Geomorphic characteristics and Strahler order of streams in the Mad River Valley

Sarah Leidinger, Jody Stryker, Arne Bomblies

Background

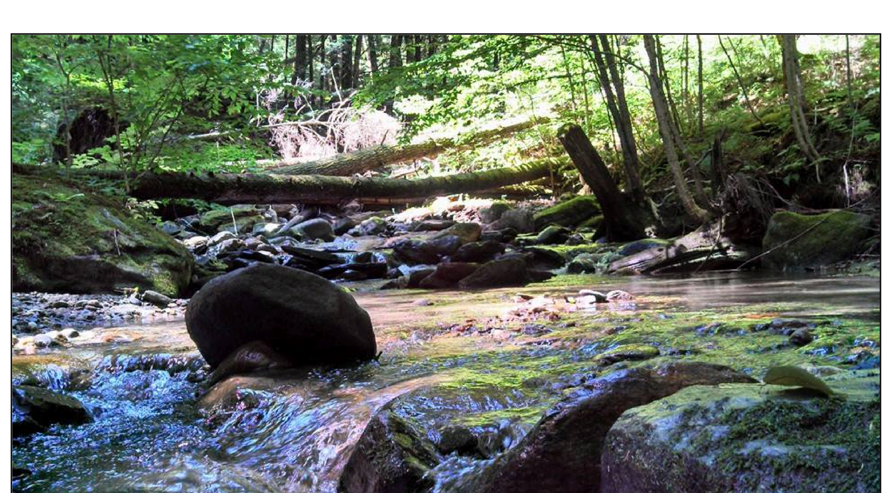
• Strahler classification system is used to estimate the relative size of streams and rivers within drainage basins or watersheds.
• In a study by Hughes et al. (2011), the Strahler classification system accurately predicted the watershed size, distance to outflow point, annual discharge and bankfull measurements, at a scale of 1:100,000. However, these values varied significantly in and among regions with similar climatic and geological characteristics (Hughes et al. 2011).
• Compared to the study area analyzed by Hughes et al. (2011), the Mad River watershed is considerably smaller and the Stahler system may more accurately estimate stream measurements.
• The purpose of this study was to determine if a correlation existed between Strahler stream order and field-measured attributes of streams in the Mad River Watershed.

How does it work?

The Strahler classification system begins by first identifying the headwaters of a given watershed. These streams are assigned a value of 1. Second order streams begin at the confluence of first order streams and continue until they reach a confluence with another second order stream. At this point, a third order streams begins and continues downstream and so on (Pierson et al. 2008). The final product of this method, as applied to the Mad River watershed, is shown in Map 1.

Methods

• Identify accessible streams or rivers in the watershed using ArcGIS and relevant data layers (roads, hiking trails, public lands, etc.).
• Using orthoimagery to inspect stream access area for land cover type and potential obstacles.
• Visit stream site and measure stream attributes, including channel width, bankfull width, bank height, bank width, toe height, and toe length.
• Also record GPS coordinates of field site.



Methods cont.

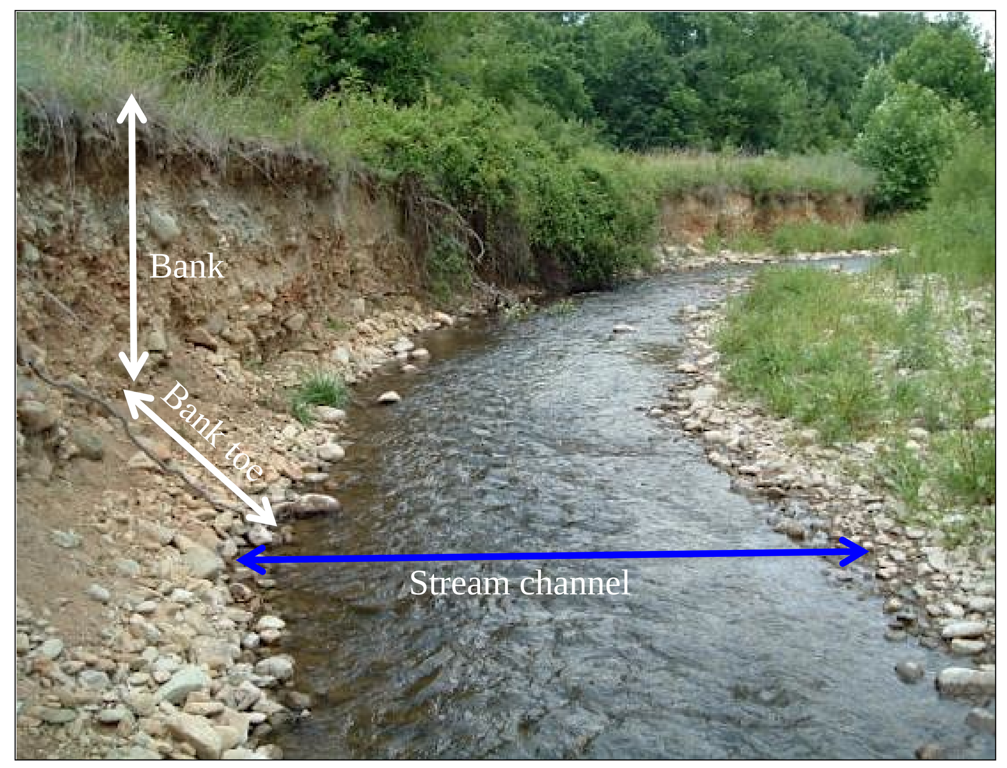


Figure 1. Streambank erosion and geomorphic measurements Image from Roussos; "Friends of the Rockfish Watershed;" Roussos Web Services, 2006; Web; 15 Mar 2015.

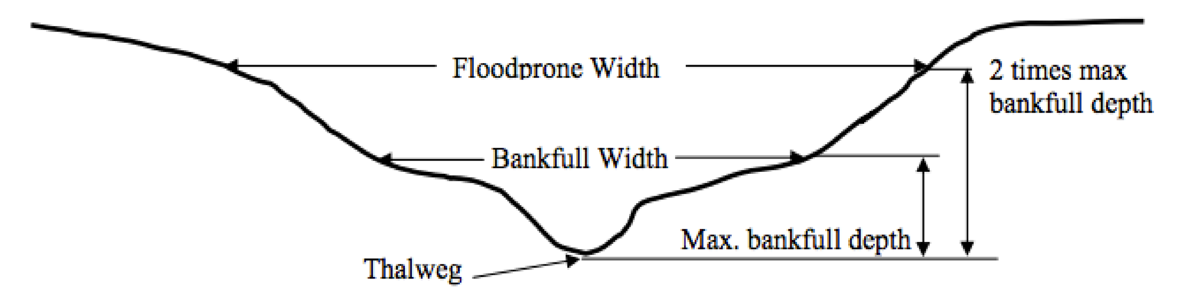


Figure 2. Channel dimensions cross-section from Kline et al.; "Vermont Geomorphic Assessment Protocols Phase 2 Handbook: Rapid Stream Assessment;" State of Vermont; vtwaterquality.org, 2003; Web; 15 Mar. 2015.

• Most measurements were based on methods and diagrams outlined in the VT ANR Geomorphic Assessment Protocols (Kline et al. 2009)
• Materials used included a survey-grade measuring tape, bank pins, measuring stick, Trimble GPS and map.

Results

• 53 sites were surveyed.
• Majority of the field sites were accessed from trails or roadsides.
• Most of the measurements were obtained to the west of the Mad River (fifth order) in mountainous terrain.
• There were few accessible sites along first order streams at edges of the watershed boundary.
• Fifth order streams (mainstem of Mad River) were difficult to access or heavily altered (armored banks and berms).

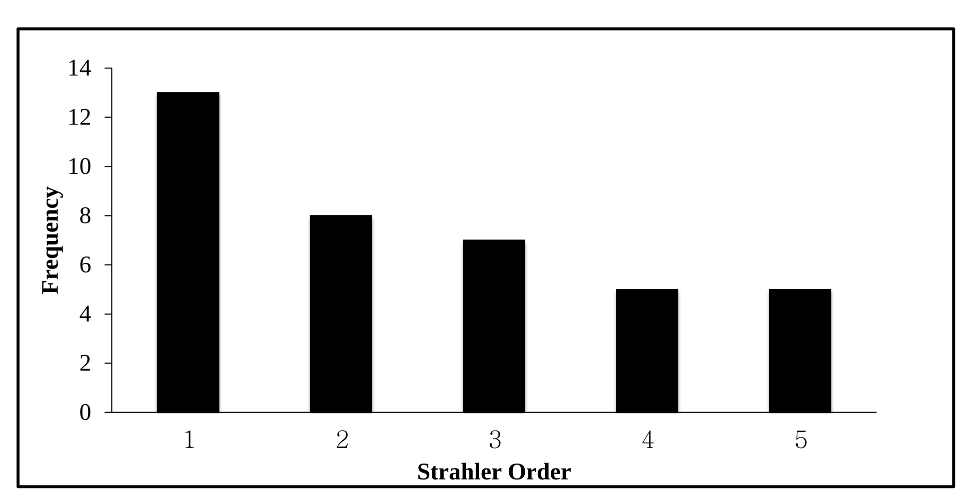
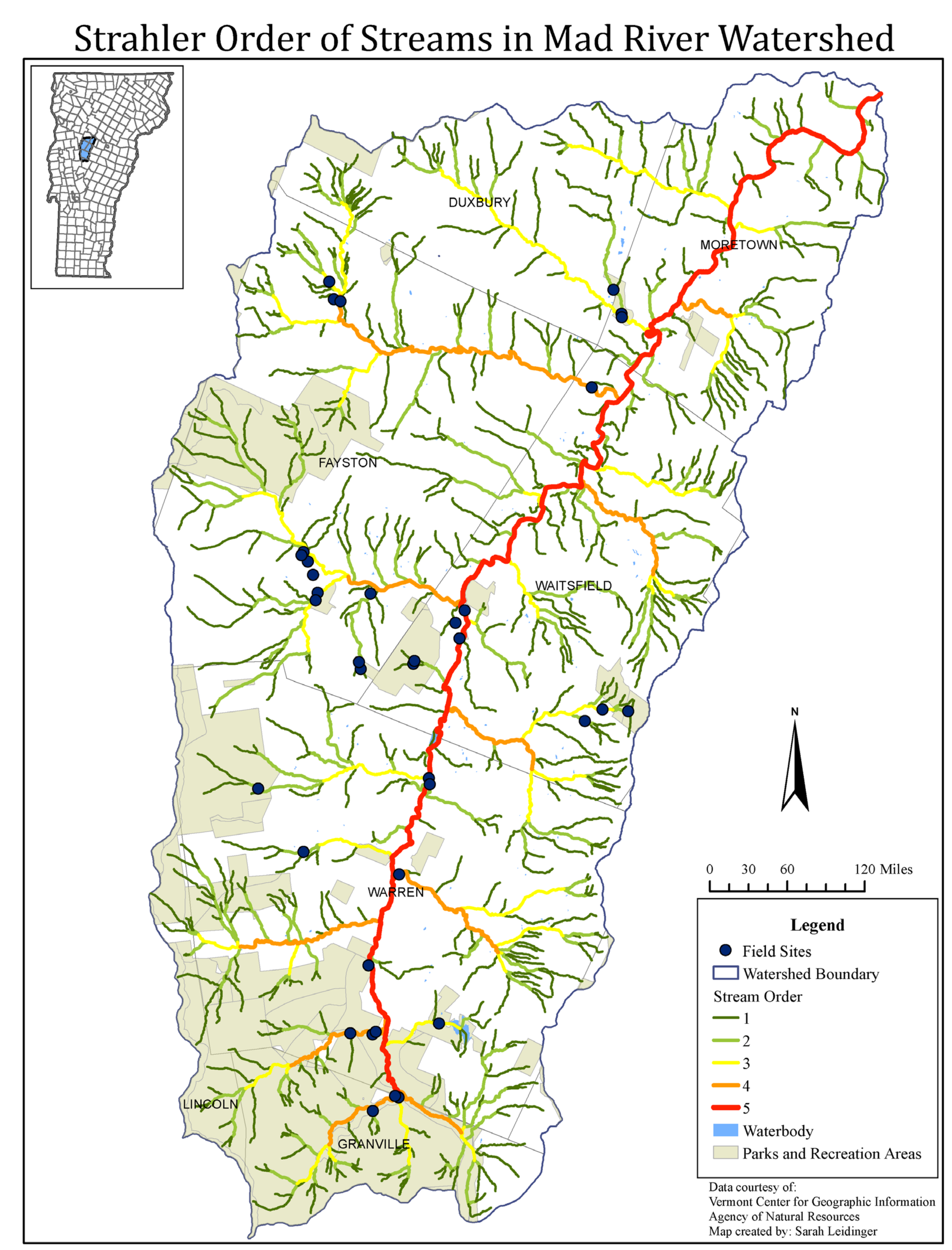


Figure 3. Number of field sites per stream order measured throughout study area.

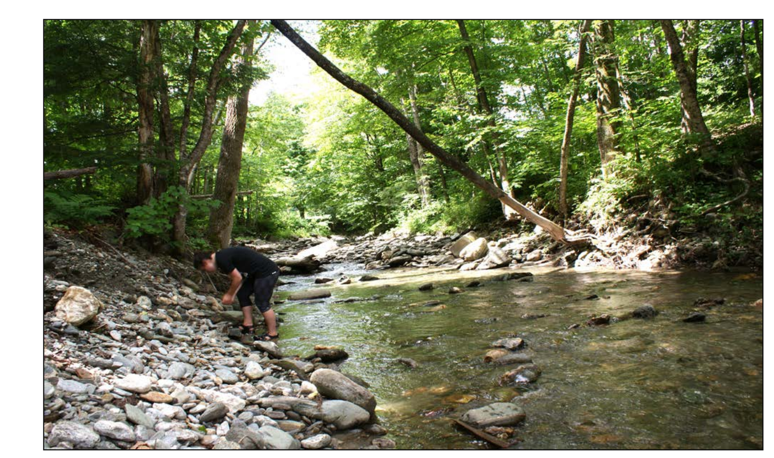
• A One-Way ANOVA was conducted for each geomorphic measurement.
• All seven measurements were statistically significant with p-values less than 0.05 (95% certainty) within groups.
• Channel width and bankfull width were statistically significant with p-values less than 0.01 (99% certainty)
• Variability for bankfull width and channel width was very high across all orders.



Map 1. Strahler order of streams in Mad River Watershed.

Conclusions

• The ANOVA analysis suggested that there are differences among stream orders in the variables measured in the field.
• There was high variability in fourth and fifth order streams, possibly a result of having a poor representative sample for these stream orders.
• The geographic locations of sample sites were concentrated on the western, more mountainous half of the watershed.
• Given the results of the research, it is suggested that a correlation does exist between the Strahler order and the field measurements. However, variability in the data, geographic bias, and lack of fifth order stream data may be skewing the results.
• Further research should be conducted at more locations throughout the watershed, especially those near the watershed boundary and on the eastern side of the Mad River to obtain a more representative sample of each stream order.



Literature cited

Hughes, R. M., Kaufmann, P. R., and Weber, M. H. (2011). National and regional comparison between Strahler order and stream size. *Journal of the North American Benthological Society, 30*(1):103-121.

Kline, M., Alexander, C., Pytlik, S. and Pomeroy, S. (2009) Vermont Stream Geomorphic Assessment Phase 2 Handbook: Rapid Stream Assessment. Vermont Agency of Natural Resources, Watershed Management Division. Web.

Pierson, P. M., Rosenbaum, B. J., McKay, L. D. and Dewald T. G. (2008). Strahler Stream order and Strahler Calculator Values in NHD*Plus*. US EPA Office of Water. .

Strahler, A. N. (1957). Quantitative analysis of watershed geomorphology. *Transations, American Geophysical Union, 38*(6):913-920.

Acknowledgements

I would like to thank Vermont EPSCoR and RACC for this internship opportunity as well as the UVM Engineering department for the use of their equipment. Funding provided by NSF Grant 1101317.