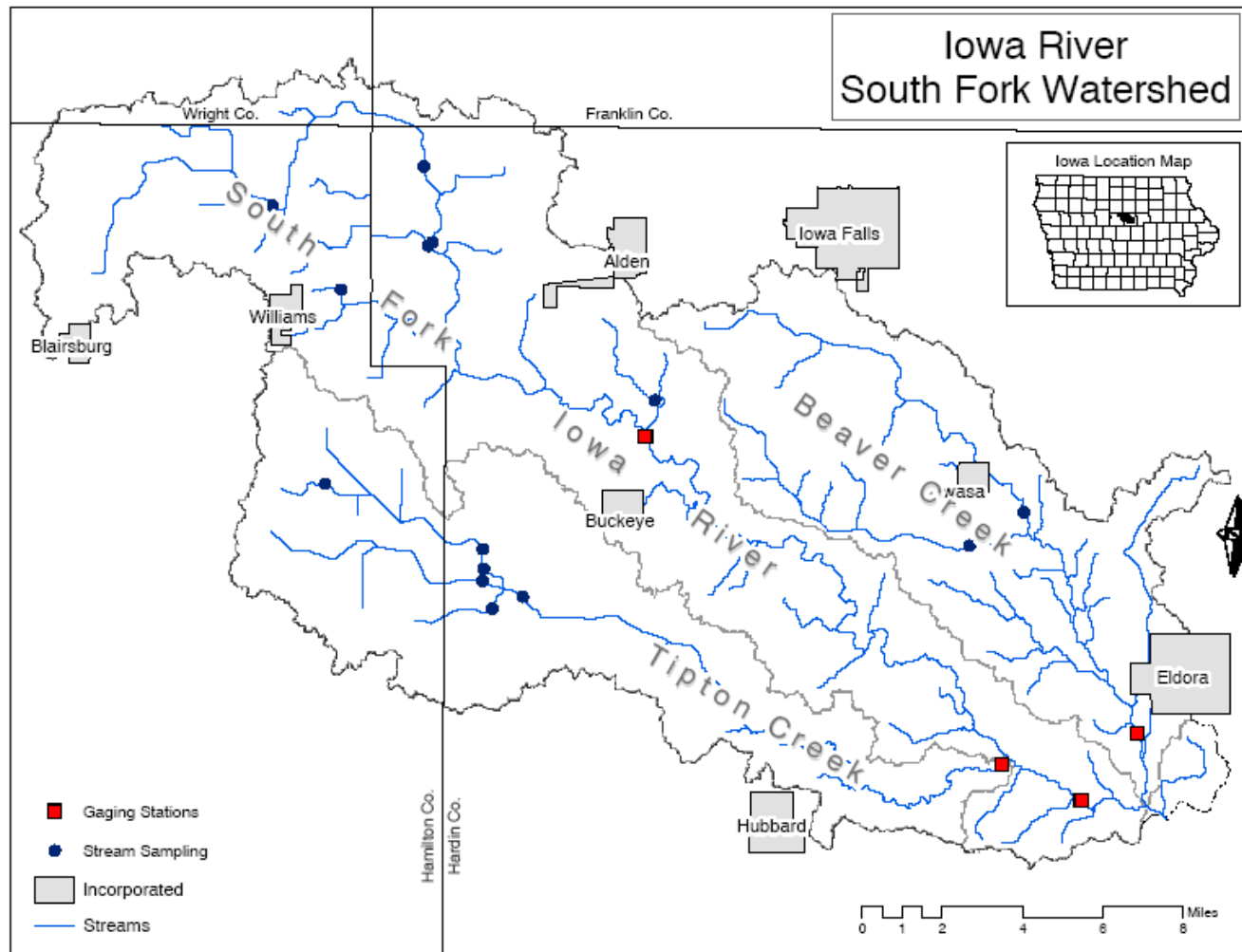


Manure Management and Water Quality

USDA-ARS, National Soil Tilth Laboratory, Ames

- ***The Problem:*** Swine and cattle production leads to off-site movement of pathogenic bacteria and antibiotics into streams, rivers and lakes. Effects on community health?
- ***Perception***
 - *Water Tests Reveal Antibiotics, Other Organics In Area Streams, Thursday, September 1, 2005 The Northwest Arkansas Morning News*
 - "The most important source of environmental, antibiotic-resistant bacteria is domestic animals," says Richard Novick of New York University Medical Center.
- ***Research***
 - Define the extent of the problem and level of risk
 - Develop management options that reduce the risk
 - Watershed and field scale

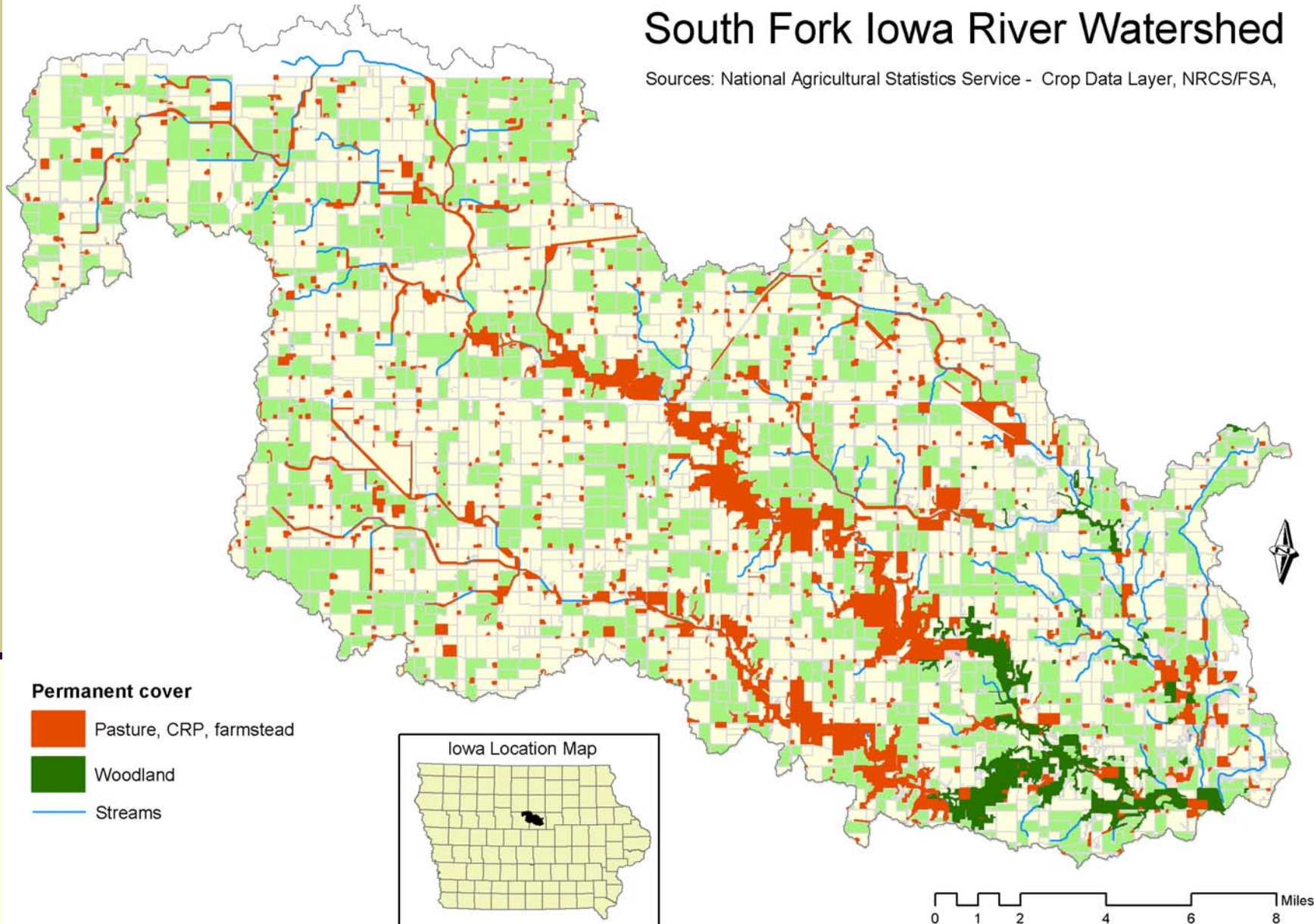
Pathogens and Indicator Bacteria in the South Fork of the Iowa River



Areas of row-crop production and permanent cover

South Fork Iowa River Watershed

Sources: National Agricultural Statistics Service - Crop Data Layer, NRCS/FSA,



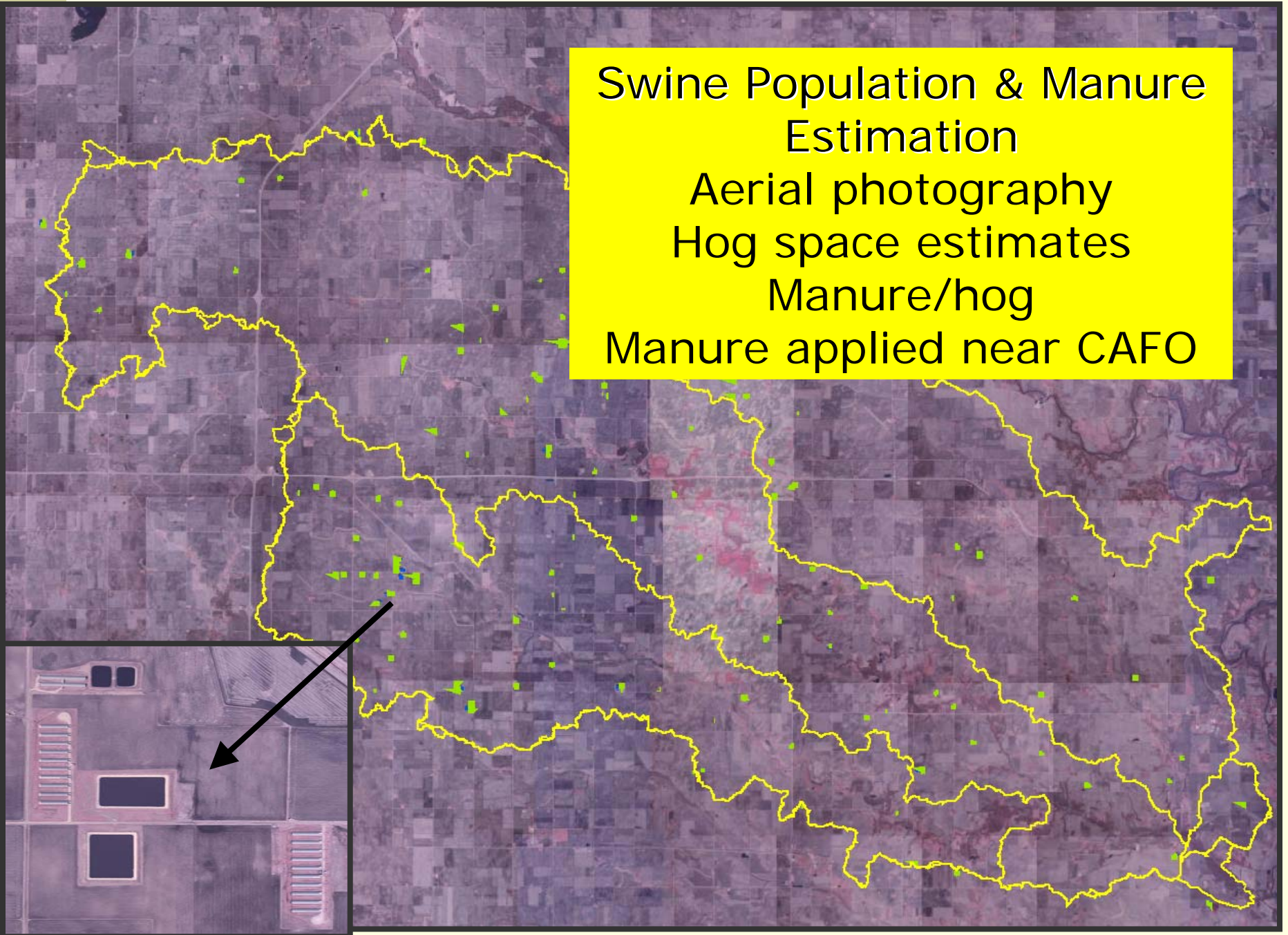
Swine Population & Manure Estimation

Aerial photography

Hog space estimates

Manure/hog

Manure applied near CAFO



2002-2005- Seasonal Means: *E. coli*

Season	Beaver Cr.	South Fork	Tipton Cr.
----- <i>E. coli</i> (cells/100 ml) -----			
Spring	232 a	201 a	104 b
Summer	1047 a	649 b	500 b
Autumn	208 a	139 a	87 b
Winter	21 a	19 a	14 a
Annual	182	136	90

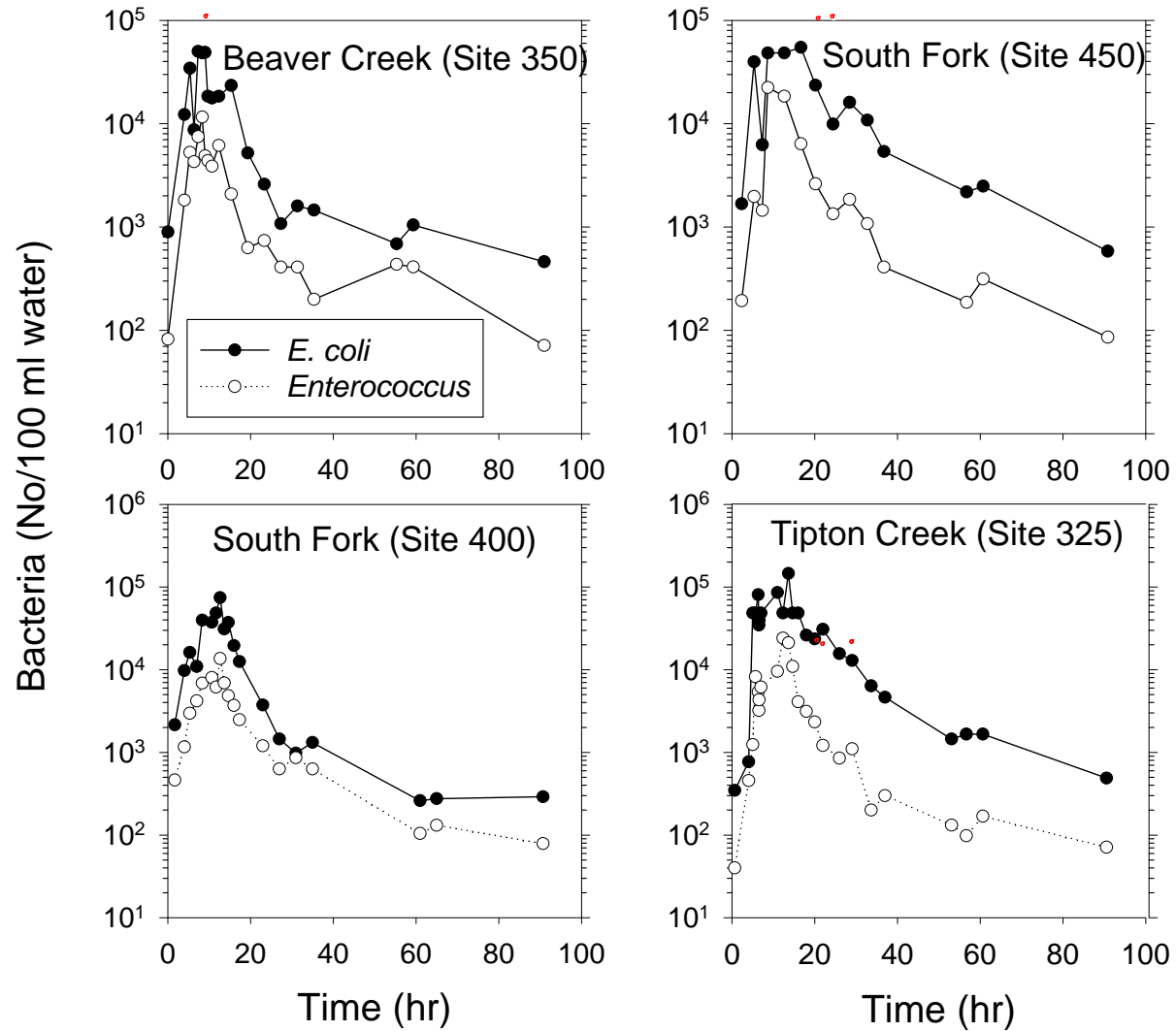
Swine/ac	1.7	5.6	4.8
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Means on same row followed by different letters are significantly different ($p=0.05$).

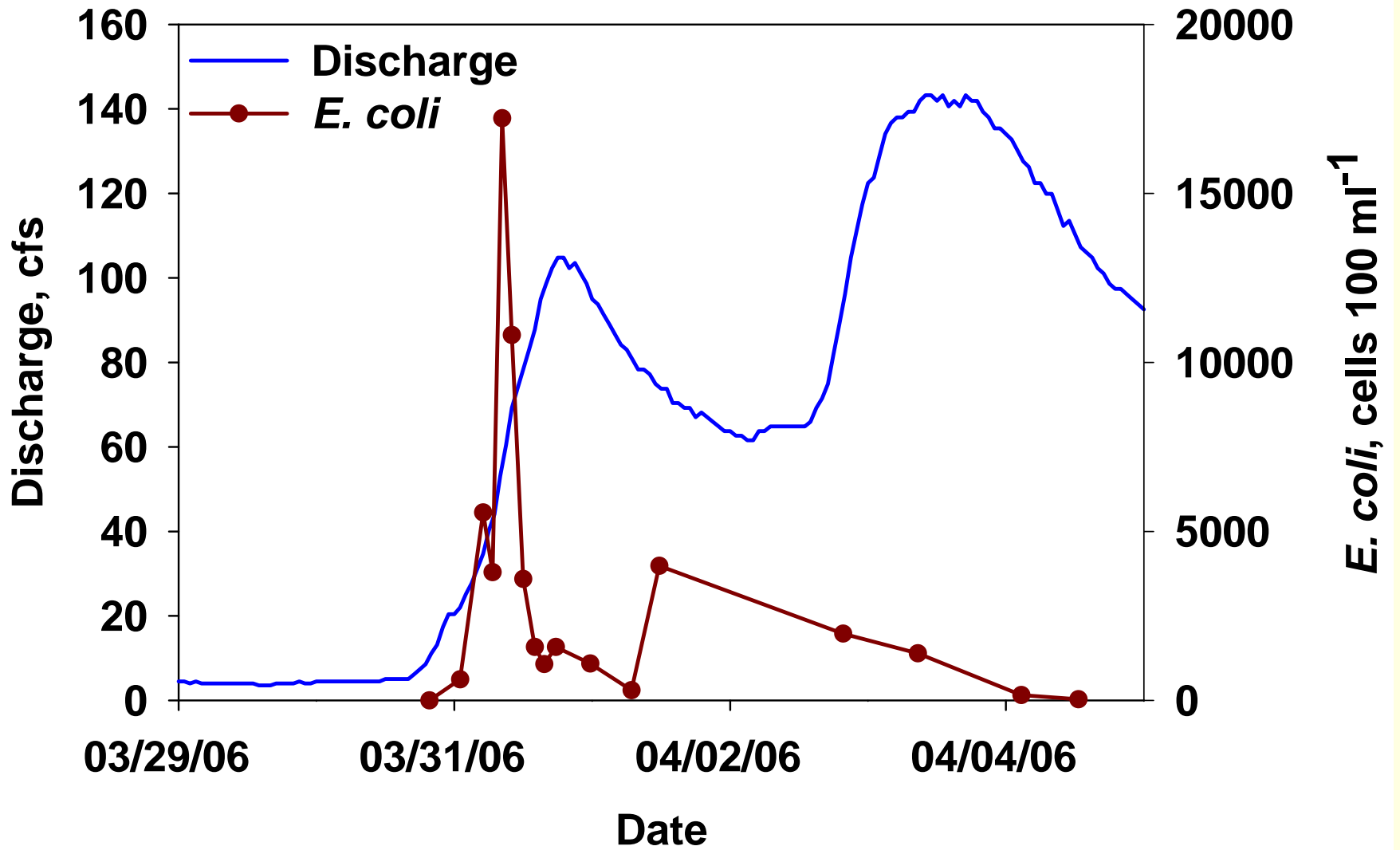
A1 standard 126 A2 standard 630 (cells/100 mL)

Storm Events Deliver Large Loads

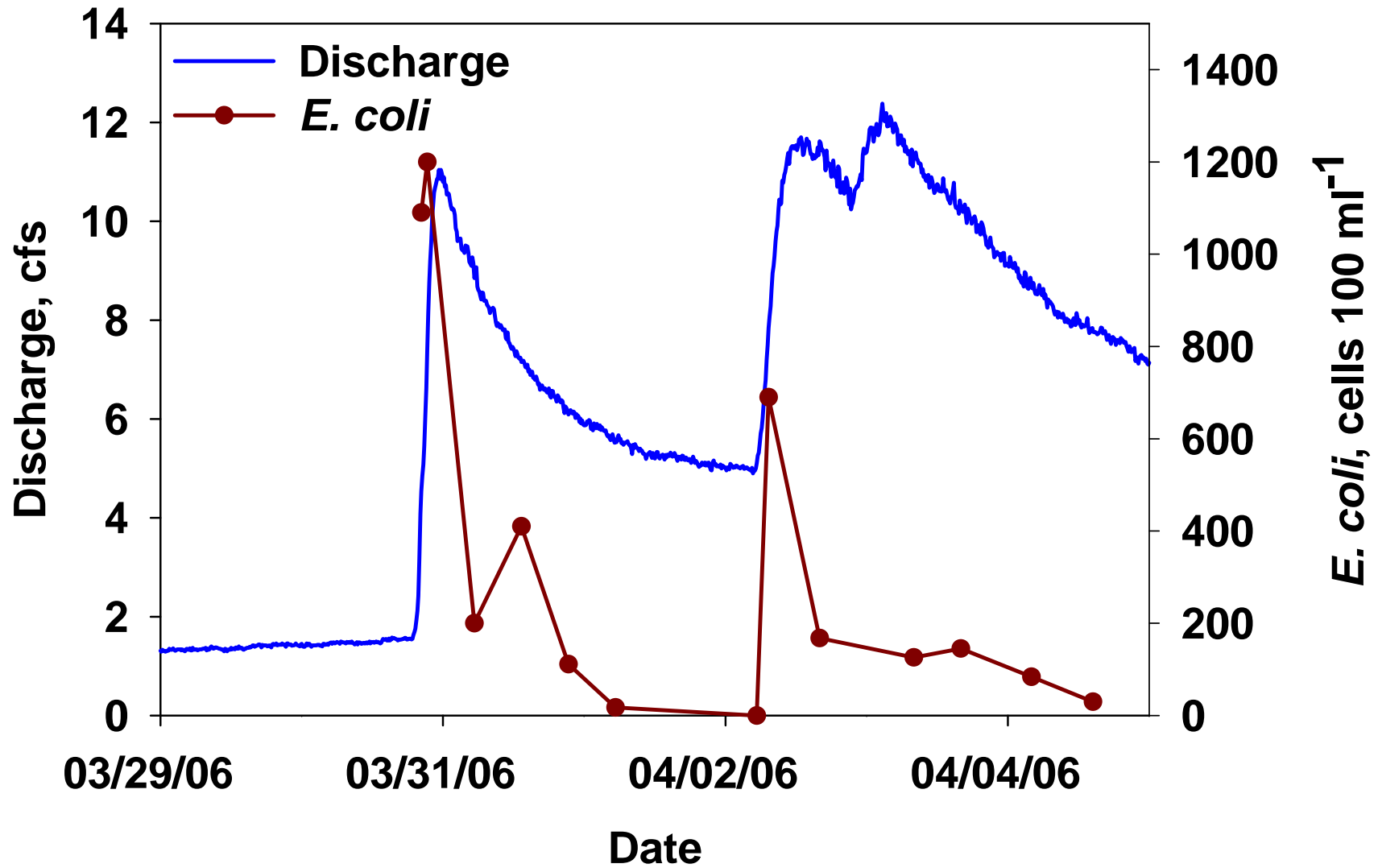
April 11, 2005 Storm Event



River Station TC325: Discharge and *E. coli*

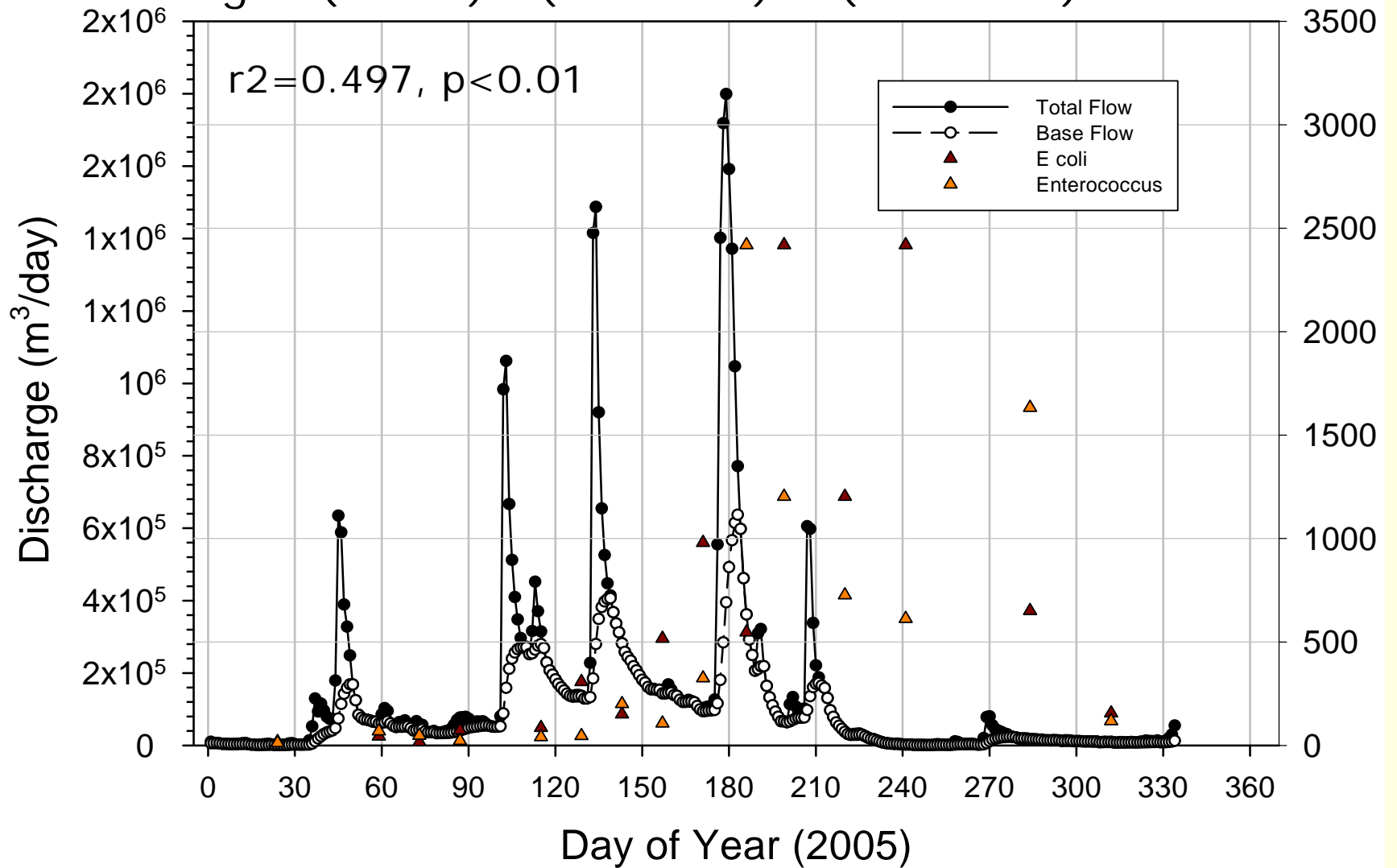


Tile Station TC240: Discharge and *E. coli*



SF400

$$\text{Log}_{10} (E. coli) = (0.052 \text{ AT}) + (0.059 \text{ RQ}) + 1.767$$



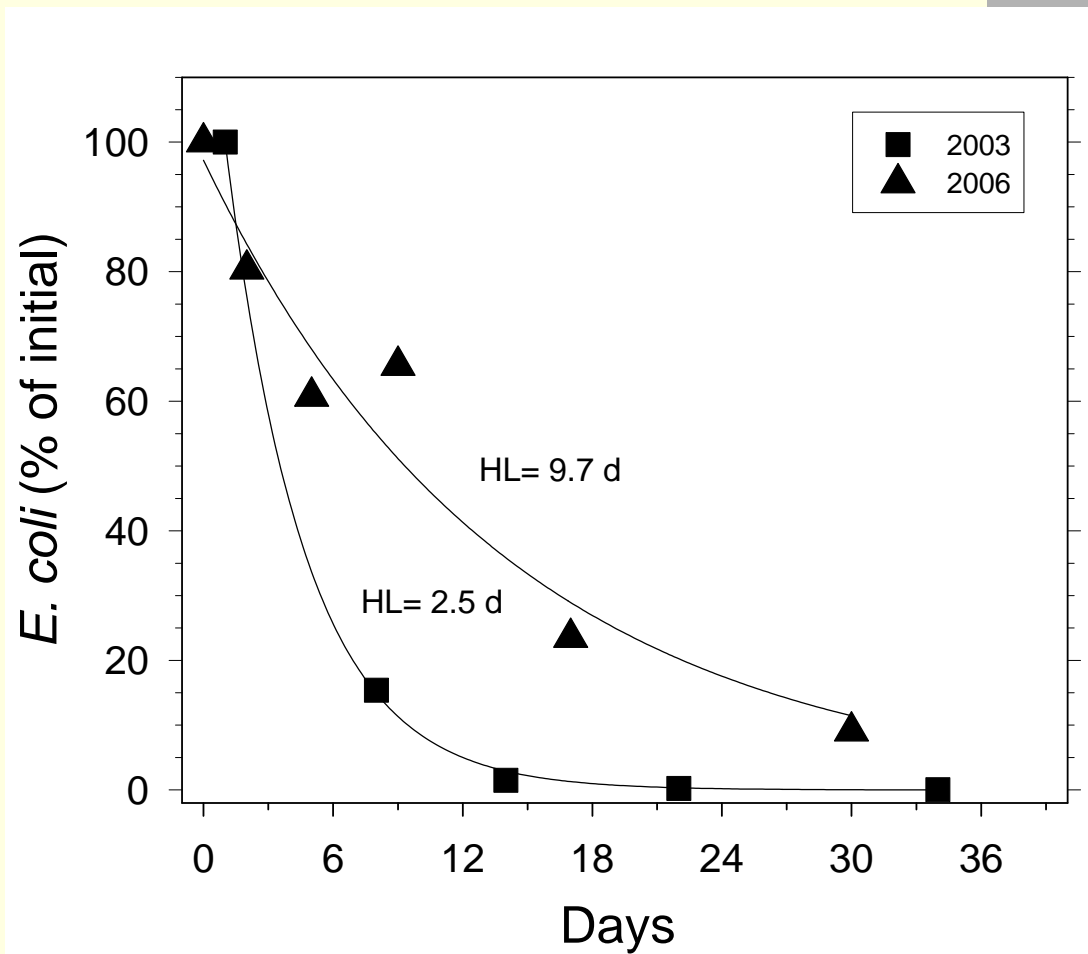
RUNOFF

Comparison of *E. coli* transport at manured and non-manured sites

- One site receives manure every other year (after soybean)
 - One site receives no manure
- Surface run-off volume and samples (same day analysis of *E. coli*)
 - Soil sampling for *E. coli*



Survival in Soil: Field Conditions



E. coli in field runoff

Runoff Event	<u><i>E. coli</i> / 100 ml runoff water</u>	
	Field 101 (manure)	Field 102 (no manure)
Nov 4, 2003 6 days after application	5,172	3,873
April 11, 2005 after fall application	1,553	160
June 2005	64,880	25,994
Aug 20, 2007 9 months after application	24,950	68,830

Key Findings

- Seasonal differences in populations were found in all tributaries.
- Beaver Creek *E. coli* populations were greater than Tipton Creek, despite BC having only one third as many hogs per unit area as TC.
- Field-scale runoff studies show that wildlife is a significant source. Concentration of *E coli* in runoff is dependent on time after manure and amount of runoff.
- Populations of *E coli* are similar throughout watershed (didn't find "hot spots")
- Tile water populations were much lower than stream water . Peak concentrations in tiles may be due to runoff through surface inlets.
- Collaborators: Jeremy Singer, Mark Tomer, David James, Cindy Cambardella

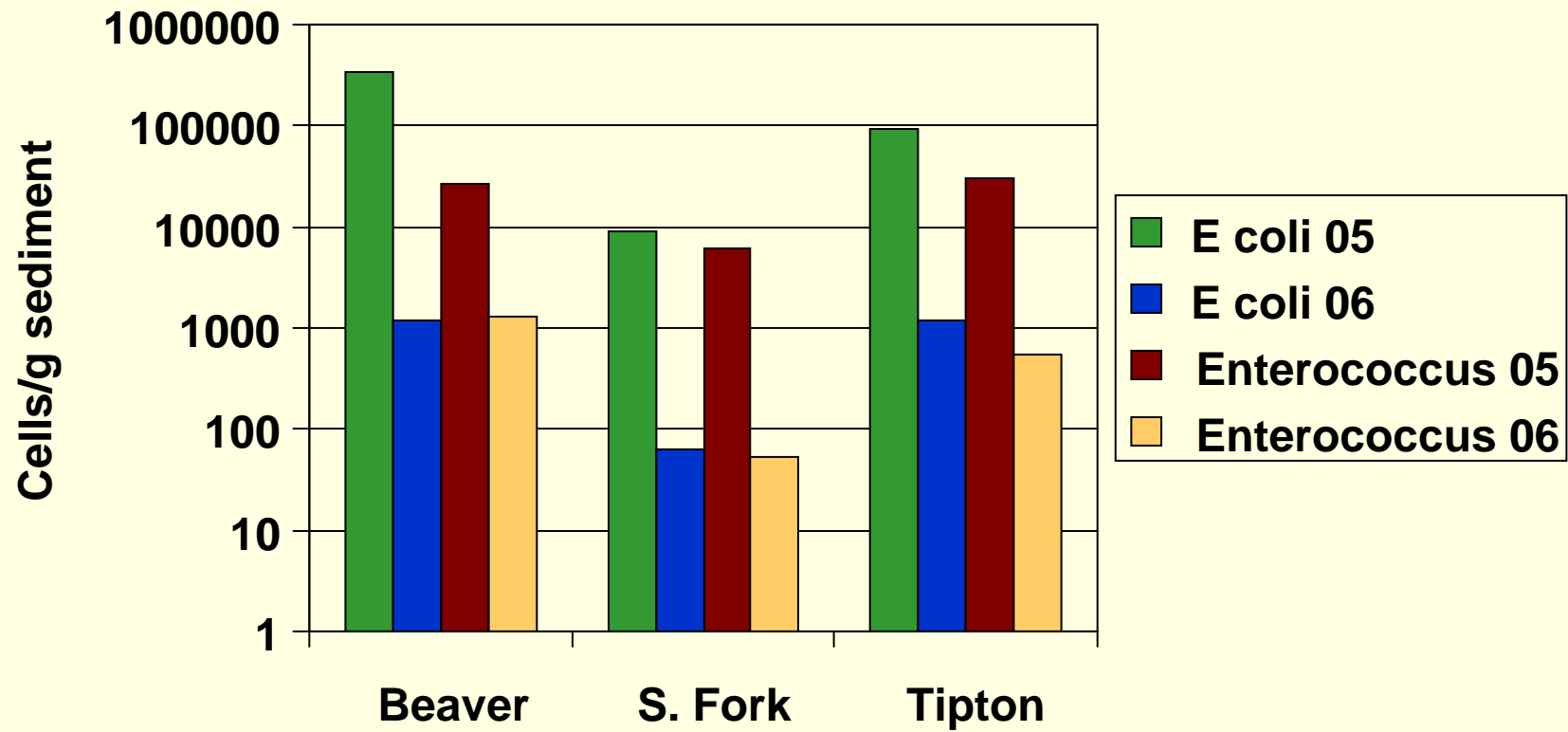
What we don't know

- Why summer populations exceed water quality standards?
 - Manure applied in fall and spring
 - Runoff events rare in July and August
 - *E coli* lives in stream sediments: are these a source?
 - Cattle and wildlife?



Stream Sediments

Source or Sink?



Current and Future Work

- Integrating cover crops with manure application
 - cover crops may simultaneously reduce N leaching and runoff losses of P and *E coli*
- Source Tracking
 - DNA based methods that determine source animals (cow vs pig vs deer, etc)
 - Need to understand relative contributions of different animals to develop rational load reduction plans

Application of manure into conservation tillage systems: Can over crops mitigate erosion and nitrate leaching?

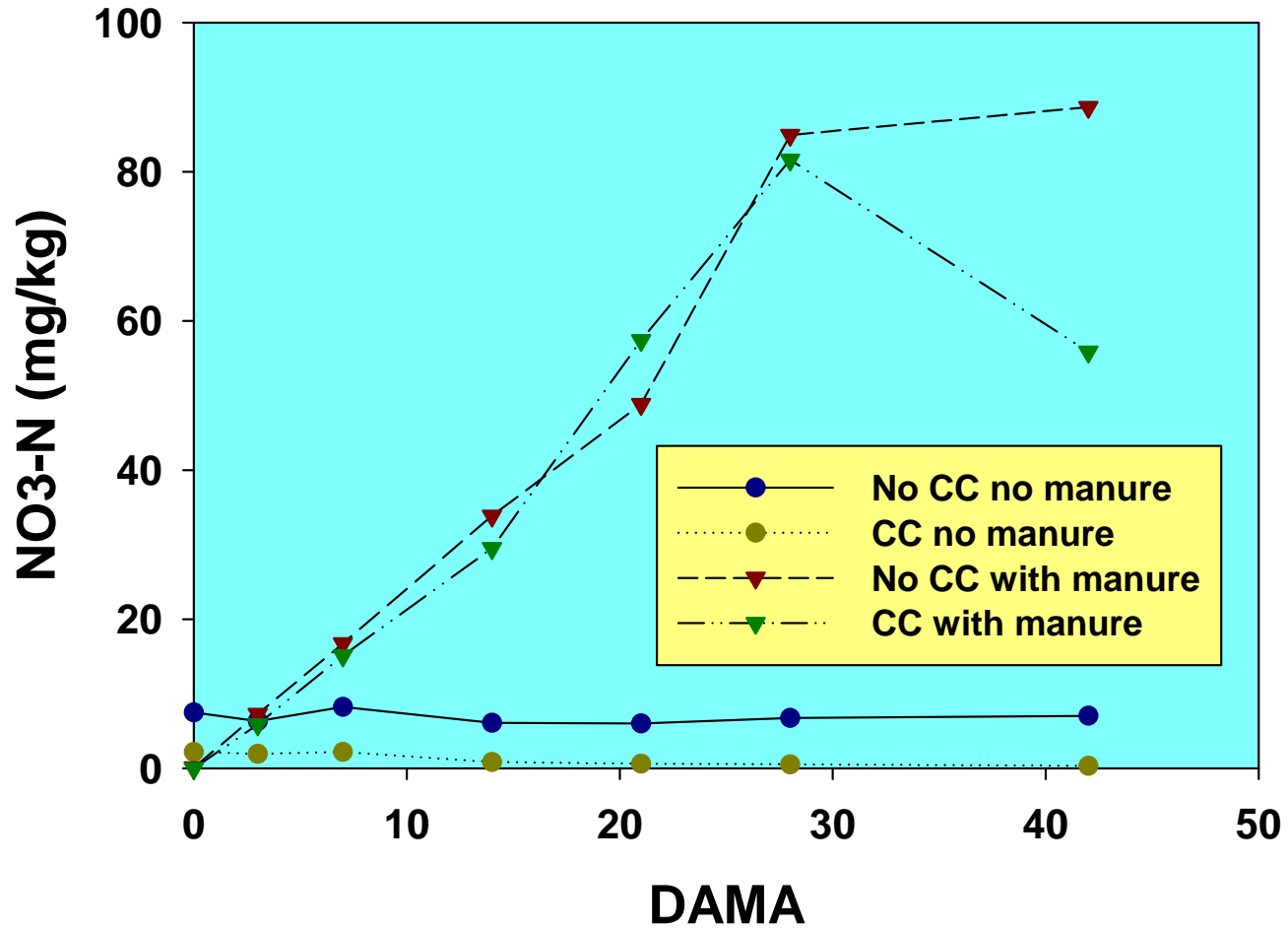


Fall 2005

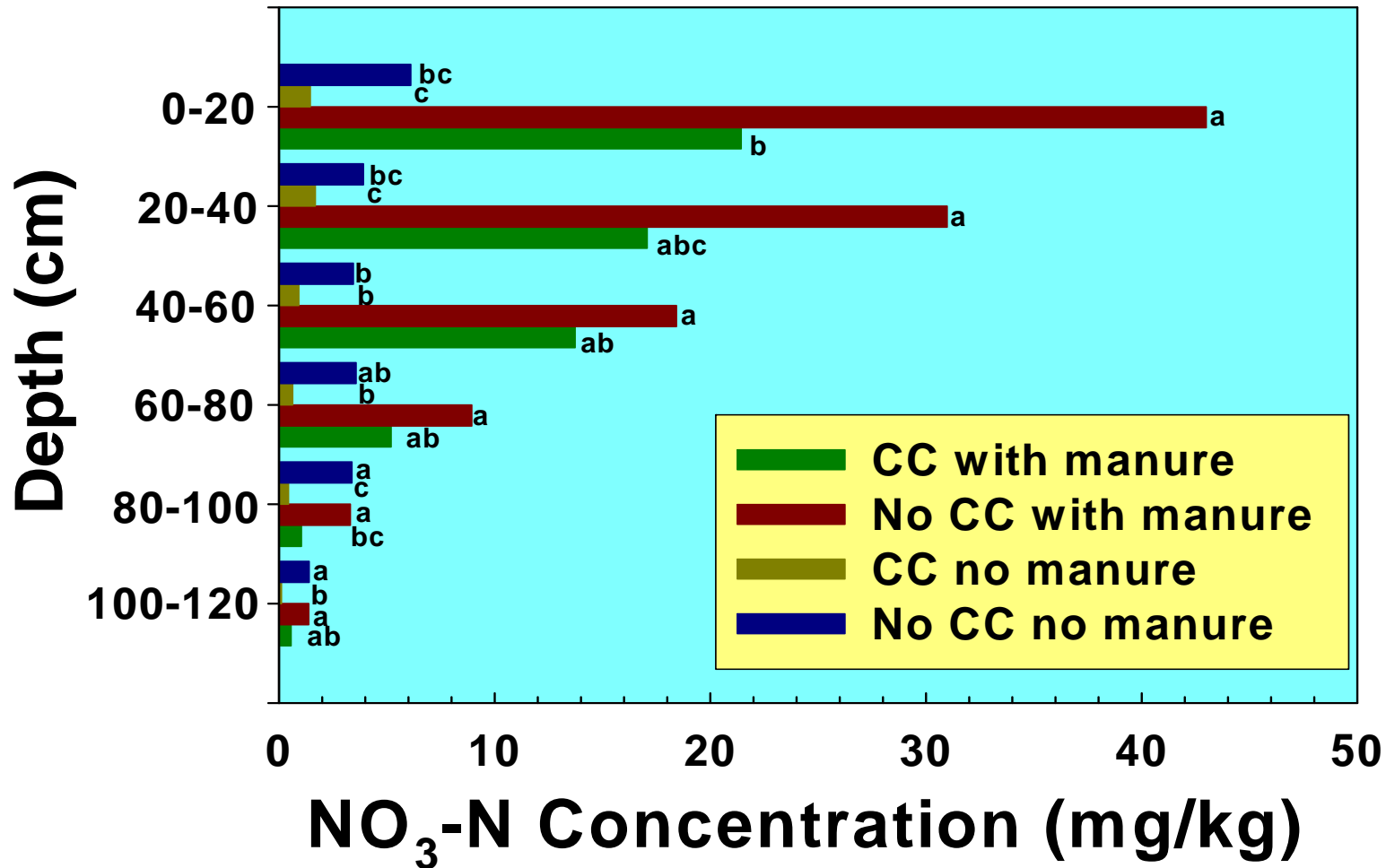


Spring 2006

Fall 2005



Spring 2006



Cover Crop Nutrient Uptake

- The rye/oat cover crop took up between 41 and 62 lb/ac of N. About 9 lb/ac of this uptake occurred in the fall. Corn yields were increased at the 200 and 300 lb rates of N over the 100 lb rate of manure N.
- Cover crops reduced the leaching of nitrate in the spring of 2005.
- Current work is using ^{15}N -labeled manure to evaluate when and how much N in the cover crop is released to the following corn crop.

Research on Antibiotics in Soil and Manure

- Measure persistence in soils, water and stream sediments
- Identify degradation rates and mechanisms
- Develop methods to determine bioavailability of soil-bound residues
- Ecotoxicology: aquatic invertebrates