Effect of Sampler Dimension and Sampling Time on Measured Bedload Transport Rates and Particle Sizes in Gravel-Bed Streams

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Abstract. The transport frequency of bedload particles in the size class that is just beginning to move is very low. A threshold transport rate can be set to one particle per m width per hour. For accurate samples of marginal transport rates of pea gravel and cobbles, the sampler bag must have a mesh small enough to retain small gravel particles, while the sampler opening needs to be large enough for cobbles to enter. The bag size also needs to be large enough to hold the large quantity of smaller bedload particles that accompany cobble transport at the onset of motion. The sampling duration must be of equal or larger length than the transport frequency of the largest mobile particle size to be collected in the sampler. Bedload traps developed at CSU as initial motion samplers have these qualities.

The traps consist of a 0.3 by 0.2 m aluminum frame onto which a net 0.9 m long with a 3.9 mm mesh width is attached. For the 1-hour duration of each sample, the frame is fastened to a ground plate anchored on the stream bottom. This arrangement frees the operator from holding the traps and avoids unwanted particle pick-up during trap setting or retrieval. Several bedload traps are deployed across the stream in 1 - 2 m increments. Bedload has been sampled with the bedload traps in four mountain gravel-bed streams with predominantly plane-bed or step-pool morphology. At each stream, bedload was also collected with a 3-inch Helley-Smith sampler using a standard sampling scheme (2 minutes per location spaced at 0.5 - 1 m increments across the stream). The dimension and sampling schemes of the bedload traps resulted in sampling intensities of 15 - 30% (100% = sampling the entire stream width and time), while sampling intensity reached only 0.4 - 0.5% for the Helley-Smith; a difference of a factor of about 50.

At all four streams, bedload traps provided gravel transport rates that increased steeply with discharge. Power function rating curves fitted to the data were well-defined ($0.76 < r^2 > 0.91$) and had high exponents between 8 and 16. Gravel transport rates obtained from Helley-Smith samples had larger data scatter ($0.35 < r^2 < 0.59$) and lower rating curve exponents (1.7 and 3.6). For any given stream, the rating curves from the two samplers crossed between 1 and 1.3 times bankfull discharge. At 0.5 of bankfull flow, the bedload trap rating curves were up to 4 orders of magnitude lower than the Helley-Smith rating curves. At 1.5 of bankfull flow, the bedload trap rating curves were up to 2 orders of magnitude higher. Bedload trap rating curves for fractional transport rates and the flow competence curve (increase of the D_{max} particle size with discharge) also had less scatter (higher r^2) and higher exponents than those for the Helley-Smith samples. These differences are attributed to the different sampler dimensions and sampling schemes as well as to the avoidance of unwanted particle pick-up when using the bedload traps.

The differences in sampled particle-size distributions and transport rates have implications for computed initial motion conditions and annual bedload discharge. Critical discharge for initial motion of various gravel sizes is higher when computed with the bedload traps, while annual bedload discharge computed from the bedload traps is smaller for years of low flow and higher for years with high flows than bedload discharge computed from the Helley-Smith samples.