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Mapping increases in hyporheic exchange from channel-spanning logjams

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Logjams increase hydraulic resistance and create hydraulic head gradients along the streambed that drive groundwater-surface water exchange. Here, we quantify changes in hyporheic exchange flow due to channel-spanning logjams using field measurements and numerical modeling in MODFLOW and MT3DMS. Electrical resistivity (ER) imaging was used to monitor the transport of solutes into the hyporheic zone during a series of in-stream tracer tests supplemented by in-stream monitoring. We conducted experiments in a variety of reaches in Little Beaver Creek, Colorado (USA) of varying complexity: a control reach with no logjams, a reach with a single, channel-spanning logjam, and additional jams with greater logjam complexity. Our results show that 1) higher hyporheic exchange flow occurs at reach with logjams, 2) logjams create complex hyporheic exchange flow pathways that can cause bimodal solute breakthrough behavior downstream, and 3) higher discharge rates associated with spring snowmelt increase the extent and magnitude of hyporheic exchange flow. The numerical modeling supports all three field findings, and also suggest that lower flows increase solute retention in streams, although this last conclusion is not strongly supported by field results. This study represents the first use of ER to explore hyporheic exchange flow around a naturally occurring logjam over different stream discharges and has implications for understanding how logjams influence the transport of solutes, the health of stream ecosystems, and stream restoration and conservation efforts.