Evaluating Stream Restoration Designs with Engineered Log Jams in Experimental River Channels

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ABSTRACT: With increasing awareness of the damaging effects of ecological degradation, the restoration of streams and fluvial corridors has become an increasingly important civic activity. However, research-based guidelines for stream restoration design remain sparse, especially for urban environments. To develop design guidelines, a two-part experimental campaign was conducted to evaluate the hydraulic and morphodynamic effects of engineered log jams (ELJs) deployed in single and multi-structure configurations in fixed- and movable-bed physical Froude-scale river models. Model ELJ structures are designated as ELJ-1, a two-tiered bank-attached crib-style flow deflector deployed normal to flow, and as ELJ-2, a spur-style flow deflector deployed at angle of approximately 40° downstream relative to flow. Results from fixed- and movable-bed experimental campaigns are reported here, responding to ELJ type and spacing interval between structures. Drag forces acting in the the streamwise direction on ELJs in the fixed-bed channel were greater for ELJ-1 compared to ELJ-2, and significantly exceed transverse forces, yielding single-structure drag coefficients of 2.72 ± 0.19 and 1.60 ± 0.37, respectively. A single ELJ of either design type also created a protective near-bank wake extending for greater than 30 flow depths downstream. Movable-bed results show that both ELJ types created a similar extent of bed-deformation, including a chain of pools and associated bars farther downstream. Channel-bed response was amplified when ELJs were deployed at shorter spacing intervals, but this also increased opposite-bank erosion. ELJ-2, which penetrated a shorter distance in the flow, might be more suitable for deployment at sites susceptible to greater adverse effects, such as higly-constrained urban environments. Conclusions drawn from this investigation are intended to describe the complex hydraulic and morphodynamic interactions and impacts of ELJs and to guide the design and deployment of ELJs in rivers including novel applications in urban streams.