Report for 2004VT16B: A Comparison of Bacterial Concentrations in Streams: a Paired Watershed Study

Publications

- There are no reported publications resulting from this project.

Report Follows

A Comparison of Fecal Concentrations in Streams: a Paired Watershed Study

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Final Progress Report

Reporting Period March 1, 2005 – February 28, 2006

Rationale: Throughout the U.S., high-elevation forested watersheds are facing the pressures of development for increased housing, year-round recreational use, water management, and timber. This research addresses how development-related disturbances may affect these highly sensitive ecosystems by evaluating fecal contamination in paired undeveloped and developed watersheds within a northeastern high-elevation forest.

Runoff from residential, agricultural, and forested lands carrying microorganisms from fecal sources can pose a serious risk to human health through contamination of drinking and recreational waters. Uncertainties in the relative importance of these fecal sources, however, have constrained federal and state agency efforts to understand and manage water quality. In particular, although fecal levels in streams are strongly correlated with development and agricultural runoff, there is considerable debate regarding the contribution of undeveloped areas (which in the northeastern U.S. often are represented by higher elevation forested lands). Limited observations, however, suggest that fecal levels in streams draining undeveloped forest lands may significantly contribute to downstream concentrations and may exceed water quality standards during storm events. To date, however, no studies have addressed fecal contamination in streams draining high-elevation forested watersheds in the northeastern U.S.

Goal: Quantification of stream fecal levels in the two paired, forested watersheds on Mt. Mansfield in northern Vermont will enable assessment of the contribution of developed and undeveloped forested lands to fecal levels in adjacent streams, providing improved understanding of downstream water quality and a baseline for planned future management of the two watersheds.

Progress to Date: Matthew Bruhns was recruited as a M.S. student in the Aquatic Ecology and Watershed Science concentration to conduct this research. Weekly *in situ* water samples (with replicates) were collected at the paired watersheds from snowmelt in April through freeze up in November of 2004 and 2005. *E. coli* and fecal coliforms were analyzed in the laboratory following EPA protocols. Water samples were also collected every 2 hours during select storm events.

Storm events resulted in more than a 10-fold increase *E. coli* concentrations compared to non-storm events (Figure 1), although streamflow alone was a weak predictor of *E. coli* concentrations ($r^2 = 0.33$; $n = 24$). Only 5% of the non-storm weekly water samples for the two watersheds violated VT Water Quality regulations (77 cfu/100mL). However, 58% of the water samples collected during storm events (defined as meeting a 20% exceedance rate) in both the developed (Stowe Ski Resort) and undeveloped watersheds were in violation.

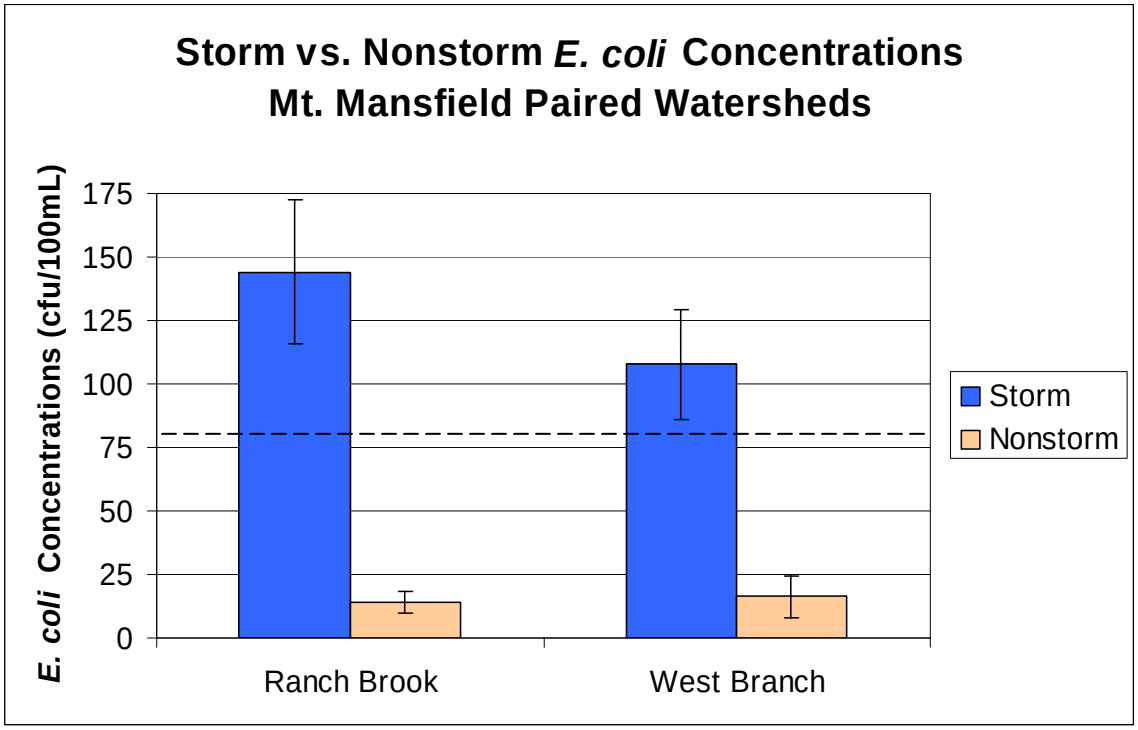

Figure 1. *E. coli* concentrations (mean ± 1 SD) for samples collected during storm and non-storm events in two paired watersheds (VT Water Quality Standard is indicated by the dashed line). Fecal contamination increased 10-fold during storm events for both the developed West Branch and undeveloped Ranch Brook watersheds. Although not statistically different, the undeveloped Ranch Brook concentrations appear higher than the developed West Branch during storm events.

A stormwater retention pond was built during the Spring of 2005. The building of the stormwater retention pond was a BMP instituted to reduce contaminants reaching the stream from areas under current development. This particular watershed, home to Stowe Ski Resort, is in the process of building new homes, condominiums, lodge, and parking garage – an anticipated doubling of the impervious surface area. As a result, the USGS gaging station was moved to a new location downstream of the 2004 location to incorporate output from the stormwater pond. This move provided an opportunity to sample above (areas of limited development) and below the stormwater pond (areas with current major development) within the same watershed. Although *E. coli* concentrations during non-storm events showed little difference for the two watersheds, significant differences were noted during storm events (Figure 2). The stormwater retention pond reduces contaminants reaching the stream during non-storm events by acting as a collection basin, however, during storms the pond acts as a reservoir for fecal contaminants which are then flushed out of the pond and into the stream resulting in exceedingly high fecal concentrations.

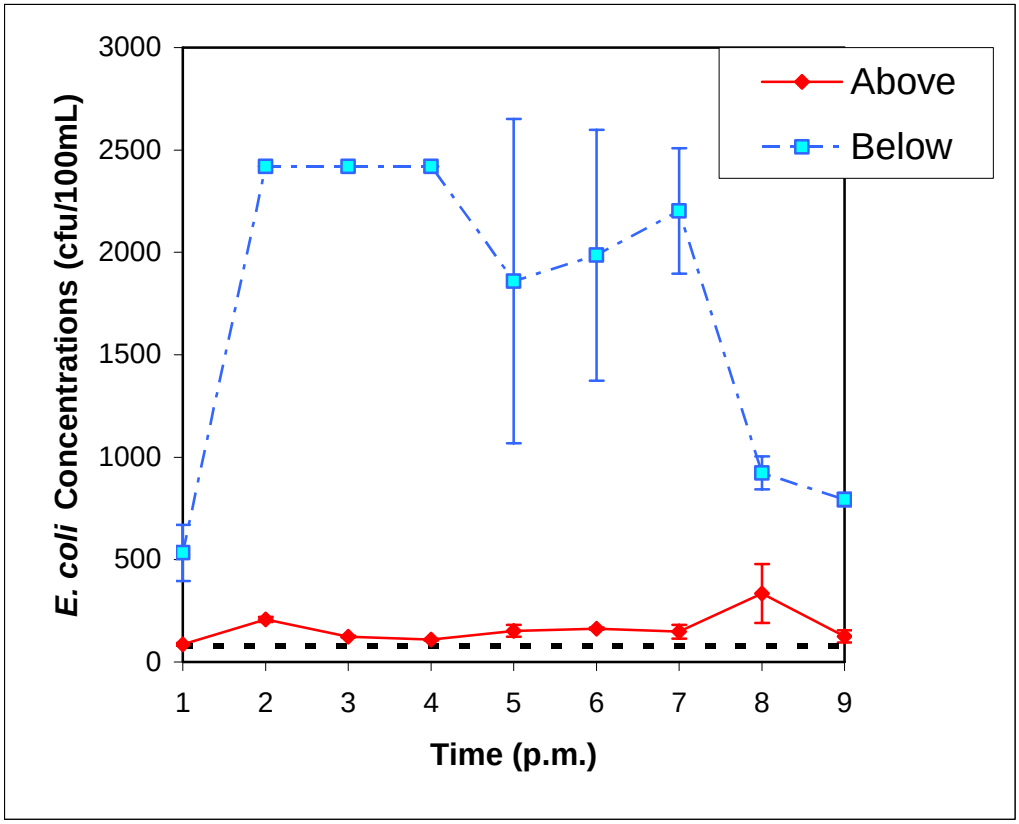

Figure 2. *E. coli* concentrations (mean ± 1 SD) measured below the stormwater pond were much higher than concentrations measured below the pond during this storm event. The VT Water Quality Standard is indicated by the dashed line. The stormwater pond BMP not only failed to reduce downstream water pollution but may have enhanced it by acting as a reservoir for fecal contaminants which were then flushed out during the storm.

In collaboration with B. Wemple (University of Vermont), water samples were also collected during storm events and baseline flow to analyze suspended sediment as a second potential predictor variable. Analyses of these data, however, are still underway. Access to near-real-time meteorological and stream gage data was provided by collaborator Dr. J. Shanley (USGS).

In parallel with field sampling efforts, IKONOS high resolution satellite data acquired on September 17, 2004 were orthorectified to a map base. Classification of land use and land cover (LULC) using eCognition object oriented classification software has also been completed providing recent and detailed LULC information for the two watersheds. GIS data layers (1:5000 roads, buildings, surface water, digital elevation data, and digital orthophotography) were also compiled for both watersheds.

Final Tasks: Complete analyses and preparation of manuscript for thesis and publication.