ABSTRACT

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Environmental DNA (eDNA) is organismal DNA found in nature. It has emerged as a practical way to measure species distribution and abundance in their habitat. Because eDNA is transported in the environment, knowing where it originates remains a challenge, particularly in flowing waters. eDNA is a heterogeneous mixture of particulate organic matter that settles out of the water column and can be trapped in or near the bed sediment. eDNA data collected during experiments or surveys have a large amount of unexplained variability, making it hard to constrain eDNA transport models. The two guiding questions we answer in this thesis are: 1) Can we predict eDNA transport patterns in a flowing system? and 2) Can we explain the observed variability in eDNA data by the interfacial processes between the water column and the sediment bed? We conducted three experiments in an artificial laboratory channel. In the first experiment, we measured eDNA retention, i.e., the distance eDNA travels downstream of an injection on average. In the second experiment, we compared the observed breakthrough behavior to the predicted pattern from the first experiment results. Finally, in the last experiment, we loaded the streambed with eDNA prior to reproducing the second experiment. For the first experiment (retention), we injected known quantities of Atlantic Salmon (Salmo Salar) and sampled the water column at five locations during the plateau phase. We measured the retention rate as the slope of the (logged) concentration data vs downstream distance and the travel distance as its inverse. The measured travel distance in our small channel (30cm wide) with a coarse sediment bed (1cm d_{50}), low flow (1L/s) and shallow water column (10cm) was 18.51 m (15.38 – 23.24 m, ± SE). We used the measured retention rate to predict the breakthrough behavior with a simple transport model and showed good agreement between the predicted and the observed concentrations measured in the second experiment. The results from the third experiment had the same overall pattern, but with more erratic values. Our results indicate that eDNA settling out of the water column and filtration

in the streambed may limit the distance eDNA travels downstream and thus constrain where it came from. We also demonstrated that exchange processes between the water-column and the bed-sediment could explain the observed variability in eDNA transport data, suggesting a crucial influence of parafluvial processes in eDNA transport.