Understanding the effects of roads in upland settings on hydrology, geomorphology and water quality

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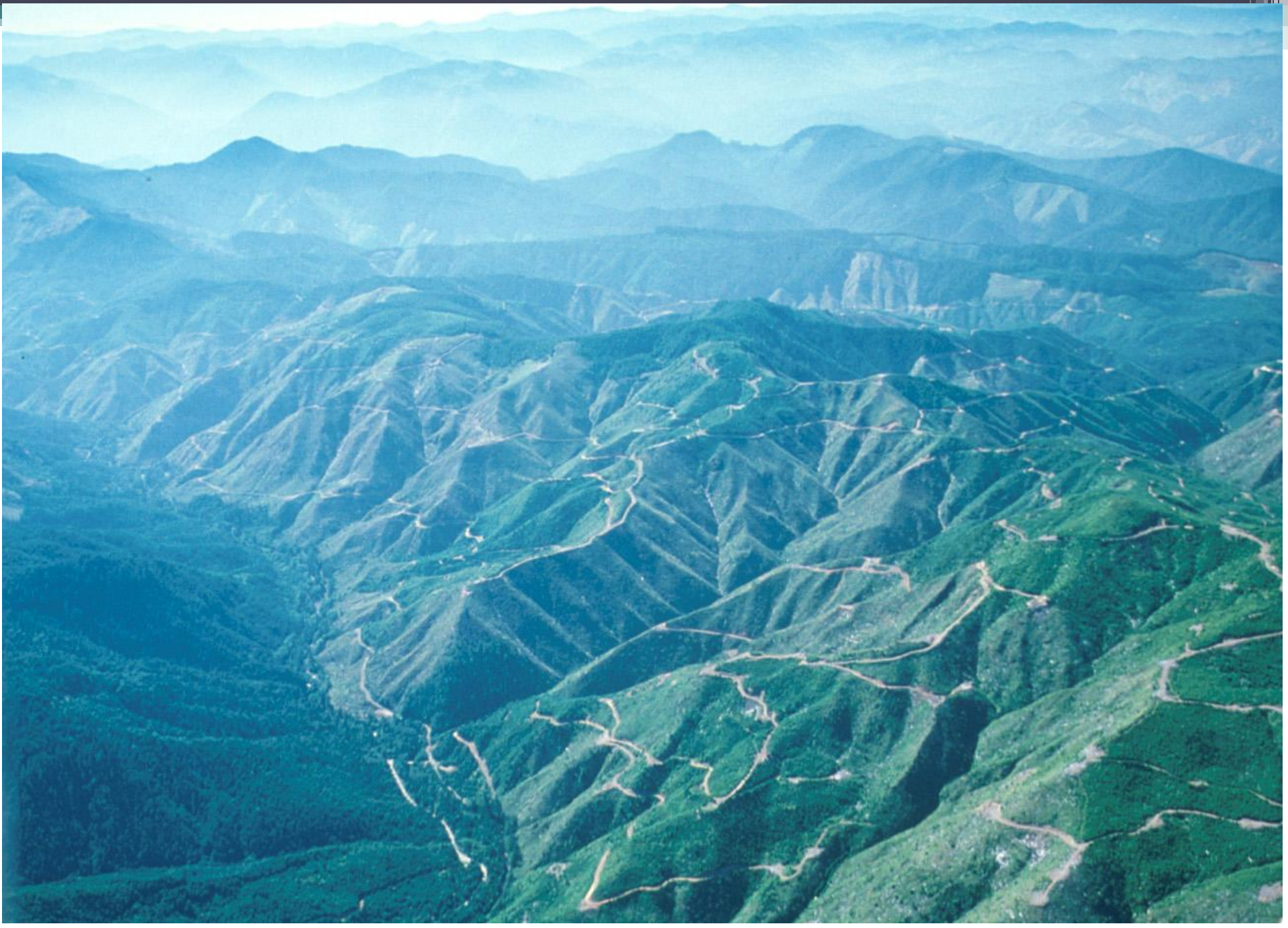
The University of Vermont

Replumbing the Chesapeake Bay Watershed Workshop

Easton, MD

October 9-10, 2014



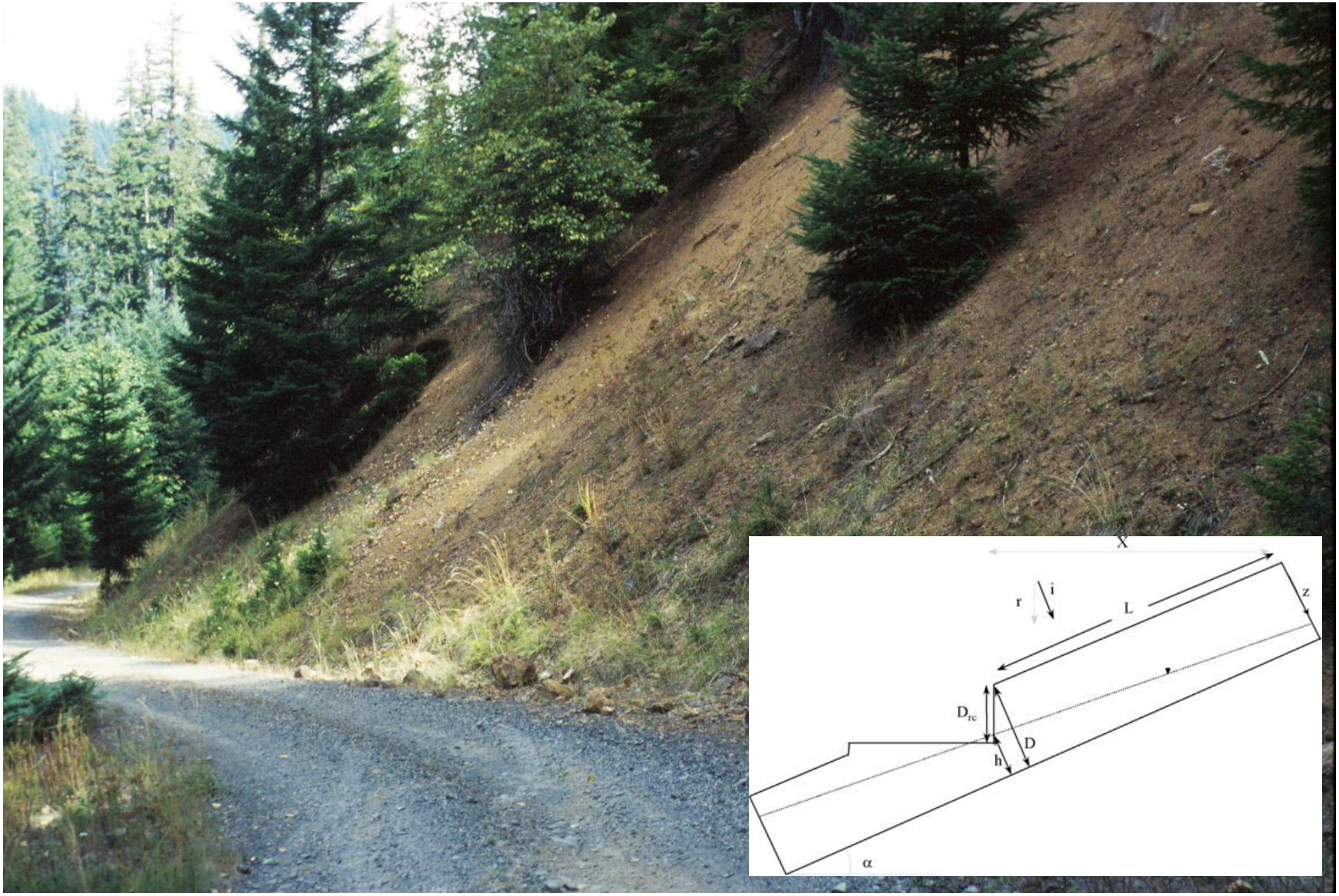
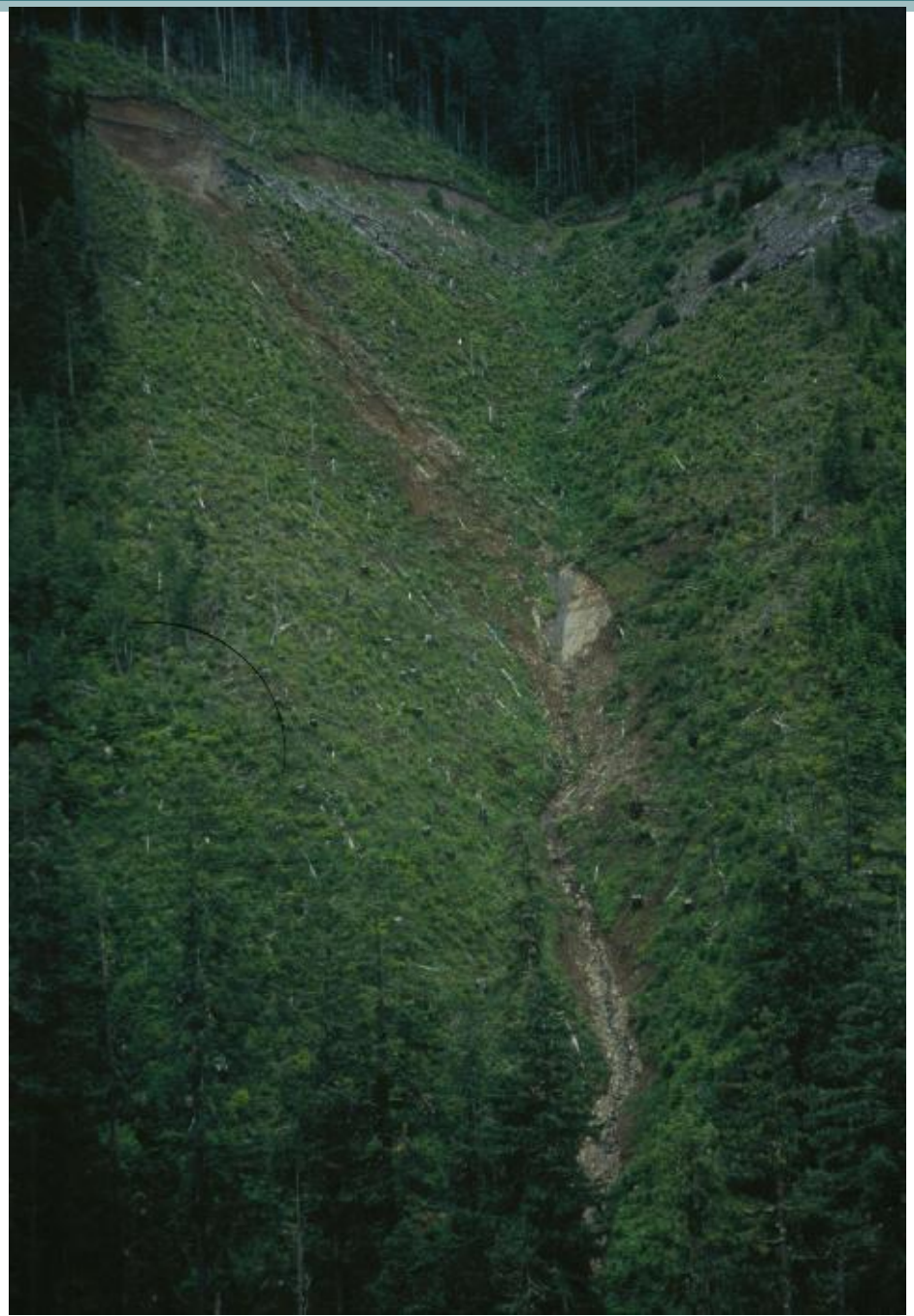


Figure 3. Schematic diagram illustrating the interaction of the hillslope water table with the road cut and parameters used in calculations. (Wemple and Jones, 2003)

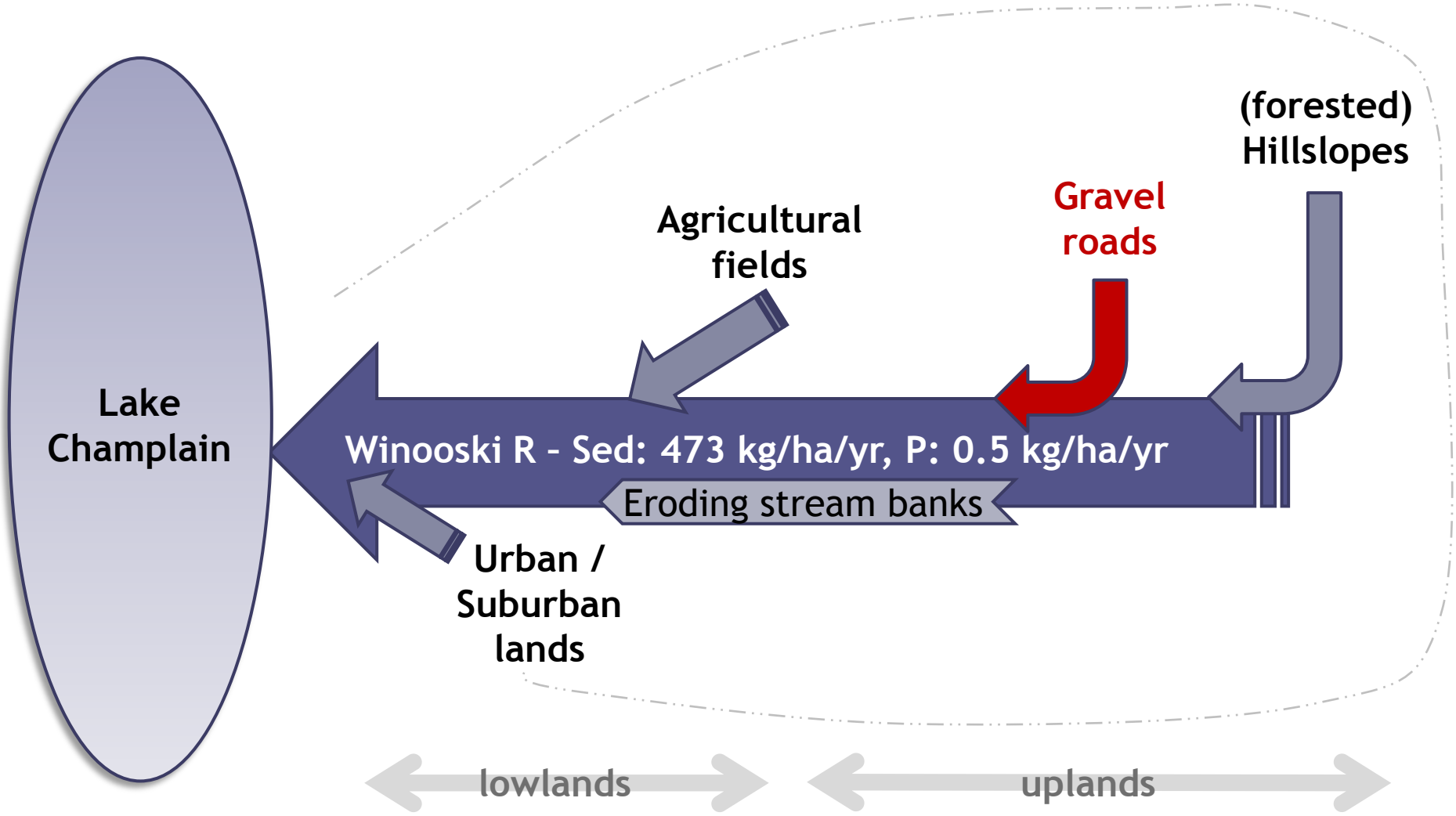


(Logging) Roads in upland settings

- Impervious surfaces in an otherwise pervious landscape (overland flow production)
- Effectively rearrange flow paths (subsurface flow interception)
- Highly integrated into the channel network (gullying, debris slides)

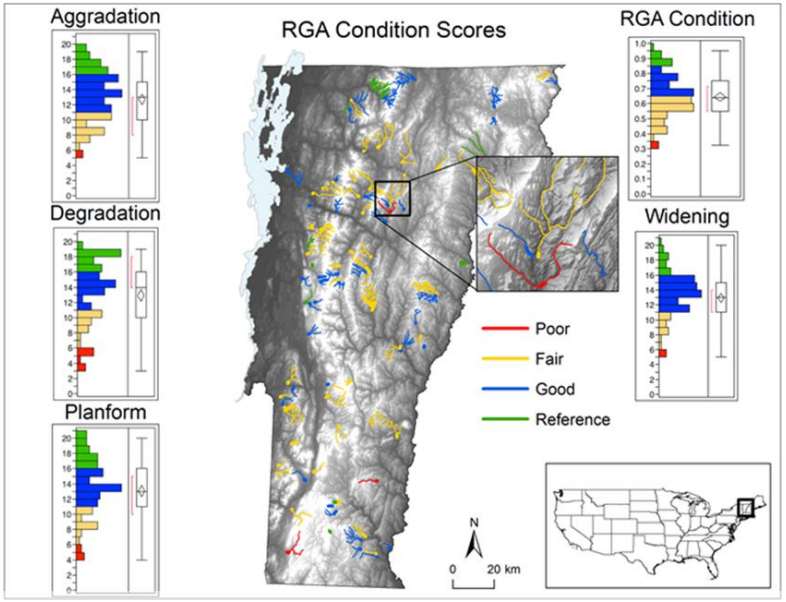
Context: Lake Champlain Basin

Conceptual Material Budget



Research approach

Storm-based monitoring of runoff and water quality



GIS mapping and analysis of stream geomorphic assessments

Field inventories of road erosion

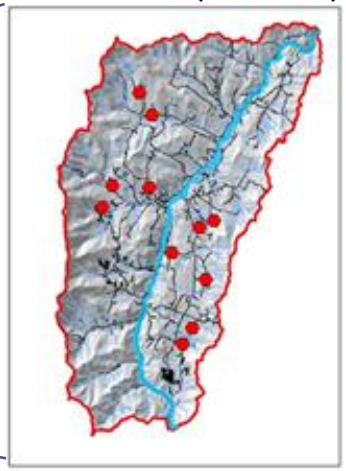
Experimental installation and monitoring of BMPs with cooperating towns

Study sites and scales of investigation

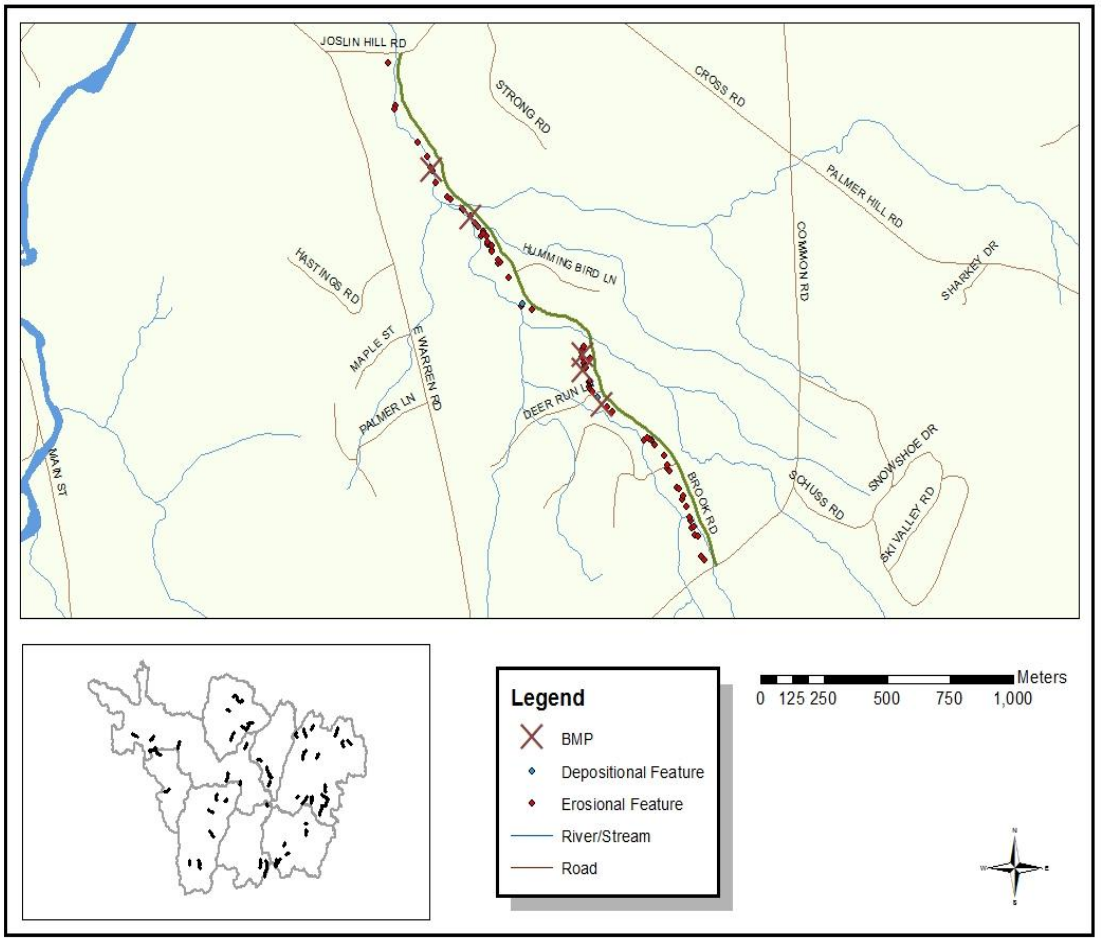
Lake Champlain basin (21000 km^2)

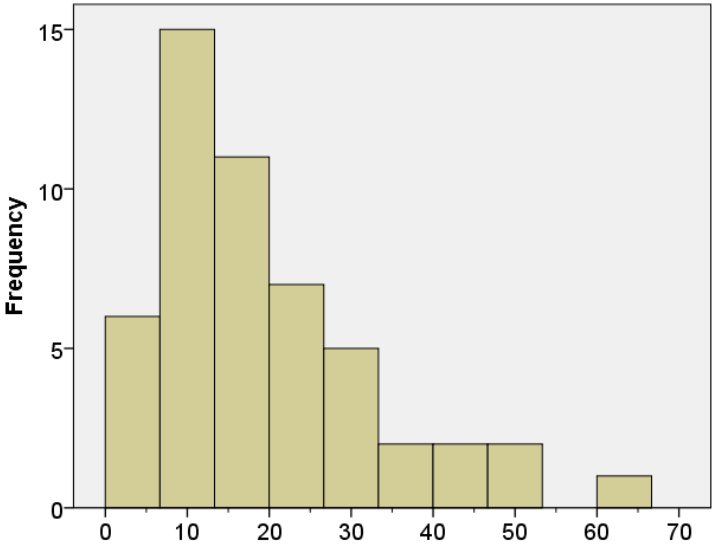
Winooski basin (2800 km^2)

Mad River watershed (373 km^2)

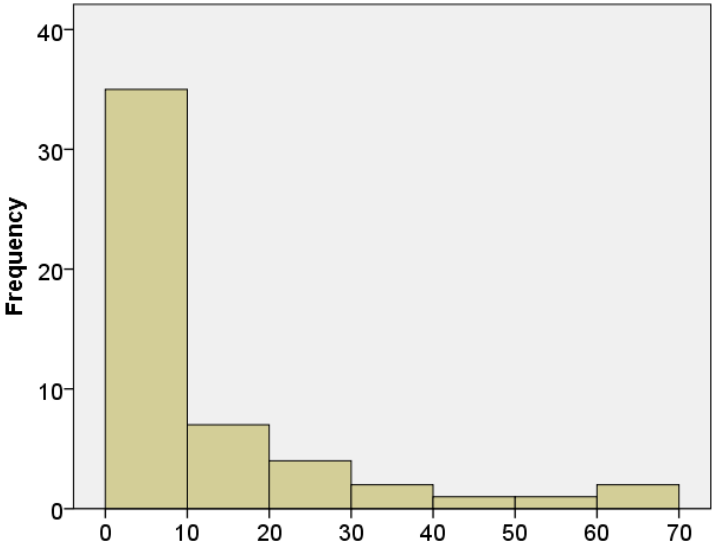


Road erosion inventory



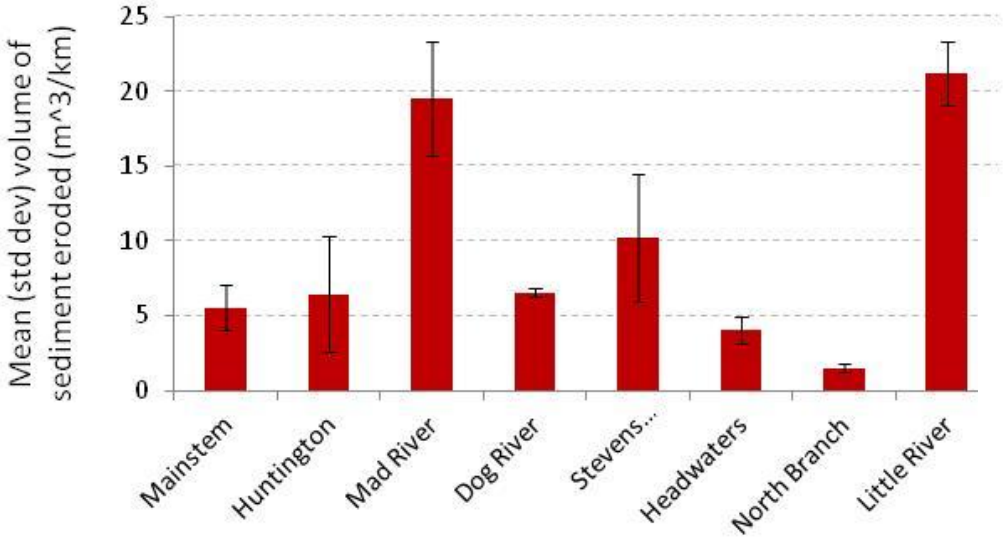


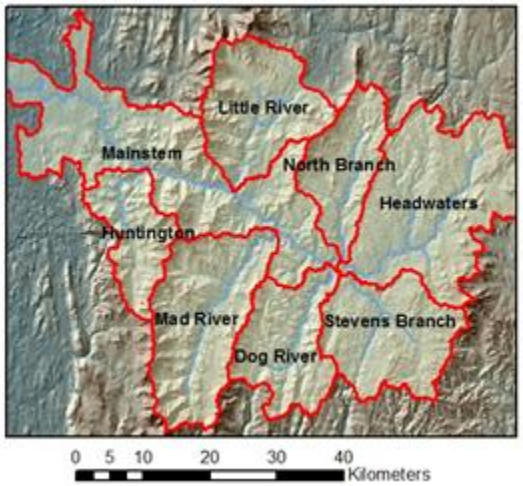
Erosional feature frequency (#/km)

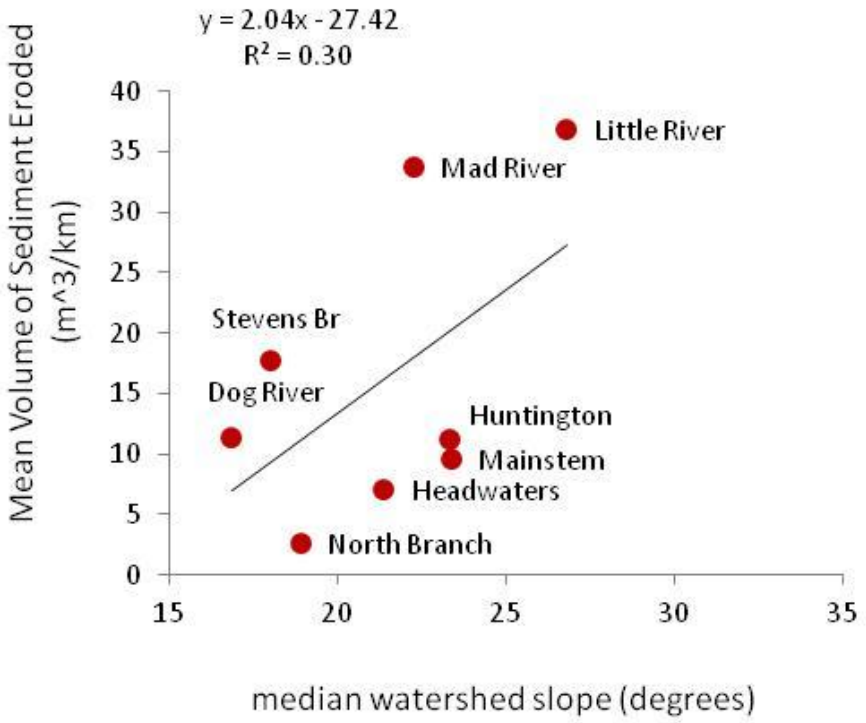


Volume of eroded sediment (m^3/km)

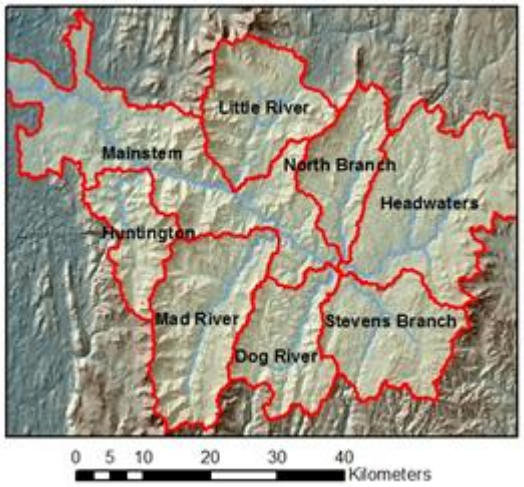
Inventory Results

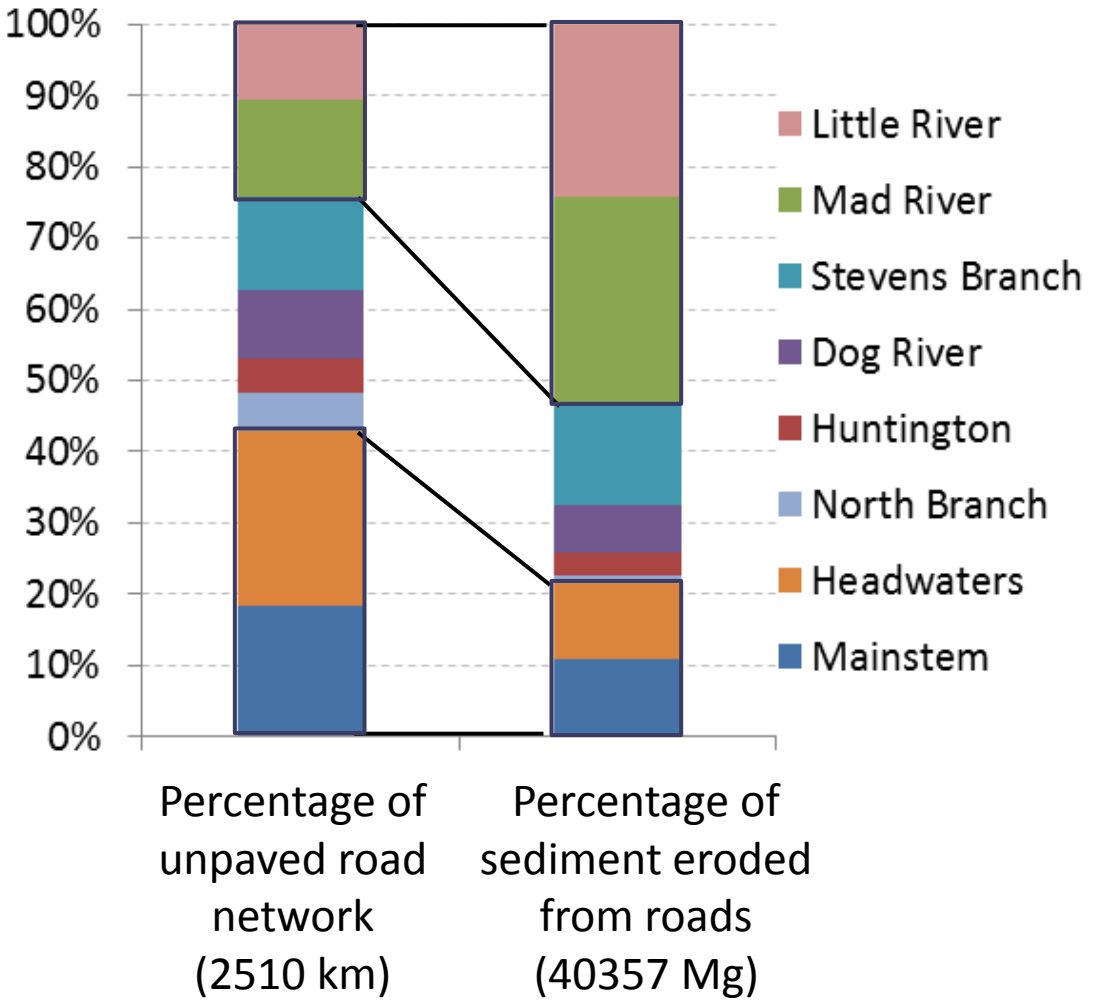






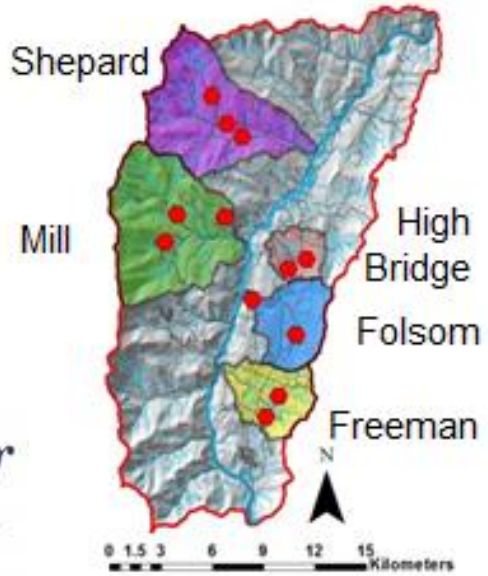
Sediment from roads

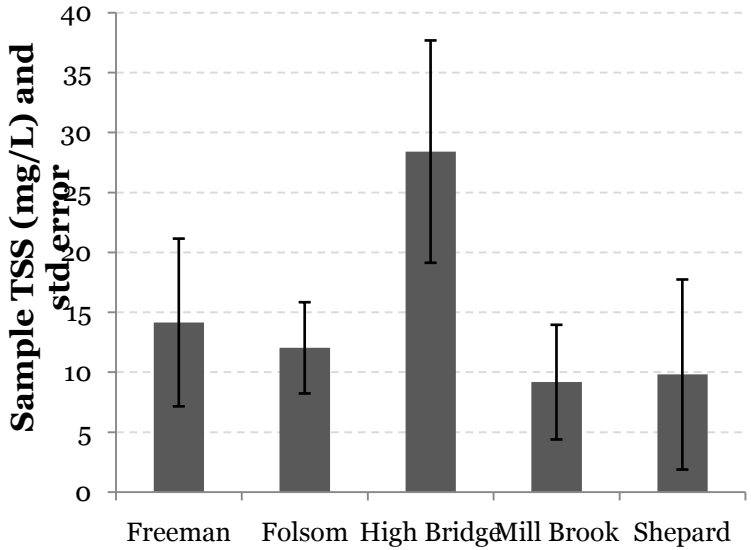


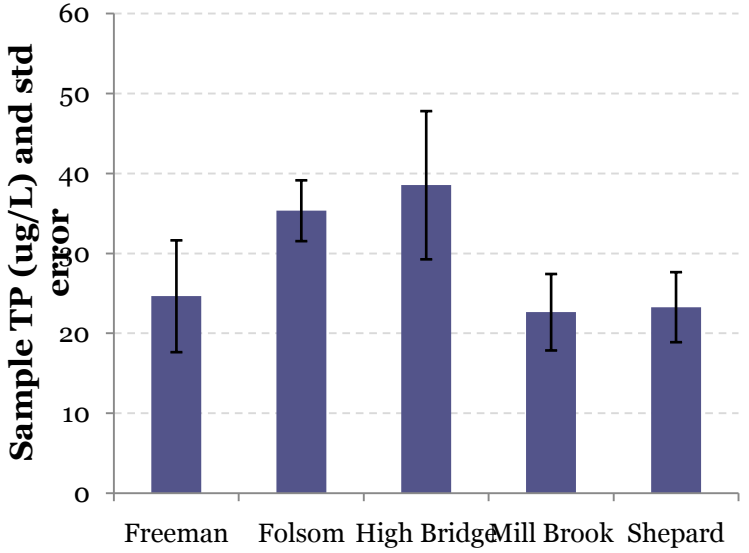


Community-based WQ monitoring

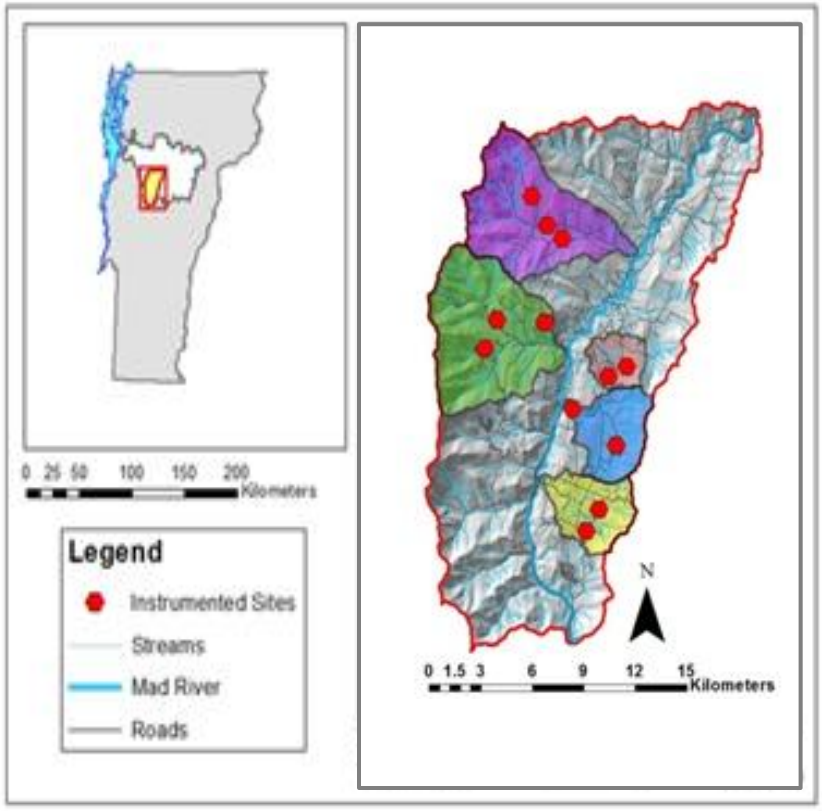
Friends of the Mad River



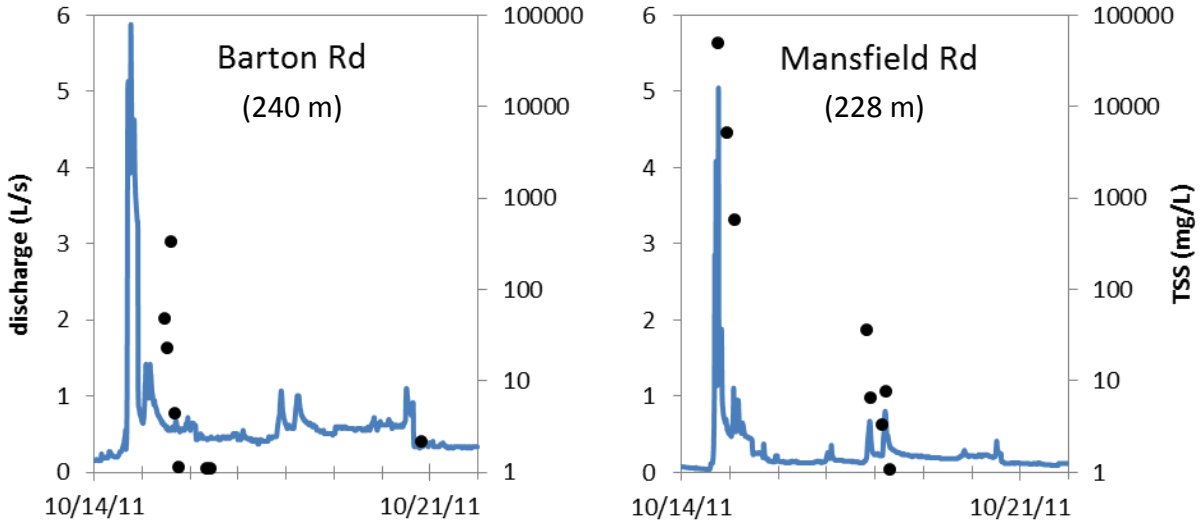


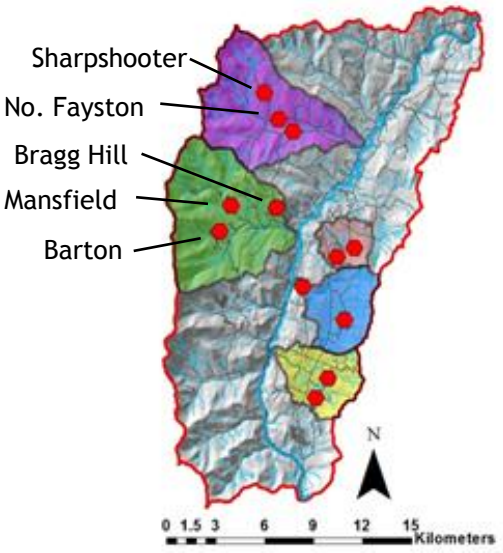


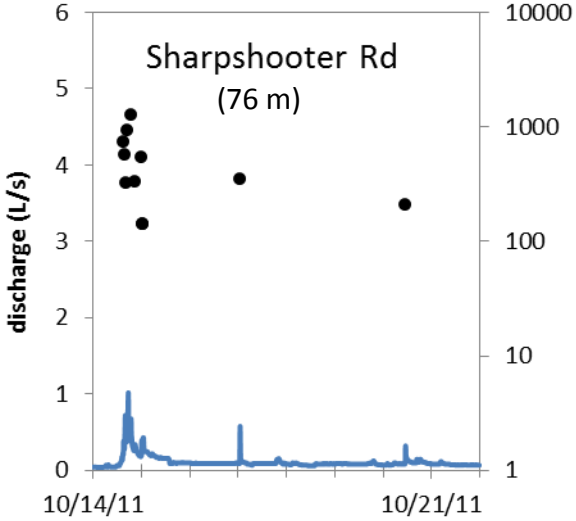
Storm-based monitoring & sampling

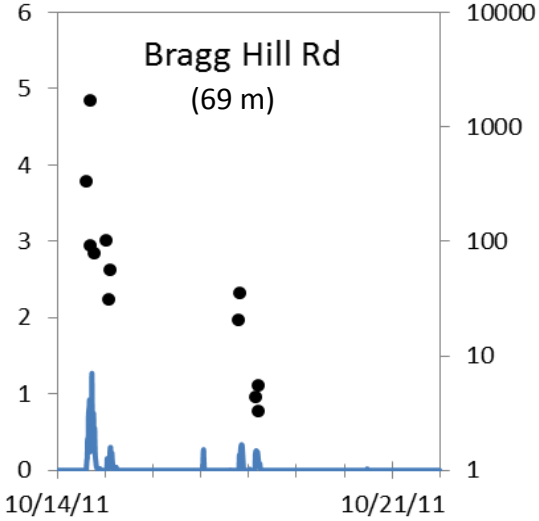


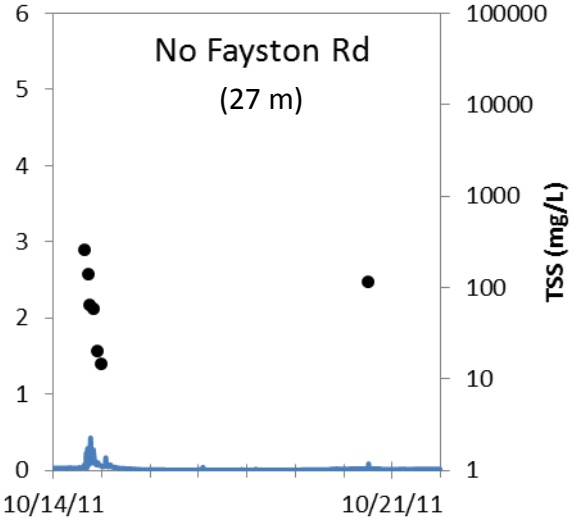
Road segment dynamics



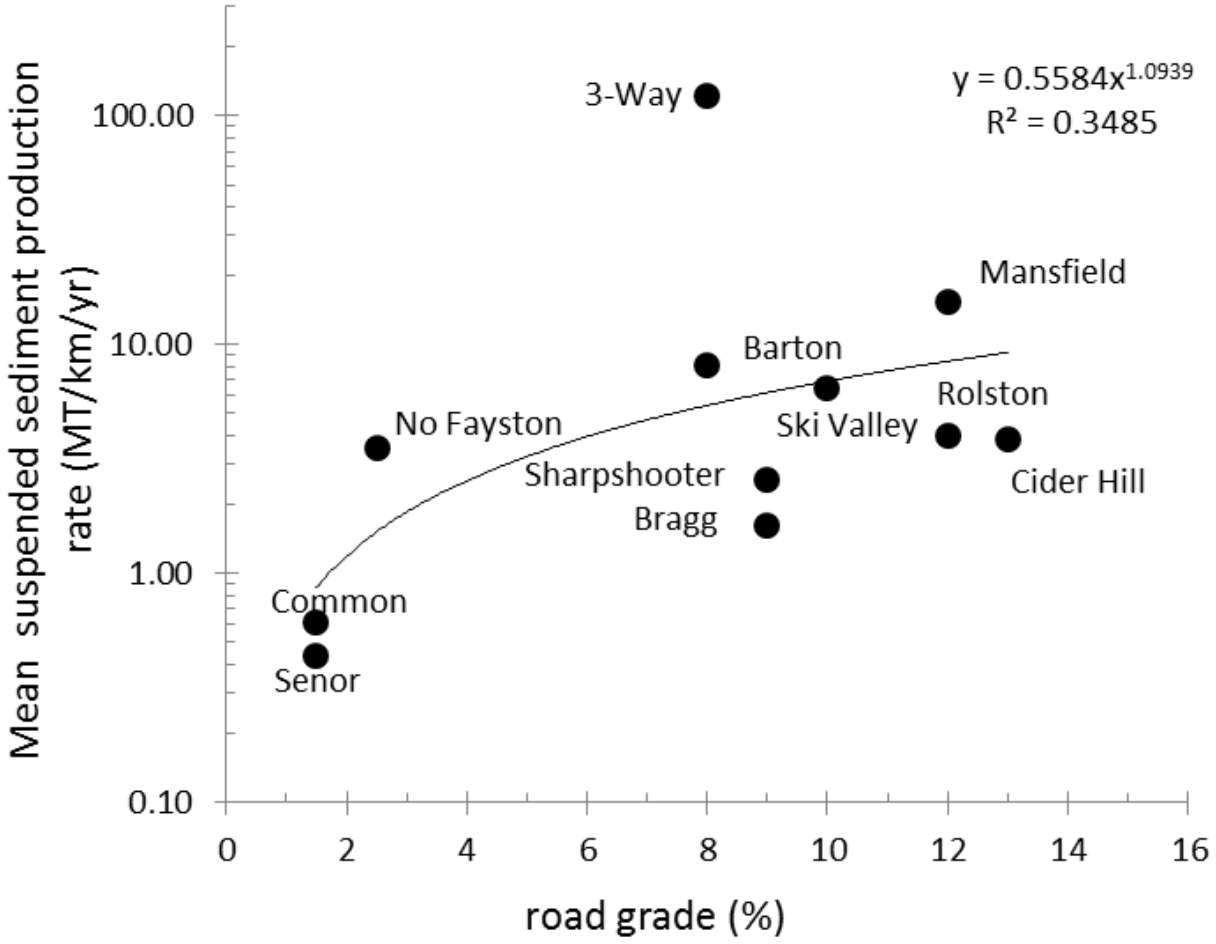


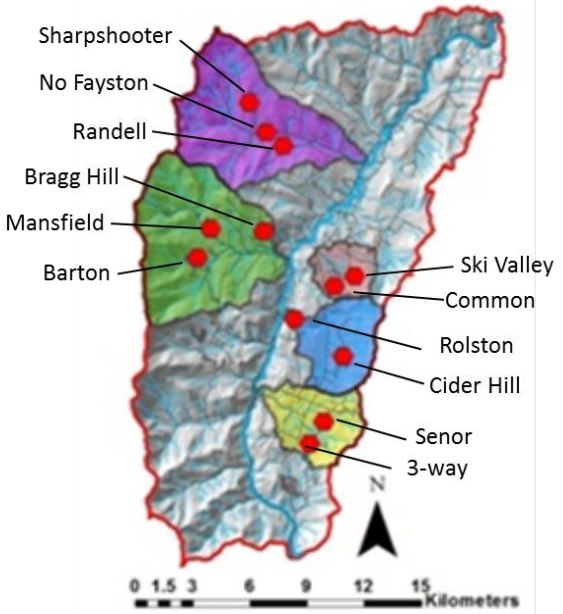




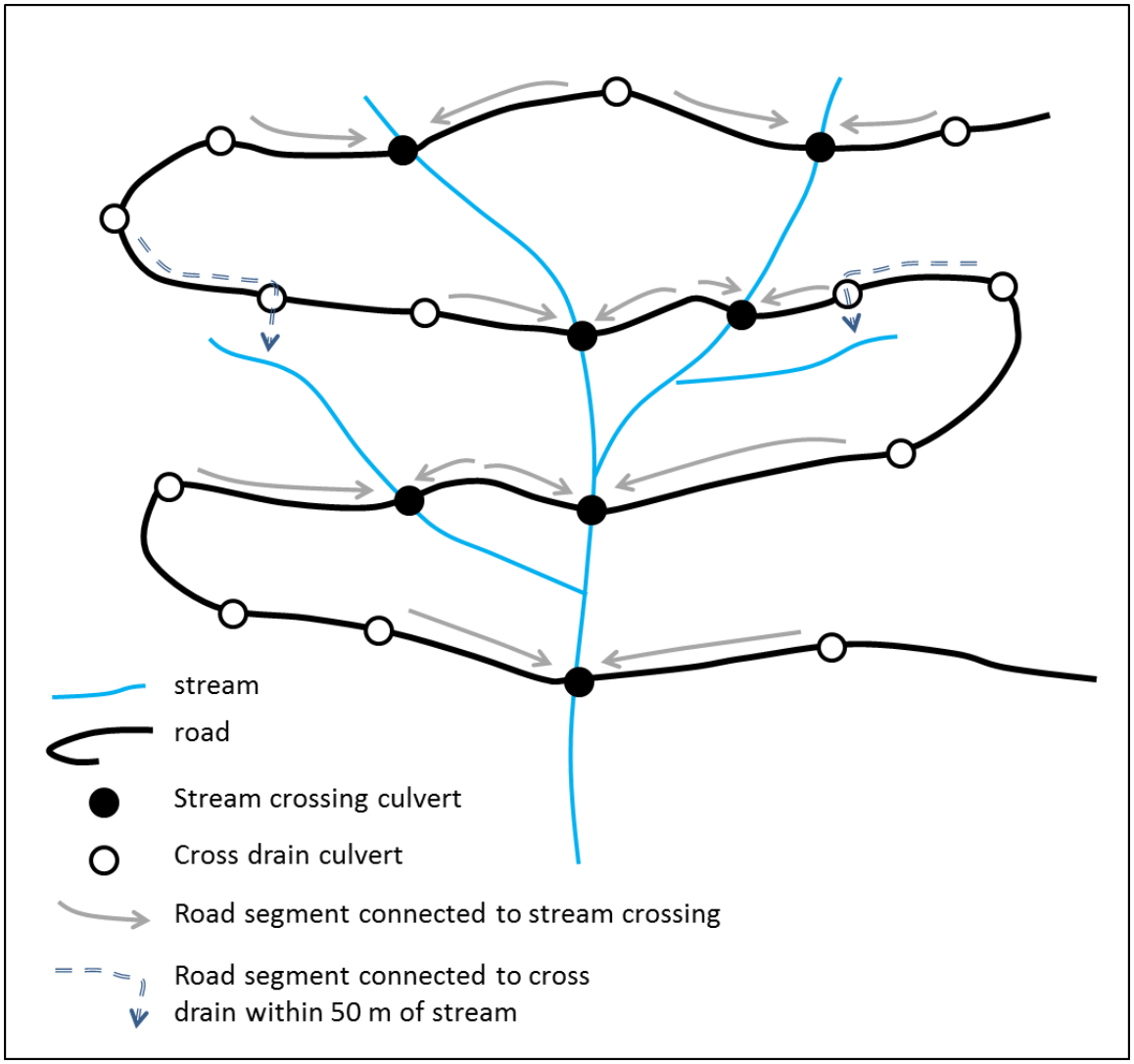


Mass Flux from roads

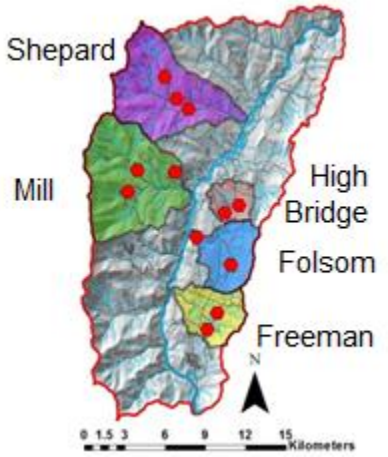




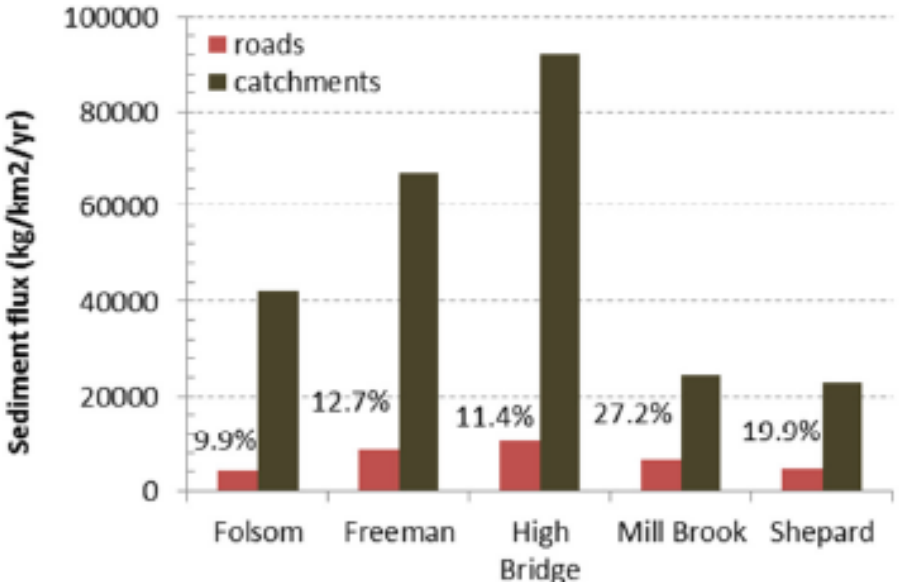
Network connectivity



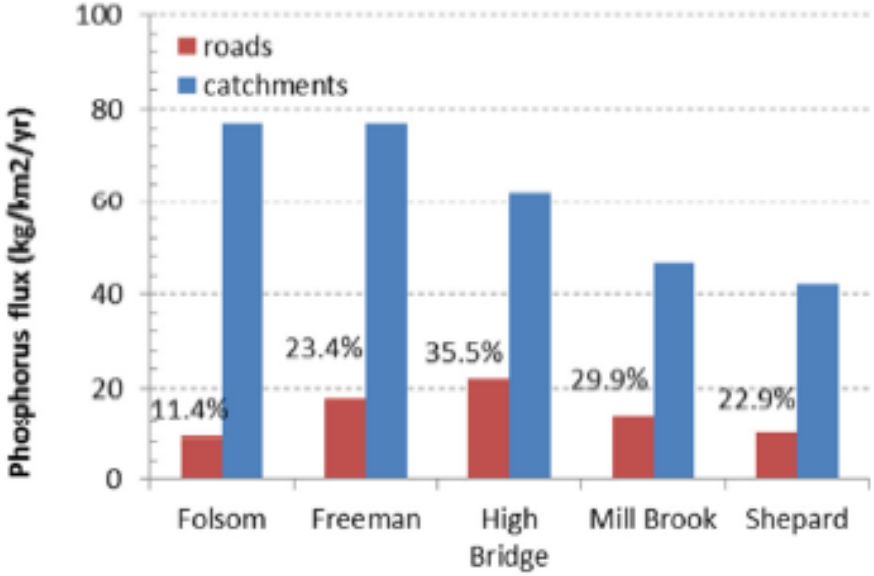
Mass Flux: Roads vs. Streams



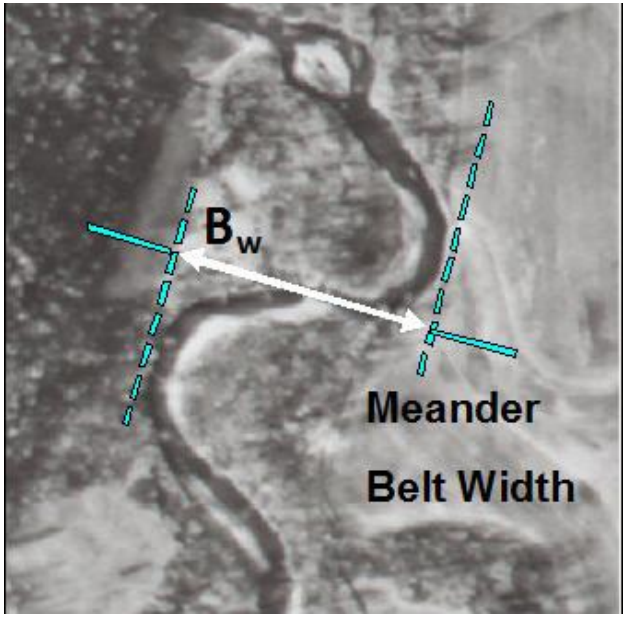
Suspended Sediment



Total Phosphorus



Geomorphic Assessments, Vermont River Management Program



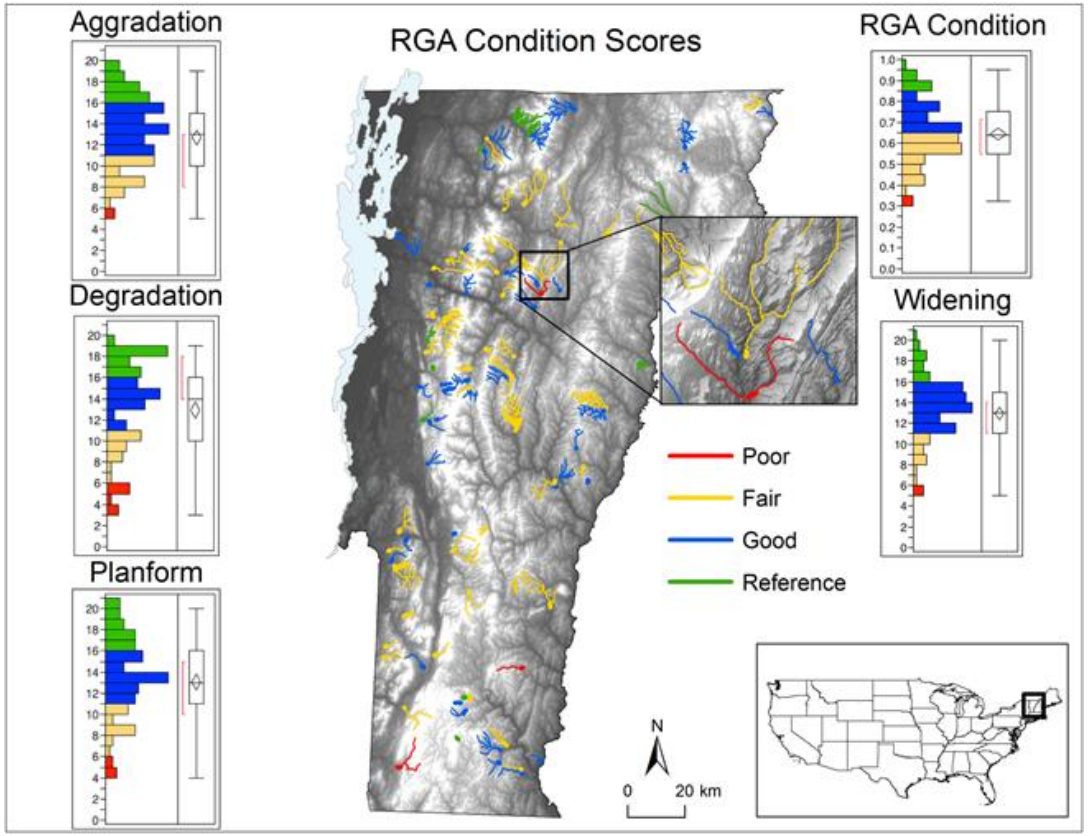
Images courtesy of Vermont Rivers Program, Agency of Natural Resources

http://www.anr.state.vt.us/dec/waterq/rivers.htm

Study reaches

- Forest cover > 75%
- No impoundments, railroads, history of dredging/gravel mining, development (other than roads) along reach corridor
- Downstream-most assessed reach

→ 102 reaches

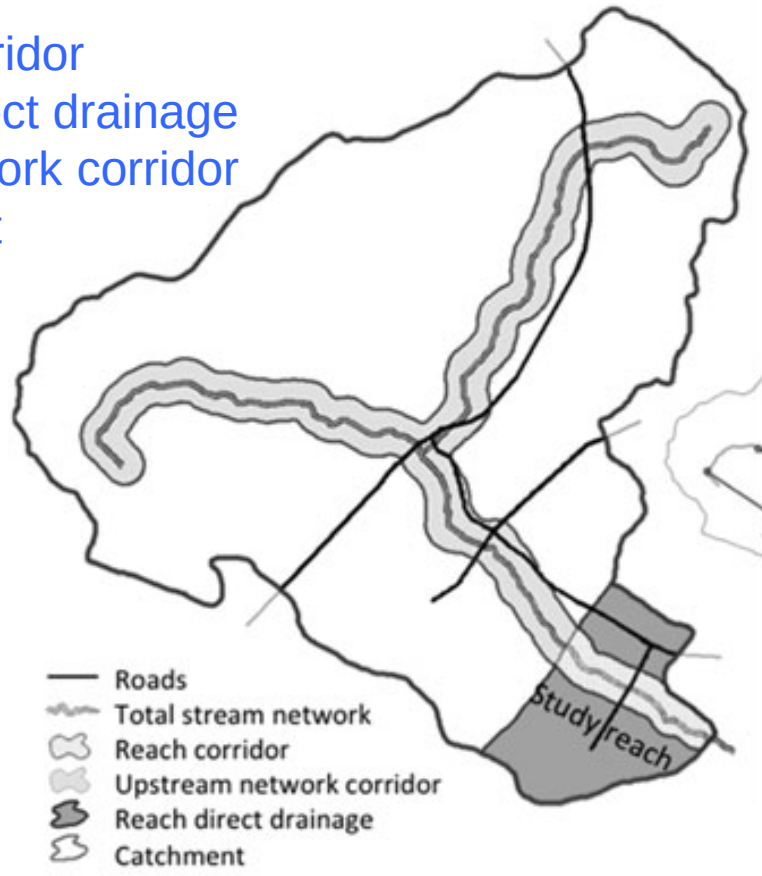


Pechenick et al., 2014

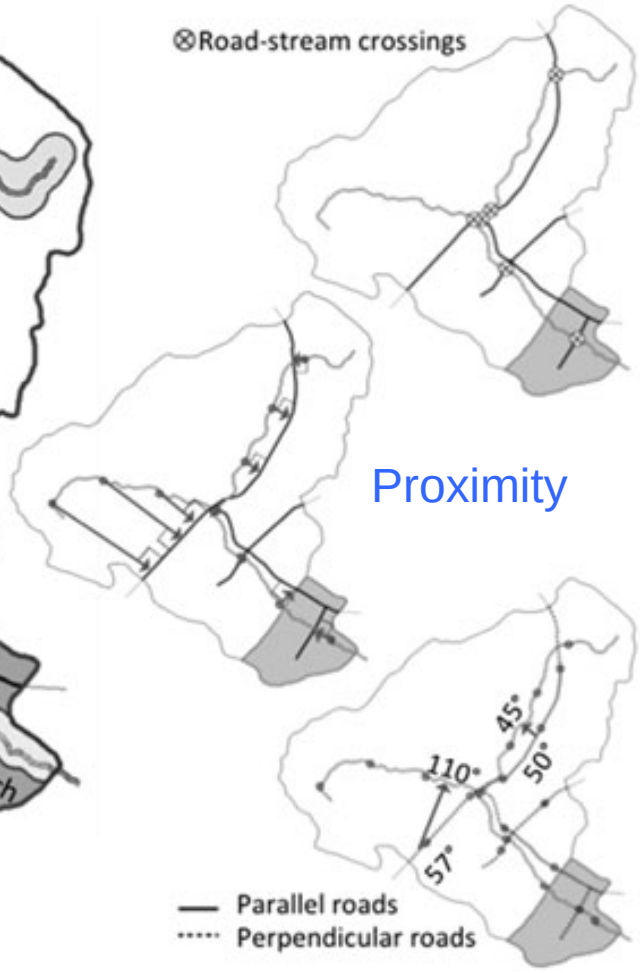
Scales and metrics of road impact

Scales/regions

- Reach corridor
- Reach direct drainage
- River network corridor
- Catchment



Metrics

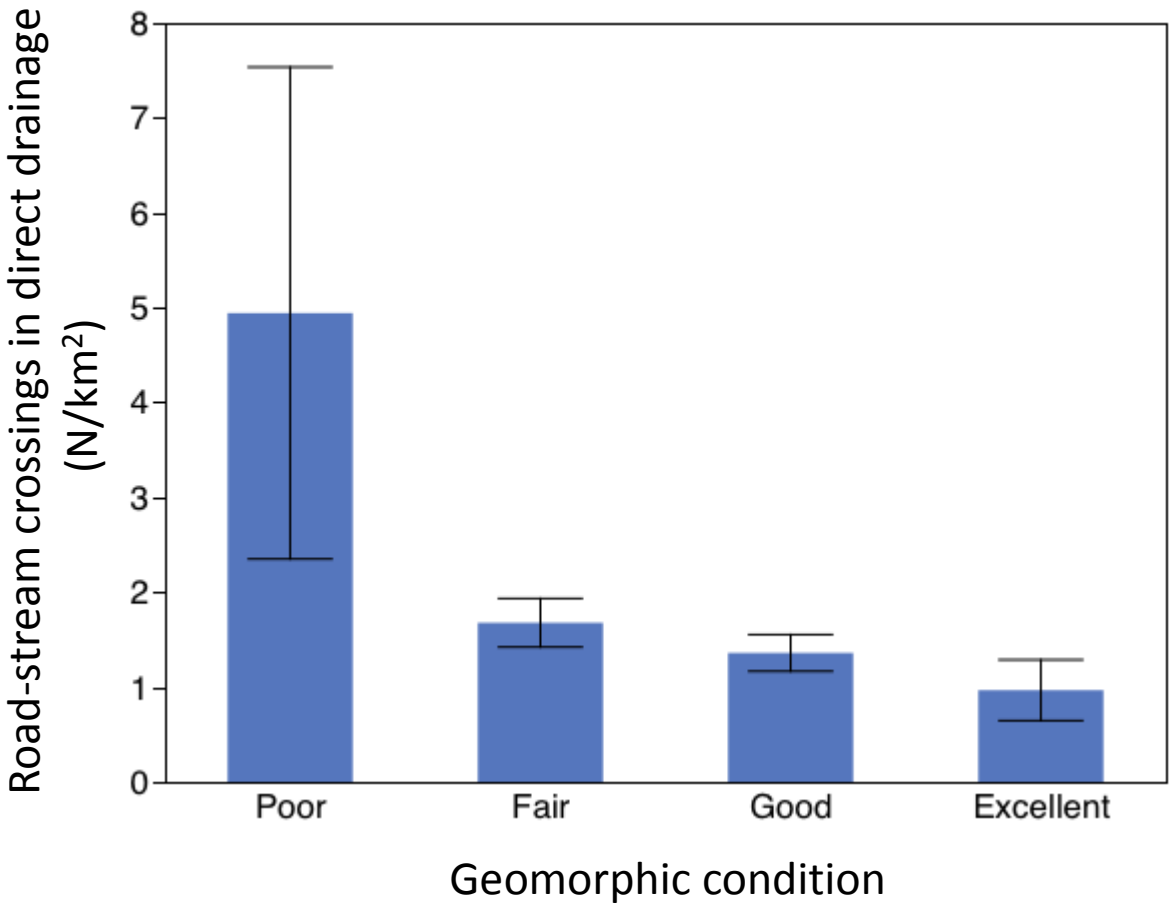


Density

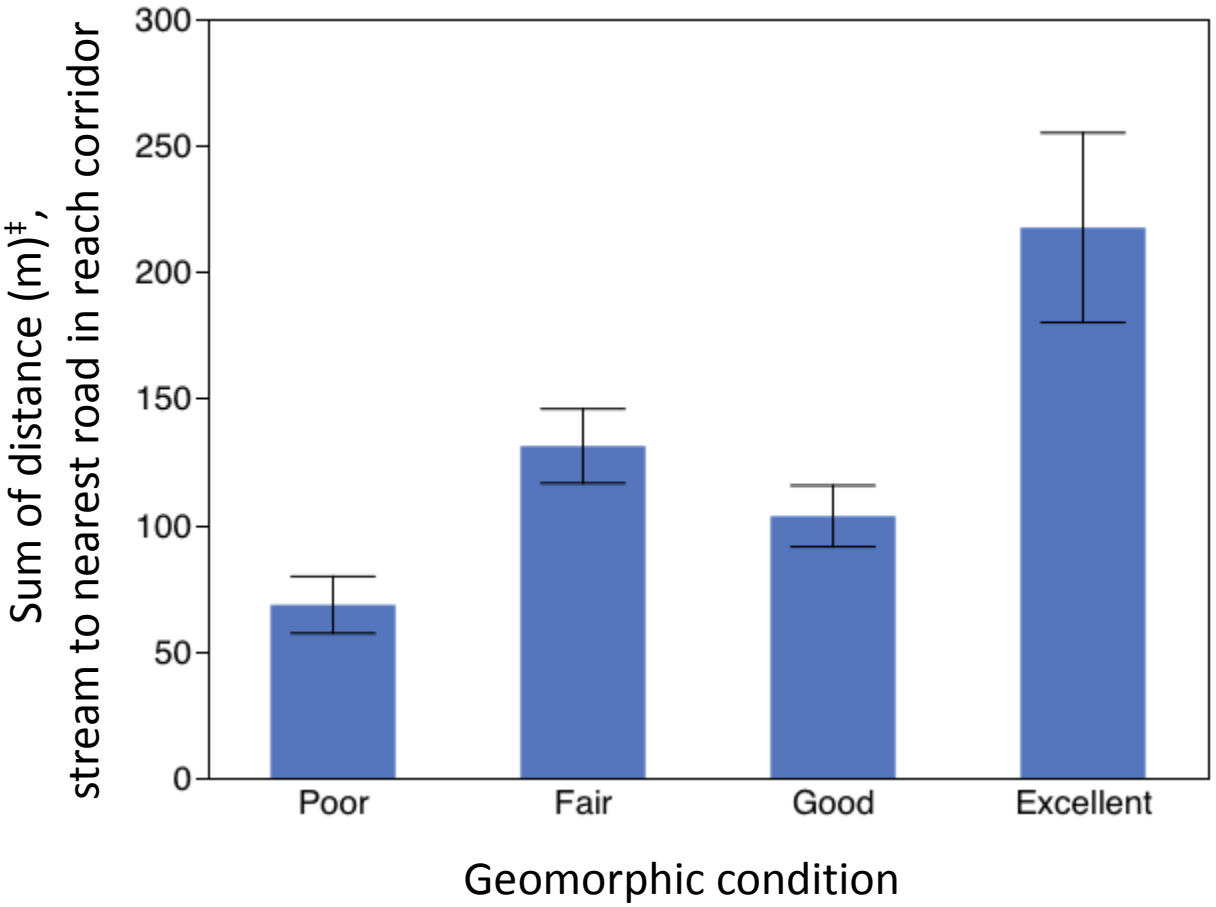
Proximity

Orientation

Density metrics of channel condition



Proximity metrics of channel condition



‡ Normalized by stream length

SUMMARY:

Inventories identify nature and location of road impacts to waterways

Coupled water quality monitoring of ditches and receiving waters allows identification of relative importance of roads on water quality

Geomorphic assessments allow identification of downstream impacts

Improved understanding of how & where roads impact waterways helps inform mitigation measures

Acknowledgements

Collaborators:
- Don Ross, Dept of Plant & Soil Science, UVM
- Donna Rizzo, Environmental Engineering, UVM
- Leslie Morrissey, Rubenstein School, UVM

Students and technicians:
G Clark, J Garton, K Garvey, S Hamshaw, A Larson, H Schmid, A Pechenick, C Webster, R Zeyzus

Funding Sources:
- US EPA and New England Interstate Water Pollution Control Commission
- VT DEC Ecosystem Restoration Program
- Northeastern States Research Cooperative (Theme 1)
- U.S. Geological Survey (NIWR)

For More Information:

Lake Champlain Basin Program report:

http://www.lcbp.org/wp-content/uploads/2013/07/74_Road-Study_revised_June2013.pdf

Northeastern States Research Cooperative:

http://nsrcforest.org/project/assessing-road-impacts-stream-stability-and-health-forested-watersheds

UVM Blog site for BMP study:

http://blog.uvm.edu/aplarson/

bwemple@uvm.edu