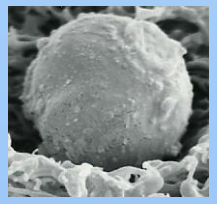
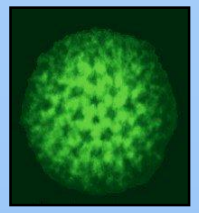
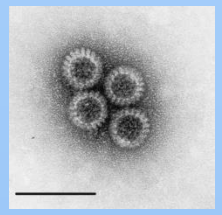


Surface Runoff from Manured Cropping Systems Assessed by the Paired-Watershed Method, Part 2: Pathogen Transport

Mark Borchardt,

Susan Spencer and Bill Jokela

USDA-Agricultural Research Service

US Geological Survey Wisconsin Water Science Center

Marshfield, Wisconsin USA

Manure's Double-Edged Sword

Manure as Asset

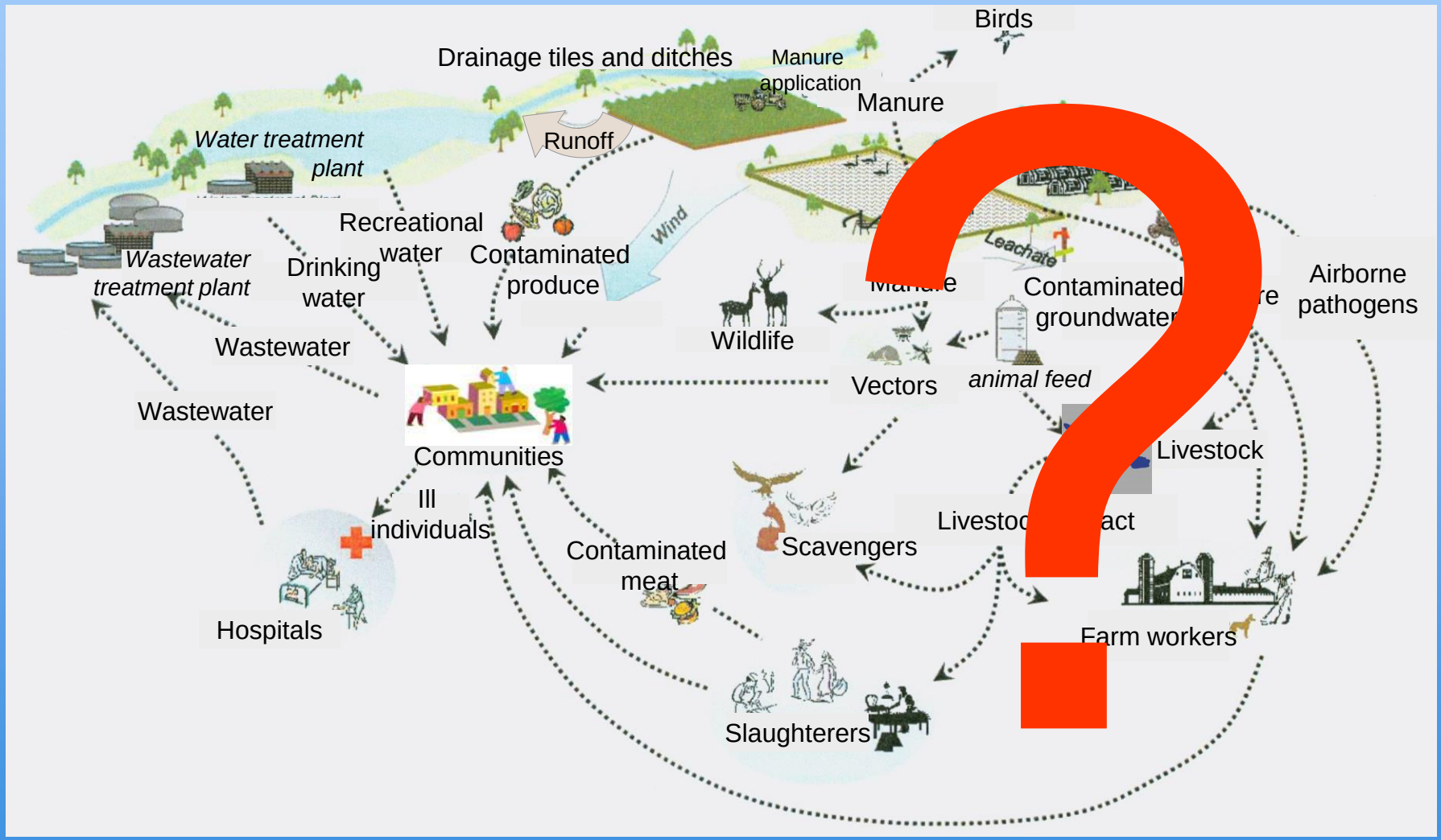
Manure field-application is a cost-effective and sustainable approach for optimal soil tilth and fertility

Manure as Liability

Manure may contain pathogens harmful to both humans and livestock

Societal goal: Maximize the beneficial uses of manure while minimizing environmental pathogen transmission

Human and Livestock Pathogen Movement in the Environment



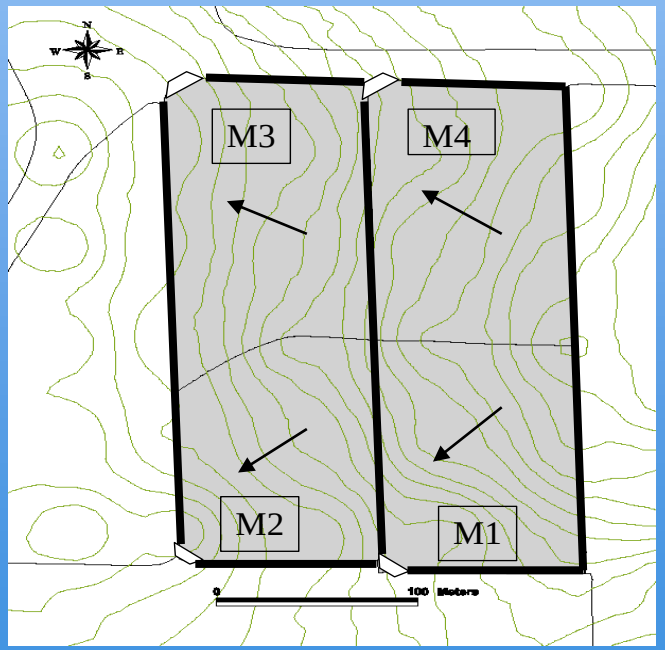
Rogers and Haines, 2005, EPA/600/R-06/021

Study Objectives

1. Quantify bovine pathogens in runoff from manure-applied fields
2. Identify cropping, tillage, and manure application practices that minimize pathogen runoff

Field Site

- UW/USDA-ARS Research Station, Marshfield, WI.
- Withee silt loam, 1-3% slope
- Surface drainage using drive-through diversion pathways and berms
- Each field about 4 acres, cropped in corn
- Manure application once per year, about 5,800 gals/acre



Runoff Monitoring Stations

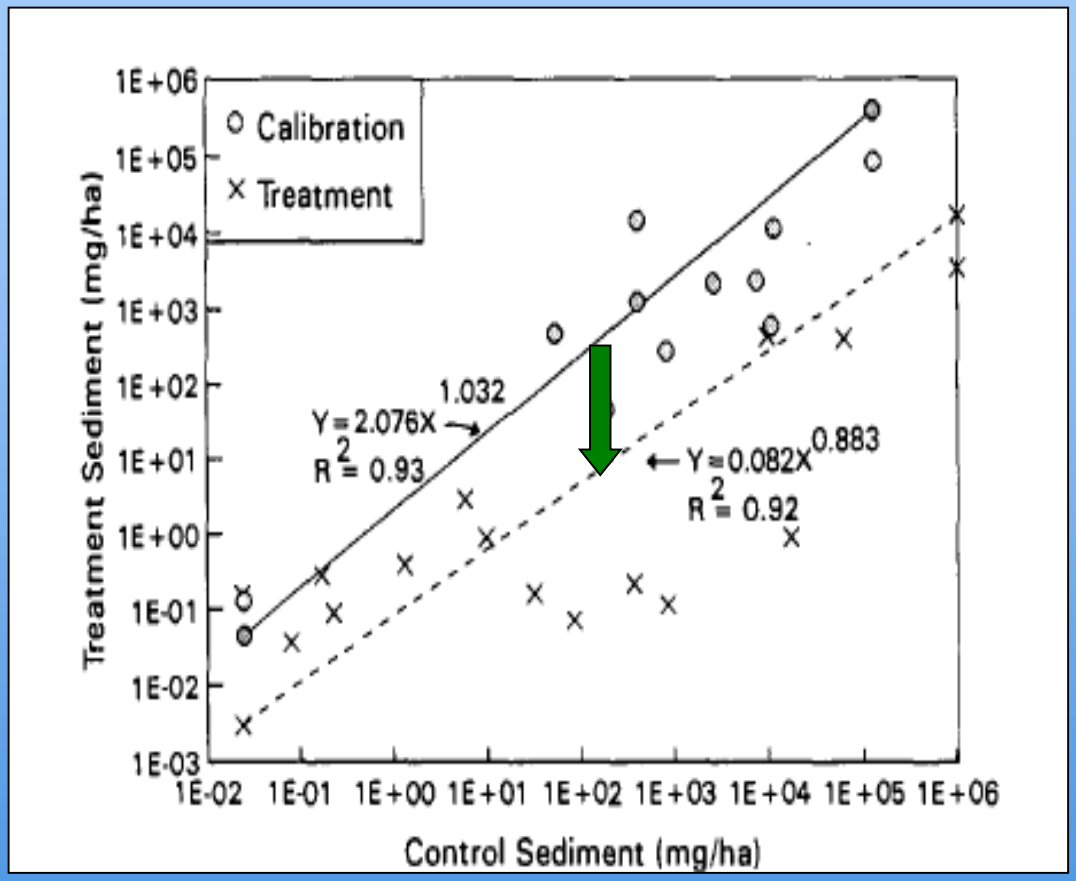
H-flume: stage measured using bubble-pressure transducer

Pathogens: refrigerated glass wool filtration; event-based sampling, not flow-weighted; qPCR measurements

Nutrients, sediment, and indicator *E.coli*: automated refrigerated sampler with time-based sampling

Controlled remotely by radio telemetry

Study Design – Paired Watershed



Example from Clausen et al. 1996

The relationship between two watersheds (i.e., fields) is compared between two time periods, calibration and treatment periods.

Any shift in the regressions represents the treatment effect.

Treatments (Oct 2008 – April 2012)

Fall Manure/Chisel Plow, Spring Cultivate (Control, Field 1)

Fall Manure/Chisel Plow, Vegetative Buffers (Field 4)

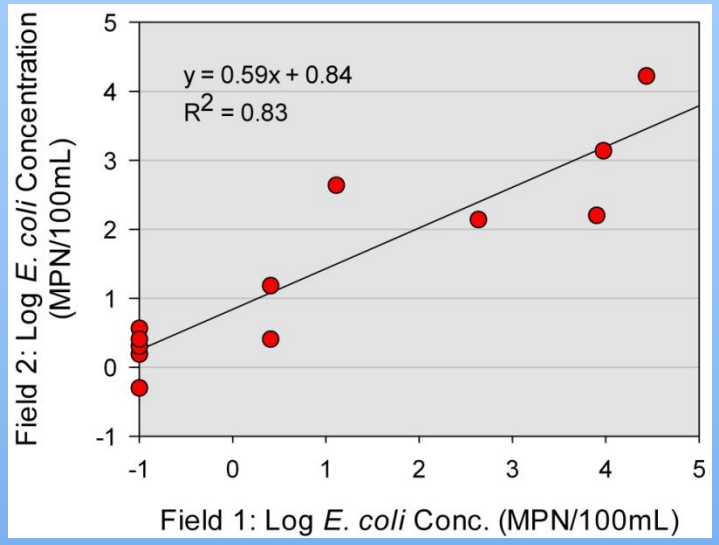
Fall-Seeded Rye Cover, Spring Manure/Chisel Plow (Field 2)

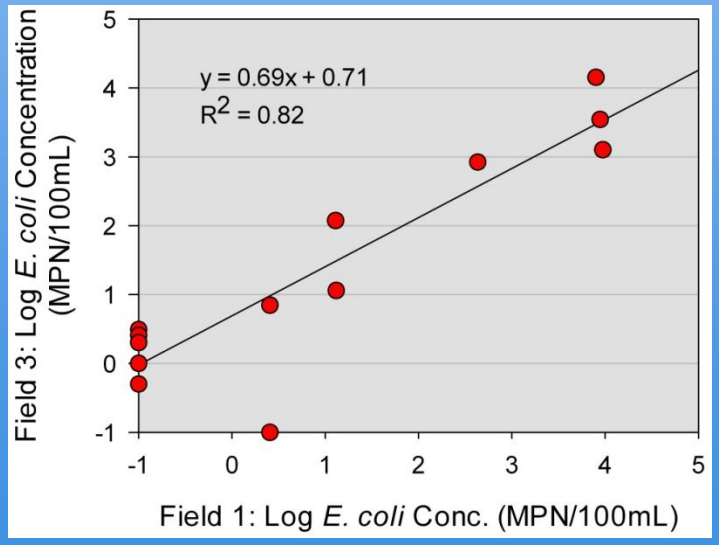
Fall Manure/ Spring Chisel Plow (Field 3)

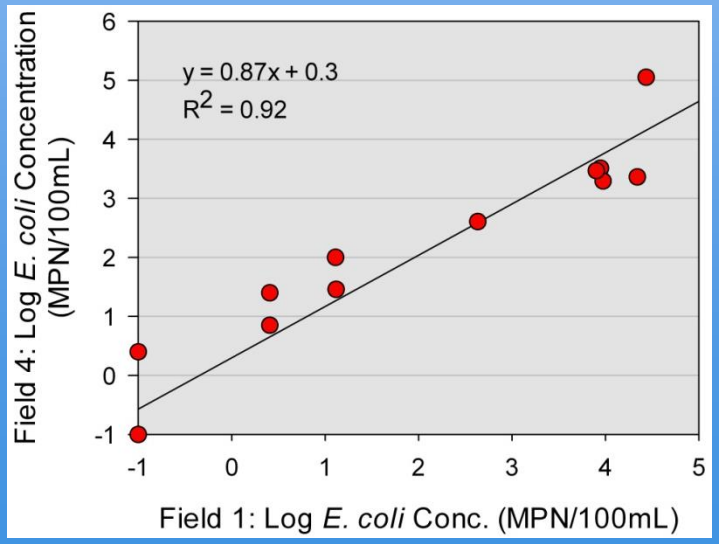
Calibration Period Regressions

Indicator *E. coli*

April – August, 2008





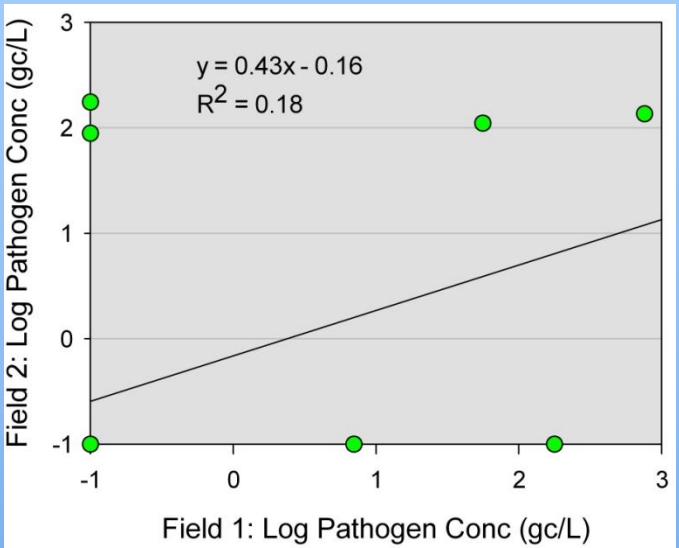


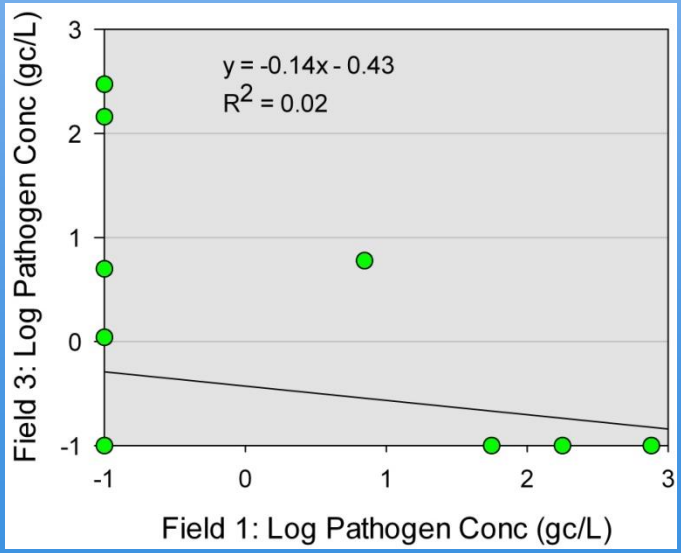
Calibration Period Regressions

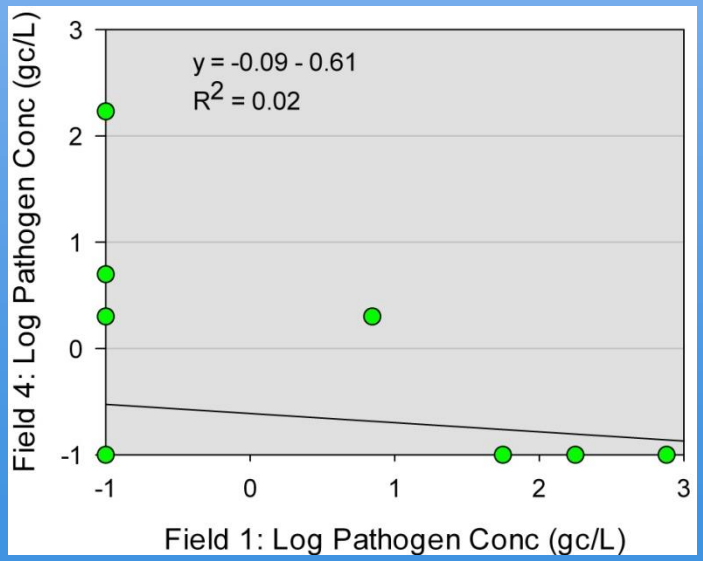
Total Pathogens

(Sum of genomic copies across taxa)

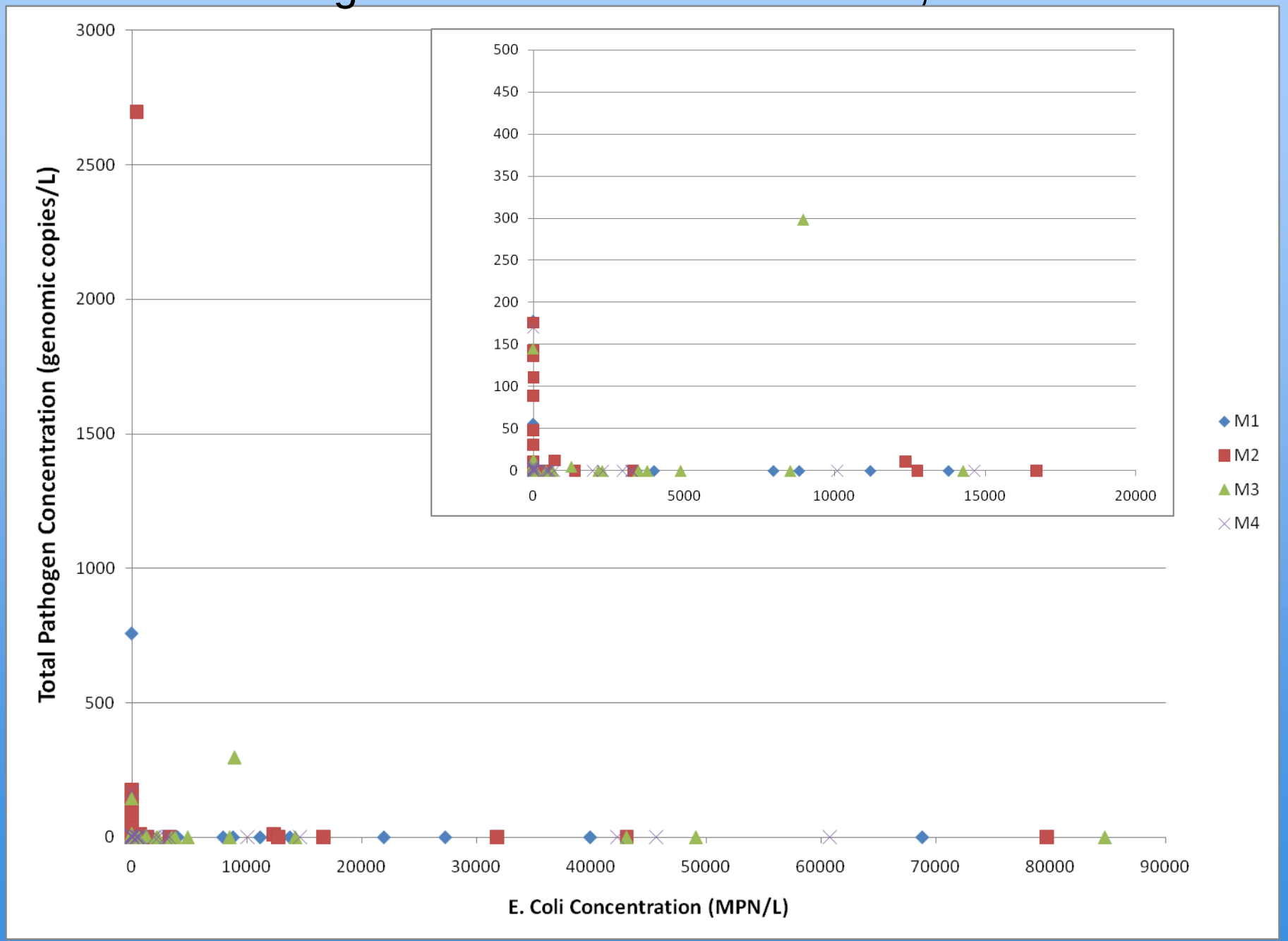
April – August, 2008



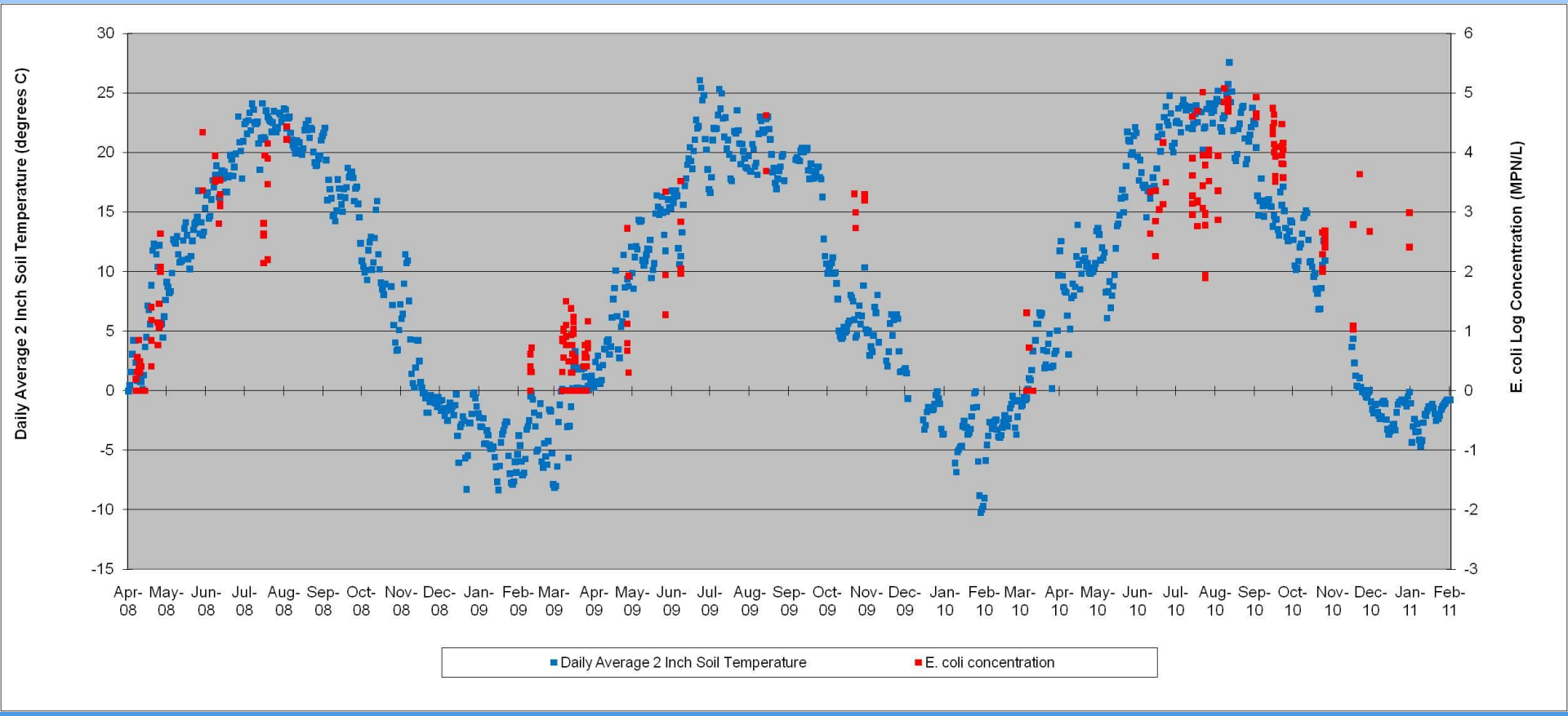




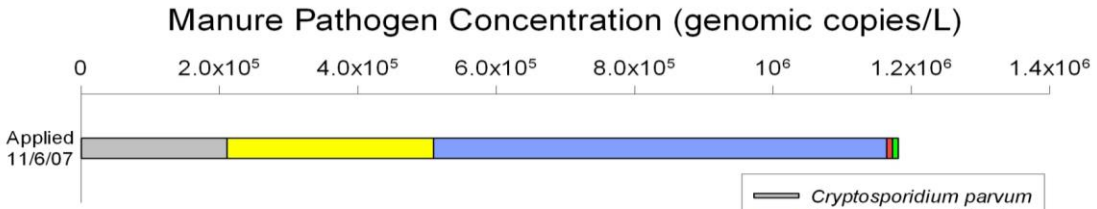
Total Pathogen vs *E. coli* Concentrations, 2008-2010



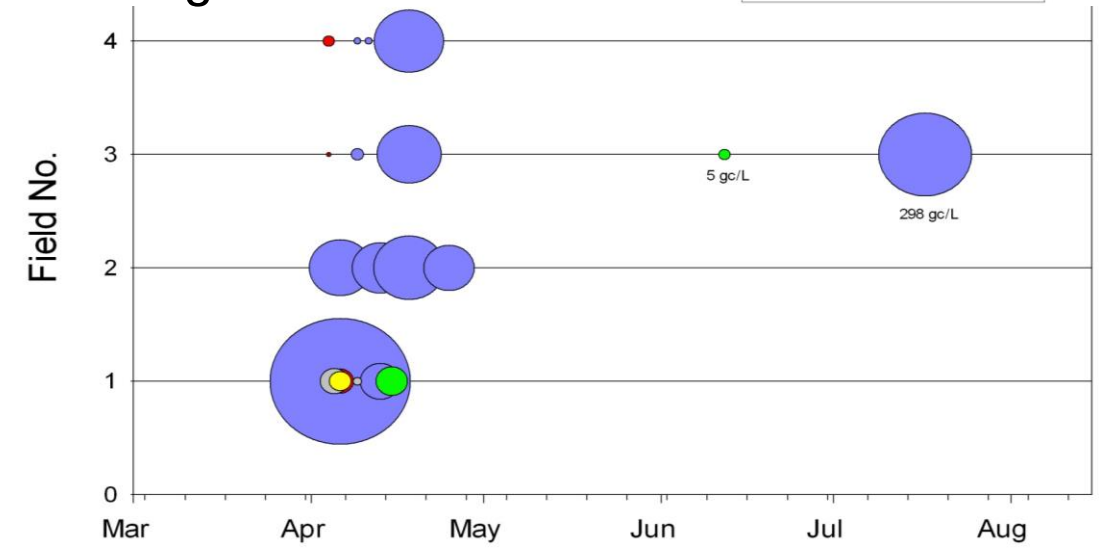
Daily 2 Inch Soil Temperature vs *E. coli* Log Concentration

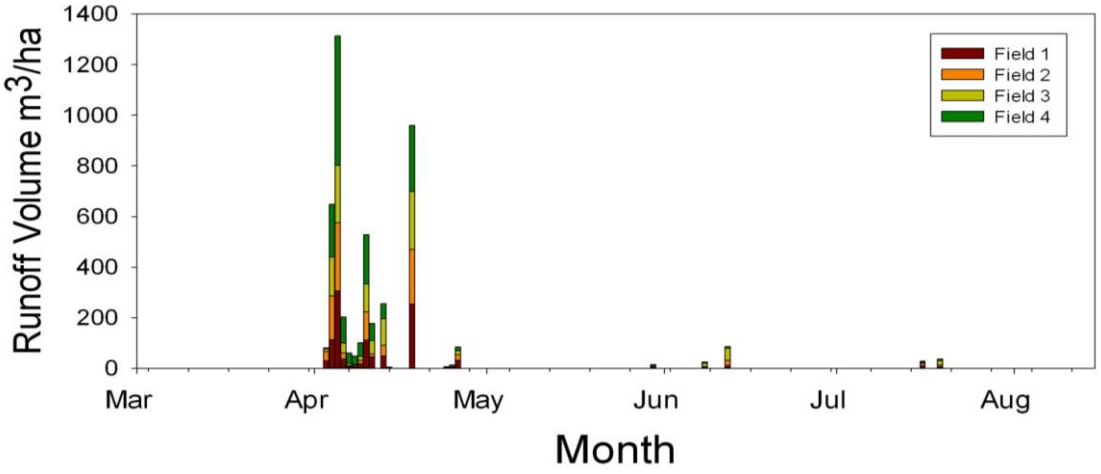


Year 2008

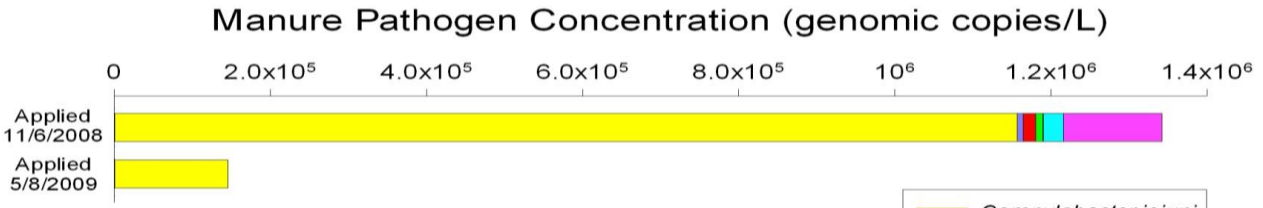


Pathogen Concentrations

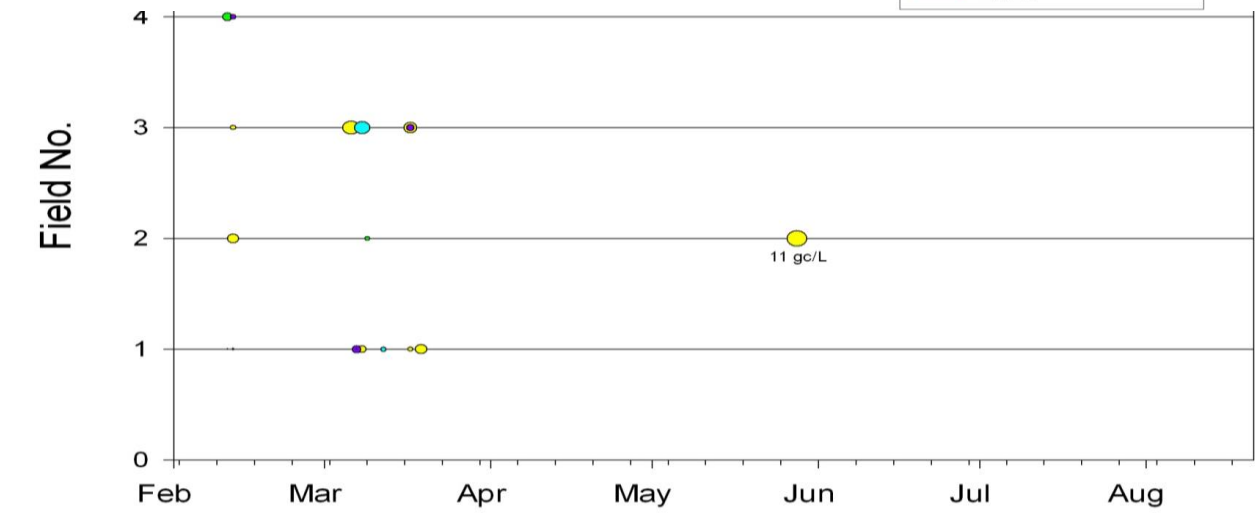


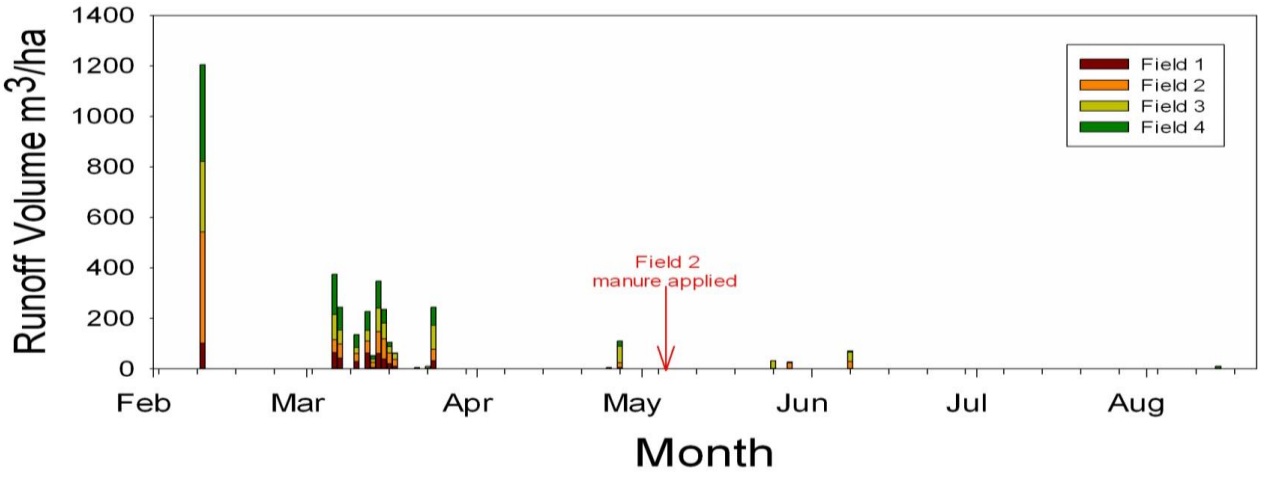


Year 2009

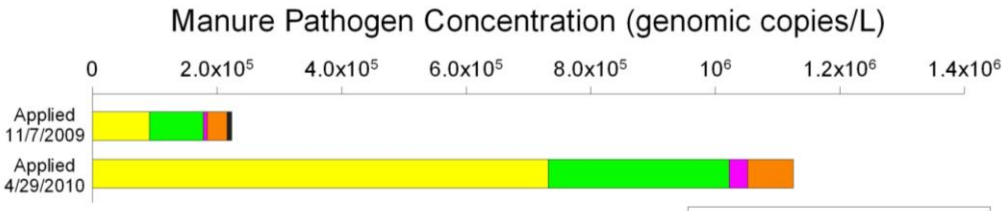


Pathogen Concentrations

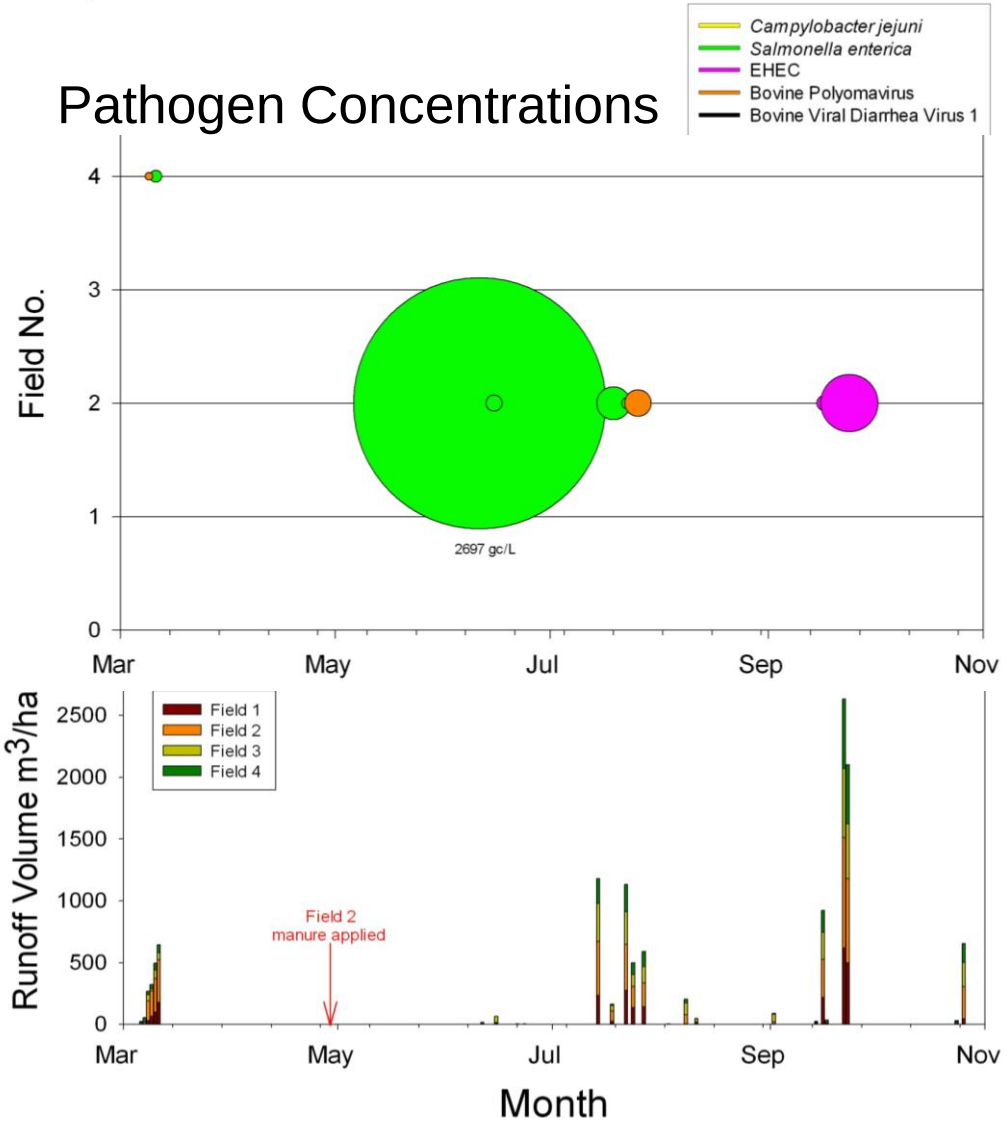




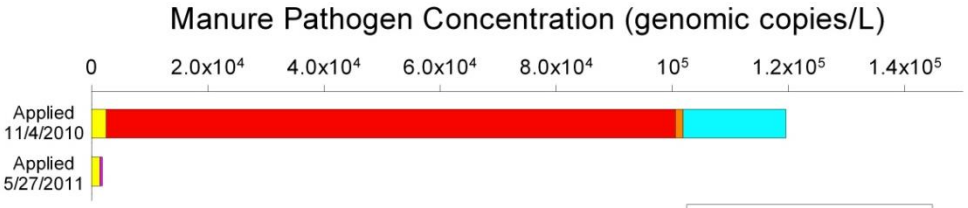
Year 2010



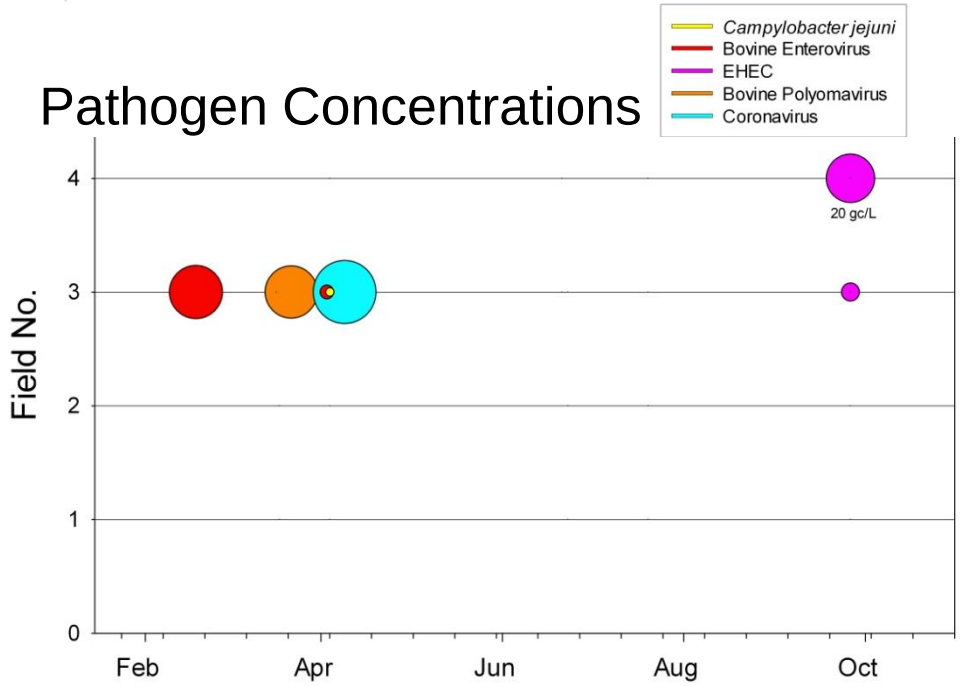
Pathogen Concentrations

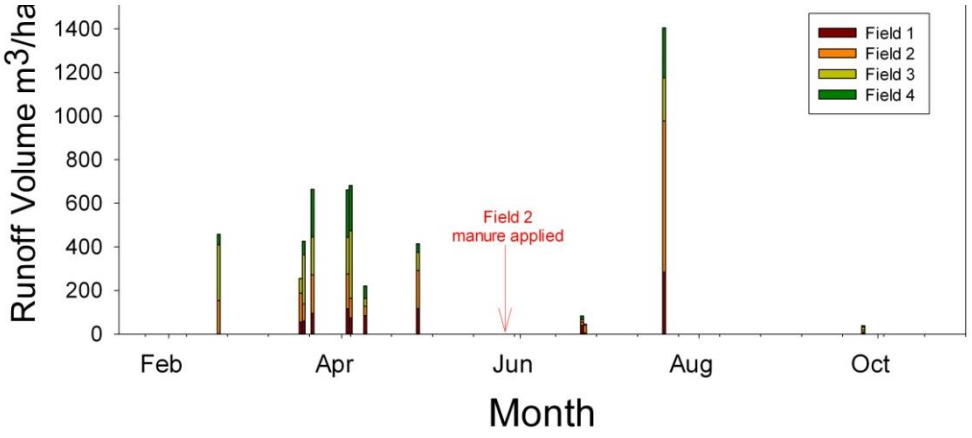


Year 2011

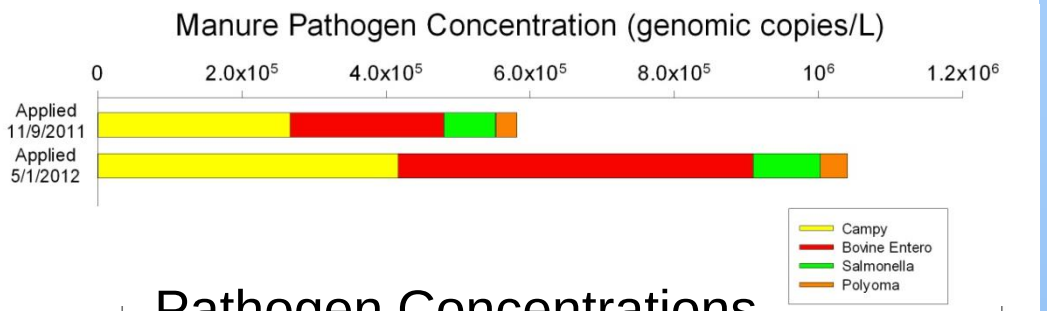


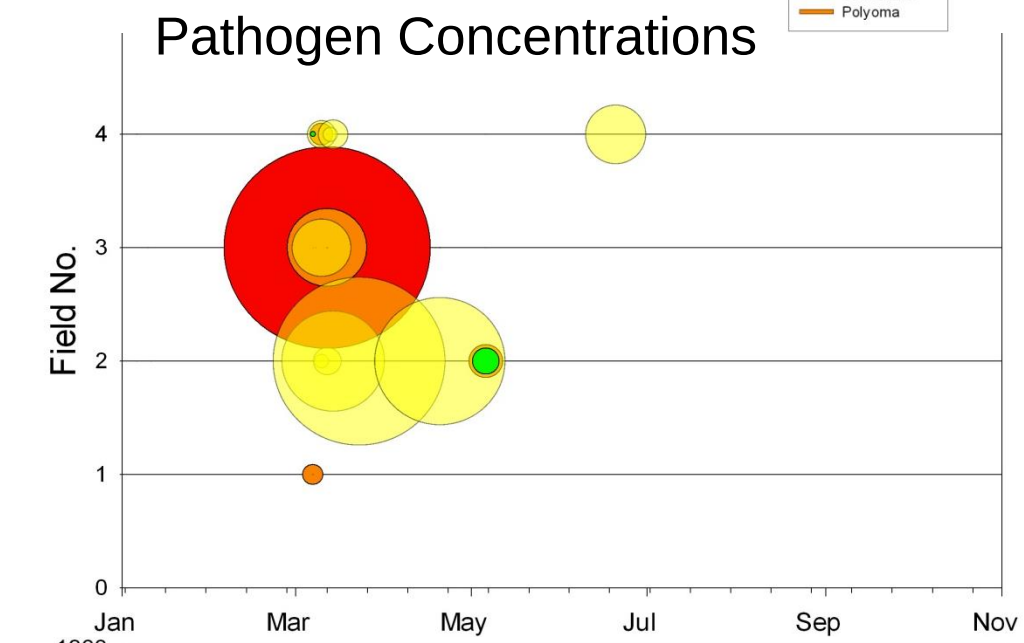
Pathogen Concentrations

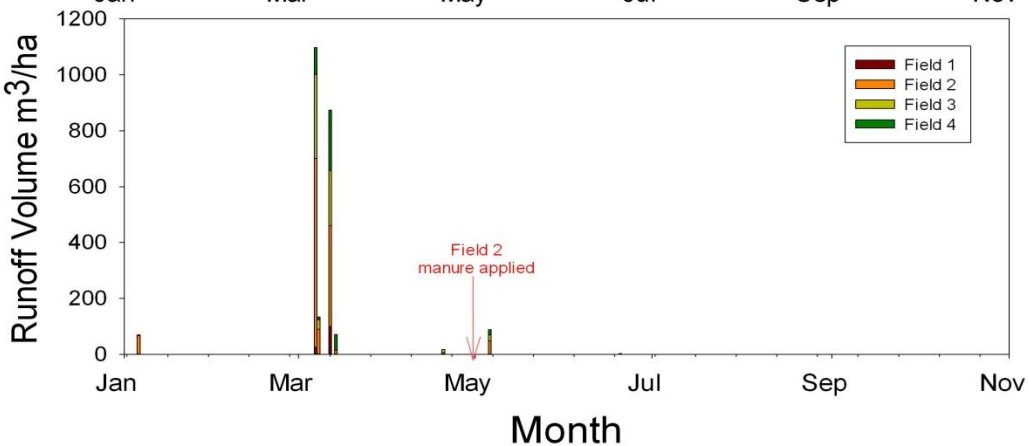




Year 2012

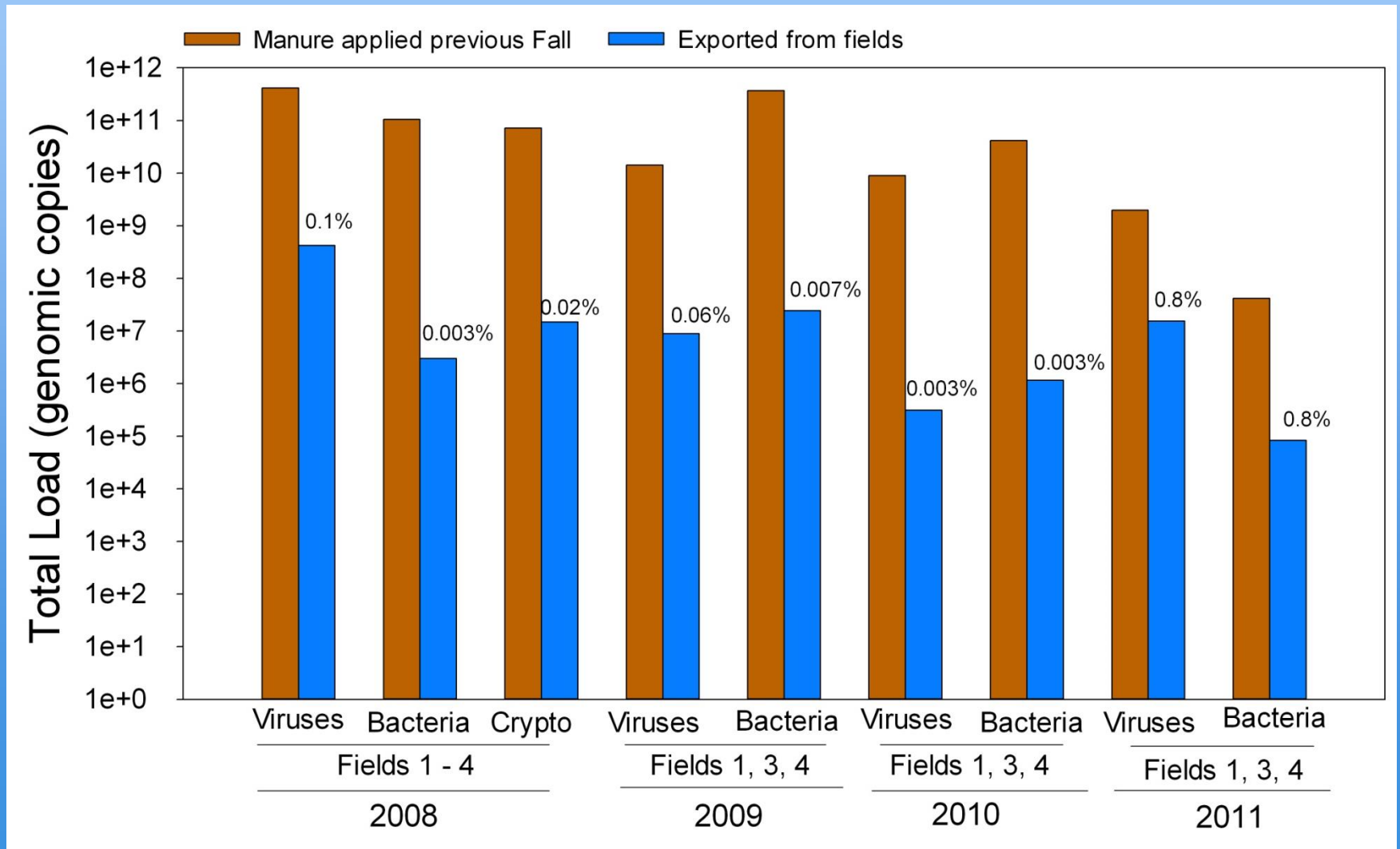

Manure Pathogen Concentration (genomic copies/L)
0
2.0x10^5
4.0x10^5
6.0x10^5
8.0x10^5
10^6
1.2x10^6
Applied 11/9/2011
Applied 5/1/2012
Campy
Bovine Entero
Salmonella
Polyoma


Pathogen Concentrations
Field No.
0
1
2
3
4
Jan
Mar
May
Jul
Sep
Nov


Runoff Volume m3/ha
0
200
400
600
800
1000
1200
Field 1
Field 2
Field 3
Field 4
Field 2
manure applied
Jan
Mar
May
Jul
Sep
Nov
Month

Pathogen Cumulative Export from Fall-Applied Manure

Caveat: Export values are not-flow-weighted



Perennial forage phase established 2012

Summary

- Pathogen types and concentrations in field runoff are highly variable.
- Runoff may contain pathogens many months after manure application; e.g. rotavirus applied in Fall 07 ran off in April 08 and EHEC applied in April 2010 ran off 5 months later.
- In four of the five study years, the majority of pathogen runoff occurred in the spring time.
- Exposure risk to pathogen-contaminated runoff is not necessarily shown by measuring indicator *E. coli* because *E. coli* and pathogen quantities in field runoff are not related.
- Estimated from export rates, fall-applied manure resulted in a 3 to 5 log reduction in pathogens in runoff.

Questions?