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How does wood move on forested floodplains? Wood tracking in flume experiments of a forested river corridor

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Large wood (LW; >10 cm in diameter and >1 m in length) within river corridors – including channels and adjacent floodplains – plays a key role in shaping hydraulic conditions, sediment deposition and erosion, nutrient cycling, and habitat availability for aquatic and terrestrial species. Thus, to fully understand how a river system functions, we must understand when, how, and why LW is stored or transported. Most previous work on understanding LW dynamics in river systems has focused on LW behavior in channels, overlooking the possible importance of floodplains on how LW moves through these systems. Leveraging video datasets from a series of flume experiments on LW behavior in forested river corridors, we tracked LW piece movement to understand controls on LW trajectories and deposition patterns.

We analyzed of a set of 36 experiments conducted in a 4m wide by 10m long fixed bed flume at St. Anthony Falls Laboratory at the University of Minnesota. The flume represented a river corridor for a relatively steep, headwater stream in the central Rocky Mountains. These experiments explored variations in LW transport and deposition across a range of 4 floodplain forest stand densities, 2 overbank flood magnitudes and 2 LW transport regimes (the amount of LW added at one time). For each experiment, we dropped a total of 870 pieces into the channel at the head of the flume and observed where they were deposited. Using video data from the experiments, we developed a dataset of wood piece trajectories under different conditions. The videos were collected using four nadir-oriented GoPro cameras mounted above the flume surface. We orthomosaiced the video streams and stitched them together to form a single video covering the entire experimental surface at a resolution of 2mm/pixel and 24 frames/second. We then retrained and tested a python-based convolutional neural network (CNN) for real-time object detection and tracking called YOLO (You Only Look Once) v11 (Redmon et al., 2016) on 2000 images of LW in the flume (70/30 train/test split). We ran this object detection model for each experiment, resulting in a dataset of LW trajectories for hundreds of LW pieces for each of the 36 experiments. We performed survival analysis on distances traveled by each piece using the Kaplan-Meier method to statistically assess how far LW pieces tended to travel in each experiment.

We present results of the survival analysis for each experiment compared across forest stand densities, flood magnitudes and transport regimes. We found that sparser forests and larger overbank floods increased transport distances. Additionally, as each experiment progressed, there

were changes in the distance traveled by pieces, likely due to the formation of jams that promoted wood deposition in specific locations. These analyses advance our understanding of how LW moves in forested river corridors by providing information at the wood piece level – something rare among LW studies. Additionally, these results will support future efforts to use IberWood (a 2D numerical model of river flow and LW transport) to connected channel-floodplain systems, improving tools used to inform river restoration and management.