EVALUATING PHYSICAL MODELS OF DAM REMOVAL AGAINST RESULTS FROM CONDIT, MARMOT, AND ELWHA FOR PROCESS DRIVEN SEDIMENT TRANSPORT AND CHANNEL BED RESPONSE

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As dam removals have become more frequent in recent decades, the interest in and research on the downstream impacts of releasing large amounts of formerly impounded sediment on the downstream channel morphology have been investigated. A series of recently completed flume experiments evaluated the downstream effects of dam removal sequencing, impounded sediment grain size distribution, and channel flow rate on sediment transport rates and channel morphology during and following dam removal. Recent dam removals have provided data from field scale experiments in sediment transport and downstream morphologic adjustments following dam removal from situations with a variety of independent driving variables. These provide the data necessary to evaluate the physical modeling results.

Through physical modeling, 5 different dam deconstruction sequences were tested against 2 flow rates and 3 sediment mixtures to evaluate the 30 different combinations of channel and dam type. The dam deconstruction sequencing scenarios simulated were chosen to replicate current dam removal practices and included: removal in horizontal layers from the top down; removal in vertical sections with the first section removed from the middle of the dam; removal in vertical sections where the first section removed is adjacent to the channel edge; notched removal where the sides of the dam remain in place, and complete dam removal in a single step. Each removal scenario was repeated using flow rates designed to simulate low (Froude number =0.2) and high flow (Froude number = 0.6) conditions. Sediment transport was monitored throughout each stage of each dam removal and the bed surface was scanned using a laser displacement scanner after each removal stage. Digital Elevation Models (DEMs) of each bed surface were created from the bed surface laser scans and by differencing these DEMS, the spatial distribution of preferential deposition and erosion downstream of the dam removal was identified and quantified. A bed load monitoring system (BLMS) collected real-time data on the movement of the sediment through the flume channel during the experiments. BLMS data enabled re-creation of the sediment transport rates following each stage of a dam removal. Together these data provided a means of evaluating the impact of each removal type on the rate and volume of sediment movement as well as the short and long term impacts on the bed surface around the dam removal site and downstream.

This talk will present a comparison of results from flume runs against those from recent dam removals. The Marmot Dam removal from the Sandy River, OR is compared to a flume run where the dam was removed in one step, flow was moderate, and the sediment was a gravel and sand mixture. The Condit Dam removal from the White Salmon River, WA is compared to a flume run where the dam was removed in one step, flow was high, and the sediment was a mixture dominated by sand and silt, but with a small gravel fraction. Dam removals from the Elwha River, WA are compared to a flume run where the dam was removed in a sequence of horizontal stages and the sediment was a mixture dominated by sand and silt, but with a small gravel fraction. The comparisons between laboratory and field were evaluated for the representativeness of the flume

results and the information gained from both flume and field measurements. Additional information gained from the lab included measurements of real time estimates of deposition and erosion over the downstream channel reach while the field supplied information on broad scale planform channel changes. Similarities between flume and field results indicate a potential for improving predictive abilities related to sediment transport rates through and changes to the downstream channel over a range of channel and dam removal scenarios.

Research results seek to identify relationships between dam deconstruction sequencing, channel and impounded sediment sizes, and flow rate during removal so that the impact of sediment release with dam removal on the downstream channel morphology can be predicted. Many aging dams are not removed due to the economic expense of dredging impounded sediment prior to deconstruction and fears of ecosystem damage if the sediment is released. By quantifying sediment movement associated with different dam deconstruction sequencing, the effect of dam removal on the downstream channel morphology can be better predicted and impounded sediment can be released and transported downstream in a way that benefits, rather than harms, the downstream ecosystem and protects downstream infrastructure. The experimental results can aid in planning a dam removal to address specific goals related to impounded sediment movement and impact to the downstream channel.