

South Sound Science Symposium Project Summary

Title: Vaughn Bay Microbial Source Tacking Study

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Project Summary: A microbial source tracking (MST) study was designed to identify and quantify fecal bacteria sources in Vaughn Bay on the Key Peninsula in Pierce County, Washington. Shellfish harvesting continues to be restricted in Vaughn Bay despite long-term efforts to control fecal sources from farm animals, pets, and on-site septic systems in the 3,600-acre watershed. Water samples were collected from 7 freshwater and 3 marine stations during 4 baseflow and 3 storm events. Two MST methods were used in the study: 1) quantitative polymerase chain reaction (qPCR) of 7 fecal host biomarkers using non-library Bacteroidetes methods and 2) Next Generation Sequencing (NGS) of five fecal host categories. A total of 88 fecal source samples were collected from septage and animal feces in the watershed to validate qPCR accuracy and build the national NGS library with local sources. The qPCR results were found to be highly accurate and the NGS results did not vary much between the local and existing library sources.

The qPCR results indicated that bird was the most prevalent fecal host followed by ruminant (sheep/goat/llama/ deer) (Figure 1). Human and dog were typically less abundant, cow and horse were rarely detected, and pig was never detected. Total biomarker DNA concentrations were of similar magnitude in the freshwater and marine sites during base flow, and were much higher during storm events in both forks of Vaughn Creek and all three marine stations but not small drainages. Fecal host DNA loadings to the shellfish beds were clearly dominated by Vaughn Creek due to its high biomarker concentrations and flow compared to the small streams and drains.

The similar hydrologic patterns in DNA concentrations between Vaughn Creek and marine waters indicate that bird sources observed in marine waters were from terrestrial birds in the watershed. The study results suggest that other shellfish growing areas fed by rural watersheds are likely impacted primarily by large freshwater inputs rather than marine fecal sources.

Fecal host abundance changed to high human and low ruminant when DNA concentrations in water samples were normalized by the amount of DNA found in the host feces samples (Figure 2). Biomarker concentrations were found to be much higher in septage samples than in feces samples from sheep, goat, llama, and deer. Furthermore, the literature shows that fecal coliform bacteria concentrations are much higher in human waste (400 million/gram) than ruminant feces (6 million/gram). Thus, the relative amount of human biomarker observed in water samples underestimates the amount of human waste and associated fecal coliform bacteria compared to that for ruminants. However, other MST studies by Herrera have shown that human biomarker DNA are more readily transported to surface waters than viable fecal coliform bacteria where samples with high human biomarker concentrations have low fecal coliform bacteria concentrations. These are important considerations often overlooked in MST studies.

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The NGS results similarly showed that bird was the most prevalent host, followed by human and not ruminant. Livestock, dog, and deer were detected at very low levels. Deer concentrations were higher than livestock, suggesting that deer was the primary component of the ruminant detected by qPCR.

Source control actions were identified based on the study results. The low livestock loadings suggest that farm BMP inspection and education have been effective in this watershed, but more work is needed to control septage loadings. MST study protocols were developed for other Puget Sound shellfish recovery projects.

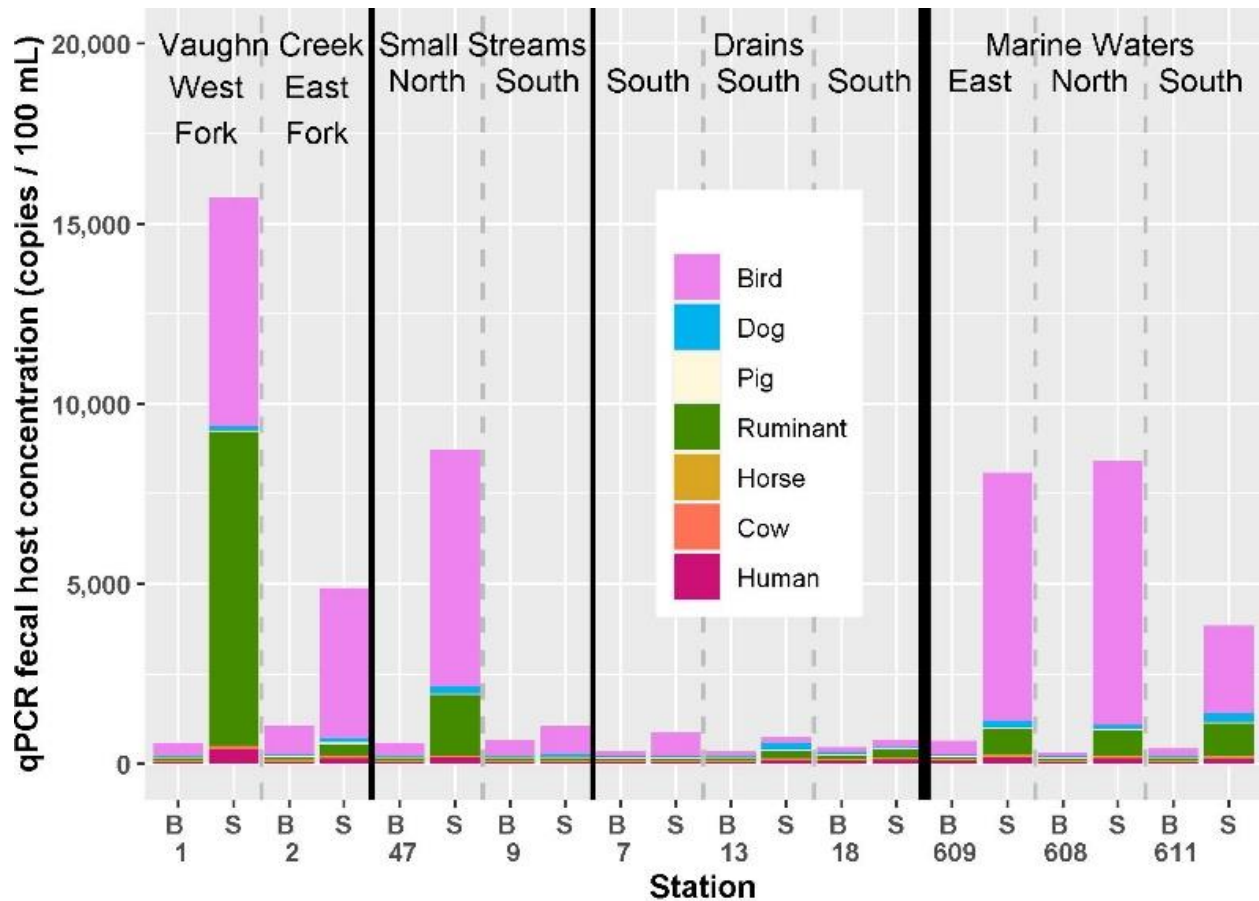


Figure 1. Fecal Host DNA Concentrations by qPCR During Base (B) and Storm (S) Events at Freshwater and Marine Waters Stations for the Vaughn Bay MST Study.

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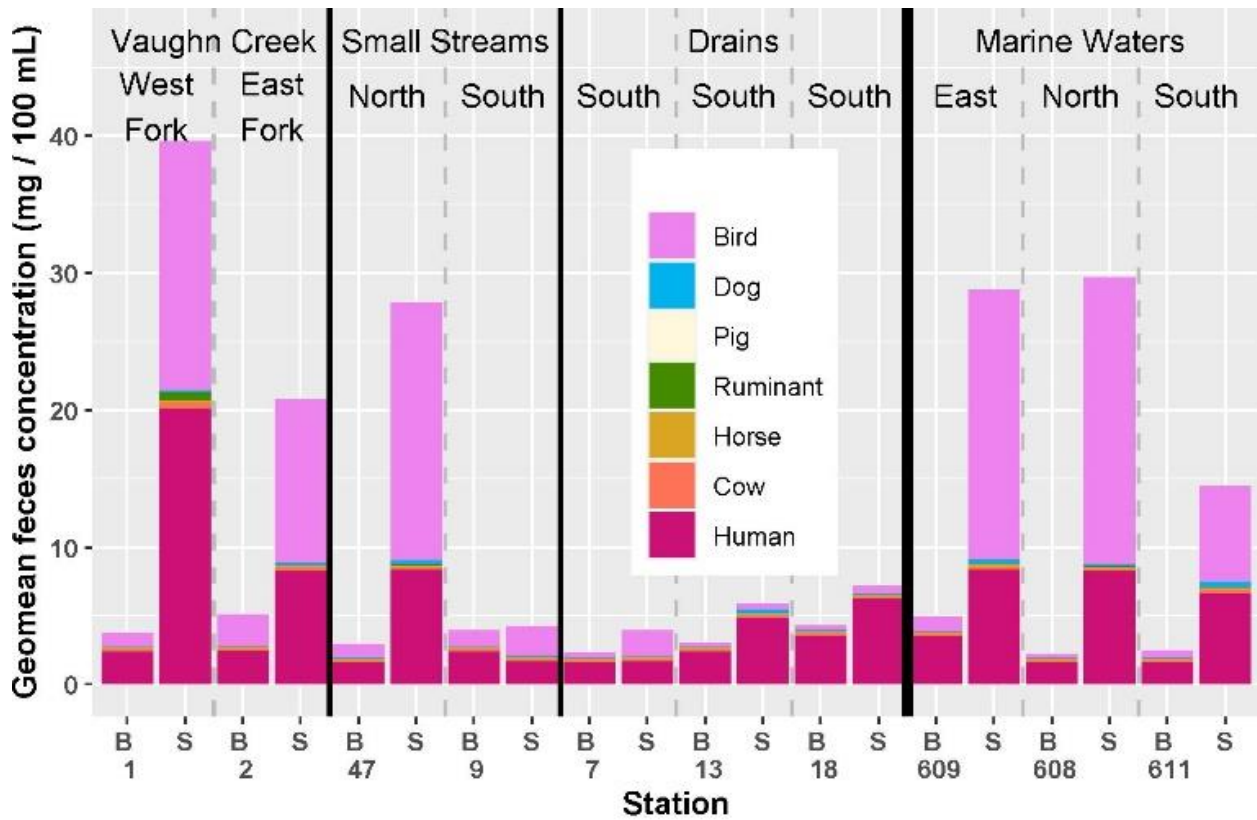


Figure 2. Fecal Host DNA Concentrations by qPCR After Normalization by Feces DNA Concentrations During Base (B) and Storm (S) Events at Freshwater and Marine Waters Stations for the Vaughn Bay MST Study.