



Alliance du bassin versant
Petitcodiac
Watershed Alliance

Irishtown Nature Park



High School



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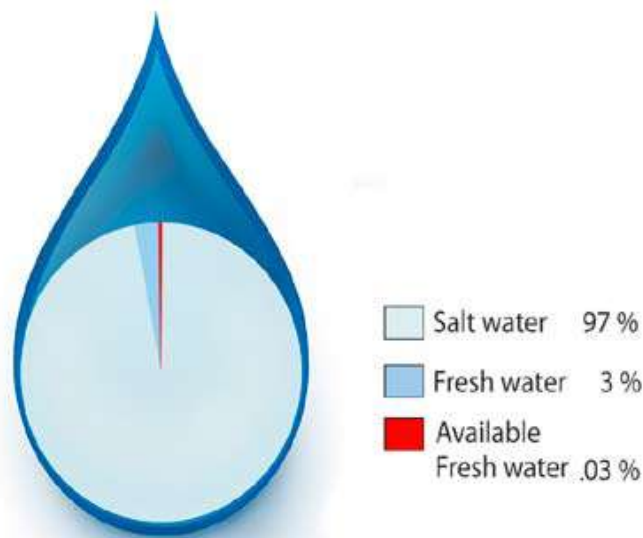
Who are we?

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



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 excrement. Although some evidence of water on other planets does exist, water is a unique feature of the planet earth; it is water that gives our planet its characteristic blue appearance from space. There appears to be plenty of water on earth, but **only 3%** of the earth's water is freshwater and **97%** is salt water. Of the 3% that is freshwater only a fraction of that is available for human use. Much of the freshwater on our planet is tied up in glaciers; snow capped mountains and contained in deep water reservoirs that are difficult to access.



Given what a small fraction of the earth's total water is available for our use, conservation is extremely important. **Conservation** involves the preservation and careful management of a resource so that it will last. In order to conserve water we must ensure we protect our water sources from pollution and other contaminants, as well as use water responsibly. A recent study found that this is an area we could use a lot of improvement in: 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!



Calculate how much water is used in each of the following 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

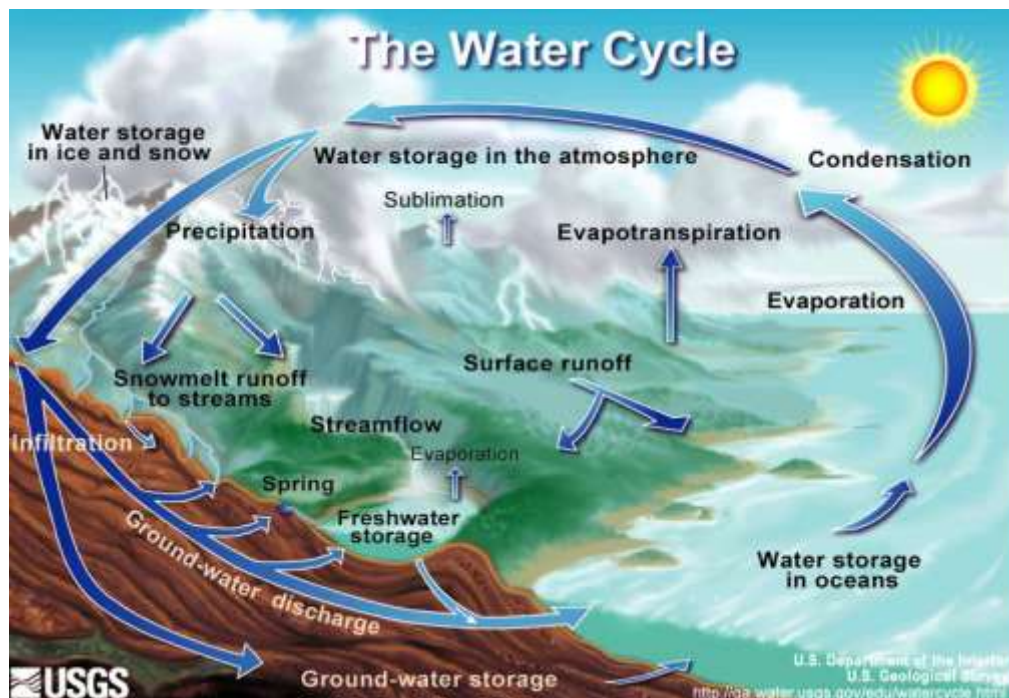
EXERCISE: Estimate how much water you use in an average day.

While this exercise provided you with a rough estimate of your water usage, get a more detailed assessment online at http://www.on.ec.gc.ca/reseau/waterCalculator/login_e.html.

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.

Hydrologic Cycle

Let's start with our heads in the clouds. Clouds are made up of water vapor, which condenses into heavy rain droplets that fall to the earth in the form of **precipitation** – rain, snow, hail, even sleet. Approximately 505,000 km³ of precipitation falls on the earth each year. Some of that might fall as snow and 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 precipitation falls back into the oceans, or on land where it flows over the ground as **surface runoff**. Some precipitation falls into lakes and rivers, where **streamflow** moves the water towards the oceans over time. Some runoff will flow into these rivers; however much of it is absorbed into the ground as **infiltration**. Some of this becomes **ground water**, or water located beneath the ground surface. Groundwater will naturally seep back to the surface at springs and wetland areas. Overtime streamflow will move water to the ocean, where the sun beats down on it and heats it. This leads to **evaporation**, which is the transformation of water from a liquid state to a gas as it moves from the earth's surface or bodies of water into the overlying atmosphere. Ice and snow can also transform into water vapor in a process known as **sublimation**, or a state change directly from a solid form to a gas form, without becoming a liquid in between. **Transpiration**, or the release of water vapor from plant leaves, adds to the vapor in the atmosphere. The release of water vapor into the atmosphere through transpiration and evaporation is collectively known as **evapotranspiration**. 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 hydrologic cycle there is the potential for damage caused by pollution.



Water pollution is contamination of water by foreign matter that deteriorates the quality of the water. There can be direct pollution of a lake or river, such as when garbage or chemicals are dumped into a body of water. Surface runoff can pick up contaminants on the ground and carry them into a body of water where they can accumulate. Toxic substances in the atmosphere can combine with water vapor to produce acid rain. As well pollutants can infiltrate 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: Construct an experiment to determine the effects of polluted water on plants. Obtain seedlings of the same kind (such as bean sprouts) and plant them in different containers. Give one container clean water, and give the others different kinds of polluted water – perhaps one with dish detergent mixed in, and another with road salt. Water the plants with their respected water over a course of several weeks. Measure the plants to see which one grows the most.

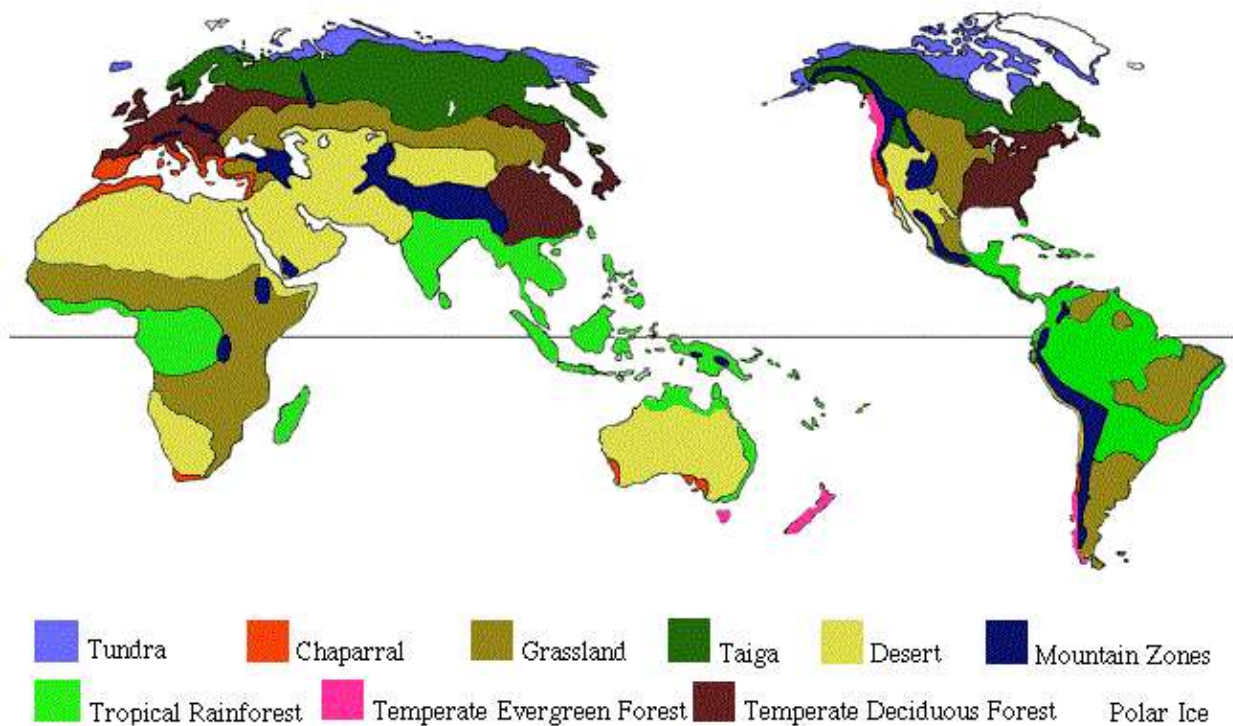


Ecosystems

An **ecosystem** is all the different organisms living in a certain area, including their physical environment. It would include both **biotic factors** (or living factors, like animals, plants, bacteria and fungi) and **abiotic factors** (non-living factors, like rocks, soil, water and air). 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.

Similar or related ecosystems are often grouped together to form major ecosystems known as **biomes**. The forest at Fundy National Park is an example of a local ecosystem, but it's part of a much larger biome of Temperate Deciduous Forest that spreads across eastern Canada and the United States.

EXERCISE: Based on the diagram, what are the main biomes found in Canada?

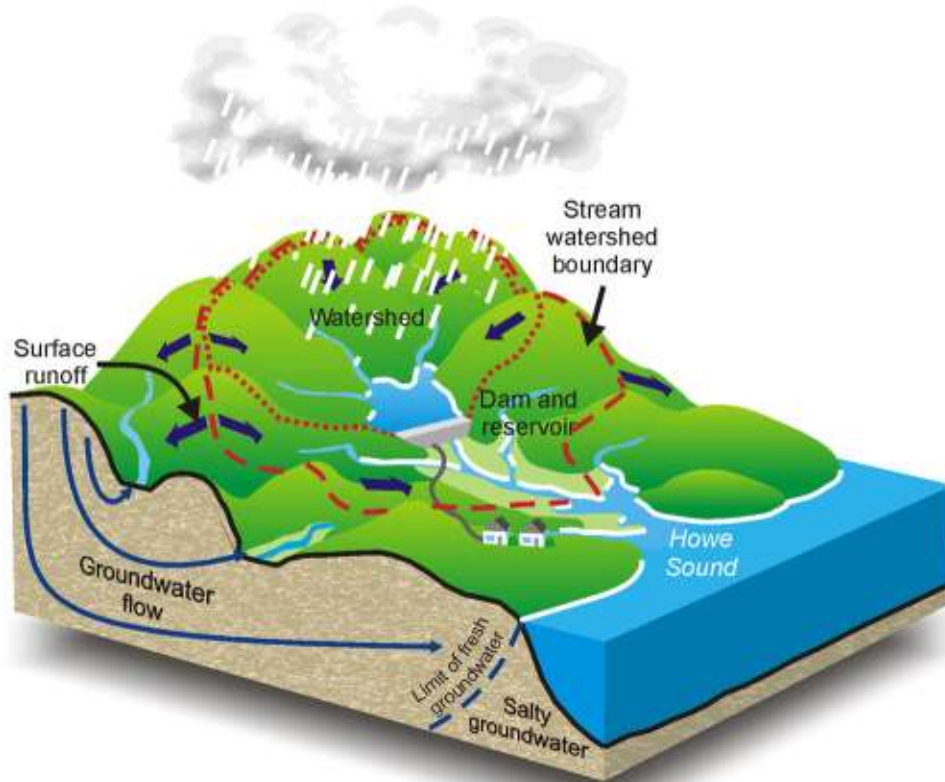


Some major biomes include deserts, grasslands, tropical rain forests, temperate forests, coniferous forests, tundra, freshwater swamps, marshes and bogs, lakes and rivers, estuaries, intertidal zones, coastal ocean, and the open ocean.

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.

Watersheds

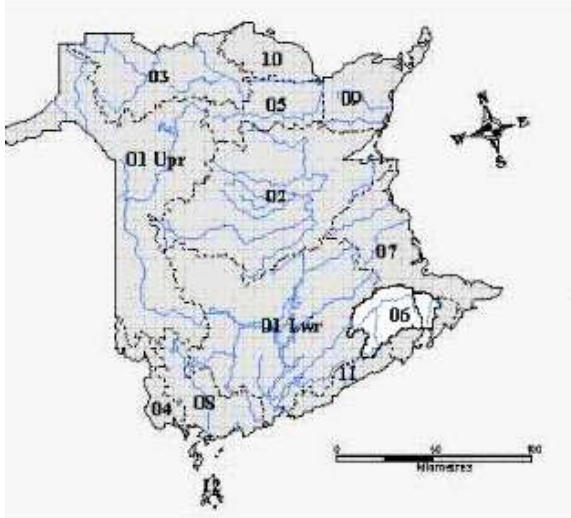
A **watershed** is a geographical area that acts as a drainage basin, collecting all the runoff as it moves downhill into a body of water like a river, lake, or estuary. Eventually, most watersheds



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.

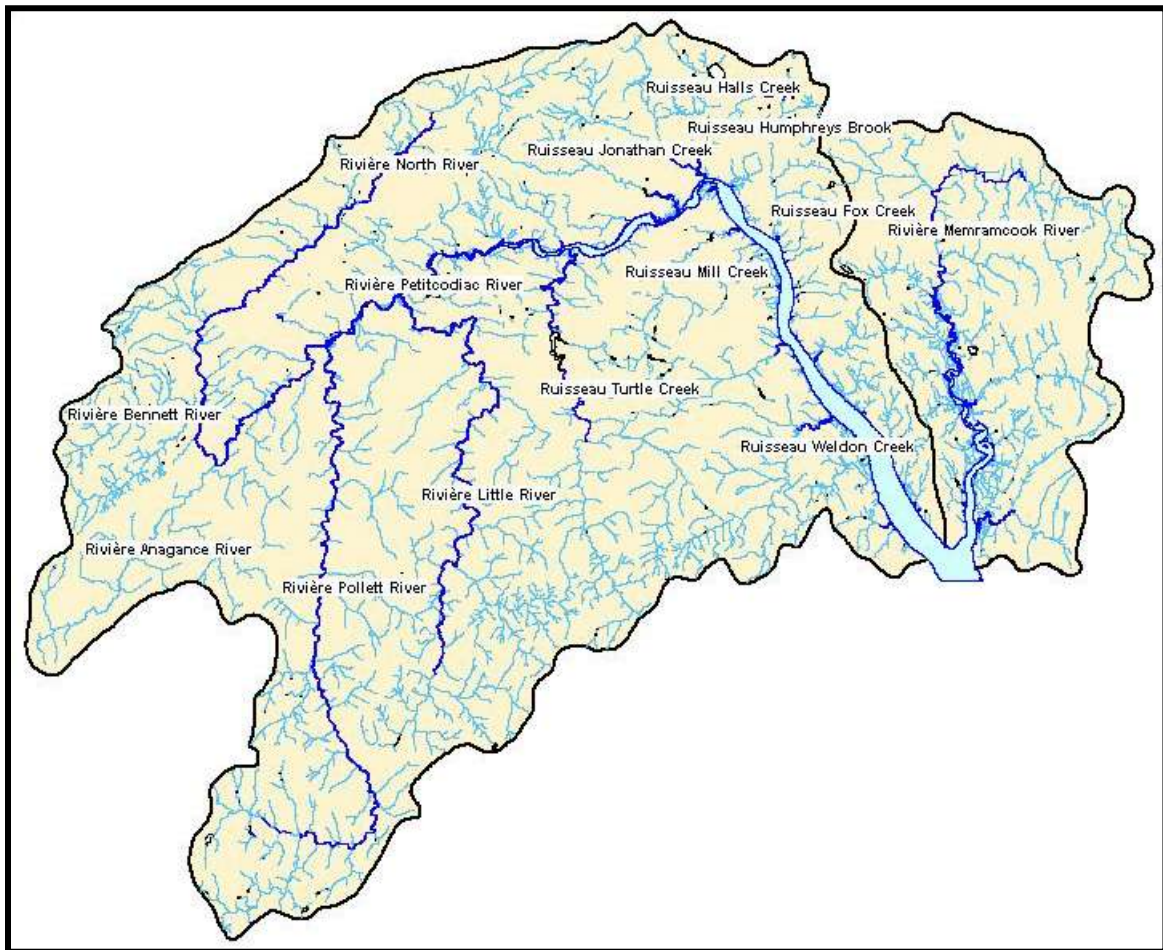
Water supports the life of all organisms found within the watershed. A range of materials found in the watershed – nutrients and toxins alike – will eventually gather and accumulate in the waterways and end up in the water cycle. Because of the interconnectedness of the system, what affects a watershed in one place eventually affects other sites downstream.

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 2400km². This area stretches from the Village of Petitcodiac to the Village of Dorchester, including all of Greater Moncton. It is part of the **Temperate broadleaf and mixed forest biome** that encompasses the Maritime provinces and New England states. The watershed is surrounded by **Acadian forest**, a mix of conifers and deciduous trees. 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. The average annual precipitation for the area is 1223.2 mm. 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 9km². Its main feature is a large (1.20 km²) 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. Public service announcements have been issued alerting people of the presence of non-toxic

blue-green algae, resulting in some temporary closures of the lake to recreational use. The predominant species of the algae found at the lake, *Anabaena smithii*, and *Micocystis wesenbergii*, are not toxin producing, 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 Lake

Water quality is defined as the physical, chemical and biological characteristics of water. Water quality can be assessed in relation to drinking water, safety of human contact, and the health of ecosystems. For Irishtown Nature Park, we are most concerned with the last two assessments.

Water quality testing is a scientific process, and as such follows the **scientific method**. That is, just as you collect data in the classroom through observation and experimentation to test hypotheses, we will be doing the same at the lake.

The Scientific Method

A **hypothesis** is basically a predication of what you think might happen in an experiment, or a suggested 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 replicate your study. 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.

The **discussion** is where you analyze your data and explain what it means. This is followed by the **conclusion**, which sums up your study.

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 formulate an explanation for why it tested in the manner it did.



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

E. Coli is a bacterium commonly 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 beneficial to 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 makes them a good indicator of the presence of fecal contamination 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 up side 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°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°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: _____

DISCUSSION/CONCLUSION:

Dissolved Oxygen, Conductivity, Salinity and Water Temperature

Dissolved oxygen (DO) is the amount of oxygen 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 Celsius. 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.

When you get the YSI, check the membrane cap. This is found on the probe. If the membrane is fouled or damaged, the YSI will not calibrate. If it is, you will need to **install a new membrane**.

1. Unscrew and remove the probe sensor guard (the top plastic part with 4 rectangular holes)
2. Unscrew and remove the old membrane cap (the plastic part inside that has the metal sensor)
3. Thoroughly rinse the sensor tip with distilled water.
4. Prepare the electrolyte according to the directions on the KCl solution bottle.
5. Hold the membrane cap and fill it at least ½ full with the electrolyte solution.
6. Screw the membrane cap onto the probe moderately tight. A small amount of electrolyte should overflow.

7. Screw the probe sensor guard on moderately tight.

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.

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 that you are 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 than 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: _____

Materials

- YSI
- Hip waders or boots
- Pen and paper

Salinity: _____

Conductivity: _____

Temperature: _____

DISCUSSION/CONCLUSION:



The Mystery (and Chemistry) Behind Portable YSI Meters

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

The YSI conveniently measures dissolved oxygen (DO), conductivity, salinity and temperature with just a push of the button. DO is usually the first parameter you measure with the YSI, and also the one you need to calibrate the device for prior to entering the water. In order to do this, you need to test the accuracy of a YSI for measuring DO in a sample solution with a known DO concentration.

There are two easy ways to calibrate the device. One way is to use the storage chamber on the side of the YSI. By placing the electrode into the storage chamber with the sponge inside moistened, you provide a water saturated air environment that is ideal for air calibration of the dissolved oxygen probe. Begin by placing 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. To calibrate the YSI, press both the up and down arrows on the YSI at the same time; you may need to do this two or three times. Eventually you will be able to see a screen on the YSI which will give you an altitude reading and it will most likely be 0. You 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 approach 100%. The YSI will then be calibrated and ready to use.

The other way to calibrate the YSI is to make a saturated solution yourself; see the Exercise box below.

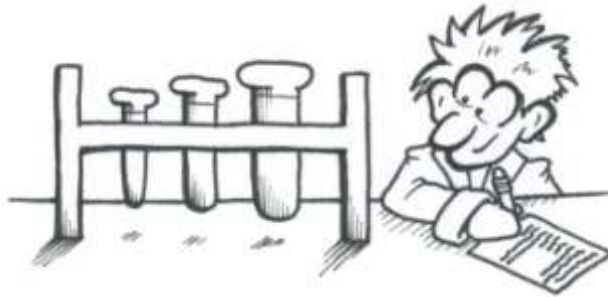
EXERCISE: Make a saturated solution for calibrating the YSI. Pour 500mL of water from one beaker to another 10 times. This should completely saturate a water sample. You can test the accuracy of the YSI by measuring the DO in the oxygen saturated water; it should be close to 100%. Compare this to the 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 are sometimes low?

The DO sensor has an oxygen permeable membrane that covers an electrolytic cell consisting of a gold cathode (a negatively charged electrode) and a porous silver anode (a positively charged electrode). The membrane acts as a barrier, preventing potentially damaging substances in the water from reaching the cathode. If the calibration is done correctly, the electrode will be able to obtain an accurate reading of the DO when placed in the sample.

For the conductivity reading, the main determinant is the ion concentration of the solution. **Ions** are neutral atoms that have either lost or gained electrons to become charged particles. 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. For measuring conductivity, four pure nickel electrodes are used. Two of the electrodes are current-driven, part of an electrical circuit that carries a moving charge (the “current”), and two are used to measure the voltage drop. **Voltage drop** is essentially the reduction of voltage in an electrical circuit; it is the electrical potential of the circuit lessening (dropping) across a component or conductor. The measured voltage drop is then converted into a conductivity value, usually measured in microsiemens per centimetre ($\mu\text{S}/\text{cm}$). 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 $\mu\text{S}/\text{cm}$ is ideal.

Because conductivity is determined by the ion concentration of the water, it is often used as a measure of salinity. Salinity, afterall, 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 algorithms. Temperature is simply obtained from a temperature sensor in the probe.



Nitrates and Phosphates

A nitrate is a type of ion with the empirical formula NO_3 . Nitrates are commonly found in the soil, making their way there through the application of farmyard manure or fertilizers, as well as arising as a result of the breakdown of organic materials by bacteria. While many nitrates in soil are taken up by plants, some are leached out by runoff and make their way into the water system.

A phosphate is a type of ion with the empirical formula PO_4 . Phosphate is commonly found in fertilizers, and like nitrate, can leach into ground water and runoff and end up in a water system.

Nitrates and phosphates in the water are not necessarily a bad thing; they are only damaging when present in excessive amounts. Undesirable in drinking water, excessive nitrates can also be damaging to nitrogen-sensitive plants. As well, excessive nitrates and phosphates in the water can lead to overenrichment of the water, causing them to become eutrophic.

The original condition of most bodies of water is **oligotrophic**, meaning it is LOW in nutrients, particularly phosphate or nitrogen compounds. While this might seem counter intuitive to a healthy waterway, 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. Low nutrient water is clear, allowing sunlight to penetrate and support the growth of submerged aquatic vegetation. Plants are important for releasing oxygen 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 the rapid growth and multiplication of phytoplankton, which increases the cloudiness (or **turbidity**) of the water, preventing the sun's rays from reaching the submerged aquatic vegetation. These plants die off, and stop releasing oxygen into the water. In addition, the dead plant material becomes food for decomposers, mainly bacteria, which use up any remaining oxygen in 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.

EXPERIMENTAL DESIGN:

For this parameter we will be using the **YSI 9500 Photometer**. We will briefly discuss it now in order to familiarize you with its operation.

Using the YSI 9500 Photometer

Spills and moisture should be wiped off immediately 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 instrument automatically and compensates for any inherent 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 **Nitratetest Powder** (Zinc powder) and one **Nitratetest 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 aid flocculation. Allow tube to stand for two minutes or longer to ensure complete settlement.
4. Remove screw cap and wipe around the inside of the top of the tube with a clean tissue.
5. Carefully decant the clear solution 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 stand for 10 minutes to allow full color development.
8. Press the ON key (green) on the **Photometer** and the instrument will display the 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 on the sampling data sheet.

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 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 PO₄ in mg/l.
10. Record the results on the sampling data sheet.

RESULTS:

Nitrates: _____

Phosphates: _____

DISCUSSION/CONCLUSION:

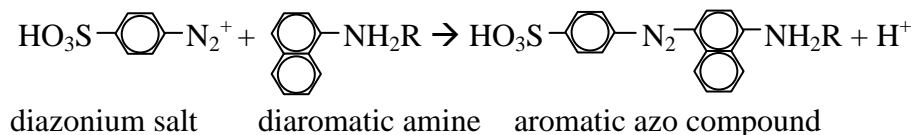


The Mystery (and Chemistry) Behind Nitrate and Phosphate Testing

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 decipher it?

The nitrate test uses something called a colorimetric technique. It involves converting colourless nitrate in a water sample into a pink coloured compound through a series of chemical reactions. The brighter the pink, the more nitrates there were in the water sample. When placed in the photometer, 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 (NO_3^-) into nitrite (NO_2^-). The nitrate must be reduced since nitrite ions react to the tablets that are added and are thus easy to identify, but nitrate does not. This has to do with the chemical structure of each ion. Nitrate and nitrite are examples of **oxyanions**, or polyatomic (many-atom) negatively charged ions, also known as anions, containing oxygen. The ending *-ate* (as in **nitrate**) is used for the most common oxyanion of an element. The ending *-ite* (as in **nitrite**) is used for an oxyanion that has the same charge but one less O atom. Although they have a similar charge, they are quite different substances. Whereas nitrate is a fairly stable compound, by losing an oxygen atom nitrite becomes a very volatile and unstable substance, and does not exist long in the natural environment. This makes it a very reactive ion.



To determine how much dye is present, the sample is placed in the photometer. Light at a wavelength of 520 nm (or blue-green light) is shone through the sample; this is the wavelength of light that is absorbed by reddish purple dye. A nitrate reading is calculated based on how much light is absorbed and how much passes through.

The phosphate test starts by crushing up a No 1 LR tablet in the sample. This contains potassium hydrogen sulphate, ascorbic acid and antimony potassium tartrate trihydrate (which has a chemical formula of $\text{K}_2(\text{C}_4\text{H}_2\text{O}_6\text{Sb})_2$). The second tablet used is No 2 LR, which contains ammonium molybdate (with a chemical formula of $(\text{NH}_4)_6\text{Mo}_7\text{O}_{24}$). The phosphate in the sample reacts with the ammonium molybdate and antimony potassium tartrate trihydrate to form phosphomolybdic acid. The equation for this reaction, while a little intimidating, looks like this (please note that this is not a balanced equation):



Although that sounds like a lot of complicated names, you can think of it like making chocolate chip cookies. The phosphates are like chocolate chips (the really important part!), but you still need the flour, butter and sugar (the ammonium molybdate and the antimony potassium tartrate trihydrate) to make a cookie (or the phosphomolybdic acid). This complex is then reduced by ascorbic acid to a brightly coloured molybdenum blue, which is measured by the photometer (think of this like baking the cookie to produce a strong, easily identifiable smell). Red light (882 nm) is passed through the solution and absorbed by the blue dye, with the amount absorbed depending on the concentration of phosphate present.

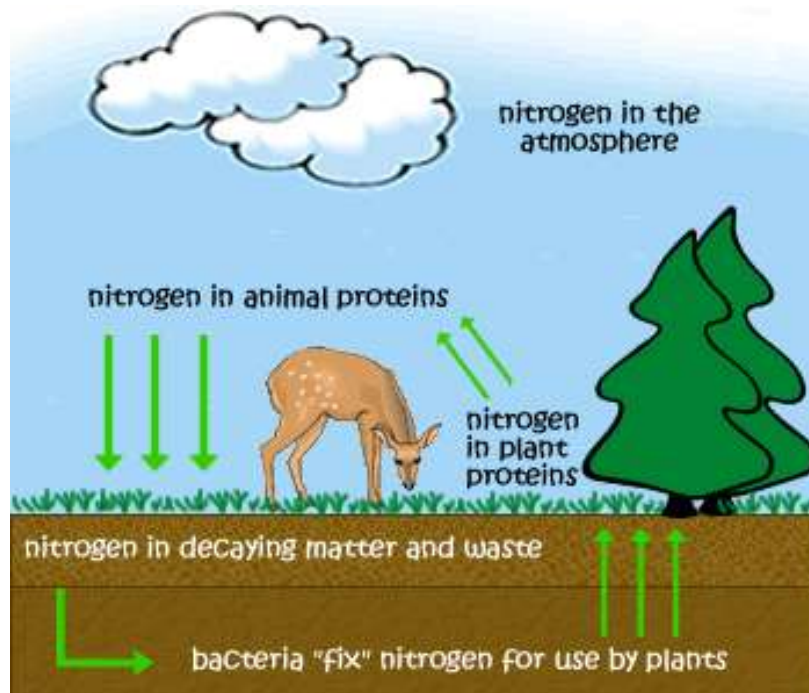


Inserting the phosphate sample into the photometer

Although too much nitrogen and phosphate in the soil can lead to contaminated surface runoff and deteriorated water quality nearby, both substances are necessary for a healthy environment in certain amounts. Nitrogen in particular plays a very important role in ecosystems, affecting and passing through most members of the environment. To learn more about this cycle, see “The Nitrogen Cycle” on the following page.

Nitrogen is the most abundant element in our planet's atmosphere. In fact, this element makes up 78% of our atmosphere. Nitrogen is not only plentiful, but extremely useful, and needed by life forms to carry out many functions of life. It is especially important for plants, which incorporate nitrogen to form proteins.

However, nitrogen in its gaseous form is nearly entirely unusable to living things. Therefore it first must be converted, or **fixed**, into a more usable form. This process of converting nitrogen is called **fixation**, and requires specialized bacteria and algae located in the root nodules of certain plants. These bacteria and algae fix the nitrogen from a gaseous form into a form that can be absorbed by plants. Other bacteria found in soil engage in **nitrification**, where nitrates are created from simpler chemicals in the soil, which are then also absorbed by plant roots. All the nitrogen that plants absorb is then used to make plant proteins, which are important in plant walls and for chlorophyll. Plants are in turn consumed by animals, and the nitrogen passes to them in the form of proteins. Finally when the plants and animals die, the decaying matter and waste contains nitrogen which works its way back into the soil, and the cycle starts anew.



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 insoluble substances become more soluble and thus available for absorption by animals and plants. 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 optimal for most aquatic organisms to live.

HYPOTHESIS: Based on observations around the lake, do you think the pH will fall within an optimal 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.

RESULTS:

pH: _____

Materials

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



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

DISCUSSION/CONCLUSION:



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** that is added in small amounts to a solution so the pH of the solution can be determined. A halochromic chemical compound is a substance that changes colour when pH changes occur. pH indicators are usually either weak acids or weak bases themselves, that when added to a solution bind with either the Hydrogen ions or Hydroxide ions. The different electron configurations of the bound indicator cause the indicator's colour to change, allowing the pH to be determined by different colours.

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 individual particles (**suspended solids**) that are generally invisible to the naked eye, similar to smoke in air. As previously stated, turbidity may be caused by the growth of phytoplankton. Increased turbidity prevents the sun's rays from penetrating to the bottom of the water, thus preventing the growth of aquatic vegetation. Turbidity is important for water purification processes as well; contaminants like 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:

DISCUSSION/CONCLUSION:

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?

How much has human action played a role in its current state?

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

Not all changes to an environment are caused by humans. Sometimes an environment will change itself, over the course of years, to become something drastically different. One biotic community will give way to a second, and perhaps even a third or fourth, in a process of orderly transition known as **ecological** (or **natural**) **succession**. This happens when the physical environment becomes gradually modified by the growth of the current biotic community, so much so that it becomes better suited for a different biotic community, and less favourable for the current occupants.

For example, a pond may become gradually filled in and taken over by the surrounding terrestrial (or land-locked) ecosystem. This happens when soil particles inevitably are eroded (washed away) from the land and settle at the bottom of the pond, gradually filling it in. This is combined with pieces of dead aquatic vegetation to increase buildup. As more build up occurs, terrestrial species can move further out. The shoreline keeps advancing to the center of the pond, until the pond disappears altogether!

Succession can be caused by a disturbance to an existing ecological community as well. Forest fires can wipe out existing mature trees, leaving behind a more open clearing better suited for smaller shrubs and ground covering plants. The introduction of a new species can cause sudden change as well. Certain organisms, like the spruce bud worm, can destroy a specific type of tree in an area, drastically changing the forest ecosystem.

Succession does not go on forever though, with one biotic community replacing another after another. Eventually a state of **equilibrium** is reached, or a balance between different species and the physical environment. This final state is called a **climax ecosystem**. This state is considered the most stable for the biotic community and the environment of the area. An example might be our former forest devastated by a wildfire. Succession occurs first, with tall grass and smaller plants moving in, followed by a few pine sprouts, which develop into pine trees and then a forest again. This forest is the climax ecosystem, but that doesn't mean it *can't* be changed. Climate conditions could change, a new species could be introduced, or an unexpected disturbance (like another forest fire) could change even climax ecosystems.

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. 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 Species the most specific. A full taxonomic name includes each rank. For example, your full taxonomic name would be:

Kingdom: Animalia

Phylum: Chordata

Class: Mammalia

Order: Primates

Family: Hominidae

Genus: *Homo*

Species: *H. sapiens*

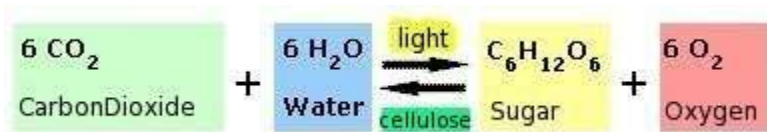
The Kingdoms we will be looking at in and around the lake include **Animalia** (animals), **Plantae** (plants), and **Fungi** (such as mold or mushrooms).

EXERCISE: Look at the Taxonomic Booklet. See what you can identify around the Irishtown Nature Park. Choose five organisms and research them to find out their complete taxonomic classification.

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 convert carbon dioxide and water into glucose (a type of sugar), releasing oxygen and water vapor into the atmosphere. This is known as **photosynthesis**. The chemical formula for this is as follows:



Six carbon dioxide molecules combine with six water molecules to make one glucose molecule and six oxygen molecules. Since plants 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 eat both plants and animals (called **omnivores**), and therefore take on both the role of primary and secondary consumer at different times.

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.

Different organisms serve different roles in the community, as we have just seen with producers, consumers, and decomposers. They have different relationships with one another as well. Some of these include:

- **Predation/Parasitism** – one species eats another. In this relationship one species benefits (the predator or parasite) and the other is harmed (the prey). Examples might be a fox hunting a chicken, or a tapeworm attached to the gut of an animal.
- **Mutualism** – both species benefit from the relationship. A classic example of this is pollination between a bee and a flower. The bee obtains nectar from the flower to use as food, while at the same time pollen becomes attached to its body. When it lands on another flower to collect more nectar, the pollen is deposited, and pollination occurs, fertilizing the flower.
- **Commensalism** – one organism benefits from the relationship, while the other neither benefits nor is harmed. You can see this with a remora living with a shark. Remoras eat the shark's leftover food. The shark is unaffected by this, as the remoras eat only leftover food of the shark which doesn't deplete the shark's resources.
- **Amensalism** – a relationship where one species harms another without benefiting or becoming harmed in the process. An example of this is common bread mold, known as *Penicillium*. *Penicillium* secretes a chemical called penicillin, which kills any bacteria around it. However, this does not benefit *Penicillium*.

EXERCISE: Choose an organism found in the watershed. Describe its life cycle, its role in the community, and its relationships with other organisms.



A bee pollinates a flower, above, demonstrating mutualism. To the right, a remora and a shark display commensalism.

Although we've talked a lot about different organisms in the Irishtown Nature Park Community, we haven't said a lot about the one 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 refers to a process or system that can be continued indefinitely without depleting any of the material or energy resources required to keep it running. Furthermore, a **sustainable society** neither depletes its resource base by exceeding sustainable yields nor produces pollutants in excess of nature's capacity to absorb them. 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 not dumping dangerous chemicals down the drain that could end up in the waterways.

But on a large scale, applying the concept of sustainability to modern society is more complicated. Large factories can produce huge amounts of pollution, but they also produce many of the things we use in our day to day lives. Should these be banned? Many activities we undertake – driving to the movies, taking a road trip in a gas guzzler, hanging out at an air conditioned mall, buying a toy that comes heavily packaged – produce pollution we aren't even always aware of, and are not necessary to survival. Should these activities be stopped?

Living sustainably is more than just mere survival. Humans have the ability to explore and acquire knowledge and experience from our surroundings like no other organisms. In order to have a sustainable society, we must also preserve this capacity to explore, reflect on, and understand new things. A sustainable society does not necessarily mean regressing back to pioneer days or any other time. The history of the world is filled with the ruins of civilizations that did not sustain themselves and became extinct. Rather, living sustainably means moving forward to a state that has never been, one where we can work together across nations as global citizens to preserve our resources, while allowing the continued growth of scientific, cultural, and spiritual needs.

EXERCISE: Think about all the different activities you do in an average week. Which ones do you consider sustainable? Which behaviours could be changed to become more sustainable?

Impact on Wildlife

Humans have a large impact on their surroundings. Within the Petitcodiac Watershed there are examples of humans changing their environment to suit their needs, in the process altering the preexisting ecosystem. We'll take a look at a few examples of this.

Your Way or the Causeway – The Petitcodiac River Causeway between Moncton and Riverview was built in 1968, as a way to protect farmland from flooding. On one side of the causeway, an **estuary** (an area where fresh and salt water mix) became a freshwater lake, while on the other side a sizeable river became much smaller. Before the causeway was built, the river used to have many types of fish in it. Although a slotted fish passage was built into the causeway so fish could still travel into the lake to lay eggs, numbers of salmon in the river following construction dropped significantly. Shad, brook trout, and striped bass disappeared altogether. The river on the other side of the causeway also shrank in size, filling in with silt and developing massive mud flats. After years of debate, the causeway's gates are set to reopen soon, in an attempt to revert the river back to its natural state. However, since the causeway was built, the surrounding ecosystem has changed and adapted to its existence. Blue heron, bald eagles, and other birds hunt for food at low tide in the river, and fresh water marshlands have developed on the lakeside. No one is sure how this ecosystem will adapt to the causeway reopening. As well, there is a former landfill located on the river side of the causeway that could potentially leach unknown substances into the water and into the former lake area once the gates are open.



Photos comparing the Petitcodiac River before the causeway was constructed (bottom) and after (top)

Back at the Farm – The agriculture industry is important for keeping us healthy and well fed. However, farming can be damaging to the existing land. Forests are cut down to establish farm fields, eliminating the home for many wildlife organisms. The loss of forests leads to more soil erosion, causing land to get literally washed away. Crops suck up all the nutrients in the earth, especially nitrogen and phosphorus, which farmers usually replace with synthetic fertilizers. These fertilizers can end up in surface runoff, landing in bodies of water and leading to eutrophic lakes. Because of erosion, more sediments are likely to end up in the runoff as well, along with animal fecal matter.

Urban Expansion Puts a Drain on Wetlands – Growing cities need land area to expand outwards on. Forests are frequently cut down to make way for a new subdivision or shopping

complex. Besides forests, wetlands are frequently destroyed for the sake of city development. **Wetlands** cover 14% of Canada's land area, and are sporadically or permanently covered by shallow water. These include swamps, marshes and saltwater flats. Although they are some of the most ecologically diverse habitats in the world, they are frequently drained for more industrial uses. For example, Champlain Place sits on former marsh ground.

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 Kouchibouguac National Park located outside Miramichi, 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 proposed research project related to the Petitcodiac Watershed. It could deal with monitoring a specific species, protecting the environment from human impact, utilizing the watershed's resources wisely, or water quality control. Explain why the research would be important.

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