

Water Quality Lab

In this lab you will be using the water, snow, and soil samples to determine the general “quality” of the stream water and sediment. The lab will focus on finding correlation between **pH** (the acidic or basic level of an aqueous solution), **dissolved oxygen levels** (the measure of the amount of oxygen dissolve in water or within the soil; DO), **electrical conductivity** (the measure of a material’s ability to conduct an electric current) and **water colour** (an indicator of dissolved organic matter) of each sample.

Equipment and Supplies

- pH meter
- Dissolved oxygen probe
- Electrical conductivity probe
- Water Colour Meter
- Water Filter Apparatus
- Soil, water, and snow samples
- Sample cups

Prepwork:

- Allow the frozen water and snow to melt to room temperature (TAs will take them out of the freezer prior to analysis). Pour water from each sample into a labeled cup.
- In a separate sample cup measure out 50g of the soil sample and pour in 50 ml of distilled water. Stir the soil slurry until well combined. This will be your soil sample for each test.
- Test the three samples (water, snow, and soil) for each of the sites using each of the water quality probes. Be sure to rinse with distilled water between samples to reduced cross-contamination.
- When using the DO probe, make sure to swirl the probe in the water to keep water moving over the probe. For the pH and EC meter you can simply rest it in the water. **Write down** the number on the meter when it stops changing.
- In order to find snow density, find the volume of the jar and divide by the volume of the melted snow in the jar (ml/ml). This give you volumetric density of the snow.
 - **Snow Density (ml/ml)** = Volume of melted snow (ml) / Volume of Jar (ml)
- *Please also write down the units from the probes as you write down the result. The probes often shift between units so this step is very important!*

Report

- You are tasked to look at one or two of the water quality parameters and write up a report focusing on those elements. You will need to do more in-depth research and analysis to see trends and report any findings. Look at previous year’s data and compare/contrast. The analysis is up to you, but we want solid research for this report.

Analysis 1: pH

The pH of an aqueous defined as the logarithm of the reciprocal of the hydrogen ion activity:

$$pH = -\log_{10}[H^+]$$

In soil and water, hydrogen ions are found free in solution and as exchangeable cations on the negatively charged surface of clay and organic matter particles. Both fractions exist in contact with one another in a state of equilibrium. This equilibrium will shift with: (i) changes in salt concentration of the solution (because metallic cations will replace hydrogen ions at soil cation exchange sites); (ii) additions of CO₂ to the solution (CO₂ dissolves and, while forming H₂CO₃, contributes to the hydrogen ion concentration); and (iii) changes in the ratio of solid to liquid within the soil. High pH denotes low acidity and low pH is high acidity.

Analysis 2: Electrical Conductivity

Electrical conductivity (EC), expressed in $\mu\text{m}/\text{cm}$ (microsiemens per centimeter) or ms/cm (millisiemens per centimeter), is a measure water's ability to conduct an electric current.

The rate of the electric current depends on the concentration and charge of dissolved ions in solution, and temperature of the solution. Electrical conductivity values increase as ion concentration and ion charges increase. With regard to temperature, electrical current and temperatures increase concurrently. Most EC testers normalize readings to 25°C.

While the activity of ions can be measured with EC, the specific ions in solution cannot be read with an EC tester (one ion cannot be distinguished from another). Total dissolved solids (TDS), however, can be inferred from EC values; an increase in EC equals an increase in TDS. Total dissolved solids have implications on fish bearing waterways.

Electrical conductivity values increase as water moves through mineral soil and bedrock; electrolytes from the mineral component of the soil are dissolved into the water, raising the ion concentration. Soil and bedrock composition, therefore, will affect EC values. Further, evaporation of mineral rich water will increase the concentration of dissolved solids.

Analysis 3: Dissolved Oxygen

Dissolved oxygen (DO), expressed in mg/L is a measure of oxygen content in water. DO levels are controlled by processes that add oxygen to water and those which consume it.

Oxygen is added to water in three ways: 1) diffusion, 2) water aeration, and 3) plant exudes. As the concentration of oxygen is higher in air than in water, oxygen will try to diffuse into the water to reach equilibrium. The process of oxygen diffusion into water increases with an increase in surface area. Water aeration can occur as turbidity of water increases, raising the pressure with which air meets water, forcing oxygen into the water. Plants generate oxygen through photosynthesis; as this oxygen is carried to plant roots, some oxygen exits into soil water.

Oxygen is removed from soil water as a result of biological oxygen demand (BOD). This can occur as microorganisms use oxygen as electron acceptors during respiration, or as plants consume oxygen at night. Biological oxygen demand will continue as long as there is sufficient organic matter in water for

organisms to consume, and a supply of electron acceptors. As oxygen levels drop below 1 mg/L, water begins to turn anoxic, therefore various anaerobic bacteria will begin to use nitrogen, manganese, iron, sulfur, and carbon, in sequential order, as electron acceptors.

Analysis 4: Water Colour

Water colour, which can be measured in platinum cobalt units (PCU), refers to the yellow to brown tint in filtered water, with clear and highly coloured samples having low and high tints (PCU values), respectively. True colour (suspended particles removed), as opposed to apparent colour (suspended particles included), is an indicator of dissolved organic matter, including lignin, humic and fulvic acids; with bog water being shown to contain higher true colour values than fen or swamp water. Clear colour in fens and swamps compared to bogs is attributed to increased movement of fen and swamp water. Water colour, specifically dissolved humic substances, can affect water chemistry by influencing metal complexation, light absorption and pH values.

METHODS:

Take a small sample from the melted water and pour it into the 10ml flask for the water colour meter (this is the **apparent colour**). Take a 50ml sample of your water and filter it with the water filter apparatus. Fill the second 10ml flask with filtered water (this is the **true colour**).

Test your water using the water colour meter.

- Place the blank flask into the water colour meter, making sure the notch on the cap is lined up.
- Press **ZERO/CFM**, after a few seconds the display will show “-0.0-“ (this zeroes the meter).
- Insert your apparent colour and press **READ**, the meter will display the value for the apparent colour (**write it down**).
- Replace the flask with the true colour and line up the cap. Press **READ** and the meter will display the value for the true colour (**write it down**).

Lab Results

Stir the mixture gently for 30 seconds. Let the soil sit for 30 minutes. Stir water gently before taking an EC or pH measurement with the probes.

Probe	Soil	Soil Temp (°C)	Snow	Snow Temp (°C)	Water	Water Temp (°C)
EC (µm/cm)						
pH						
DO (mg/L)						

Apparent Colour (PCU)	True Colour (PCU)

Snow Volume (ml): _____

Snow Density (ml/ml): _____

Report Outline

The purpose of this lab is to compare the quality results of DO, EC, and pH across any or all of the study sites. In your analysis, try and showcase any trends that form (i.e. quality trends by soil type, by location to pollutants, etc...). In your introduction, introduce the importance of water quality and the types of measurements and tests you've done for the various sites. Methods should include a detailed overall explanation at what was done in the lab with the probes, as well as any explanations needed for statistical work. Results should include a table of results (might be suitable for an appendix depending on size), maps showing visual trends of data results, as well as any statistical results. (*Please do not forget to talk about results in this section. Don't just plop tables and graphs here, you need to introduce and talk about them*). Your discussion section is where you talk about your results, and elaborate on the trends/relationships found. This section is important and should include research and references to support your findings. You should also focus on the belief and trust regarding the outcomes of the results i.e. reliability, uncertainty, representativeness, appropriateness. Discuss the results but also the methods in which you found them and their reliability. Conclude your report with stated objectives and the overall lesson learnt. (Don't forget appendices and reference)

Report worth:

*Title

Introduction - 20

Methods - 15

Results - 20

Discussion - 30

Conclusion - 5

*References

*Appendix

**Title, References, Appendix together: 10*

Notes: You need a title page with a title that is descriptive and creative. Make sure to have appropriate references. We discourage the use of web based references (i.e. Wiki). Utilize the library and the online archives to find actual scientific references and books. Make sure to have a properly formatted list of references. Appendices should each have a title. Number your pages, and remember that page 1 starts with your writing, not with the table of contents (if you chose to add one). This report is marked from a 3rd year university level, therefore be sure to write and format appropriately.

Marking Guide

Introduction (20)

- Did they introduce the topic and do some background research on the water quality parameter of their choice? We are looking for something of depth as previous years had to look at all water quality parameters and this year they only need to look at 1 or 2 of their choice.
- Did they introduce the water quality parameter? Explain what it is? Units of measure?
- Did they introduce the sites that they visited across Fredericton? A brief description of each site (urban/rural, forested/non-forested, etc...)? Are there references in their research? (Proper references)
- Did they state the objective of the report? (Where? Why? How?)

Methods (15)

- Did they explain the water quality measuring apparatus of their chosen parameter? (i.e. DO, pH, and EC probes or water colour meter) Did they explain the science behind how it works? How the probe was calibrated? Remember since they are looking at 1-2 parameters we are looking for good details.
- Did they show equations if needed? (i.e. snow density)
- Did they keep the writing in the proper tense? No first person.

Results (20)

- Are the figures introduced before they are placed in text? (i.e. need to reference them before they show up)
- Are the figures formatted properly? (Proper axis, significant digits, axis labels, colour/pattern to differentiate, clean looking?)
- Did they do any statistical analysis between water quality parameters (i.e. colour vs. DO?). Something that shows critical thought in the analysis, not just showing straight lab results.
- Overall trends over the years? Is there a trend for each site over the years? Similar? Different?
- Quick mention of trends in the results? Elaborate on this in the discussion but a quick mention of drastic differences. The “what” goes in results, the “why” in discussion.
- Don't just copy and paste the same paragraphs over and over again.

Discussion (30)

- Is there a discussion about the results? Do they go into detail about the “WHY”?
- Did they go over any trends found and explain them with research to support their explanations?
- Are there appropriate references backing up their discussion?
- Did they deal with the matter of belief and trust regarding the results? (Reliability, uncertainty, representativeness, context) Did they suggest ways to enhance reliability? How would they make the lab better? (Sampling? Procedure? Human errors?)
- Why is knowing about water quality in snow/soil/water important, especially in watershed management?

Conclusion (5)

- What was learned from looking into the water quality at each site? Urban to rural? Overall trends found?
- No personal comments about what they feel, but just what was accomplished in the lab.

Title, Appendix & References (10)

- Is the title creative and informative? Does it specifically state what will be looked at in the report?
- Is the bibliography formatted properly? (Alphabetical order, APA, consistent format) Are all of the reference academic? (I.e. no URL/wiki references)
- Is the appendix formatted properly? (I.e. proper titles for each appendix) If necessary, data should be in appendix if it's too large or complex for the body of the report.
- Is the paper grammatically correct? Does it flow well? Proper paragraph and sentences? Spelling?