Utilizing benthic macroinvertebrates as indicators of fecal contamination in streams

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Introduction

- Vermont occupies the largest portion of the Lake Champlain Basin and has a vested economic interested in water quality improvement and protection of the lake.
- Phosphorus causes toxic blue-green algae blooms to occur in the lake. Fecal contamination (including *E. coli* and other coliforms) also threaten water quality in the lake. Bacterial contamination and blue-green algal blooms are indicative of poor water quality (Lange, 2013) and lead to beach closings in Lake Champlain.
- While point sources of pollution in Lake Champlain and its Basin, such as pipes, channels, etc., are easy targets for regulation, nonpoint sources contribute the most to the Lake's pollution.
- Nonpoint sources of pollution occur in both urban centers (e.g. impervious surfaces such as parking lots) as well as in agricultural areas (e.g. confined animal feed operations and manure spreading). Rainfall washes contaminants from these sources into Lake Champlain tributaries (Pandey, 2012).
- Contamination alters macroinvertebrate communities in streams as they respond to both chemical pollution and particles (Heino, 2003). Low water quality resulting from runoff pollution decreases the abundance and richness of sensitive EPT (Ephemeroptera, Plecoptera, Trichoptera) macroinvertebrate species in streams. By surveying these species, it is possible to infer the habitat quality of a stream (McCabe, 2012).

Discussion

- Members of the insect orders Ephemeroptera, Plecoptera, and Trichoptera respond negatively to high agricultural and urban catchments (Figure 1). While macroinvertebrates have a strong negative response to high urban % catchments, (Figure 3) their response to agricultural % catchments is weakly negative, with a weaker correlation (Figure 4).
- EPT macroinvertebrates respond positively to highly forested catchments, with a tight correlation (Figure 2).
- Contrary to these results, the negative correlation between EPT macroinvertebrates and maximum stream *E. coli* is weak, which although significant, is not as strong as expected from catchment data (Figure 5).
- This may be because physical habitat differences have greater effects on an EPT index than does water quality. While agricultural and urban streams typically provide poor habitats for macroinvertebrates, forested streams provide beneficial habitats. The differences between these habitats may cause the trends visible in the graphs, rather than *E. coli* pollution.
- This hypothesis agrees with data provided by Chung (2012), in that topography, geology, riparian cover and type, and other physical factors of a habitat can have great influence on the taxa of macroinvertebrates living within.
- While the correlation between habitat assessments and %EPT is not very strong (Figure 6), this may be due to the subjectivity of habitat assessments, and not necessarily due to lack of a relationship.

Results

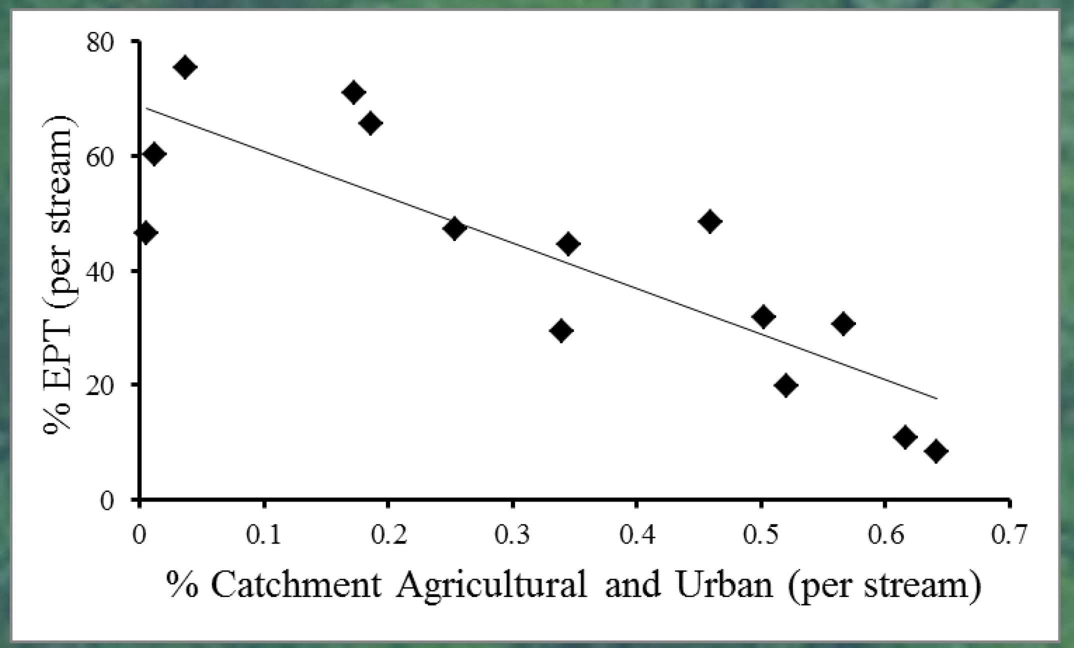

Figure 1. A comparison of the % catchment agricultural and urban combined and the % EPT of 14 streams in the Lake Champlain Basin in 2011. (p<.01, R^2 = 0.7098)

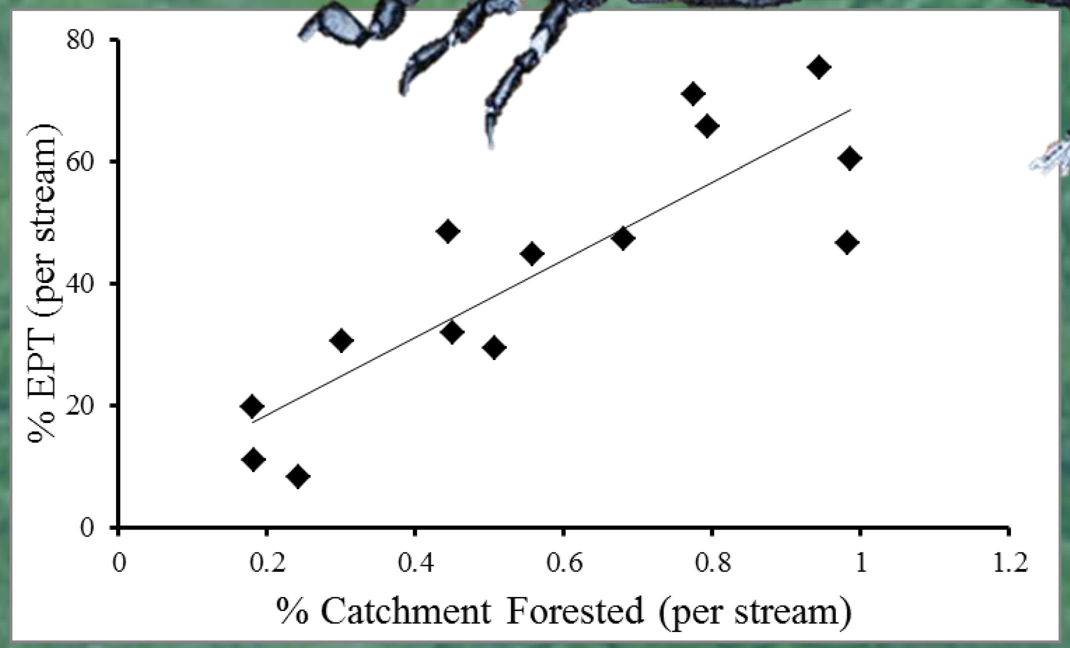

Figure 2. A comparison of the % catchment forested and the % EPT of 14 streams in the Lake Champlain Basin in 2011. (p<.01, R^2 = 0.744)

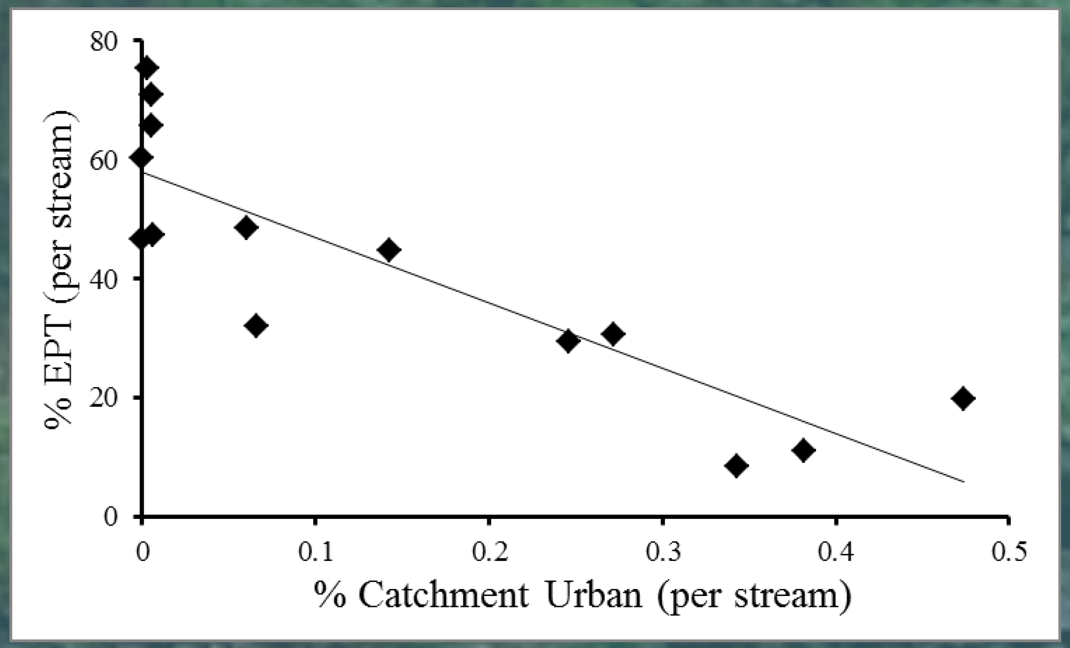

Figure 3. A comparison of the % catchment urban and the % EPT of 14 streams in the Lake Champlain Basin in 2011. (p<.01, R^2 = 0.7401)

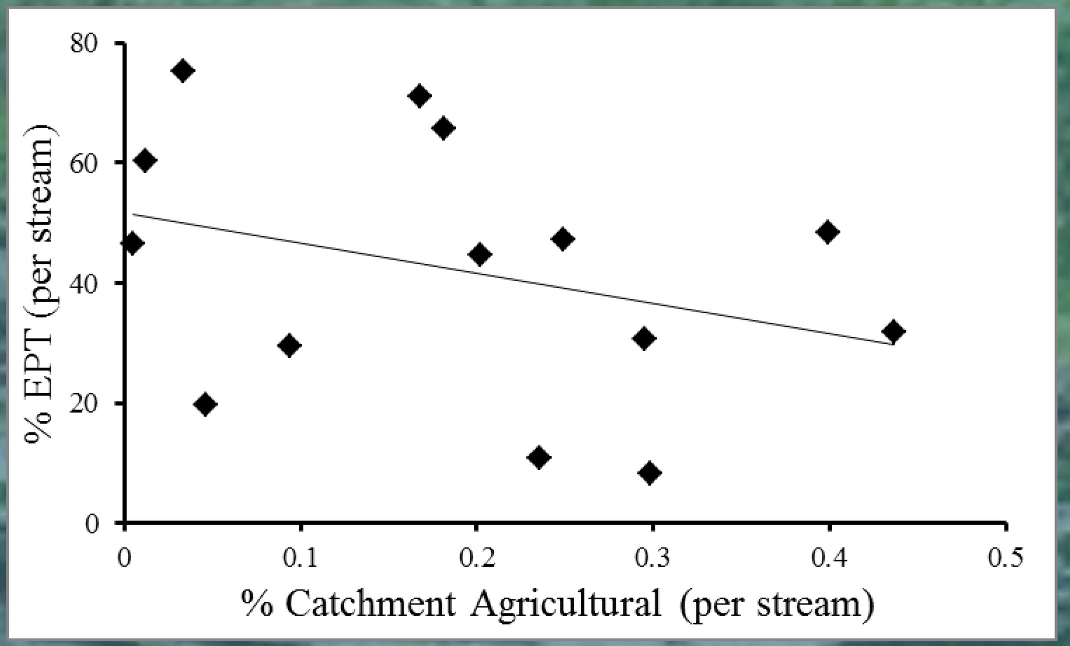

Figure 4. A comparison of the % catchment agricultural and the % EPT of 14 streams in the Lake Champlain Basin in 2011. (p=0.249263, R^2 = 0.1089)

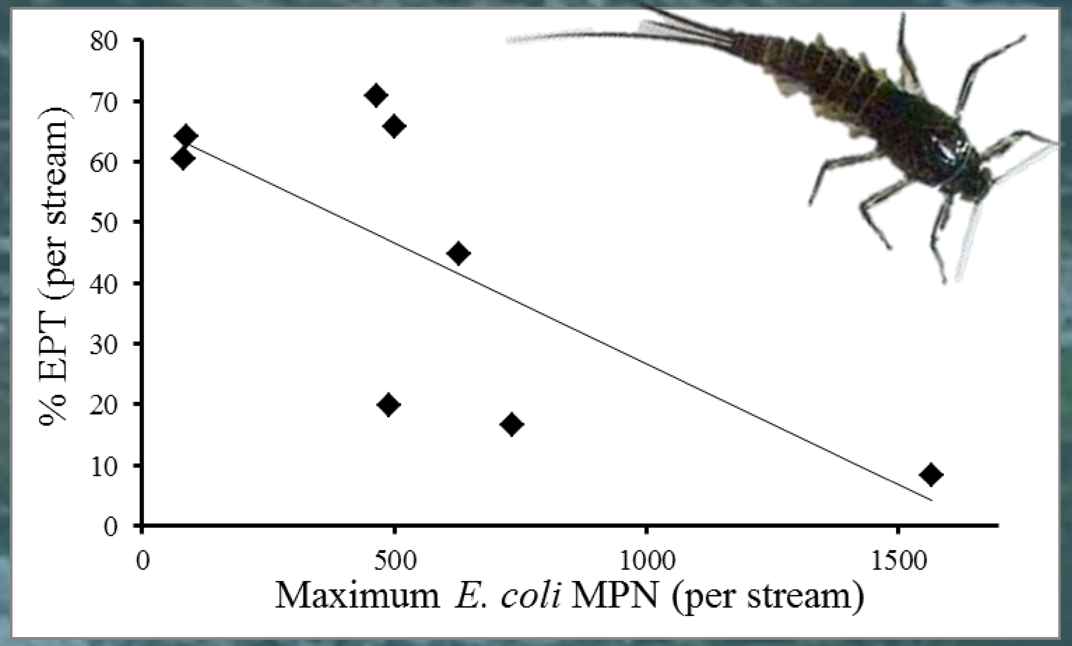

Figure 5. *E. coli* maximum values compared to % EPT of 8 Streams in the Lake Champlain Basin in 2011. (p= 0.039434157, R^2= 0.534142096)

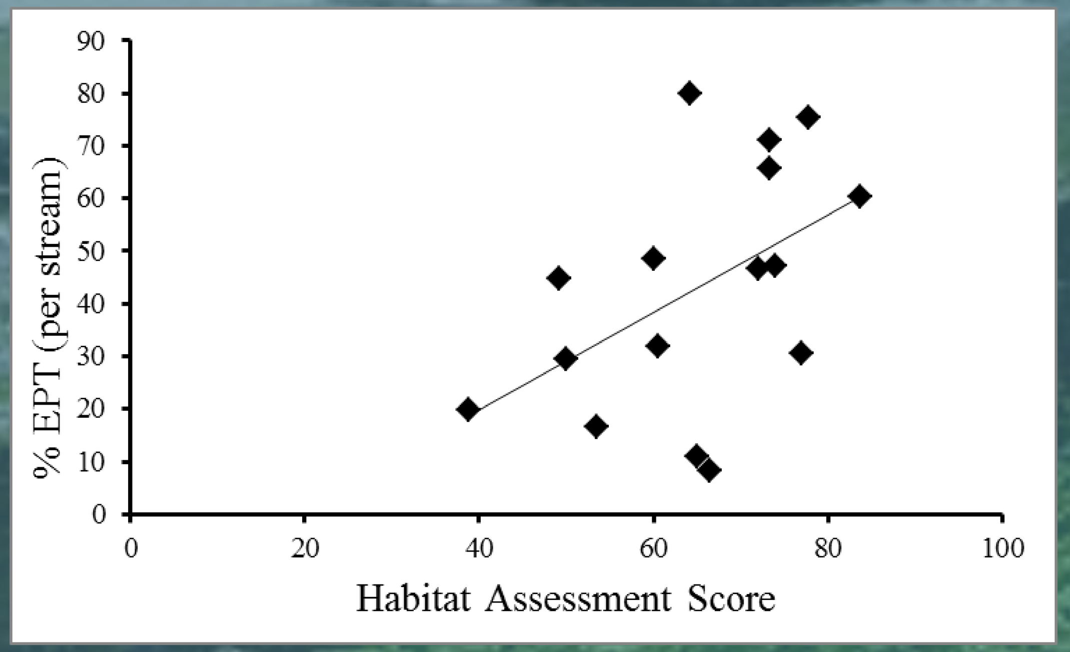

Figure 6. Habitat assessment of 16 different streams compared to % EPT per stream in the Lake Champlain Basin in 2011. (p=0.052356, R^2=0.243015)

Methods

E. coli Data

- Analyzed data from 2011.
- Three samples were taken at a time per stream. Raw samples in addition to 1% and 10%, dilutions were poured into Quanti trays. Trays were incubated and scored to yield the Most Probable Number of E. coli per 100mL sample.
- The mean of the 3 samples per day was taken, and graphed to produce moving timelines of E. coli levels.

Macroinvertebrate data

- Kick nets were placed on the stream bed and the sediment upstream from the kick net was kicked, scrubbed, and disturbed such that macroinvertebrates were washed into the downstream net. Samples were dispersed on plastic trays, picked, sorted, and identified under dissecting microscopes. Macroinvertebrates were identified to lowest practical taxonomic level.

Data analysis

- Analyzed data from 2011.
- The % EPT index was used as an index of pollution intolerant taxa. This was done by calculating the percent abundance of macroinvertebrates in the orders Ephemeroptera, Plecoptera, and Trichoptera.
- Linear regression was used to compare % EPT to the percent of each catchment that was agricultural, urban, or forested.

GIS Data

- GIS data were obtained from VT EPSCoR data page. Streams analyzed include, Potash Brook, Snipe Island Brook, Wild Branch Brook, Indian Brook, Stevens Brook, Bartlett Brook, Englesby Brook, Lewis Creek, Rugg Brook, Mud Creek, Deer Brook, Halls Brook, Brown River, Gold Brook, Centennial Brook, and Allen Brook.

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