Izaak Walton League Creek Freaks
Physical Observations and Measurements Procedures

Materials

- Boots
- Rope
- Tape Measure
- Yard stick
- Clothes pins
- Timer
- Data sheet on clip board with pencil
- GPS unit
- Calculator
- Whiffle balls with string – tie one end of string to the ball, measure out 3 feet, cut the other end so the string is 3 feet long

- **Before students arrive**, pick a representative location on the stream, paying attention to access knowing that students must walk across the stream to collect measurements. Limit group size to 10.

- **When students arrive,** briefly explain what they are going to do and why.

1. We will be recording information about what the stream looks and feels like, and even how it smells. Also, we will record information relating to the stream corridor (the adjoining banks/buffer zone/riparian zone).
2. We will be taking **measurements**, including stream width, depth and flow rate to determine the volume of water flow. This tells us, over time, if upstream activities are having an affect on the volume of water in the stream – which could contribute to erosion and associated problems.
3. We will record our coordinates using a GPS unit so that we and other groups can find this exact spot again in the field or on a map.

Enter General data, weather, and GPS coordinates

- You may want to record some of this information, including the GPS coordinates, on your own before the group arrives.
- For Creek Freaks program leader trainings, have the group complete this general information together. Show the group how to turn on GPS units, how to make sure they are using the correct coordinate system, and how to read/record the coordinates. Use decimal degrees, not minutes/seconds.
- For Creek Freaks students, discuss weather. Explain that weather is important to know because weather conditions today and over the longer term can greatly affect streams. [IE: Floods and droughts can change the shape of the stream channel and affect stream life. Recent rains may cause more pollution like fertilizers or oil to run off the land and the roads into streams. Colder air temperature may lower water temperature and allow more dissolved oxygen needed by stream life.] Read off weather choices and ask the group to pick the ones that apply.

Physical Measurements
An important physical parameter that is measured is stream flow, or discharge. The flow rate is first estimated through measurements and calculations, while the actual flow rate is measured using the float method. The stream flow will be calculated by multiplying the transect area and average velocity. The average stream depth and width of the stream are needed to determine the transect area of the stream in order to calculate the flow rate. The students, through what we call the "float technique" will collect the average velocity. Flow rates are recorded in units of cubic feet per second (ft^3/s or cfs). Stream flow (discharge) is expressed in the following equation:

Stream flow = area x velocity = cubic feet per second (cfs)

In advance of the students' arrival, two transects are prepared across stream sites where the data will be collected. The transects are selected with an eye toward average visual representation of the stream, and by accessibility. The transect provides the cross-sectional area of the stream. The students record the width (measured in feet) and depth (measured in feet) of the stream at this selected site, using a measuring tape and a straight-edge measuring stick (yard stick). The width is marked across the stream along the previously placed rope (secured at a 90 degree angle to the stream's current). Five evenly distributed locations across the stream transect are marked using clothespins. The depth is measured at the five marked locations with a straight edge measuring stick. The average of the depth measurements is recorded on the field data survey form.

The velocity of the stream at the monitoring site is measured using the "float technique." The float technique involves volunteers timing how long it takes for a float (a whiffle ball works well because it tends to run below the surface yet above the bottom, thus moving at an average speed within the water column) to travel a specified distance from upstream to downstream. In this case, we will use whiffle balls with a 3-foot string attached. One person releases the float in the main current at the point on the transect with each clothespin while holding securely onto the end of the string. The end of the string should be held close to the water surface at the transect point. Another individual uses a stopwatch to determine the amount of time it takes the float to travel the specified distance. The five float trails are released at the five evenly distributed points (where the stream depth was also measured). Velocity is then calculated by first adding all the times of the five runs together and then dividing by five to get the average time, then dividing the distance the float traveled by the average amount of time it took the float to go that distance. Average velocity is recorded in a unit of feet per second (ft/s). The average velocity is calculated and recorded on the field data survey form.

***English units are used for physical measurements since this system is what is most commonly used in the field of hydrology.*

Begin physical measurement with students.

1. Have students put on waders (if you are rotating students through different stations, including physical monitoring, have them put on waders as a larger group and keep the same waders for the entire field session).
2. <u>Select an on-land data recorder</u> and give her/him paperwork on clipboard.

Width (width can be done in advance and explain what was done to students to save time)

1. Student <u>carries</u> one end of the <u>rope across the stream</u> where it is <u>secured around a tree</u>, shrub or boulder, <u>1 to 2 feet above water level</u>. **[Note – program leaders may want to set up the transect rope and/or measuring tape and clothespins ahead of time, depending upon the amount of time students will be at the physical monitoring station.]**

2. On the near bank, directly across, a student secures rope in a shrub/tree at same height, making rope taut.
3. Student carries the end of the tape measure across stream and holds it where water meets the bank.
4. Near-bank student holds tape measure taut and calls out width of stream for recording.
5. Stream Width is divided by 6 to establish 5 equidistant points across the stream from shore to shore. Use the calculator if needed, or have students do the division.
6. Students then clip clothespins to the rope at measured equidistant points.

Depth

1. Measuring depth - Ask if anyone has ever walked across a stream thinking it was shallow and then hit a deep spot. Streams are not the same depth all the way across. We are going to measure the depth at various points across the stream.
2. In-stream students, using a yardstick, measure steam depth (in inches) below each clothespin. Measurements are called out to recorder to place in data sheet.
3. (At some point, these measurements in inches need to be converted to fractions in feet, and than decimal equivalents. (Example: 6” = 1/2 of a foot. 1/2 foot converts to .5 feet. Another example: 20” = 1 2/3 feet. 1 2/3 feet converts to 1.66 feet.) This is necessary in order to simplify the math calculations in determining stream flow later. This can be done using a calculator at the stream site or back at the office by the program leader.

Velocity

1. Explain that stream velocity is how fast the water is moving (distance over time or meters per second). We will measure velocity using a whiffle ball and stopwatch. The ball has a string attached that is one meter long. Demonstrate how the students should hold the string and ball under the measuring tape at the transect and release the ball, but not the string, when the timer says “GO.”
2. Choose a student to release the ball, a student to be the timer, and a student to record. Walk the students through these steps:
    a. Hold the ball (with three-foot string attached) with one hand and the end of the string in the other. Hold both of these directly below the one-meter mark on the tape measure.
    b. Have someone with a stopwatch say "GO," while you release the ball, but continue to hold the string at the one-meter mark.
    c. When the ball floats to the end of the string (3 feet), stop timing. Record in seconds the time it took the tennis ball to travel the one meter.
    d. Repeat the procedure at each of the five equidistant points along the transect (at each clothespin).
3. Ask the group to note that velocity is not the same at each point along the transect. That is why we take velocity measurements at different points across the transect. Then we can add our five velocities together and divide by three to get average velocity.
4. This information, along with the stream’s water depth and width, is needed to calculate the flow rate, which is measured in cubic meters per second. This is a measure of how much volume of water the stream moves each second. If we have time, we can use the white board to show the calculation of stream flow.
5. Calculate average float time by adding results for trials 1-5 and dividing by 5. Use calculator as needed.

6. Find average velocity by dividing 3 (because each ball traveled three feet, which is the length of the string attached to the whiffle ball) by the average float time in seconds to get velocity in feet per second.
7. Calculate area of stream transect by multiplying average stream depth by stream width.
8. Calculate flow rate by multiplying Area of Stream Transect by Average Velocity.

Visual Observations

- In recording the **general characteristics/observations** of the stream and the stream corridor for the data sheet, the recorder calls out options to look for (and smell) in the stream (this is asked of students in the stream) and along the stream corridor – and checks appropriate boxes that reflect responses. There can be more than one box checked for each observation. Include Riparian Zone width with these visual observations.

Water Color

1. Read off water color choices and ask the group to pick the ones that apply.
2. Discuss what those color choices could mean using the information below:
   - **Clear –** Clear water doesn't necessarily mean clean water, but it could indicate low levels of dissolved or suspended substances.
   - **Brown –** Brown water is usually due to heavy sediment loads.
   - **Blackish –** Blackish water is usually is caused by a natural processes of leaf decomposition.
   - **Foamy –** Foam can indicate detergent in the water, or can be a result of natural causes like water bubbling over rocks and picking up oxygen.
   - **Oily Sheen –** Oily sheens can be caused by petroleum or chemical pollution, or they may also occur naturally as byproducts of decomposition. To tell the difference between petroleum spills and natural oil sheens, poke the sheen with a stick. If the sheen swirls back together immediately, it's petroleum. If the sheen breaks apart and does not flow back together, it is from bacteria or plant or animal decomposition.
   - **Milky –** A milky appearance may be caused by salts in the water.
   - **Muddy –** Muddy water is due to excess sediments in the water. This sediment can clog fish gills or smother fish eggs.
   - **Scummy –** Can indicate a variety of natural causes or pollution sources.

Stream Bottom Appearance

Similar to water color, colors on the stream bottom may have natural or human-induced causes.

Water Odor

1. Read off water odor choices and ask the group to pick the ones that apply.
2. Discuss what those odor choices could mean using the information below:
   - **None –** The water has no odor.
   - **Musky –** Musky odors may result from natural or human-induced activities.
   - **Rotten Egg –** This odor can be caused by hydrogen sulfide gas, a by-product of **anaerobic decomposition** (rotting without oxygen). This is a natural process that occurs in areas that have large quantities of organic matter and low dissolved oxygen. It may be caused by excessive organic pollution.
   - **Oil/Petroleum –** Petroleum or chemical smells can indicate serious pollution problems from a direct source, such as industry or storm sewer runoff.

- **Sewage/Manure –** These smells can be common in air (especially near farmland) but should NOT be what our water smells like. It is important to differentiate whether the odor is coming from the water or the air.

Algae Color and Texture
Algae feels slimy. A great deal of algae may indicate too many nutrients in the water. Sometimes more algae will appear in the spring after snowmelt releases extra nutrients into the stream. However, take note of the percent and type of algae present in the stream to make sure it is not increasing over time.

Algae Amount
See above.

Stream Bed Stability
An unstable stream bed can mean that soil is eroding from the bottom of the stream and may indicate water quality problems. When standing in the stream, determine how frequently the bed sinks beneath your feet.

Riparian Zone Width

1. Have the group face upstream and estimate width of the riparian zone [area along the stream with trees, shrubs, or grasses] on first the left bank and then the right bank.
2. Discuss why this riparian zone is important. [Tree roots hold the bank together during floods and provide habitat for stream life. Shrubs, grasses, and other plants slow and filter runoff water before it enters the stream. While a zone as little as 10 feet may help keep banks from eroding, 30-50 feet is needed for nutrient removal and more than 100 feet is needed for wildlife habitat.]

Stream Channel Shade

1. At the stream transect looking upstream, have the group estimate what percent of stream is shaded by trees and overhanging vegetation for as far upstream as you can see when standing at the stream transect.
2. Ask the group which is better for the stream – more canopy cover or less. [More]. Ask why. [Shade means the water will be cooler, which means more dissolved oxygen for stream life.]

Stream Bank Composition

1. Explain that we are going to look at the stream banks because the shape and condition of the banks give important information about the health of the stream and what kind of life it can support. Steep, cut, and eroding banks are not as healthy as gently sloped banks with trees and grasses growing on them. Ask the group why we don't want eroding banks. [Erosion means too much dirt in the stream which clogs fish gills and smothers bugs. It also means there are not a lot of good places in the stream for fish and bugs to live].
2. Ask the group to face upstream and look at the banks. Read off the options and check off the ones the group picks. Make sure they are thinking about both banks together.
3. Ask the group if they think the stream is healthy based on the banks.

Stream Bank Erosion

1. Ask the group to face upstream and look at the banks. Read off the options and check off the ones the group picks. Make sure they are thinking about both banks together.
2. Ask the group if they think the stream is healthy based on the banks.