**Activity Description and Teaching Materials**

**Title: Quantifying Our Stream: A Field Lab on Stream Channel Morphology and Stream Discharge.**

*Introduction*

In this field and lab activity, students will collect field data at a local stream and will later analyze and interpret this data in the lab to draw conclusions about the stream behavior and the natural and human factors that affect it.

This lab is divided in two parts, a field lab part and an in-class lab part. For the field lab, we will walk to our local stream, Boeing Creek, to make a variety of observations on the stream channel and to take measurements of channel depth and stream velocity at selected cross-sections along the stream course. We will then come back to classroom to analyze the data we collected, calculate the stream discharge and to draw conclusions about the stream’s dynamics based on our field observations and considerations about the influence of natural and human factors. Finally, we would explore and suggest sustainable stream management options for stream conservation and restoration.

*Materials check-list:*

*Instructor’s list:*

* Wood stakes (2 for each cross-section to measure)
* Hammer (1 per team)
* Colored flagging tape (1 per team)
* Permanent marker (1 per team)
* Measuring rods (1 per team)
* Measuring tapes (1 per team, length sufficient to measure across the widest stream section)
* Flow-meter (propeller-type) or other instrument/method to measure stream velocity (since these are relatively expensive instruments, may need to have teams share one and account for consequent time constraints)
* Graph paper

*Student’s list*

* Note pad and pen to record data collected (one for each student)
* Digital camera (optional)
* Water-proof boots (optional)
* Weather-resistant field note book and pen/pencil or regular note pad or note-book with plastic sheet protector (one for each student)
* This lab instructions including Table.1 (one for each student)
* Calculator (at least two per team)
* Clothing adequate for the weather

**PART 1: FIELD LAB**

**Stream data collection**

Instructions:

1. ***Weather and Stream channel observations:***

At the location along the stream assigned to your team by your instructor, make the following observations (write them down on your field note-book)

1. *Weather conditions:*

* What are the weather conditions today?
* Is it raining, is it dry?
* Has it rained in the last 24 hours? If so, how much? (give an approximate estimate-the actual amount of precipitation can be checked later)
* Do you see a lot of water flowing in the stream? Is the water clear or turbid (muddy)?

1. *Stream channel morphology observations*:

In your notebook, draw a sketch (map view) of the stream channel and record any of the following morphological features that are visible at this location along the stream or its banks.

* Is the channel straight or curved at this location?
* Is there a meander at or near this location?
* Can you see any stream bar (point bar, mid-channel-bar?)
* Can you see any evidence of bank erosion (cut-bank)?
* Can you see any evidence of deposition or recent flooding?
* Can you see any evidence of mass wasting on either side of the stream channel?

1. *Photo documentation:*

Consider taking photos that you might later want to review about the morphology of the stream at this location.

1. ***Stream cross-section and velocity measurements:***
2. In your team, divide these tasks as follows:

* *2 students who will get across the stream to plant the stakes, string the flagging tape, and measure and mark intervals on it*
* *1-2 students who will record depth and velocity data in Table 7.1 and do some calculations*
* *2-3 students who will measure the width of the channel (you should take turns)*
* *2-3 students who will measure water depth and stream velocity*

1. Using a hammer, plant the two stakes at the opposite sides of the stream channel at the water’s edge, along a line perpendicular (at right angle) to the stream flow direction.
2. String the flagging tape across the stream channel and tie ends to each stake.
3. Using the long measuring tape, measure the channel width in feet from stake to stake along the tape and record it at the top of Table 7.1 in the space provided. Table 7.1 will be the table where you will record all stream measurements.
4. Using a permanent marker, mark the tape at 1 foot intervals with zero being at one end of the tape (on the water’s edge) and then 1, 2, 3 etc. At the zero mark the depth of the water is obviously zero. If the stream’s width is not an even number of feet, mark the last foot and then mark END on the other edge of the water as well as the number of inches beyond the last foot mark.
5. Move to the 1 ft mark on the tape; using the measuring rod, measure the depth of the water in inches and feet (from the surface of the water to the stream’s bottom).
6. For each depth measurement, make sure at least two people are recording the data that are being called out.
7. Once you have collected all the depth measurements, calculate 6/10 of that depth to get the depth of the water where the velocity is the average. This is called “the 6/10 rule” and we already discussed why this is the best depth to take velocity measurements.
8. At each foot, measure the stream’s velocity at 6/10 of the stream’s depth using the instrument your instructor provided and taught you how to use. Make sure you take the measurements at the same spots where the depth was measured. Make sure the velocity data is recorded by the students who are working as recorders.

**PART 2: IN LAB DATA ANALYSIS**

**Analyze and interpret data collected in the field; calculate stream discharge**

Instructions:

1. Using graph paper provided by the instructor, construct a cross-section of the stream channel using the graph in figure 1 as a model. (Use graph paper NOT the sample graph).

On the horizontal axis, mark increments of one foot using the large squares starting from zero on the left (at the water edge at which the first stake was planted) to the other stake across the stream.

On the vertical axis, mark increments of one foot with the highest depth at the bottom of the stream (at the bottom of the vertical axis) and 0 as the water’s surface at the top.

1. Now look up the depth and distance measurements you recorded in the field and plot the data as points in the graph. Round your data to the nearest inch.
2. Draw a curve that connects the dots. This is the channel cross-section.
3. Now look back at the sketch of the stream and your notes on stream channel morphology (item 1 in part 1). Compare the cross-section with your sketch, notes and photos if you have taken any. Can you interpret any variations in the channel depth in terms of specific landforms that you observed at that cross-section? (Hint: stream bars, cut-bank etc.). If so, label these features on your cross-section and explain here:
4. Look at the data on velocity that you collected in the field and recorded in Table 7.1 and answer the following questions.
5. Apart from the exact water’s edge, where, along the width of the stream do you observe the lowest velocity?
6. Where in the cross-section do you observe the highest velocity?
7. Try to explain why you observe these values of velocity where you do.
8. Look back at your cross-section. Visualize everything above the curve as water that is crossing the stream channel at that location. Now you will calculate the stream discharge. The stream discharge is the volume of water that passes through a given cross-section of the stream at a given time.

It is calculated using the following formula:



Where:

*D* is the discharge

*A* is the area of the cross-section

*v* is the average velocity of the stream

1. To calculate the area of the cross section, you need to count all the squares included in the area above the curve you drew in #3. To do so, first count all the full squares, then count each half and quarter squares and add them all up to make full units. Add all the numbers up and round up the total to the nearest quarter foot. Since this is an imprecise method to calculate the area, work individually within your team and then share the data for the total area with the rest of the team and use an average. (Ask your instructor to confirm that the area calculations for each team member are within an acceptable range).
2. What is the area of the cross-section of the stream?
3. Average all the data on stream velocity collected in the field and recorded in Table 1

What is the average stream velocity at this cross section?

1. Using the equation in #6. , calculate the stream discharge at the cross-section your measured.
2. Share your results on stream discharge with the other teams. Did the other teams get higher or lower discharge on a different cross-section of the stream?
3. Formulate a hypothesis on the potential influence of at least two different factors that may affect the difference in water discharge between the cross sections. Make sure that this hypothesis actually reflects observations you have made in the field when you collected the stream data.

You may want to consider some of these factors: stream channel width and depth, type of sediment present on the stream bed, proximity to natural or artificial waterfalls or rapids, springs and tributary channels, erosional and depositional landforms, human modifications of the stream channel.

1. Would you expect the discharge of the stream at your location to be higher or lower in periods of higher precipitation? Why?
2. Consider the potential effect on stream discharge caused by human modification to the watershed upstream of the stream cross-section you analyzed.

List at least 3 different direct effects of urbanization in the upper portion of the watershed and explain how they can affect water discharge, erosion and potentially cause flooding at the location you analyzed.

1. Go to <http://www2.cityofseattle.net/util/tours/seastreet/slide1.htm>

Explore some of the water management interventions adopted by the City of Seattle to mitigate environmental impacts on the watersheds of some North Seattle neighborhoods.

Do you think similar projects may benefit the Boeing Creek watershed? Do you think these actions are feasible in this watershed? Why or why not? Be specific and articulate which actions you would suggest to local water management officials at the City of Shoreline.

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| Table 1: Field Stream Data | | |
| Width of the stream=\_\_\_\_\_\_\_\_ft  Cross-section orientation \_\_\_\_\_\_\_\_\_\_\_\_  Latitude and Longitude coordinates (if GPS is available) \_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | |
| Distance from first stake | Depth (in ft and inches) | Stream velocity (in ft/sec) |
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Figure 1 Sample graph for cross-section of the stream

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| 0  Water depth  (feet)  1  2  3  4  5 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Stream’s width (feet)