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SUBSTRATE

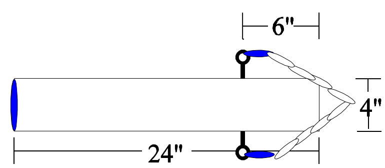
I. General

Substrate composition will be determined by visual estimation of dredge contents and will be periodically calibrated to insure accuracy. The substrate will be categorized in varying proportions as belonging to four established size classes.

II. Materials & Methods

A. Sampling- Hesse Sampler

1. 24 in.x4 in. metal pipe
2. 4 in. sheet metal disk
3. 2, ¼ in. eyebolts and nuts
4. 3 feet of sturdy chain
5. 2 screwable chain links
6. White spray paint
7. ¼ in. minimum diameter rope (length determined by user)
8. Diagram:



B. Analysis-Calibration

a. wash bottle
b. jug for storing tap water
c. funnel
d. metric ruler
e. sorting tub/tray
f. 2 mm ($^{-}1\phi$) screen sieve
g. .0625 mm (4ϕ) screen sieve
h. 3 plastic graduated cylinders: 1000 ml, 100 ml, and 10 ml
i. 1 plastic graduated beaker: 1000 ml

III. Procedure

A. Size Classes and Data Recording

1. The frequency of each of the gravel, sand, and silt/clay size classes

represented will be rated from 0 to 100%.

2. The sum of the gravel, sand, and silt/clay samples must always equal 100% unless Cobble/Boulder is ubiquitous where it would sum to 0%.
3. Cobble and Boulders will be rated on an ordinal scale as either present or absent.
4. If present, their representation will be classified in one of three categories: ubiquitous, dominant, or incidental.
5. Classification / Size Range (Gordon et al. 1992)

<u>Classification</u>	<u>Size Range</u> (Gordon et al. 1992) (mm)	(ϕ)
Cobble and Boulder	> 64	$<{}^{-}6$
Gravel	64-2	${}^{-}6$-${}^{-}1$
Sand	2-.0625	${}^{-}1$-4
Silt and Clay	<.0625	>4

6. Cobble and Boulder Examples
   a. *Ubiquitous* bedrock, bank of rip-rap, cobble-bed in a swift, shallow riffle
   b. *Dominant* cobble bed with interstitial sand, boulders covering more than half of the stream bed
   c. *Incidental* cobble or boulder which forms less than half of the stream bed or occurs anomalously

B. Sampling - HESSE SUBSTRATE SAMPLER

1. Design
   a. The cylinder is a 4" inside diameter, metal pipe.
   b. One end is capped with a welded on plate of sheet metal or threaded pipe end-cap.
   c. 2 holes (1/4”) are drilled one quarter the length of the pipe from the open end. Place an eyebolt in each hole for chain attachment.
   d. Using the screw links, attach an end of the chain to each eyebolt.
   e. The dredging rope must be attached to the exact center link of the chain to ensure proper orientation of the mouth of the dredge when it is pulled.
   f. Once given the pipe, any welder or metal fabricator should be able to easily produce this.
   g. Spray paint the inside of the pipe white so that it can be seen to be fully clean after each usage.
2. Procedure
   a. Choose the approximate midpoint of the area sampled to collect the substrate.
   b. Tie rope to boat and lower the sampler to the river bottom.
   c. Drag the cylinder until it fills by letting it dig into the substrate
      (1) Hold rope while dredging. Note presence and frequency of any cobble-boulder felt while sampling.
      (2) While it is impossible to verify the presence of bedrock,

boulders, or cobble at 30 ft., the behavior of the sampler and feel on the line should convey detailed enough information to allow tactile differentiation from gravel, sand, and silt/clay.

d. A sample is considered complete when it is obvious that the dredge is at least half full or when the distance between the midpoint and endpoint of a sub-sample has been dredged.

e. Raise the dredge and bring aboard the boat.

f. Empty the contents into a shallow tray.

g. Estimate and record the percentage of each size class represented (having a standardized vial or jar for each size class, filled with particles spanning the range within each size class is recommended).

h. Some cobble sized substrate may be collected in the Hesse sampler. If its presence in the sampler is considered representative of the entire stream bed, then count it as such. Be careful not to overestimate the cobble frequency by assuming that an incidental piece of cobble in the stream bed which constitutes half the sample volume is a dominant substrate type.

i. Sample and record an estimate of substrate composition at each site where a gear is used.

IV. Calibration

A. Calibration requires comparing the subjective data with quantitative data obtained after sieving.

B. Each team member who might be responsible for substrate sampling should calibrate before the study, and monthly thereafter.

C. Procedure

1. Choose several river sites that differ in substrate and follow the routine method for the Hesse Sampler.
2. Sieve the sample collected with the Hesse sampler through two sieves (2 mm, and .0625 mm) which will fractionate the sample into 3 size classes.
3. Air dry each substrate fraction thoroughly because mass or volume of substrate finer than 8 mm is significantly affected by the presence of moisture (Gordon et al. 1992).
4. Prepare a graduated container by filling it one quarter to half full of tap water (never use river water) - Record the volume.
5. Add each size class to an appropriately sized, graduated container.
6. Leave at least the last tenth of the graduated container empty.
7. Fill the wash bottle with a known volume of water and use it to wash all the particles of a particular separated size class into the graduated container.
8. Calculate the volume (ml = cm^3) of each of the three size classes.

9. If an odd shaped or large piece of gravel is visually indistinguishable from cobble, determine its size (mm) by measuring the axis which bisects its longest and shortest axes (Gordon et al. 1992).
10. Compare the percentage by volume of each size class with the percentage determined by visual inspection of the Hesse sampler contents.
11. Example of a calibration data sheet:

Size Class	% Hesse Sampler Visual Estimate	Actual volumetric percent	Difference
Gravel			
Sand			
Silt/Clay			
			Cumulative Difference

12. If the cumulative difference for all three size classes between the percent by volume and the percent by visual inspection is > 20%, more training is needed to improve the subjective estimates.

V. Reference:

Gordon, N.D., T.A. McMahon, and B.L. Finlayson. 1992. Stream hydrology: an introduction for ecologists. John Wiley and Sons Ltd., New York.

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