Supporting Information

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SI Materials and Methods

Alfalfa Sprouts. We seeded ≈2.6 kg of alfalfa (1.2 seeds/cm^2) by hand throughout the flume basin, while a low flow irrigated the basin. We would then allow the alfalfa to grow for 7–10 days, depending on the air temperature, before we commenced the run. During this period, five 1,000-Watt metal-halide grow lights were suspended over the channel to promote growth, and water was supplied by an irrigation flow not sufficient to transport sediment. This caused the alfalfa on the margin of the basin to die off more quickly than the alfalfa near the channel. We typically ran the flume for 15–20 h over the course of 2–3 days, by which time the alfalfa started to die because it had been submerged for an extensive period. We would then replant the alfalfa outside of the bankfull channel and allow an additional 7–10 days for the alfalfa to grow. During the course of this experiment, we seeded alfalfa 11 times. The alfalfa sprouts have one primary tap root, with very small secondary roots. The rooting network differs from mature riparian vegetation, which, typically has a broader rooting structure, but is similar to the rooting structure of young cottonwood (*Populus* sp.) and willow (*Salix* sp.) trees (1).

Sediment. Of the 102 kg of coarse sediment fed during the experiment, 82% was fed during the first 71 h (Fig. S1). This is partially due to increased supply during high peaks and also because we increased our efforts to eliminate aggradation at the upstream end of the flume as the experiments progressed. Aggradation upstream of the first bend forced water onto the floodplain and out of the channel and reduced in-channel discharge downstream. During the steady portion of the experiment, much of the coarse sediment was derived from erosion of the aggraded bed upstream of the first bend. We used two types of commercially available lightweight plastic sediment as model sand. Both types of plastic ranged between 0.25–0.42 mm in diameter and were not cohesive. The lightweight plastic for the first 71 h of the experiment was Urea type II, which has specific gravity of 1.5. For the remainder of the experiment, we replaced it with a lighter plastic (Clear-cut), which had a specific gravity of 1.3. The fine feed rate during the steady bankfull portion of the experiment (3 kg/h) is equivalent to 460 mg/L, which is within the range of suspended sediment concentrations during peak flows (2, 3). The 0.8-mm diameter sorted coarse sediment had a standard deviation of 1.3 mm. The average shear velocity (u^*) in our experiment was 1.5 and 2.4 times the settling velocity (W_s) of the plastic sediment (as reported in reference 4). The calculated critical shear stress was reduced by 66% (for Clear-cut) and 54% (for Urea type II) relative to quartz sediment of equivalent settling velocity. The critical shear stress for the plastic sediment was calculated using the best-fit line to the Shields curve proposed by (5).

Converting Experimental Time to Field Time. Once a steady channel width developed, migration rates were calculated using the methods described in Micheli and Kirchner (6). Extrapolating our experiments to the field requires scaling our experiments to the field and then estimating the data to years (the typical time unit of migration rates), by estimating the exceedance probability of bankfull floods. In Froude-scale models like this experiment, time is scaled by multiplying the experimental time by the square root of the scaling factor (5, 7, 8). Field time is converted to experimental time by:

$$t_{\mathrm{flume}} = \sqrt{\lambda}\, t_{\mathrm{field}} \qquad [1]$$

where t_{flume} is the experimental duration, λ is the scaling factor (and is less than 1), and t_{field} is the equivalent time in the field.

Assuming λ ranges between 1/50 and 1/100, our 136-h experiment corresponds to 40 to 57 days of bankfull or greater flow. Although there is significant variation, bankfull flow is exceeded ≈8 days per year in Wyoming (9) and Colorado (10). Nixon (11) found that bankfull discharge occurred 2.2 days per year for 29 rivers in England and Wales, but this was based on only 5 years of data at each river, whereas much of the data from Andrews and Nankervis (10) is from gauges with at least 15 years of data.

1. Amlin NM, Rood SB (2002) Comparative tolerances of riparian willows and cottonwoods to water table decline. *Wetlands* 22:338–346.
2. Walling DE, Webb BW (1981) in *British Rivers*, ed Lewin J (George Allen & Unwin, London, UK), pp 126–169.
3. Simon A, Dickerson W, Heins A (2004) Suspended sediment transport rates and the 1.5-year recurrence interval for ecoregions of the United States: Transport conditions at the bankfull and effective discharge? *Geomorphology* 58:243–262.
4. Rowland JC (2007) Tie channels, PhD thesis, University of California, Berkeley, CA.
5. Parker G, Toro-Escobar CM, Ramey M, Beck S (2003) The effect of floodwater extraction on the morphology of mountain streams. *J Hydraul Eng* 129:885–895.
6. Micheli ER, Kirchner JW (2002) Effects of wet meadow vegetation on streambank erosion. 1: Remote sensing measurements of stream bank migration and erodibility. *Earth Surf Processes Landf* 27:627–639.
7. Yalin MS (1971) *Theory of Hydraulic Models* (MacMillan Press, London, UK), p 266.
8. Peakall J, Ashworth P, Best J (1996) in *The Scientific Nature of Geomorphology: Proceedings of the 27th Binghamton Symposium in Geomorphology*, eds Rhoads BL, Thorn CE (John Wiley & Sons, Chichester, UK), pp 221–253.
9. Dunne TE, Leopold LB (1978) *Water in Environmental Planning* (W.H. Freeman, New York, NY).
10. Andrews ED, Nankervis JM (1995) in *Natural and Anthropogenic Influences in Fluvial Geomorphology*, *Geophysical Monograph 89*, eds Costa J, Miller AJ, Potter, KW, Wilcock PR (American Geophysical Union, Washington, DC), pp 151–164.
11. Nixon M (1959) A study of bankfull discharges of rivers in England and Wales, *Proceedings of the Institution of Civil Engineers*, *12*, *Paper* 6322:157–174.

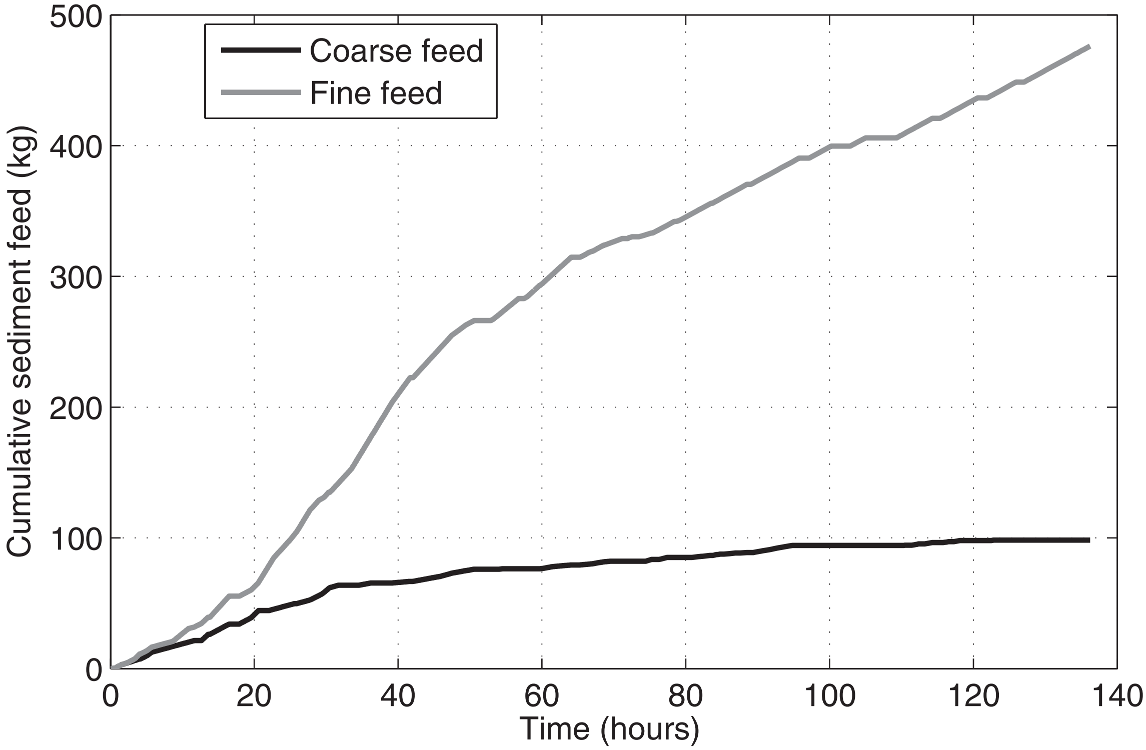
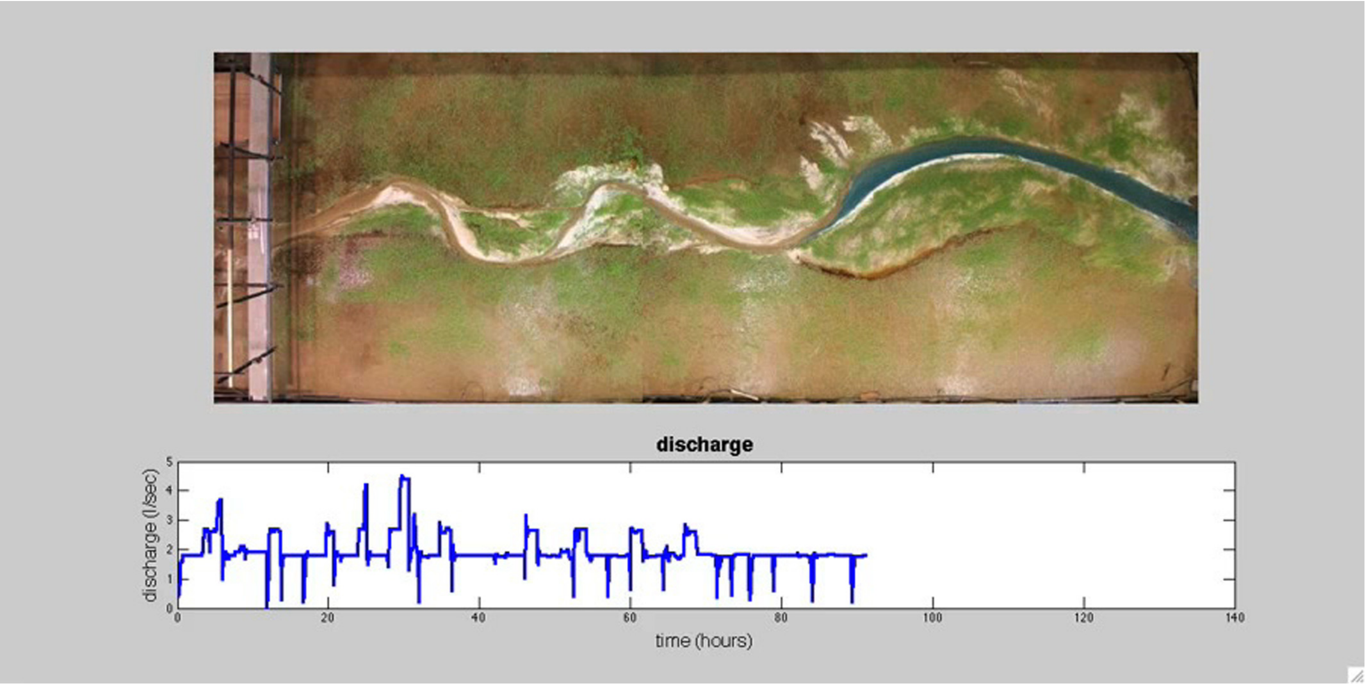


Fig. S1. Cumulative sediment feed for coarse (black) and fine (gray) sediment. The coarse feed was adjusted to prevent aggradation upstream of the first bend, and the majority of the coarse feed was supplied in the beginning of the experiment.



Movie S1. The video consists of overhead photographs of the flume every 20 min. Flow is from right to left, and the entire flume width is shown. The brown sediment is sorted coarse sediment that made up the bed and floodplain before the experiments, the white sediment is fine sediment, and the blue sediment is identical to the brown, but fed from the upstream end of the flume.

Movie S1 (MOV)