Water Rangers Canoe Content 2023

Logistics

Part of trip	Section Title	Time	Materials
Pre Trip	**Intro to Expedition Mapping**	45 minutes	• Topographic maps of the route • Masking tape • Banner Paper • Markers
	Intro to Water Testing	30 minutes	• Water rangers test kits • Field notebooks • Pens
On Trip	**Water Testing**	15 minutes every day	• Water rangers test kits • Field notebooks • Pens
	Water Teststrips	30 minutes	• Water rangers test kits • Field notebooks • Plastic bottles • Pens
	Dissolved Oxygen	30 minutes + testing overnight	• Water rangers test kits • Field notebooks • Pens
	Expedition	15 minutes	• Expedition map

	Mapping	every few days	• Markers • Masking tape • Field notebooks • Pens
Post Trip	**Reflection & Debrief**	30 minutes	• Expedition map • Markers • Masking tape • Field notebooks • Pens

Pre trip

The pre-trip stage is brief. There's lots to do to prepare for these trips, so these activities simply set the stage for the main activities throughout the trip.

Expedition mapping

The goal of this section is to introduce participants to the route we will be following, the general timeline of the trip, and the expedition mapping project.

To Do In Advance

- Go over the trip route and itinerary with Esker and the BSE staff team
- Lay out the topographic maps
    - If possible, this should be done indoors or in the shelter at McKinnon park so the maps can be taped to the floor and connected to show the whole route at once. Makes for a good photo too!

- Prepare the expedition map. Mark out the beginning and end of the trip on opposite corners of the map. This will give participants a starting point.

Activity Procedure

1. Introduce participants to the topographic maps. Explain how to read them and what information they can provide.
2. Go through the route, highlighting planned campsites, obstacles, landmarks, and hazards.
3. Introduce participants to the expedition map project. Explain they will be building an interactive map of the route. Throughout the trip, they will add to their maps as their knowledge grows.
    - Explain to participants that the place we live holds a lot of stories. Creating a map is one way we can think about what we know and how we came to know what we know.
    - Throughout the week, we will think about how we interact with places on the map, who and what uses those spaces, and how those spaces relate to the trip activities.
4. Start by encouraging participants to draw out the route based on the topographic maps we just looked at. They should draw any rivers and lakes they will pass through, along with other navigational markers.
5. Remind participants that they already have plenty of knowledge to share. Encourage them to add anything else they think is important. Examples could be potential places to spot wildlife or communities they are excited to visit.

    - There is no correct way to create an expedition map. The group can make all the decisions.

Expedition Mapping Guiding Questions

- What information will my map provide?
- Where do I see examples of STEM? How do I use STEM everyday?
- What places throughout the expedition did I find important to me?
- Where did I expand my knowledge on the trip? Who passed down that knowledge?

Introduction to Water Testing

The goal of this section is to introduce participants to the water testing equipment we will be using at different points on the route.

To Do In Advance

- Find a location to test the water.
    - Aim to test at the launch point for the trip.
    - If the pre-trip is based on Norman Wells, this could be done at Jackfish Lake or the Mackenzie River.
- Ensure the location is safe for participants to collect their samples.
- If necessary, obtain permission from community members to test their community's water.

Activity Procedure

1. Introduce participants to the testing equipment. Tell participants that throughout the trip, they will learn more about what the equipment is measuring and why that information is important.

2. Introduce the field notebooks. Explain to participants that it is important to keep detailed notes when collecting data. Participants can start filling out the top half of a new testing page in the Field Notebook.

    - Participants should record the time they start the testing process and the date or day of the trip.
    - Under body of water, participants should indicate if they are testing in a river, lake, or other body of water.
    - Participants should also give the location a name that they will remember when looking back at their notes.
    - Finally, participants should write a description of the test site. Where was the test done? In a boat in the middle of the river, on the shore, from a dock? What was the shore like? Rocky, gravel, sand, soil?

3. Encourage participants to record any other observations they may have on the notes page. This could be more details like characteristics of the river, how they think the testing procedure went, or anything else that could help analyzing the data later on.

4. Divide the participants into three groups and pass out the testing supplies. Explain that we will be focusing on the testing procedure right now, and will discuss the results of the tests in more detail throughout the trip.

    - This includes the thermometer, conductivity sensor, teststrips, container, and reacher stick (used as a sample grabber).

5. The first measurement to take is air temperature. Groups should find a spot to hang up the thermometer that is out of the sun and about 1.5m off the ground. After 5 minutes, record the temperature in the field notebook.
    - The ground radiates heat. If the thermometer is too close to the ground, this heat will affect the readings.
6. Groups will take a water sample in their cups. A reacher stick can be used to reach water that is farther away. The sample should be taken from at least 15 cm below the surface. Record this in the field notebook.
7. Groups can measure the temperature, conductivity, and salinity of the water with the conductivity and salinity meters. Turn on the conductivity meter using the top button. Place the electrodes of the conductivity meter into the sample and wait until both measurements become stable. Record these measurements in the field notebook. Repeat this process with the salinity meter.
8. Now groups can use the teststrips. Dip one entire teststrip into the sample for 2 seconds. Remove the teststrip from the water and wait 20 seconds. Compare the colors with the guide on the teststrip container. Record this data in the field notebook.
9. As a whole group, demonstrate the dissolved oxygen test. Because the tests are somewhat expensive and involve broken glass, we will do one test as a group each time we stop to take measurements. This first one will be a demonstration from the instructor, and everyone will get a chance to try it throughout the trip.

- Fill the dissolved oxygen sample cup with water from as far below the surface as possible.
- Place the ampoule into the cup and break the tip.
- The ampoule will fill with water. Remove it from the water and invert it twice (let the bubble travel to the top twice).
- Use the colour comparator to determine the concentration of dissolved oxygen. Record this in the field notebook.
- Note: Keep the colour comparator out of the sun as much as possible

10. The final test is to record the Secchi depth. Again since we have only one Secchi disc, the first test will be demonstrated by the instructor and everyone will get a chance to take a reading at some point throughout the trip.
    - Carefully lower the Secchi disk into the water. Continue lowering it until the Secchi disk disappears. Record the measurement on the tape measure at the surface of the water.
    - Lower the disk a little bit more. Then slowly raise the disk until it just barely becomes visible again. Record this measurement.
    - Add both measurements together and divide them by two to get the average. Record this in the field notebook.
    - If the bottom is visible, measure the depth instead.
    - This may be difficult to do on moving rivers. If the current is not too strong, two instructors could paddle a canoe to keep it in place and one participant could take the Secchi reading. This test may not be possible at all test sites.

On trip

Water Testing

To Do In Advance

1. At each campsite, select a testing location. Ensure this location is within sight of the campsite and that water conditions are safe for participants to collect samples.
2. Also consider the results this sampling site may bring. Is the water stagnant or moving? Does it have a colour? Etc...

Activity Procedure

1. At each new campsite, use the water rangers test kits. See the procedures in the previous section.
    - It may not be reasonable to take a sample every day. At the very least, a sample should be taken each time the group enters a new body of water.
    - Aim for a variety of samples. Some from the shore, some from the middle of the river/lake, some from where the river narrows and flows fast and some from where it's wider.
2. Record the data on a new page of the field notebooks.
3. **The dissolved oxygen test and teststrips both have separate activities to explore them further. The other tests can be discussed whenever there is time.**
4. Participants probably all know what a **thermometer** is. Ask them why we might want to measure the temperature of aquatic ecosystems.

    - All organisms have a preferred temperature range. For example, an ostrich wouldn't be able to survive in northern Canada, and a polar bear wouldn't have a great time in the desert. The same goes for aquatic organisms.

5. Why do we also measure the air temperature and record the weather when we take a sample? This information is important to collect for data analysis, because it may give clues as to why the results are what they are.

6. Explain to participants that **Secchi Discs** are used to roughly determine water clarity. The disk is tied to a calibrated line, meaning a line with measurements on it. The disk is lowered into the water until it disappears. That depth is recorded. The disk is then raised until it becomes visible again. That depth is recorded and the two depths are averaged.
    - Light can penetrate deeper into a clearer body of water. This means more light for plants, and therefore more food for animals.
    - Readings are affected by cloud cover, surface roughness (waves reflect more light), time of day, and the eyes of the person taking the measurement.

7. Explain to participants that conductivity is the water's ability to conduct electrical current, dependent on the number of ions it contains. We can measure this with a **conductivity meter**.
    - In general, higher conductivity means there is a higher concentration of dissolved solids in the water, which also usually means higher productivity.

- A spike in conductivity can act as an indicator of pollution. But this is only helpful when repeatedly measuring at the same place.
- Conductivity is the opposite of resistance. To measure the resistance we use the ohm. To measure conductivity we use the siemens, which used to be called the mho because physicists are lazy.

Some Common Conductivity Values	
Distilled Water	0.5 - 3 μS/cm
Melted Snow	2 - 42 μS/cm
Can affect fish reproduction	**Over 500 μS/cm**
Potable Water	30 - 1,500 μS/cm
Freshwater Streams	100 - 1,500 μS/cm
Industrial Wastewater	10,000 μS/cm
Sea Water	55,000 μS/cm

Water Teststrips

Activity Procedure

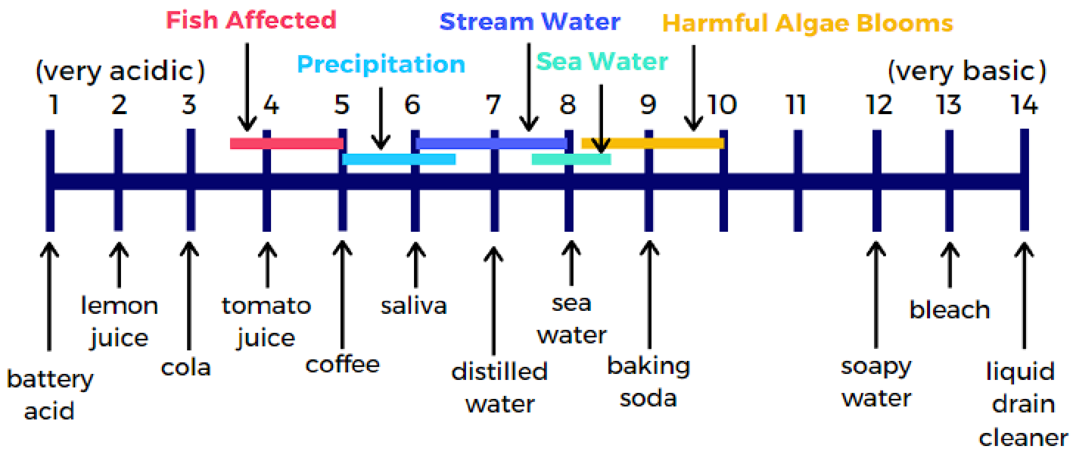
1. Explain to participants that the top part of the teststrip tests for **chlorine** in the water. It also tests for bromine because it reacts almost

the same as chlorine, but that's a secret that Water Rangers won't tell you for some reason.

- Chlorine is almost never found free in nature by itself. This means the reading should only ever be between 0 and 0.5 ppm in nature. 1 ppm is worrying and anything above 2 ppm is probably a pool.

2. Explain to participants that the next part of the teststrip determines the **pH** of the water. pH stands for the **potential of hydrogen**. To understand this, we need to learn about some chemistry.
    - Water can dissociate into **hydrogen ions** (H^+) and **hydroxyl ions** (OH^-). In pure water, there are equal amounts of hydrogen and hydroxyl ions. **Acids** have more hydrogen ions and **bases** have more hydroxyl ions.
    - Some common acids are lemon juice and vinegar. Common bases are soap and baking soda.
    - The pH scale is **logarithmic**, so a pH of 5 is 10 times more acidic than a pH of 6
    - If we come across any swamps or bogs, the pH may be very low.

pH Scale



3. Introduce the first experiment to participants. In this experiment, we will explore what happens when we add acid to water. Tell participants we will be adding some amount of lemon juice to some amount of water.

    - Participants will measure the pH of the water before anything is added and record it in their field notebooks. Participants will then develop a hypothesis as to what will happen to the pH. Will it increase or decrease, and by how much?

    - Add some amount of lemon juice to the water and mix thoroughly. Participants can then measure the pH again and record that data. Was their hypothesis correct?

    - Now ask participants to create a second hypothesis. This time we are wondering how much acid we would need to lower the pH by 1. So for example if the pH is 6, how much acid would it take to lower it to 5?

4. The third part of the teststrip measures the **alkalinity** of the water. Sometimes people confuse basic water with alkaline water because

they are similar, but not quite the same. Alkaline water is able to resist changes in pH.

- This is important because small changes in acidity can have big effects on organisms and water bodies with higher alkalinity are more resilient against events like acid rain.
- Alkalinity and hardness don't change very much over time on their own. If they are changing significantly, there may be a source of pollution.

How to Interpret alkalinity values	
10 ppm	Very Low
11-50 ppm	Low
51-150 ppm	Moderate
151-300 ppm	High
> 300 ppm	Very High

5. Tell participants we will see alkalinity in action through another experiment.
    - Fill two bottles with equal amounts of water. Add a teaspoon of baking soda to one bottle, shake vigorously. Participants will use teststrips to test the pH and alkalinity of both samples. Record this initial data in the Field Notebooks.
    - Explain that baking soda acts as a buffer in water. It "absorbs" the loose hydrogen ions, reducing the effect of acid. Because of this, the pH has probably increased.

- Explain to participants that we will be adding lemon juice to both bottles. Ask them to hypothesize what will happen to the pH and alkalinity of both bottles after lemon juice is added.
- Add a teaspoon of lemon juice to both bottles, shake vigorously. Participants will use teststrips to compare pH and alkalinity again.
- pH should have decreased (become more acidic) in the bottle without baking soda.
- Ask participants to analyze their data in the analysis section. Was their hypothesis correct? Why or why not?

6. The last part of the teststrip measures water **hardness**. This is the mineral content of the water, including calcium and magnesium carbonates, bicarbonates, and sulfates. These minerals are one of the main buffers that cause alkalinity, so the two are often linked.
   - Water bodies with a higher hardness tend to have higher conductivity and pH.

How to interpret hardness values	
0-20 ppm	Soft
21-60 ppm	Moderately soft
61 - 120 ppm	Moderately hard
121-180 ppm	Hard
> 180 ppm	Very hard

7. Tell participants that water hardness is especially of interest when it comes to drinking water. When drinking water is very hard, it can cause

mineral deposits in pipes and fixtures, and makes soap less effective. We can do a simple experiment involving soap to compare if water is hard or not.

- Fill two bottles with equal amounts of water (roughly 250 mL). Add about 25 mL (5 tsp) of epsom salts to one bottle and shake vigorously.
- Participants will use teststrips to test the hardness of both bottles. Record this in the field notebook.
- Ask participants to hypothesize what (if any) differences there may be between the two bottles after we add dish soap and shake.
- Add one drop of dish soap to each bottle. Shake the bottles again. The one without epsom salts should produce more lather (bubbles).
- Ask participants to describe the two bottles in the observations section of the field notebook. Then ask them to analyze their data in the analysis section. Was their hypothesis correct? Why or why not?

Dissolved oxygen test kit

To do in Advance

1. This activity is best done on a rest day where the group will be in the same location all day.
2. Choose a site from which to collect samples. Aim for water that is roughly 2 feet deep, but safe enough for participants to take a sample without direct supervision.

Activity Procedure

1. Explain to participants that oxygen can be dissolved in water.
    - Most organisms need dissolved oxygen for respiration, the same way we need to breathe oxygen. These organisms are **aerobic**.
    - **Anaerobic** organisms don't need oxygen to survive.
    - Different aerobic organisms can survive with different amounts of dissolved oxygen, some need more and some need less
    - If there is a reduction in dissolved oxygen, many species may not be able to survive. An increase in dissolved oxygen can be equally as harmful.
    - Dissolved oxygen fluctuates diurnally. During the day, organisms respire and plants photosynthesize. At night, there is no oxygen being added by photosynthesis so the DO levels go down
2. Tell participants that we will conduct an experiment and hopefully see this diurnal change in action.
    - Conduct tests at different times at the same site. Test right when we arrive at camp, after dinner, overnight if anyone wakes up, when the instructors wake up, and right before we leave.
    - Participants can graph the changes in DO to see if there is a trend.
    - This may not work as well as it would down south because of the 24 hour sunlight. Hopefully there will be at least some small difference.
    - **Safety note:** if participants are testing DO overnight, the test location should be as close to the tents as possible. If they need to

get supplies out of the STEM bear barrel, emphasize that it's really important for them to close it properly when they're done.

Expedition mapping

1. Every few days, set up the expedition map and ask participants to reflect on what they learned and experienced throughout the trip.
2. Ask participants to think about how they can add this knowledge to the map.
3. Transfer water testing data from the field notebooks.
4. Encourage participants to introduce their maps to guests, elders, and mentors.
    - Invite guests to share their knowledge with participants when comfortable.
    - Invite the mentor or Elder to talk about their favorite place on the map or share stories about their community.
    - Encourage participants to add this shared knowledge to the map.

Water filtration and treatment

- Need to be careful about this, don't want to scare participants away from drinking water on trip
- Can talk about tannins (dissolved organic carbons) and dissolved nutrients and metals.

Post Trip

Expedition Mapping & Debrief

- Discussing patterns in our testing data, extrapolating data
- Ex. did water temperature change on moving vs still water?
- Did testing time affect dissolved oxygen?
- Higher water hardness tends to mean higher conductivity and pH
- Do rapids or moving water increase dissolved oxygen?

References & Gratitude

Actua. (2022). Community Mapping (Land Camp)

Actua. (2022). A Deeper Look: Climate Change in Aquatic Food Webs.

Betze, C. (2022). Salinity, Osmoregulation, Modified Toxicity [PowerPoint Slides]. University of Winnipeg.

Betze, C. (2022). Oxygen [PowerPoint Slides]. University of Winnipeg.

Betze, C. (2022). pH and Ocean Acidification [PowerPoint Slides]. University of Winnipeg.

Giesler, M. (2022). Freshwater Ecology Lab 1: Limnological Sampling and Field Gear - Backgrounder. University of Winnipeg.

U.S. Geological Survey. (2019). Alkalinity and Water. https://www.usgs.gov/special-topics/water-science-school/science/alkalinity-and-water#:~:text=Definition%20of%20alkalinity%3A%20%22The%20buffering,a%20fairly%20stable%20pH%20level%22

Health Canada. (2009). Guidelines for Canadian Drinking Water Quality: Guideline Technical Document - Hardness. https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidelines-canadian-drinking-water-quality-guideline-technical-document-hardness.html

Steam Experiments. (2020). Water hardness. http://steamexperiments.com/experiment/water-hardness/

Water Rangers. (2022). Education Testkit Field Guide.