Testing hydraulic efficiency of pressure difference samplers while varying mesh size and type

Kristin Bunte, Matthew Klema, Taylor Hogan, Christopher Thornton
Department of Civil and Environmental Engineering, Colorado State University

Abstract. Pressure-difference bedload samplers are used with a variety of different mesh bags that vary in mesh width, density of the netting fabric, bag length, and bag shape. Some effects of bag properties on hydraulic efficiency (= ratio of flow velocity measured in the presence and the absence of a sampler) have been assessed in case studies (e.g., higher sampling efficiency for longer bags, higher hydraulic efficiency for higher percentage of mesh open area and higher hydraulic and sampling efficiency for flexible nets in the presence of organic debris). However, a systematic study to investigate how sampler bags with various properties affect hydraulic efficiency of various samplers in various flows is lacking. Flume experiments were conducted at CSU to systematically investigate the effects of mesh size, the % mesh opening area, the degree of bag clogging and discharge on the hydraulic efficiency of three pressure difference samplers: the 6" x 12" Toutle River 2, the 4" x 8" Elwha, and the 3" x 3" BL-84. Point velocities were measured at various locations in front of each sampler for three target velocities of 1.5, 2.5 and 3.5 ft/s. Besides runs without samplers in the flume and with each sampler but no net attached, we tested 0.25 and 0.5 mm nets for BL-84, 0.5, 1, and 3.6 mm nets for Elwha, and 0.5, 1, 2, 3.6 mm nets for the TR2 samplers. For each sampler, we also tested two nets that were partially blocked with plastic and/or gravel to mimic the effects of clogging by sediment and organic debris, conducting a total of 73 runs. Preliminary results showed that three factors determine hydraulic efficiency for the three samplers. The size of the sampler has the largest effect. For a specified flow and 50% mesh open area, hydraulic efficiencies range from 95% for the BL-84 to 125% for the TR2 with the Elwha sampler roughly in the middle. The second largest effect is exerted by the % mesh open area. This parameter combines the ratio of mesh width to thread diameter as well as the percent of net surface area blocked by clogging and hefty seams. Nets of different mesh width and weave density, sewing style and clogging typically have open areas within 30 to 60%, and hydraulic efficiency differs by 5 to 10% over this range for all three samplers and flows. Discharge seems to have the least effect on hydraulic efficiency for a given sampler and % open area. For the BL-84 and a 50% open area, the hydraulic efficiency differs by 3% over the tested range of flow velocities (1.5 to 3.5 ft/s). Those differences increase to 5% for the Elwha and 10% for the TR2 sampler. In summary, the largest sampler (TR2) has the highest hydraulic efficiency, and this sampler's efficiency reacts more strongly to variations in discharge and in the % mesh open area than the smaller samplers. As a result, the TR2 sampler is more prone to oversample bedload and react to changes in flow and net properties than smaller pressure-difference samplers.