Movement and Survival of Fecal Contaminant Indicators in an Iowa Watershed

Tom Moorman, Mark Tomer, Beth Douglass, and Colin Greenan

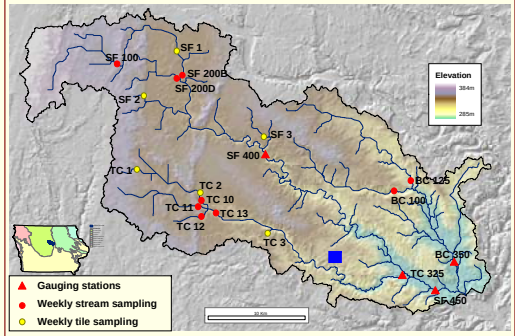
USDA-ARS, National Soil Tilth Laboratory, Ames

Abstract

The South Fork of the Iowa River drains a 78,000 ha (215,000 ac) watershed in north-central Iowa. The land is about 85% in row-crop (corn-soybean) agriculture. There are approximately 95 confined feeding operations (mostly swine), and in lower stream reaches there are wildlife, pastures with cattle access to streams, and homes that may have inadequate on-site waste treatment. These may all be sources for fecal contamination of streams. Since August 2001, stream water monitoring has been conducted to evaluate the occurrence of *Escherichia coli* in the South Fork watershed. During 2002, monitoring was expanded to include tile-drain discharge, soil populations following application of manure, and event-based monitoring of field runoff and stream flow. The first 12 months of stream monitoring showed *E. coli* populations exceeded a recreational-contact standard of 126 mpn/100 mL frequently. Tipton Creek showed a downstream increase in *E. coli* populations, i.e., with increasing distance from most swine feeding operations. This indicates downstream sources may be important, or there are resident populations in stream sediments that are released during runoff events. *E. coli* populations vary seasonally, and correlations with temperature, and sediment and nutrient concentrations were observed. Soil monitoring showed *E. coli* populations declined about 90% per week after fall manure application. But a runoff event shortly after application showed a large pulse of *E. coli* in field runoff and in streams. Research to better understand the sources and risks of fecal contamination in this watershed is continuing.

Sampling locations

Grab samples weekly (summer) to monthly (winter) at 13 stream and 6 tile locations in Tipton Creek (TC), Beaver Creek (BC), and the South Fork (SF). Stream flow at four sites (triangles). Field sampling for soil and runoff at one site (blue square).

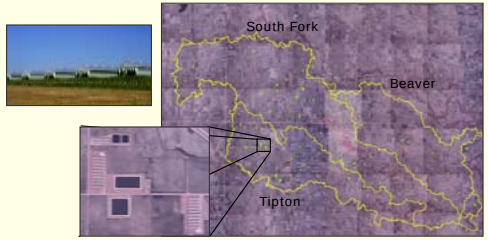


Microbiology

Grab samples were analyzed for *E. coli* using a defined substrate MPN with MUG (Idexx). Less frequently, samples were assayed (+/-) for E coli O157:H7 using an enrichment followed by a commercial (Neogen) ELISA assay.

Issue

The South Fork watershed contains about 95 animal feeding operations, most producing swine. Most operations are in the Tipton Creek and South Fork sub-basins. The possibility of associated fecal contamination is of concern. About 27% of the watershed may receive manure applications annually.

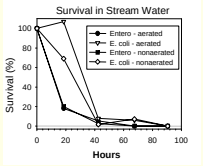


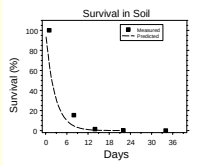
Possible sources

Include not only swine manure, but also cattle, inadequate septic systems, stream sediments and soils, and wildlife.

Survival in soils and stream water

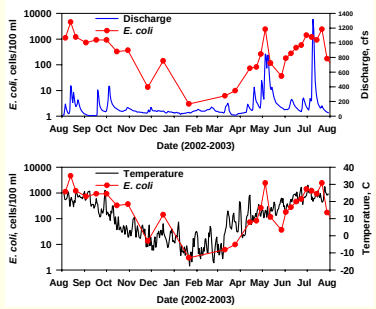
We examined E. coli survival in stream water in the lab (aerated and non-aerated), and in soils in a field study. Populations were more persistent in soils (~ 2 weeks) than in water (~ 2 days).





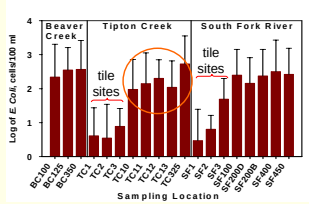
Results: stream and tile sampling

E. coli shows strong seasonal pattern that is related to temperature (r=0.47) and, to a lesser degree, storm events, during the first 12 months of monitoring. *E. coli* O157:H7 was detected in 65% of the 52 stream water samples tested.



A significant downstream increase was found for Tipton Creek ($p<0.01$).

Limited sampling shows low mean density of *E. coli* in tile drainage water (<30 cells/100 ml).

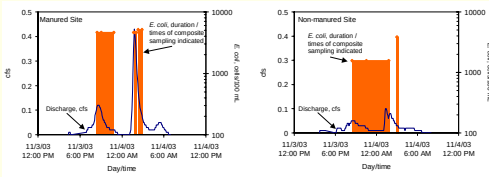


Geometric Mean - Stream Waters

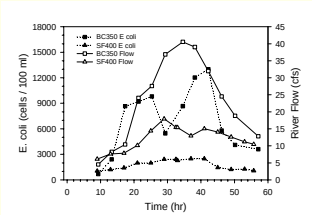
E. coli	(cells/100 ml)
Beaver Cr.	267
South Fork:	203
Tipton Cr.	146
EPA std	126

Results: a runoff event

A runof event on Nov. 3 2003 provided a unique look at movement off fields and in streams after fall manure applications in the watershed. This was six days after manure application. Surprisingly, we found significant losses in runoff from the non-manured control, and the manured field. Wildlife contribution is the most ready explanation.



Populations in stream waters during the same runoff event show increases in E. coli that follow the hydrograph.



Conclusions

Indicator bacteria exceed recreational contact standards for much of the year.

E. coli are transported in runoff from manured fields, but our data indicate wildlife also contributes. Relative contributions of swine, cattle, wildlife, and other sources have not yet been determined. Short survival times in water suggest multiple sources and/or survival in stream sediments.

Detection of *E. coli* O157:H7 indicates that some pathogenic bacteria are present.

Thanks to the National Pork Board for funding support.