PERFORMANCE OF WOODY DEBRIS STRUCTURES FOR STREAM RESTORATION

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ABSTRACT: Seventy-two large woody debris structures (LWDS) were placed along 2 km of a sand-bed stream in northwestern Mississippi for ecosystem rehabilitation. Costs for LWDS construction were about \$80 m^{-1} of treated bankline, which is only 19% to 49% of recorded costs for recent stone bank stabilization projects in this region. The project increased LWD loading to the reach by a factor of 20. About 80% of the structures were secured with steel cables and earth anchors. LWDS architecture was similar to that used by others for gravel-bed rivers in the Pacific Northwest. Mean ($\pm$ std dev) LWDS height, width, and length were 2.1 $\pm$ 0.5 m, 5.3 $\pm$ 1.9 m, and 13.9 $\pm$ 3.9 m, respectively. The average number of logs in each structure was 16.2 $\pm$ 5.6. About 23% of the logs used were placed perpendicular to the flow and 77% were placed parallel to the flow. The perpendicular and parallel members had bottom diameters of 44.9 $\pm$ 14.4 cm and of 26.1 $\pm$ 9.5 cm, and lengths of 5.5 $\pm$ 2.2 m and 9.2 $\pm$ 3.6 m, respectively.

Structures performed well during the first year after construction. Baseflow water width and depth increased in the modified reach by 116% and 17% ($p \leq 0.003$) due to scour adjacent to the LWDS and associated beaver dams. Only four of the 72 structures were destroyed, despite at least three flow events with peaks exceeding 25 $m^3 s^{-1}$, depths > 2.5 m, and velocities > 1.2 m s^{-1}. Comparison of pre- and post-construction channel surveys following several high flows showed only insignificant changes in total channel volume despite about 0.3 m of thalweg degradation because of deposition of sand berms adjacent to steep, concave banks. However, high (~40 $m^3 s^{-1}$) flows during the second year triggered progressive failure of about a third of the LWDS. Damage rates were slightly higher for anchored LWDS (20/58) than for those without earth anchors (4/14). Factors involved in LWDS failure included simplification of the LWD matrices due to breakage and decay, failure of earth anchors, scour of sediments deposited within the structures and undermining of structures by thalweg degradation. Structures located in sharp bends were most prone to fail. Acoustic Doppler velocity loggers recorded depth and velocity within and adjacent to an LWDS located at the apex of a bend with a ratio of top width to bend radius ~ 1.0. During the rising limb of a large flow event about 16 months after construction, apparently part of the structure shifted, allowing velocities within the structure to rapidly increase from 0.2 to 1.2 m s^{-1}, greatly exceeding the critical level for the sandy bed material and approaching the velocity recorded at the adjacent channel centerline. Sediments deposited within the LWDS acting as ballast were scoured away, leading to a rapid decline in the factor of safety (ratio of buoyant forces to the sum of the weight of wood, sediment, and forces due to earth anchors) and failure of the LWDS.

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