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Practical Guidelines for Estimating Sand Bed Load in Rivers by Tracking Dunes

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Understanding and quantifying bed load transport is of crucial importance to the effective management of rivers with sand or gravel-dominated beds. However, a practical and scalable methodology for reliably estimating bed load transport remains elusive. A popular approach involves calculating transport from bed form geometry and celerity extracted from time-series of bed elevation profiles (BEPs) acquired using echosounders. Practical application of these methods requires decisions about sampling design based on channel and bed geometry and available equipment. Here, we explore the sensitivities of computed bed load estimates to various candidate bed sampling strategies. Using two sets of repeat multibeam sonar surveys collected on the Colorado River in Grand Canyon National Park with a large spatiotemporal resolution and coverage, we test three different techniques of acquiring BEPs (repeat multi-beam, single beam, and multiple single beam sonar) to discern what inconsistencies may arise by using different field methods to acquire data. Significant differences arise between repeat multibeam and single beam sonar bed load transport estimates, caused by dune geometries changing in response to unsteady flows. Multiple single beam sonar systems can potentially yield comparable results to repeat multibeam data, but rely on detailed knowledge of bed form geometries and flow conditions that inform optimal beam spacing and sampling rate. These results serve as a guide to both designing an optimal sampling strategy, and when comparing bed load transport estimates from different sonar configurations.