Investigation of roadside ditches as rapid conduits and reservoirs of bacteria, nutrients, and sediments to downstream drinking water supply systems

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Introduction

Roadside ditches are hydrologic networks superimposed onto watersheds. Although they are ubiquitous, their impacts on flooding and water quality have been largely ignored. Recent research has shown that roadside ditches:

•Extend natural stream channel networks several fold
•Rapidly convey shallow runoff from ~20% of the watershed to streams
•Act as a source of sediment, especially when scraped.

Research Goal: To determine the role of roadside ditches as conduits of agricultural pollutants to drinking water supply systems.

Methods

•**Monitoring sites**
- Focused on the Finger Lakes Region of NY
- Seven ditches in three watersheds
- Four adjacent to manure-amended fields
- Three adjacent to predominately forested sites (background levels)

•**Sample Collection**
- Water was collected during storm events using ISCO™ automated water samplers
- Sediment cores were collected at approximately two week intervals between storms

•**Sample Analysis**
- Bacteria
  - E. coli were used as an indicator of fecal contamination
  - E. coli quantification - using Idexx's Colilert/Quantitray™
- Total Suspended Sediment – using Millipore Glass Fiber Filters™

Positive for Total Coliforms

Positive for *E. coli*

Water Preliminary Results

Objective: 1. To determine the intra-storm and seasonal variability of E. coli concentrations in roadside ditch water. 2. To determine the effects of land use on the E. coli concentrations and loads in roadside ditch water.

Intra-storm and Seasonal Variability

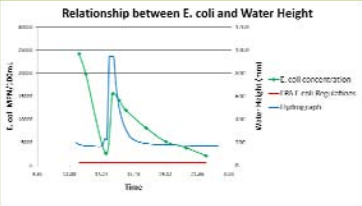

Fig. 1a. Single storm E. coli trends for a roadside ditch adjacent to a manure-amended field.

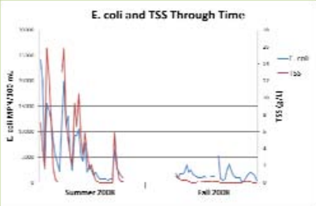

Fig. 1b. E. coli and TSS through time for a roadside ditch adjacent to a manure-amended field.

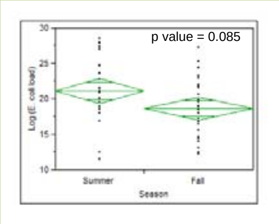

Fig. 1c. E. coli loads based on season.

- E. coli concentrations tended to follow the hydrograph. In some cases, the concentrations exhibited a first flush effect (Fig. 1a).
- E. coli concentrations were significantly higher than the least stringent EPA regulation (Fig. 1a).
- Total Suspended Sediment (TSS) and E. coli tended to follow the same trajectory (Fig. 1b).
- From July to November 2008, E. coli concentrations showed a general decline. Viable E. coli was found many months after manure-spreading (Fig. 1c).

Differences Between Manure-Amended Fields and Forest

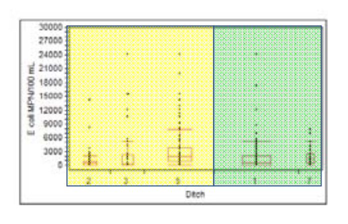

Fig. 1d. Cumulative E. coli concentration by ditch.

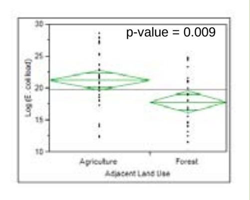

Fig. 1e. E. coli load by adjacent land use.

- E. coli concentrations were variable. Ditches in yellow are adjacent to manure-amended fields, while ditches in green are adjacent to forest (Fig. 1d).
- When comparing E. coli loads by adjacent land use, there was a statistically significant difference with agricultural sites being higher (Fig. 1e).

Sediment Preliminary Results

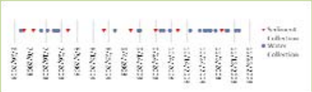

Fig. 2a. Sediment collection dates.

Objective: To determine if E. coli survives in roadside ditch sediment between rain events with the potential for resuspension.

•Sediment samples were collected at approximately 2 week intervals between rain events (Fig. 2a).
•E. coli was viable in sediment adjacent to manure-amended fields. The levels tended to decrease with time, following the same pattern as E. coli water concentrations (Fig. 2b).
•Sediment moisture content was not a determinant of E. coli levels. Future research will look at correlations between E. coli and plant cover, soil type and water concentrations (Fig. 2c).
•Based on a two sample normal approximation test, E. coli levels were significantly different for the adjacent land type with agriculture being higher (Fig. 2d).

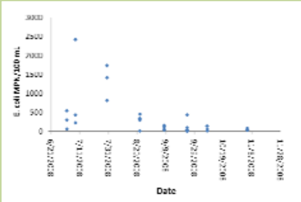

Fig. 2b. Sediment E. coli levels through time for a roadside ditch adjacent to a manure-amended field.

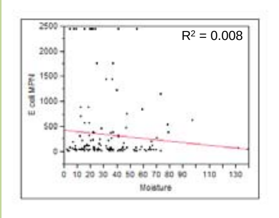

Fig. 2c. Sediment E. coli vs. % moisture.

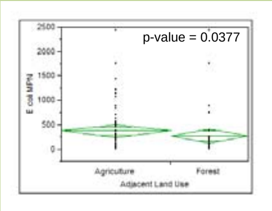

Fig. 2d. Sediment E. coli by land type.

Conclusions

- Roadside ditches are conduits of pathogens from agriculture to streams and drinking water. Pathogens have sources other than agriculture, which should be explored.
- E. coli concentrations were as high as 25,000 MPN/100mL. Although concentrations declined with time, E. coli was still detectable months after manure application.
- Ditches adjacent to manure-amended fields had higher E. coli loads than forests.
- Ditch sediment E. coli tended to follow similar patterns as water and could potentially be used as a surrogate.
- Future steps for this study may include synoptic sampling and analysis for trace metals and nutrients.
- Land, water and highways departments must all work cooperatively to manage our water resources.

Many thanks to our funders: