Predicting Relative Stream Channel Stability and Sensitivity to Land Use Changes in Kelley Creek, Portland, Oregon

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Kelley Creek, a tributary of Johnson Creek, is located on the eastern edge of the City of Portland. Over the past 80 years, land use on this watershed's valley floor has been dominated by nursery and berry agricultural production. Steeper hillsides of the Boring lava formation surround the valley. While these upland areas remain forested, they have been impacted by roads, culverts, and timber harvest. Recently, most of Kelley Creek was incorporated into the metropolitan urban growth boundary, making way for an increase in development density in the coming decades.

Increasing development could potentially increase durations of erosive stream flows, leading to channel enlargement, incision, bank failures and/or damage to aquatic habitats and the organisms that live in them. This study uses readily obtainable field measurements and GIS data to assess and quantify current channel erosion rates and relative bed stability in Kelley Creek. This same data is then used to predict channel responses to increased development. Analysis of cross sectional geometry, slope, and sediment size distributions indicates relative sensitivity of watershed subareas to potential changes in annual flow duration patterns. Three hydrologic scenarios are modeled. Each scenario increases the total annual flow by 100 mm, from 550 mm to 650 mm, but with differing magnitudes and durations. One scenario simulates unmitigated urban storm flows, assuming the highest flow magnitudes increase by as much as a factor of two. A second scenario simulates stormwater detention, assuming that the median annual peak flow magnitude stays constant, but increases in duration. The third scenario increases magnitudes of intermediate-sized storm responses, leaving the median annual peak magnitude and duration unchanged. The information provided through the modeled stream channel response could guide both zoning decisions as well as stormwater management approaches.

When stream power and the force required to move sediment approximate each other, the stream channel is considered relatively stable. Sites close to this equilibrium under current conditions are predicted to have a greater response to changes in hydrologic patterns. In the model, all of the six steep, coarsely-grained headwater sample sites were sensitive both to doubling the median annual peak flow and to increasing the duration of the median annual flow. The five lower gradient, silt-dominated sites on the valley floor were more resilient to changes in annual flow duration curves. While the steeper sites are most sensitive to changes in peak magnitude, the low gradient sites are predicted to respond most to increasing durations of current median annual flows. Sediment transport rates vary based on geologic and climatic setting. The benefits, costs, and impacts of stormwater management facilities must be weighed based on the landscape where they will be used.

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After earning a B.A. from University of Oregon in Russian Language and Literature, Yarrow served two years as an AmeriCorps volunteer in Seattle. The first year, she organized a program to increase availability of locally grown, organic produce to low-income people of South Seattle. The second year, she served with Mid Puget Sound Fisheries Enhancement Group, where she led efforts to monitor the organization's stream restoration projects. After three years in this position, she returned to her home state of Oregon to pursue an M.S. in Water Resources Engineering at Oregon State University under Dr. Julia Jones. The work presented here summarizes her Master's thesis, examining sediment transport processes in a small watershed east of Portland, Oregon. As a graduate student, she also worked seasonally for the U.S. Forest Service, conducting a watershed scale geomorphic and ecological field assessment in Southeast Alaska. Currently, she is an intern at the City of Portland, Bureau of Environmental Services, assisting with systems planning.