Correlating Geomorphic and Habitat Assessments with Water Quality Parameters in Vermont Streams

Kirk D. S. Jones, Nikos Fytilis, and Donna M. Rizzo

School of Engineering, University of Vermont, Burlington, VT

Abstract

Understanding the relationships between stream water quality, geomorphology, and habitat is essential for effective watershed management. Vermont EPSCoR Streams Project water quality parameters such as total phosphorus (TP), total suspended solids (TSS), *E. coli* (EC), and total coliforms (TC), are seen as primary risk indicators of environmental and human health. With the Vermont Agency of Natural Resources' (VTANR) rapid geomorphic assessments (RGA) and rapid habitat assessments (RHA) now completed over most of the state and with the growing base of water quality data, we can begin to compare these datasets. Where strongly correlated, the data could be used as a predictive tool to direct future watershed improvements and inform future monitoring.

Using GIS, the Streams Project sites were joined to the VTANR RHA/RGA reaches. Streams Project water quality data were compared with RGA and RHA total scores as well as their component values. The RGA assesses 4 components: channel degradation, aggradation, widening, and changes in planform. The total RGA score was found to be highly negatively correlated to average TSS (especially widening), whereas the other water quality parameters show little correlation. The RHA assesses 10 components including substrate and pool characteristics, sediment and channel flow, channel alteration and sinuosity, and stream bank and buffer characteristics. The total RHA score was found to be negatively correlated to total coliform (especially bank stability), whereas total phosphorus was most correlated to channel flow status.

Two Complementary Research Programs

Vermont EPSCoR (Experimental Program to Stimulate Competitive Research) began a long term collaborative monitoring project called the Streams Project in 2007 to study the health and water quality of Vermont's streams. High school teams across the state collect stream water and macroinvertebrate samples. The benthic macroinvertebrate samples are sent to St. Michael's College to be counted and classified. The water samples are sent to EPSCoR's Laboratory in the Cook building at UVM, where interns and research assistants test for total phosphorus (TP), total suspended solids, total coliform, and *E. coli.* This large-scale educational research project has been so successful that it has branched out to include schools in Puerto Rico, greater New York City, and greater Hartford, Connecticut.

Vermont ANR's River Management Program began Stream Geomorphic Assessments (SGAs) about ten years ago to estimate, understand, and manage interactions between human developments and fluvial geomorphology. Geomorphic river management aims to protect people, property, and ecological habitat through knowledge of channel evolution in response to changes in land use and civil infrastructure. We are beginning to use this RGA and RHA data to deduce how these streams are interacting with their environments.

Kirk in the EPSCoR Streams Water Quality Lab

Photo taken from Rapid Assessment Handbook.

Spatially Joining Datasets

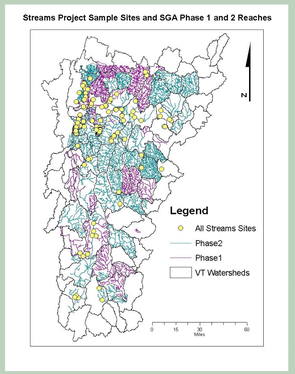
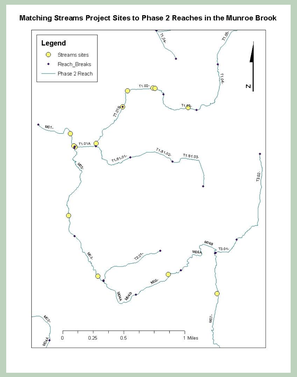


Figure 1: Map of the State of Vermont showing 82 watersheds, 158 Streams Project sites, 8420 Phase 1 reaches, and 6397 Phase 2 reaches.

Figure 2: Map of the Munroe Brook in South Burlington showing how Streams sites match up with SGA reaches. Each site was paired with the reach containing it or the reach immediately adjacent upstream.



RGA and Legacy RHA Scores

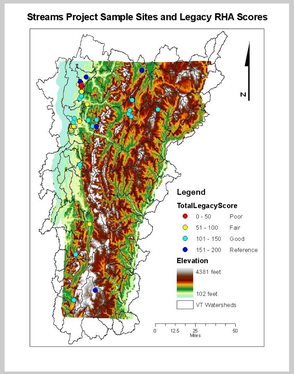


Figure 3: The 56 matching Streams sites with their corresponding Legacy RHA scores.

By joining SGA reach codes with the Streams sites we were able to associate RHA and RGA scores with these well-researched sites. Of the 158 Streams sites and ~2300 RHA reaches, only 56 matches occurred (as seen in Figure 3). Of these 56 and the 1411 RGA reaches, only 22 matches were left (as seen in Figure 4). New RHAs are being completed now, so the word "legacy" is used to denote the older scores.

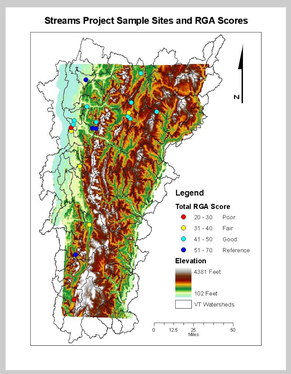


Figure 4: The 22 matching Streams sites with their corresponding RGA scores. In general, the more rural the site, with less development and more forests, the higher the score. The 2 "poor" scores are in the cities of Burlington and Bennington.

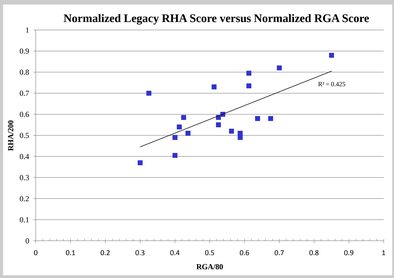
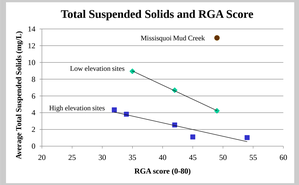


Figure 5. Total RHA and Total RGA for the 22 sites show a positive correlation. Stream evolution has a direct effect on aquatic habitat, as does loss of vegetative buffers, increase of impervious surfaces, and intentional channel modifications.

RGA and Water Quality



Of the 22 matching sites only water quality data with a sample size greater than 10 were seen as significant. Those used have an average sample size of 32.

Figure 6: A strong negative correlation exists between TSS and RGA when breaking data into lower (<300ft) and higher (>300ft) elevation sites. Also, Mud Creek seems uncommonly muddy for a high elevation site (731ft).

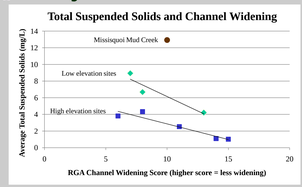


Figure 7: "Channel widening" is the RGA component which is closest correlated to TSS. As a stream channel widens, soil particles are carried away. This also shows elevation dependence.

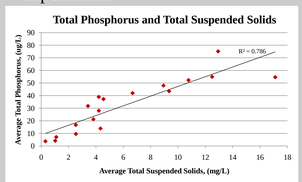


Figure 8: Average total phosphorus and total suspended solids show a strong positive correlation. Phosphorus is often bound to soil or other particles which may become suspended.

RHA and Water Quality

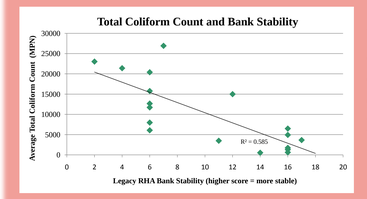


Figure 9: Average total coliform count and RHA component "bank stability" show a strong negative correlation. Many rural watersheds which report eroding banks report high total coliform counts presumably from farm animals and septic systems.

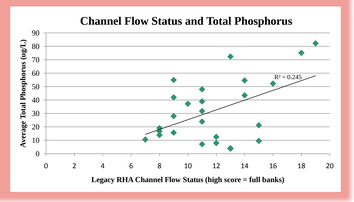


Figure 10: Average total phosphorus and RHA component "channel flow status" shows positive correlation.

E. coli did not show much correlation with RGA or RHA, however did show strong correlation to elevation (increasing downstream of people and farms).

References

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VT ANR. *Reach Habitat Assessment.* June 2008. http://www.anr.state.vt.us/dec//waterq/rivers/docs/rv_RHAProtocolReport.pdf, accessed 5/30/11.

GIS layers: DEM (VCGI), NHD (VCGI), Reaches (VTANR), Streams Project sites (Streams).

All maps prepared by Kirk Jones.

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