SEDIMENT TRANSPORT AND CHANNEL FORM IN A RECONFIGURED GRAVEL BED CHANNEL

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Abstract One of the most challenging aspects of any river restoration project involving channel reconfiguration is properly accounting for sediment flux through the restoration site. When stream restoration projects fail, it is often the result of unanticipated aggradation and degradation of the reconfigured channel, which leads to significant changes in channel shape and planform. We developed a sediment budget for a large channel reconfiguration project where sediment influx was neglected in channel design. We measured bed material flux, developed calibrated transport relations, calculated a mass balance, and directly measured post-project channel adjustment to sediment deficit and surplus.

Between 1997 and 2007, 16 km of channel along the Middle Provo River in central Utah were restored as part of the Provo River Restoration Project (PRRP). The PRRP is located between two dams: Jordanelle Dam is immediately upstream and Deer Creek Reservoir is immediately downstream. Sediment influx into the reconfigured Provo River was assumed to be zero. However, the downstream third of the PRRP has a local supply of gravel. Reconnaissance monitoring of sediment transport rates in 2005 revealed an order of magnitude difference in gravel transport rates entering and leaving this part of the PRRP. Preliminary analysis of aerial photos revealed sediment accumulation as new point bars in reaches where gravel in now accumulating in the reconfigured channel.

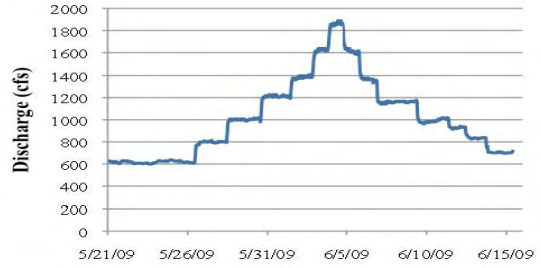

Figure 1 Hydrograph of the controlled flood at Provo River at Charleston, UT. Bed load samples were collected during periods of constant discharge.

During spring 2009, releases from Jordanelle Dam were manipulated to provide a controlled flood event that allowed systematic measurement of sediment transport (Figure 1). We measured bed load and suspended sediment transport at the upstream and downstream boundaries of the lower PRRP. Transport was measured on the rising and falling limbs of the hydrograph, at 200 ft^3/s increments for discharges ranging from 800 ft^3/s – 1800 ft^3/s. Bed load data was collected using a Toutle River (TR-2) bed load

sampler, deployed from a cataraft-based sampling platform (Figure 2). Suspended sediment was collected with a DH-59 depth-integrated sampler.

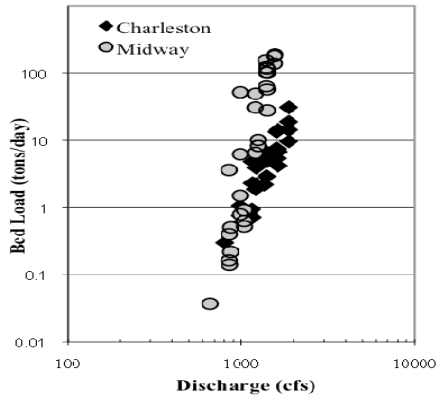

Figure 2 Bed load transport data collected at the upstream (Midway) and downstream (Charleston) boundaries of the study area.

The sediment budget determined by the difference between inflow and outflow was compared with field measurements of the change in storage based on repeat surveys of the study reach. Topographic and bathymetric data were acquired through a combination of aerial LiDAR, multispectral imagery and RTK GPS data, and were combined to provide continuous topographic coverages for 2008 and 2009. We used a spatially variable uncertainty threshold to construct a DEM of difference for the two years, identify areas of significant erosion and deposition (Figure 3). The topographic data demonstrates that aggradation in the reach has primarily occurred through the construction of point bars, and is accompanied by lateral erosion on the outside of meander bends. Our analysis also indicates propagation of a sediment wave downstream through the study reach since the period of construction.

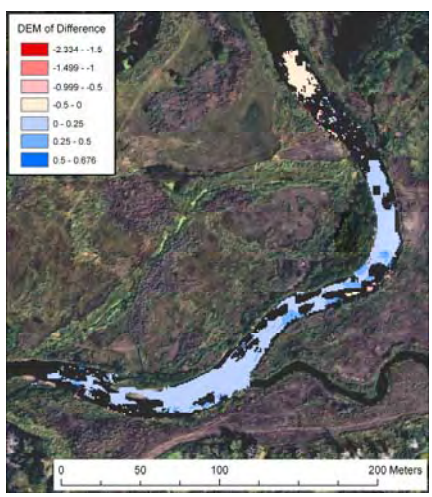

Figure 3 Example of the DEM of difference, depicting zones of significant channel change. Red represents erosion and blue represents deposition, in meters.