3. Preliminary Results of the Hydraulic Effects of Beaver Dams at Fanno Creek at Greenway Park

By James White1, Erin Poor1,2, Cassandra Smith1, Stewart Rounds1, and Krista Jones1

1 U.S. Geological Survey, Oregon Water Science Center, Portland, OR 2 Portland State University  *Residence-time correspondence: cassandrasmith@usgs.gov *Modeling correspondence: jameswhite@usgs.gov *Continuous wetted cross-sectional area correspondence: epor@usgs.gov

Goals and Objectives

Beaver dams and ponds fundamentally alter how water moves through a stream reach. Semi-porous dams can impound water, leading to backwatering, floodplain inundation, and overall changes in wetted area, depth, and velocity.

For this part of the study, USGS: 1) assessed hydraulic changes caused by beaver dams across a range of flows using a hydraulic model, 2) assessed the rate-of-change of continuous wetted area during storm events, and 3) estimated water residence time with continuous conductance data. These findings will be helpful for evaluating the effects of beaver dams and ponds on stormwater run-off and habitat diversity.

Methods

Hydraulic Modeling with and without Beaver Dams

• The Delft-3D model was used with a flexible computational mesh to simulate flow, depth, and velocity for a 1-km reach with three dams of various heights and lengths (figs. 1-2).
• The model was calibrated using discrete water-level elevation data collected at low and high flows (fig. 2) and also with continuous water levels. Boundary conditions were developed from continuous water levels and discrete discharge measurements.
• Simulations were run with dams, without dams by removing the dams from the topographic data, and for three storm events of increasing magnitude.

Storm Flow Rates-of-Change using a Continuous Wetted Cross-sectional Area Analysis

• Continuous surface-water stage data were collected above and below the beaver reach. Stage time series were combined with channel cross sections to create continuous wetted cross-sectional area datasets. These datasets are surrogates for continuous stream discharge, and have been found to be useful when assessing hydrologic change.

Water Residence Time with Conductance Analysis

• Five summer events (when specific conductance was elevated) and five winter events (when specific conductance was lower) were analyzed to assess the travel time of the water between water-quality sensors.

Hydraulic Model Validation Results

1. Modeled inundation mostly matched observed edges of water (fig. 3A-B), with some areas of underestimation.
2. The model more accurately captures channel dynamics at high flow than at low flow (fig. 4A-B). Overall results suggest the model simulates hydraulic dynamics associated with the beaver dams reasonably well (table 1).

Storm Flow Rates-of-Change Results

1. Fig. 8 illustrates the conceptual basis of this analysis.
2. Up- and downstream differences in rising limb rates were variable at Fanno Creek, but consistently lower at Stoller Creek (fig. 9A-B). This indicates a potential reduction in storm flashiness at Stoller Creek.
3. Up- and downstream differences in falling limb rates were consistently lower at both Fanno and Stoller Creeks (fig. 10A-D), potentially indicating the storage and slower release of water over time because of ponding.

Next Steps for this Study

• Complete/update Fanno Creek at Greenway Park modeling and analyses.
• Complete Bronson Creek modeling and analyses.
• Model longer time periods to allow calculation of Richards-Baker flashiness index for the Fanno and Bronson reaches with and without beaver dams.
• Finalize continuous wetted cross-sectional area analyses and evaluate effects of beaver dams on hydrographs during storm events.

Considerations for Future Studies

• Simulate the evolution of beaver dams and ponded areas by applying a morphodynamic model.
• Evaluate lifespan of dams and associated changes in hydraulic and sediment retention effects over time.
• Evaluate effects of beaver dam management strategies (such as piping) on the hydraulic and sediment retention effects of beaver dams.

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All data and findings are provisional and subject to change.

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