth of aquatic plants. The people at Turtle Creek are very concerned about turbidity when it comes to our drinking water. Certain viruses or bacteria can become attached to suspended solids in the water. The suspended solids act as a shield for the viruses or bacteria, preventing chlorine from properly disinfecting the water. As well, suspended solids can protect bacteria from ultraviolet (UV) sterilization of water.

HYPOTHESIS: Based on a visual inspection of the lake, would you predict a high or low turbidity reading (or a lot of suspended solids or not many)? Explain.

____________________________________________________________

____________________________________________________________

EXPERIMENTAL DESIGN:

There are two ways to measure turbidity at the lake. One is to use a **handheld turbidity meter**, which would operate similarly to the YSI, with a sensor placed in the water while the meter reads the results. The other method is to use a **secchi plate**, a black and white disc. This is then lowered into the water until you can't tell the black sections apart from the white. The depth this occurs at is a measure of turbidity.

*Materials*

- Handheld turbidity meter OR secchi plate
- Hip waders or boots

RESULTS:

*One Last Measurement….*

At any sample site, it's a good idea to get the stream depth. You can do this with a 1-meter ruler. Measure (in cm) directly over the area you are sampling from. Record the measurement on the sampling data sheet.

**Water Parameters Summary**

Based on all of the results found at the lake, how healthy do you think it is?

Do you think people have affected the lake's health? How or how not?

Were there any parameters that tested poorly? What impact do these parameters have on the wildlife in the area?

## Biological Classification

There's a lot more to an aquatic environment than just the water. The state of the water in the area directly affects the surrounding biotic community, which is extremely diverse. In order to study the surrounding community, we must be able to properly identify organisms, and to do that we need to know taxonomy.

### Taxonomy

Taxonomy is the science and practice of classification. Classification is important for grouping different species, based on similarities and differences. It consists of different ranks to identify an organism, becoming increasingly specific. The different taxonomic ranks are, in order: Kingdom, Phylum, Class, Order, Family, Genus, Species. Kingdom is the most broad rank, and the one we're most concerned with today.

The Kingdoms we will be looking at in and around the lake include **Animalia** (animals), **Plantae** (plants), **Fungi** (such as mold or mushrooms), and **Prokaryota** (bacteria, like blue-green algae).

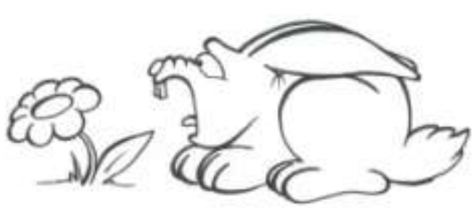
> EXERCISE: Look at the different Kingdom pages at the back of the manual. See what you can identify around the Irishtown Nature Park. Draw pictures of what you have found and group them together according to their different Kingdoms.

We've now had an opportunity to examine and identify a number of different organisms. We are now going to look at their role in the community.

### Producers

Producers are mainly green plants, which are able to use light energy from the sun to make their own food. They convert carbon dioxide and water into glucose (a type of sugar), releasing oxygen and water vapor into the atmosphere. This is known as **photosynthesis**. Since they are able to make their own food, they are known as producers.

### Consumers



Consumers include a wide variety of life from microscopic bacteria to gigantic blue whales. These organisms are unable to produce their own nutrients to sustain life, and must obtain it by eating living matter.

There are two types of consumers. **Primary consumers** feed directly on producers, eating plants. They are also known as **herbivores. Secondary consumers** feed on primary consumers, eating herbivores. For example, grass is an example of a producer, which might be eaten by a deer (a primary consumer), which is then hunted and eaten by a wolf (secondary consumer). Some animals can be both a primary and a secondary consumer. These animals eat both plants and animals, and are called **omnivores**.

**Decomposers**

Organisms that eat dead plant and animal matter are known as decomposers. These organisms include fungi and bacteria, and are vital "garbage disposals", getting rid of the waste left behind by others so we don't all have to wallow around in our own filth.

## Animal Adaptations

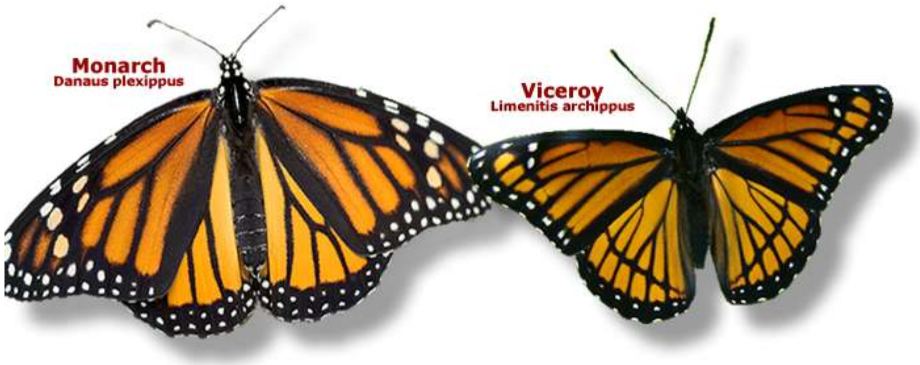
There are a lot of dangers for animals to deal with in the wild. They can't turn up the thermostat when it's cold out or run inside a building and lock the door when they see a predator. So they've come up with a lot of cool **adaptations** to help them survive.

There are two types of adaptations: behavioural and physical. **Behavioural adaptations** are an animal's actions that help it cope with its environment. There are two types: **instincts**, which don't need to be taught and happen naturally, and **learned** adaptations which must be taught. Some instinctual behaviours animals have include migrating, raising their young, hibernating, and defending themselves when confronted. A learned adaptation might be when ducks learn to stay at a specific pond all year round because people throw them bread.

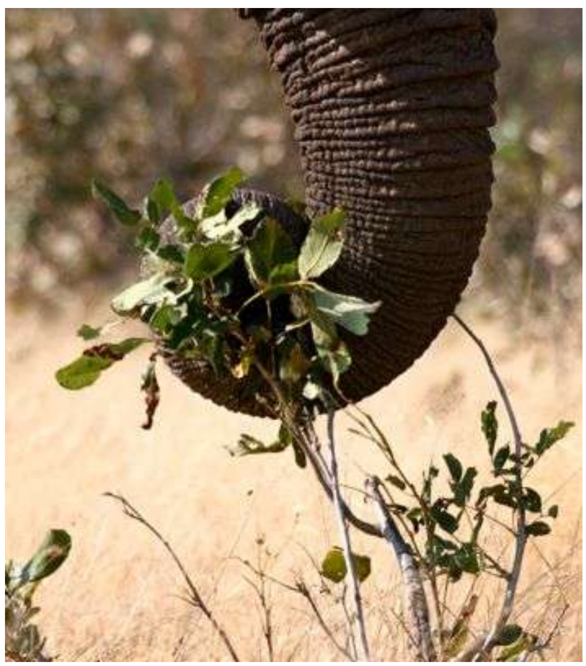
**Physical adaptations** are body structures that help an animal defend itself, find food, or attract mates. A good example of this is camouflage. **Camouflage** helps an animal blend in with its surroundings so a predator can't find it. Walking stick insects have very good camouflage, looking like a twig on the ground instead of like an animal!

**A walking stick insect on the edge of a branch**

Another example is mimicry. **Mimicry** is when an animal looks like a different animal. For example, to avoid getting eaten, the Viceroy butterfly has adapted to look like the Monarch butterfly. While the Viceroy is not poisonous, the Monarch is, so predators avoid eating both of them.




There are also **chemical** defences, like a skunk spray or a stink bug, and **specialized body parts**, like an elephant's trunk made for grasping leaves up high, or a tiger's claws that help it catch its prey.



**An elephant's trunk is specially adapted for plucking leaves and feeding itself**

Plants can have specialized adaptations too! They can have physical adaptations, like thorns to protect themselves, or colourful petals to attract insects and birds. They can grow in the direction of the sun or a water source to get more nutrients. Some are poisonous, like poison ivy, to keep predators away.

EXERCISE: Choose an organism found in the watershed. Describe its role in the community, its relationships with other organisms, and what adaptations it has developed.

## Our Role

Although we've talked a lot about different organisms in the Irishtown Nature Park Community, we haven't said a lot about the organism with one of the biggest impacts on the area – us. As people we have directly influenced the nature of the park, from damming it up for use as a reservoir to converting it into a recreational area. It is not necessarily a bad thing that we affect the area, as long as we make sure our impact is a positive one.

### Living Sustainably

**Sustainability** is a big word with a bigger impact. It means any action that can be continued indefinitely without using up any of the material or energy resources required to keep it running. A **sustainable society** neither uses up too much of its resources nor creates too much pollution. On a small scale, that might mean making sure you don't harvest so much rhubarb from your garden that you kill the plant, and biking to and from school instead of driving in a car that spews exhaust. On a larger scale it means not clear cutting so many forests so often that they are unable to grow back, and not dumping untreated sewage waste into waterways.

EXERCISE: Think about all the different activities you do in an average week. Which ones do you consider sustainable? What ideas can you come up with to have a more sustainable life?

### Preserving Wildlife

As you can see, people can have negative impacts on the environment. Although people have done, and are still doing, a lot of devastating things to the environment, more and more we're finding ways to protect it. National Parks and Reserves are one way to preserve our environment. As of 2008, there are 36 National Parks and six National Park Reserves in Canada. You can visit National Parks close to Moncton, with Kouchiboguac National Park located outside Mirimichi, and Fundy National Park by Alma.

There are also Biosphere Reserves, which are sites recognized by the United Nations Educational, Scientific and Cultural Organization (UNESCO). The Petitcodiac watershed is part of the **Bay of Fundy Biosphere Reserve**. Reserves are selected based upon the ways in which they demonstrate approaches to **conservation** and **sustainable development**. Although each reserve falls under their own national sovereign jurisdictions, they share their experience and ideas nationally, regionally and internationally within the World Network of Biosphere Reserves. There are 531 Biosphere Reserves worldwide in 105 countries.

EXERCISE: In groups, come up with a list of ways you can protect our watershed, involving responsible water use and preventing contamination. Present these ideas to your class. What things can you start doing today?

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