Watershed-Scale Variations in Bacteria

Time and Land Use and their Application to Understanding Sources

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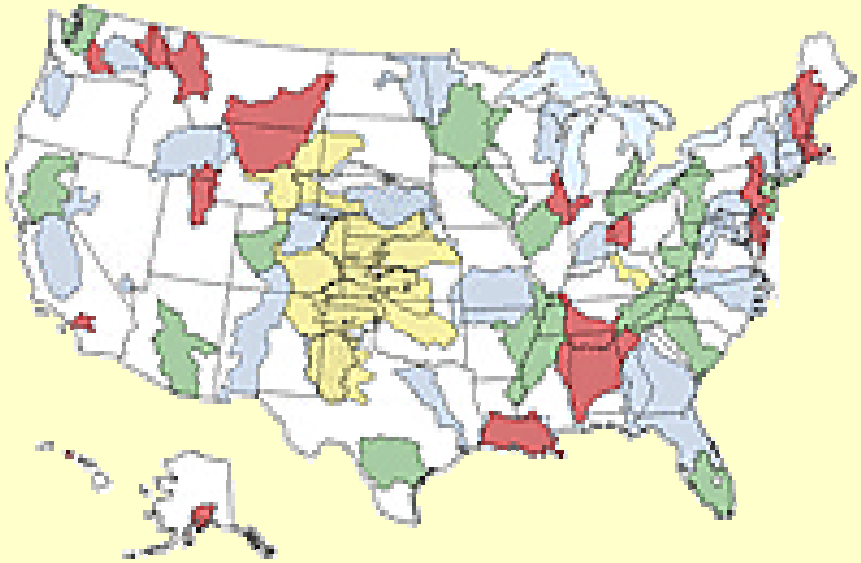
Why Watersheds?

- Watershed-scale monitoring integrates effects of farms, residences, businesses etc. over a broad scale.



USGS NAWQA Program Watersheds

Source Tracking

Currently: Genotypic, geographic and temporal variation combine to limit utilization of source-tracking methods.

Can we effectively target (sites, times or processes) source tracking studies to increase effectiveness and reduce costs?

- **what kinds of information would be useful for targeting?**

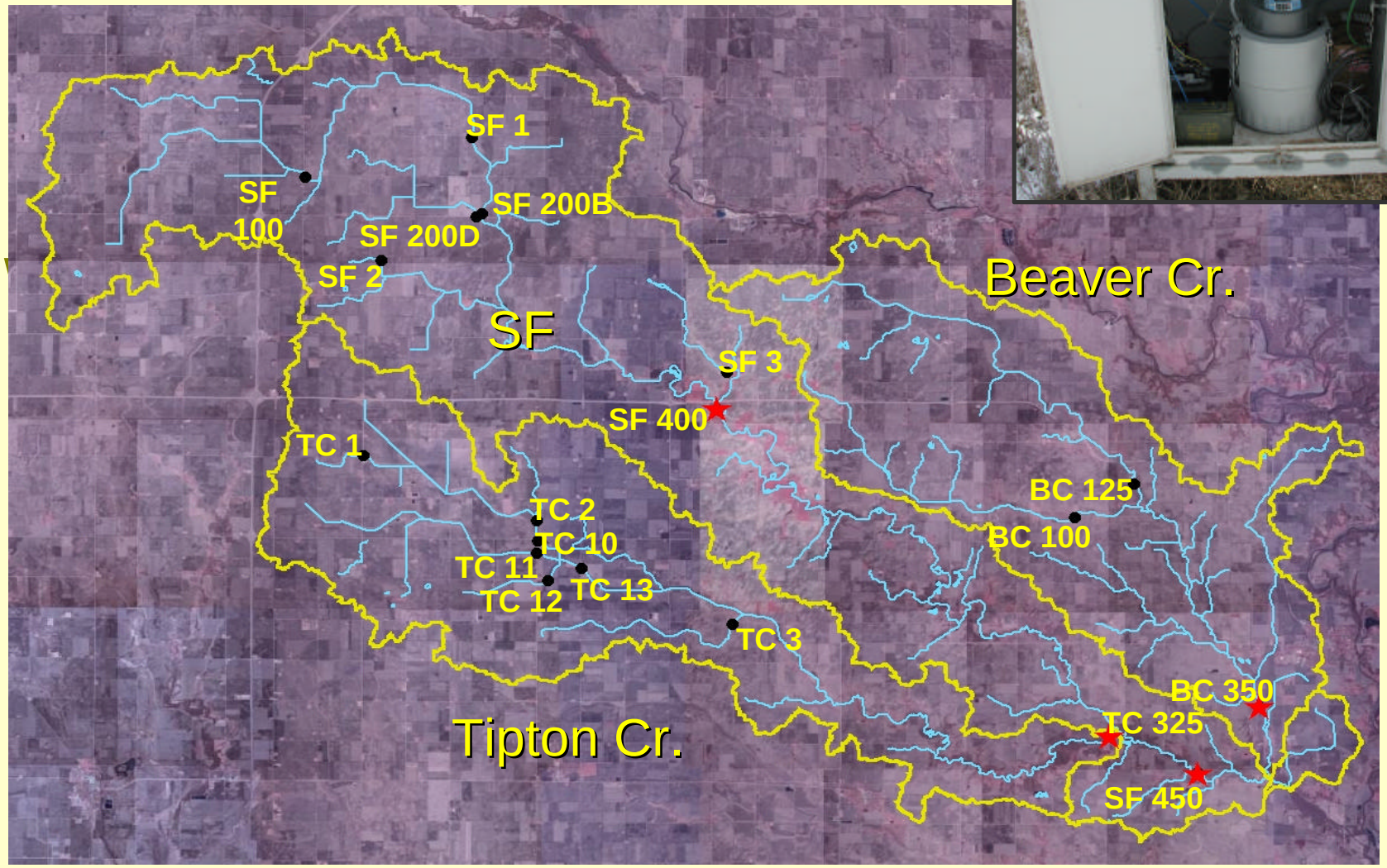
Escherichia coli (E. coli)

- What are the sources and entry routes of microorganisms?
  - What is the land use, agricultural practices? Do sub-watersheds have different levels of animals or *E. coli*?
  - What are the controlling hydrologic conditions and response times?
  - What is the effect of scale?
  - Are there temporal trends?

South Fork Watershed

- Evaluate spatial and temporal patterns in water quality and determine impact of livestock production facilities.
- Develop planning tools that identify optimal locations to place specific conservation practices.
- Encourage implementation of new practices and identify their water quality impacts.
- Conservation Effects Assessment Program

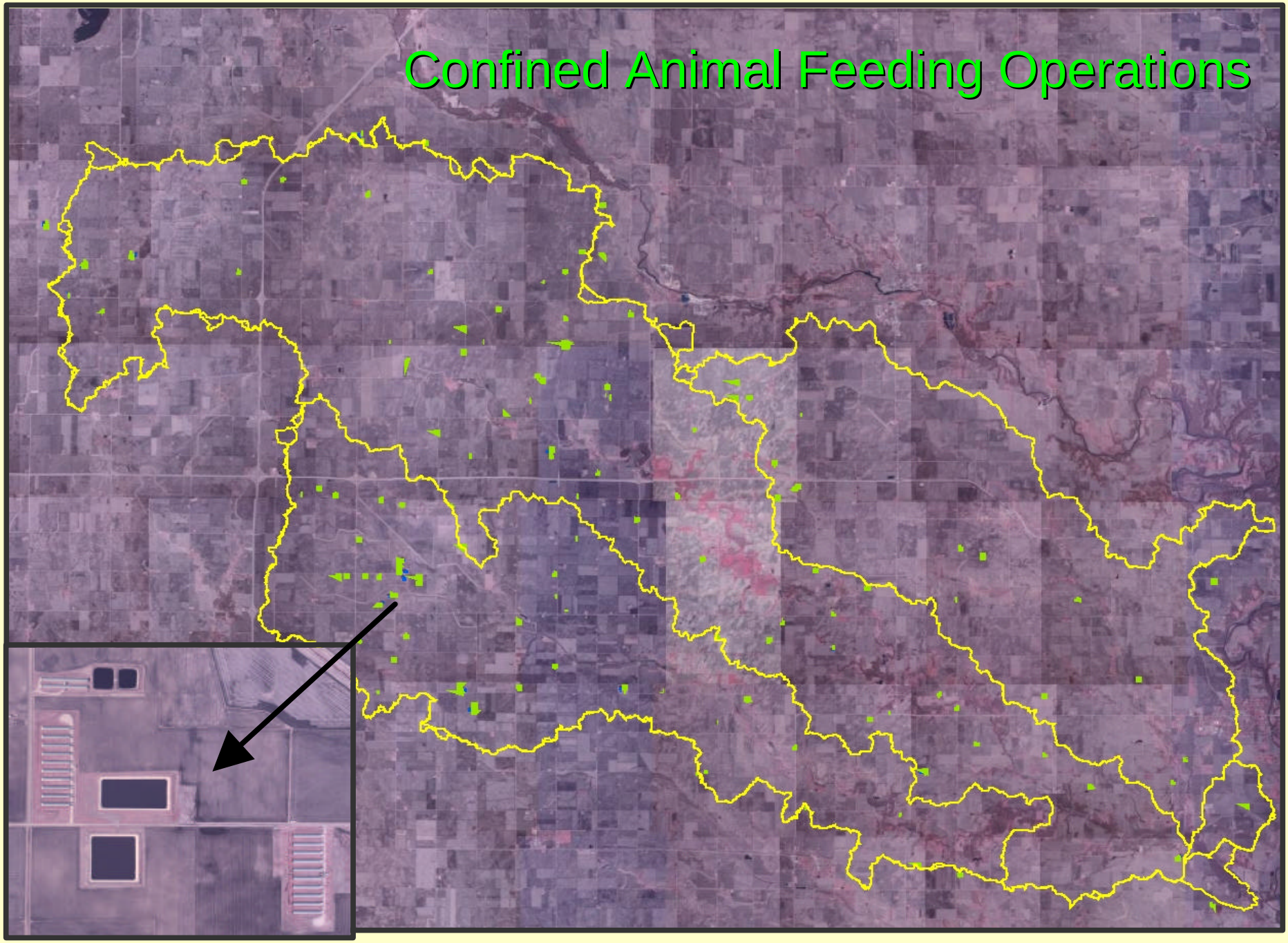
Stream flow and water quality monitoring to assess variation within watershed.

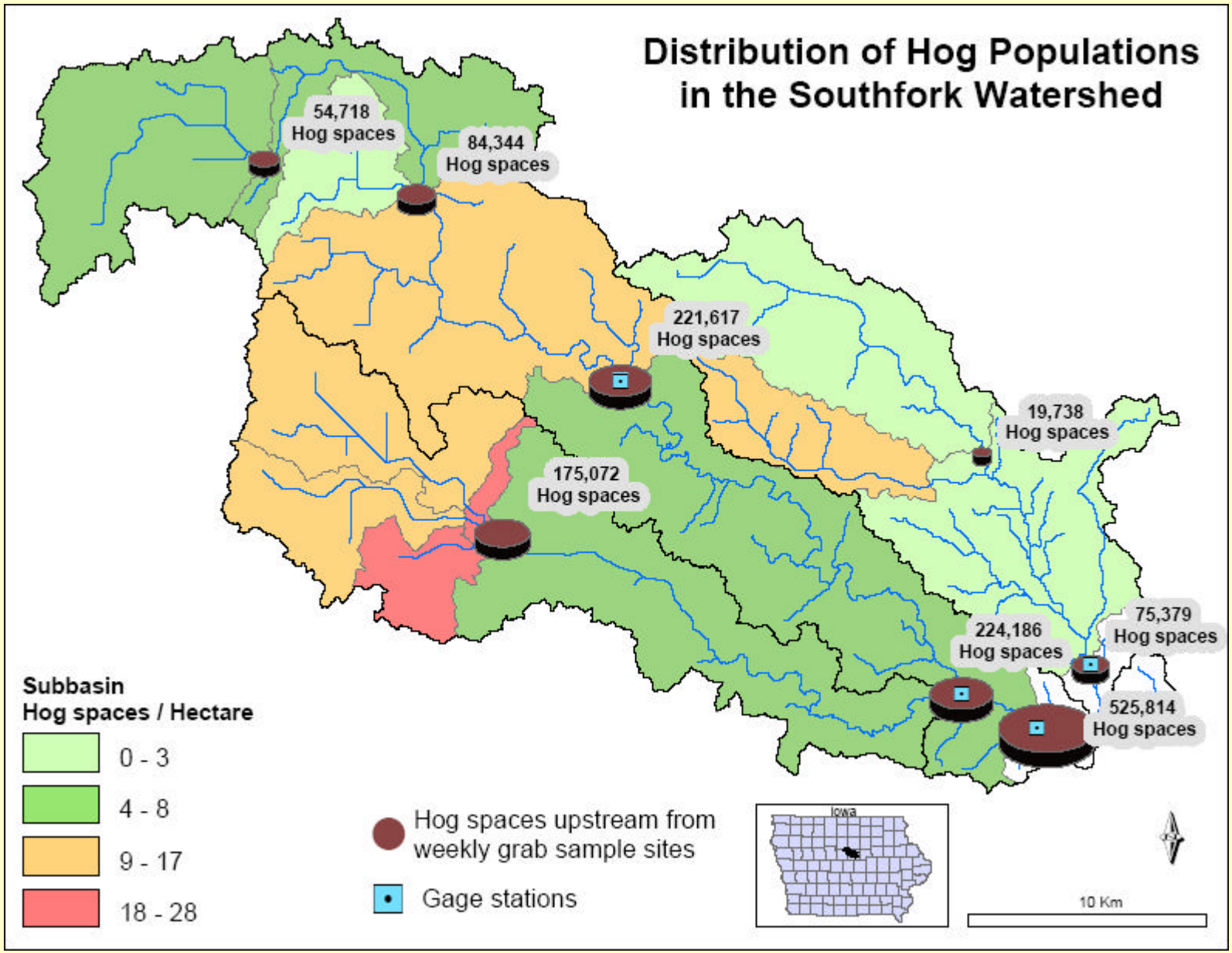


Swine Population & Manure Estimation

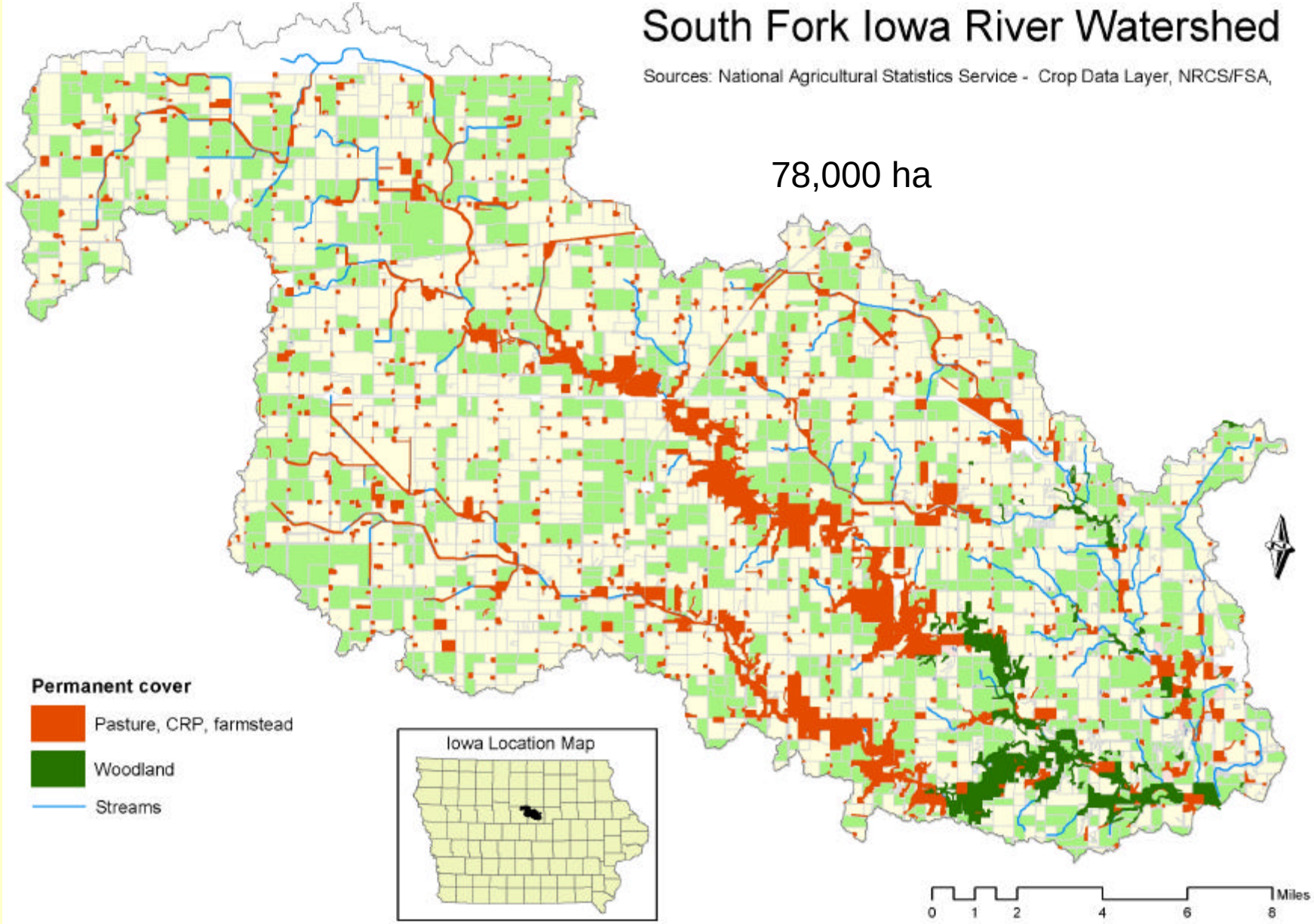
- Aerial photography
- Hog space estimates
- Manure/hog
- Manure applied near CAFO

Confined Animal Feeding Operations

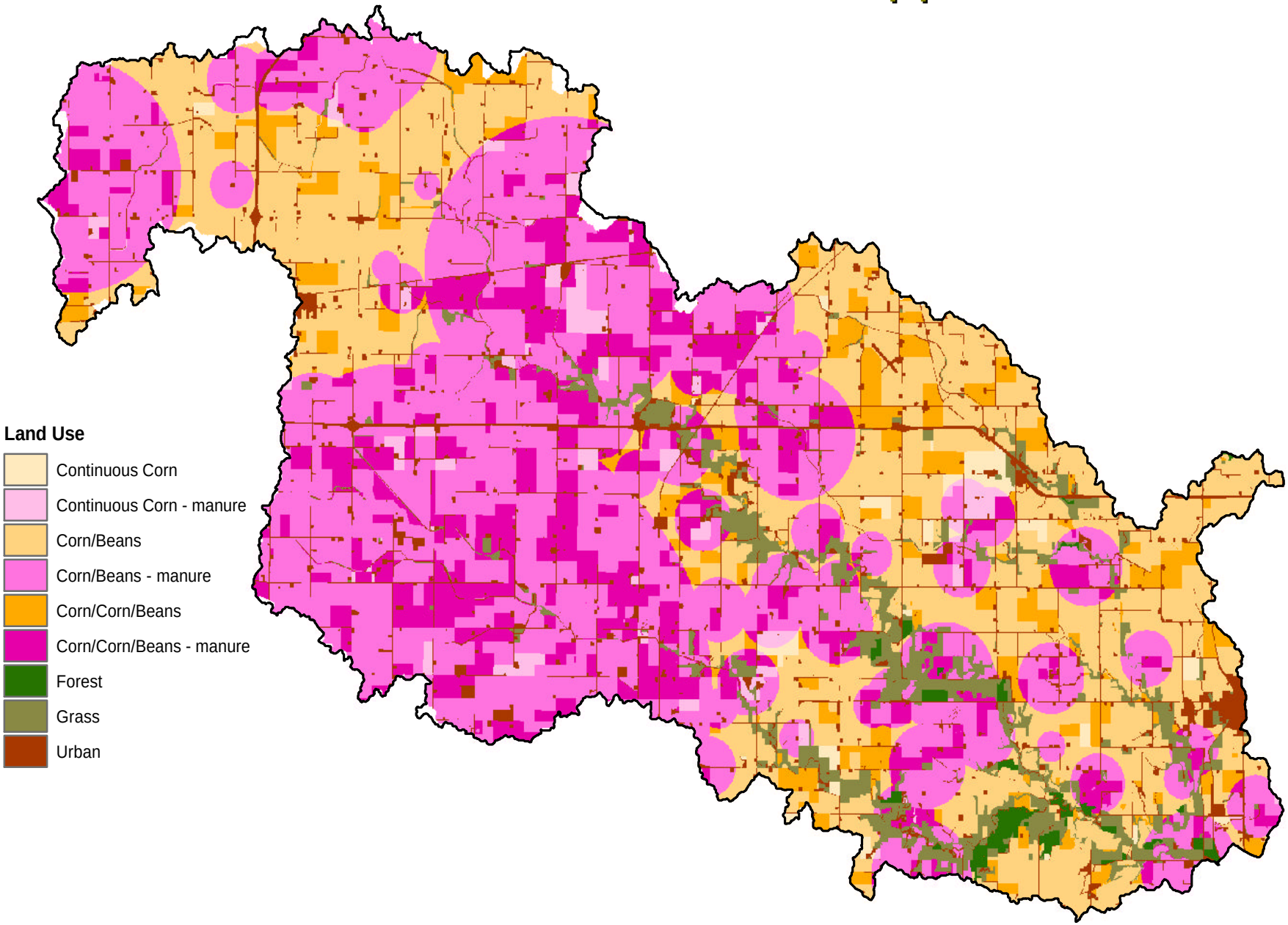



Distribution of Hog Populations
in the Southfork Watershed
54,718
Hog spaces
84,344
Hog spaces
221,617
Hog spaces
19,738
Hog spaces
175,072
Hog spaces
75,379
Hog spaces
224,186
Hog spaces
525,814
Hog spaces
Subbasin
Hog spaces / Hectare
0 - 3
4 - 8
9 - 17
18 - 28
Hog spaces upstream from
weekly grab sample sites
Gage stations
Iowa
10 Km

Areas of row-crop production and permanent cover

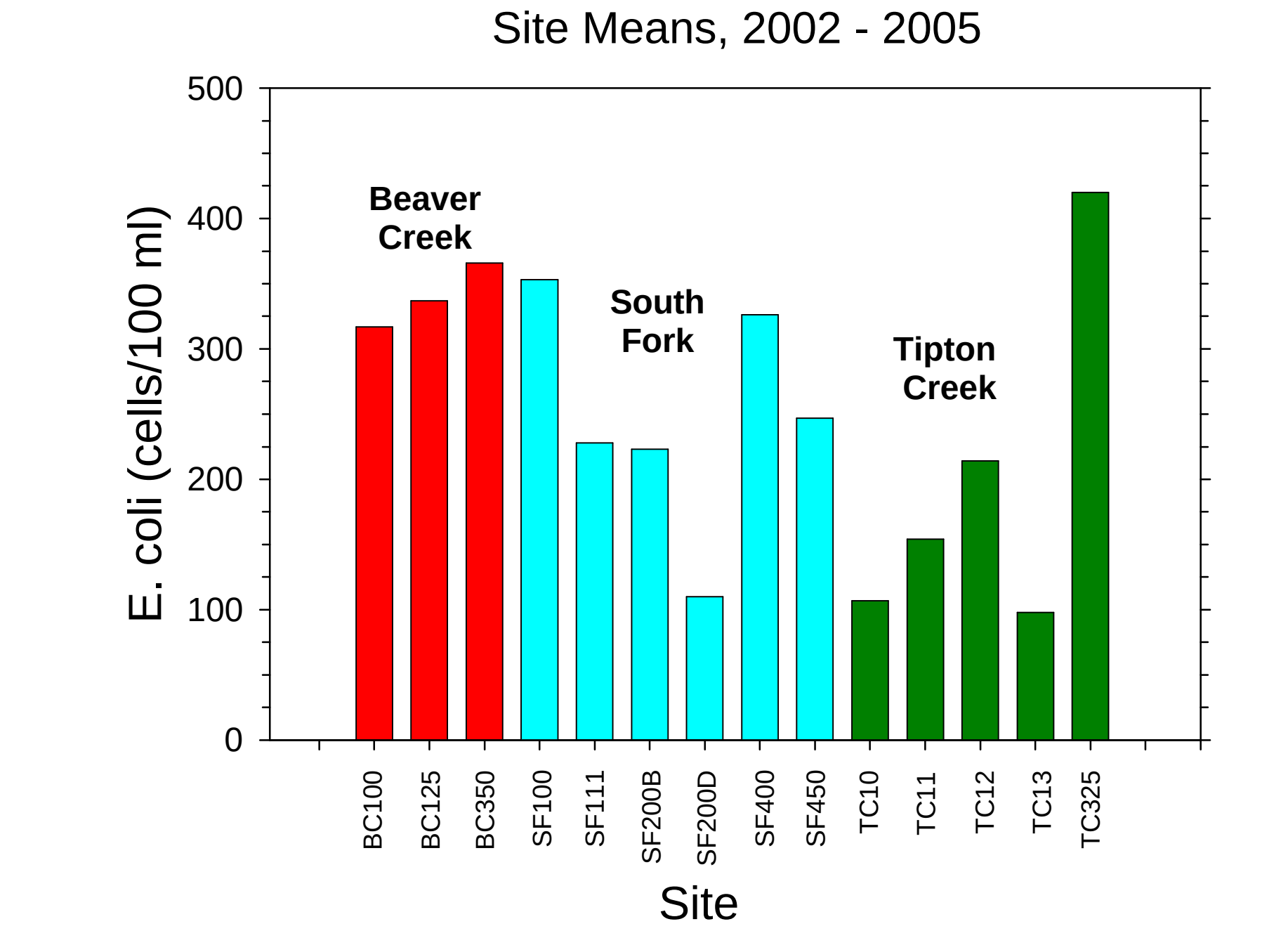


Estimated Swine Manure Application



Land Use Summary

		Watershed	
	Beaver	**South Fork**	**Tipton**
C/B	51	30	10
C/B+Manure	18	40	57
C/C	9	4	2.5
C/C+Manure	4	9	14
Grass/Pasture	4.6	5.2	4.5
Forest	0.7	2.4	2.3
CRP	1.5	1	2
Swine/ha	4.1	13.7	11.3


Site Means, 2002 - 2005
E. coli (cells/100 ml)
500
400
300
200
100
0
Beaver Creek
South Fork
Tipton Creek
BC100
BC125
BC350
SF100
SF111
SF200B
SF200D
SF400
SF450
TC10
TC11
TC12
TC13
TC325
Site

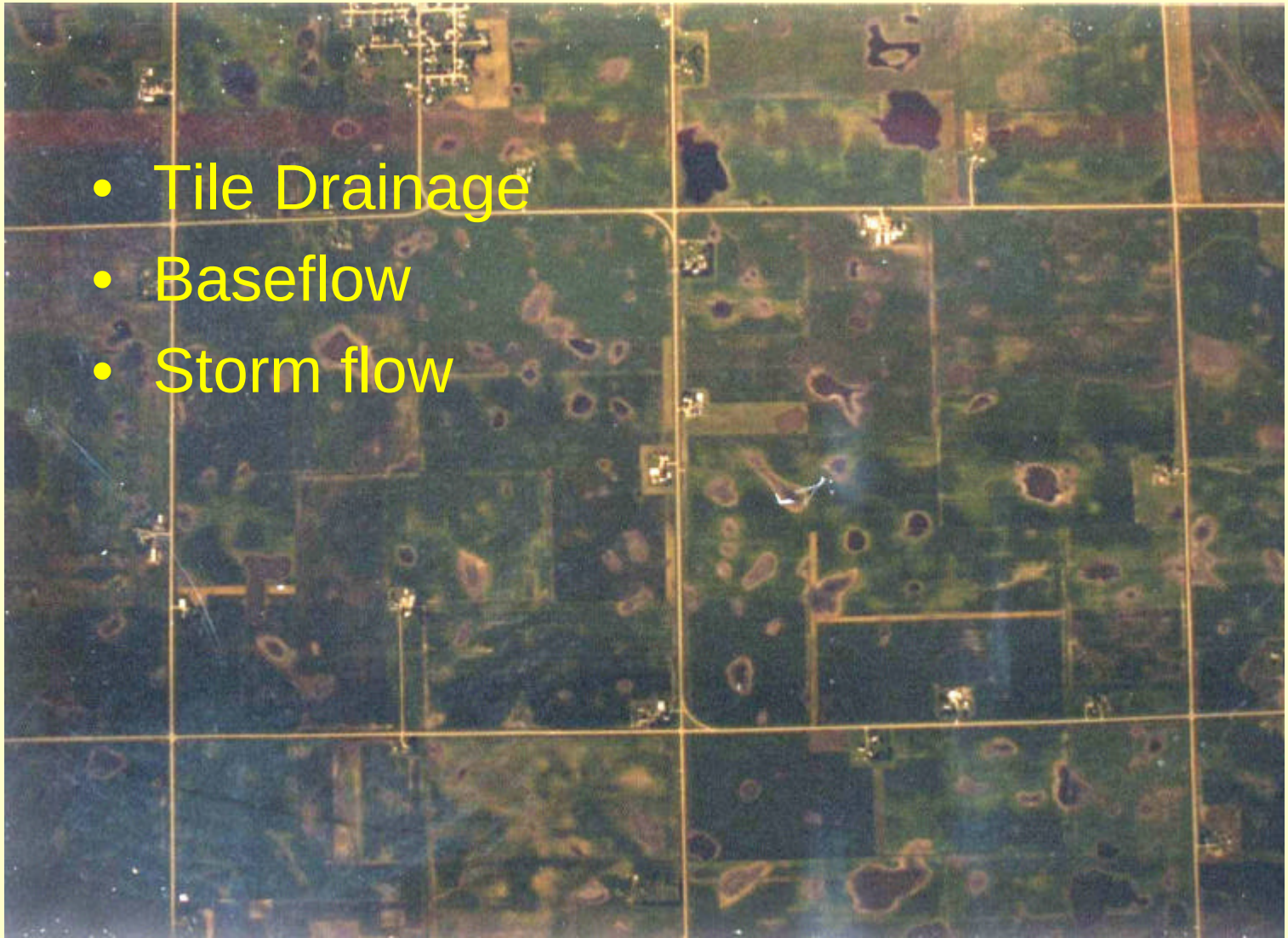
Means 2002-2005

	E. coli	*Enterococcus*	
Beaver Creek	340 a	373 y	p=0.05
South Fork	232 b	478 x	
Tipton Creek	160 c	312 y	

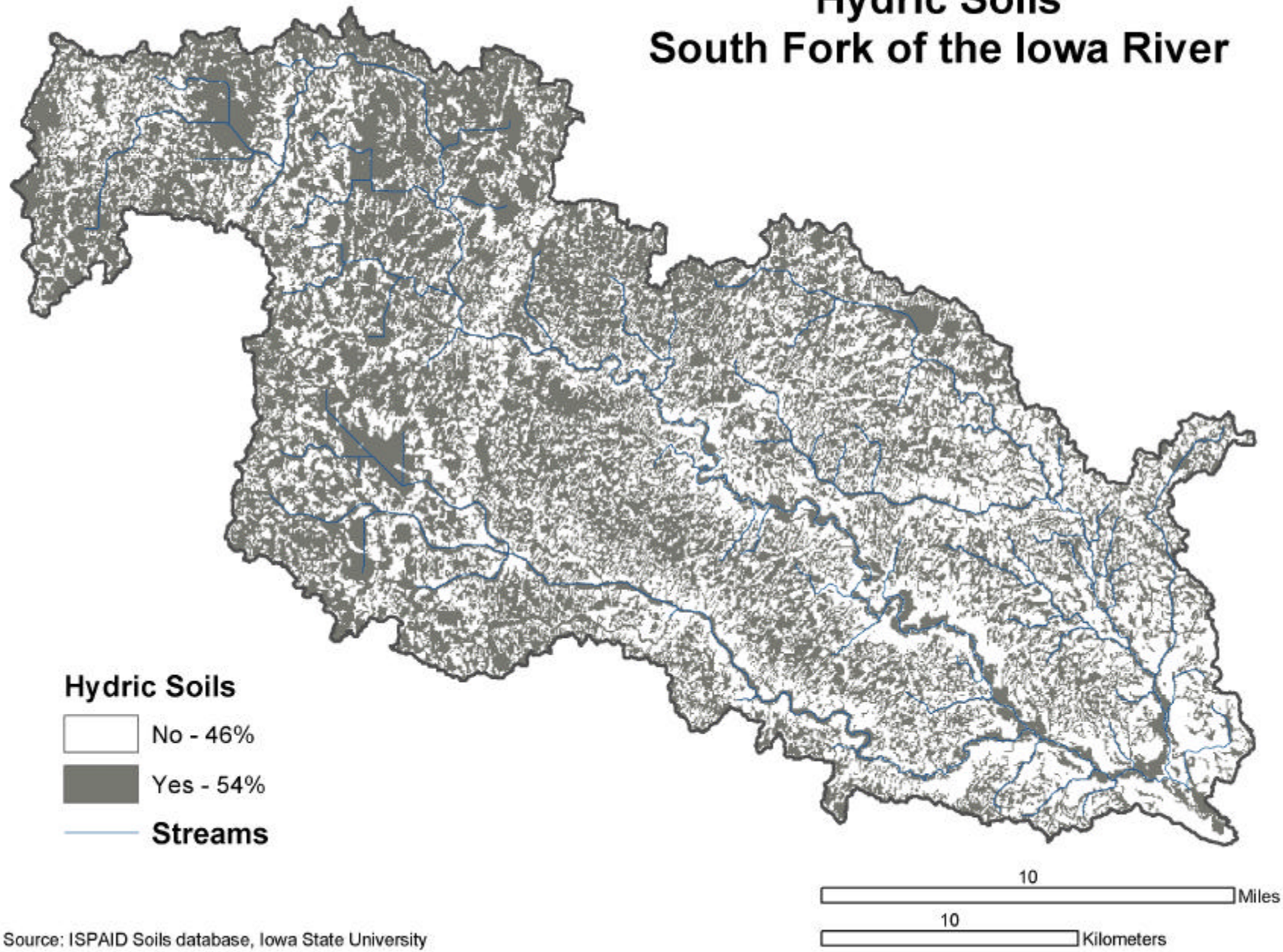
E. coli: samples > 200 mpn/100 mL

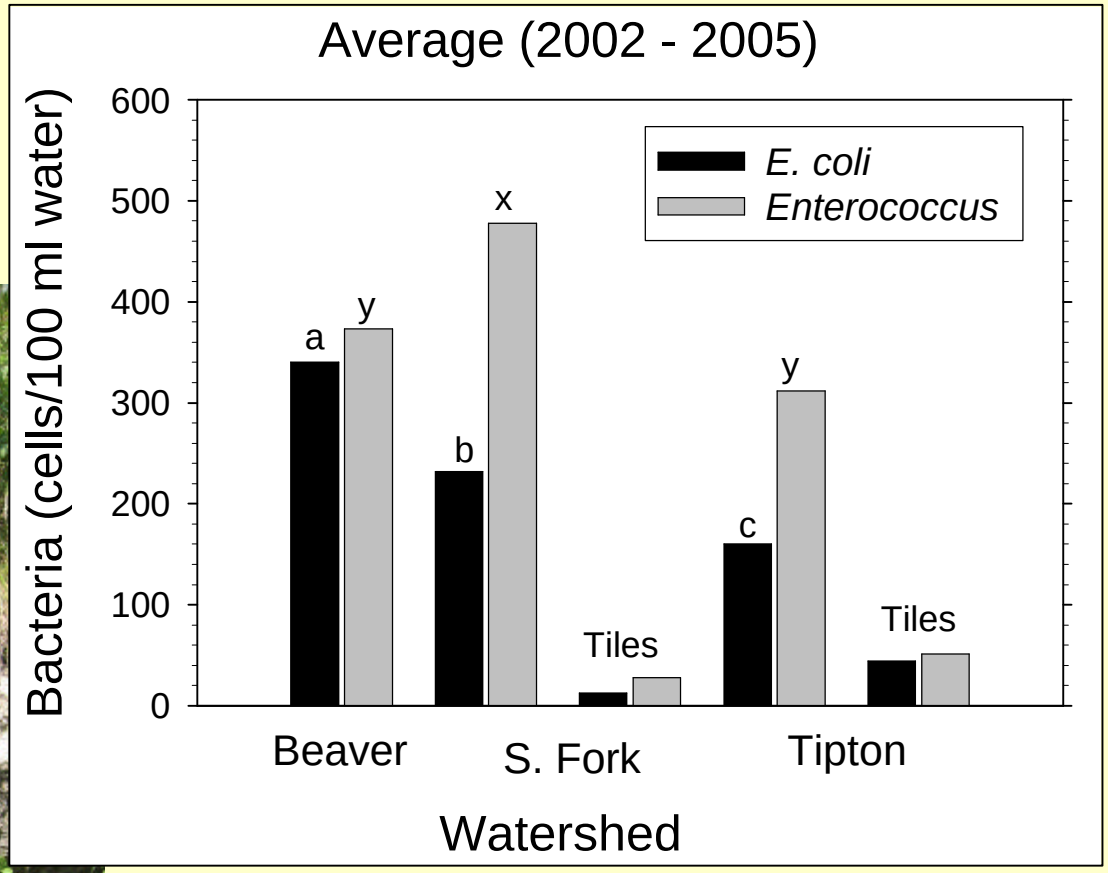
- Beaver Creek: 34%
- South Fork: 51%
- Tipton Creek: 56%

What are the controlling hydrologic conditions and response times?



- Tile Drainage
- Baseflow
- Storm flow


Hydric Soils
South Fork of the Iowa River
Hydric Soils
No - 46%
Yes - 54%
Streams
10
Miles
10
Kilometers
Source: ISPAID Soils database, Iowa State University

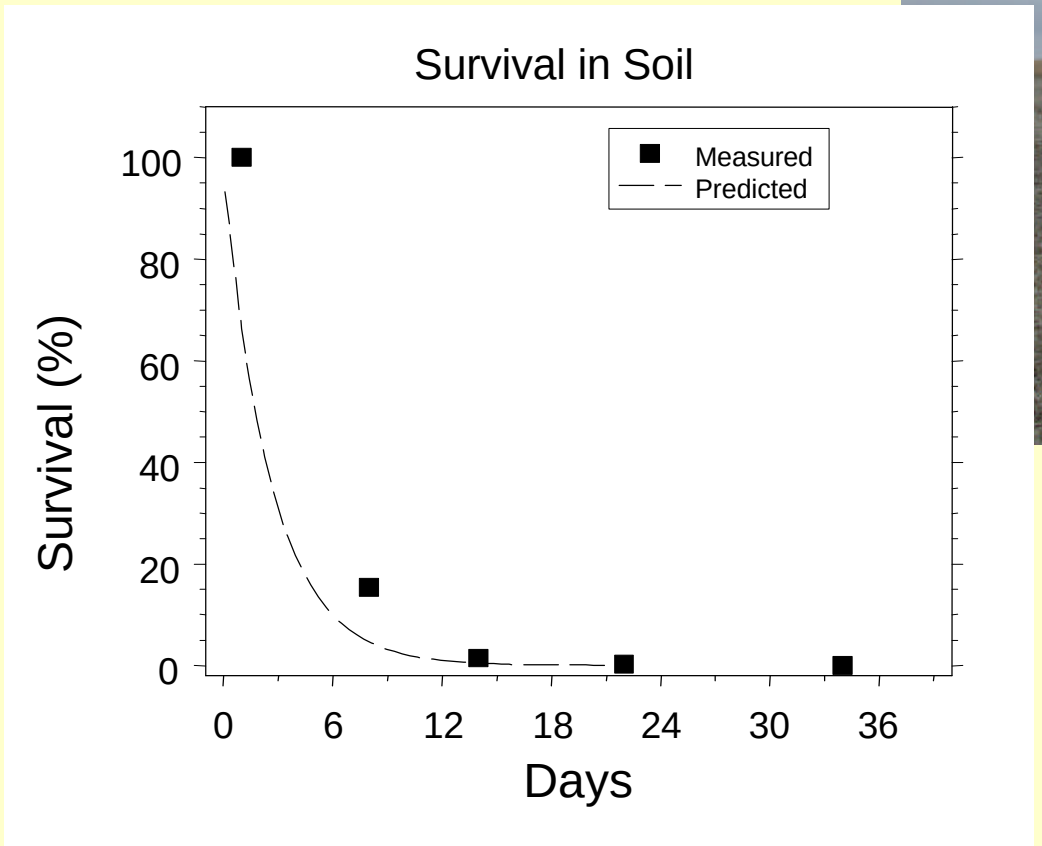

Average (2002 - 2005)
Bacteria (cells/100 ml water)
600
500
400
300
200
100
0
E. coli
Enterococcus
a
y
b
x
Tiles
c
y
Tiles
Beaver
S. Fork
Tipton
Watershed

RUNOFF

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

- One site receives manure every other year (after soybean)
- One site receives no manure for previous 6 years
- Surface run-off volume and samples (same day analysis of *E. coli*)
- Soil sampling for *E. coli*

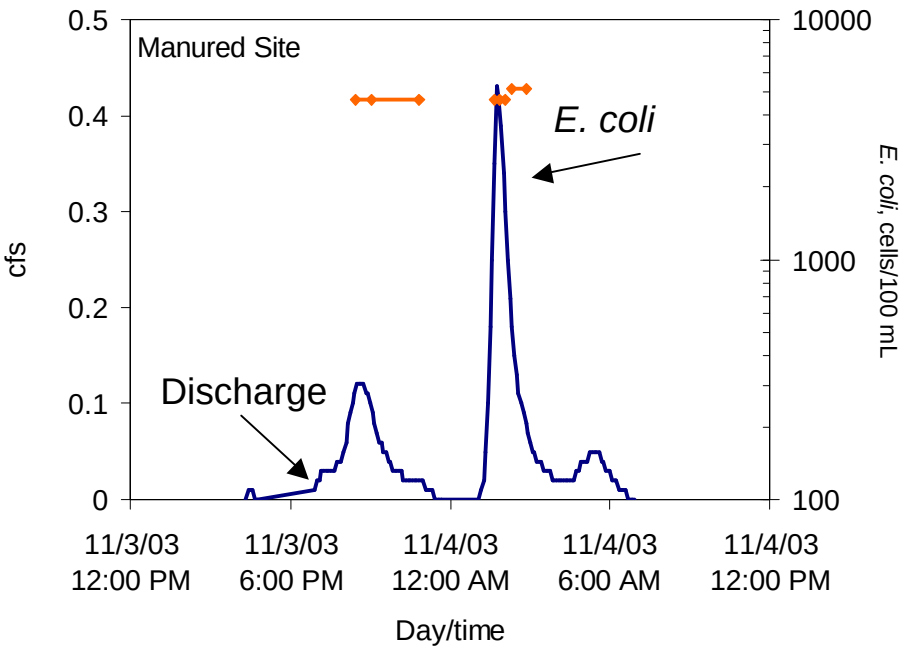
E. coli survival in soil after swine manure application November, 2003

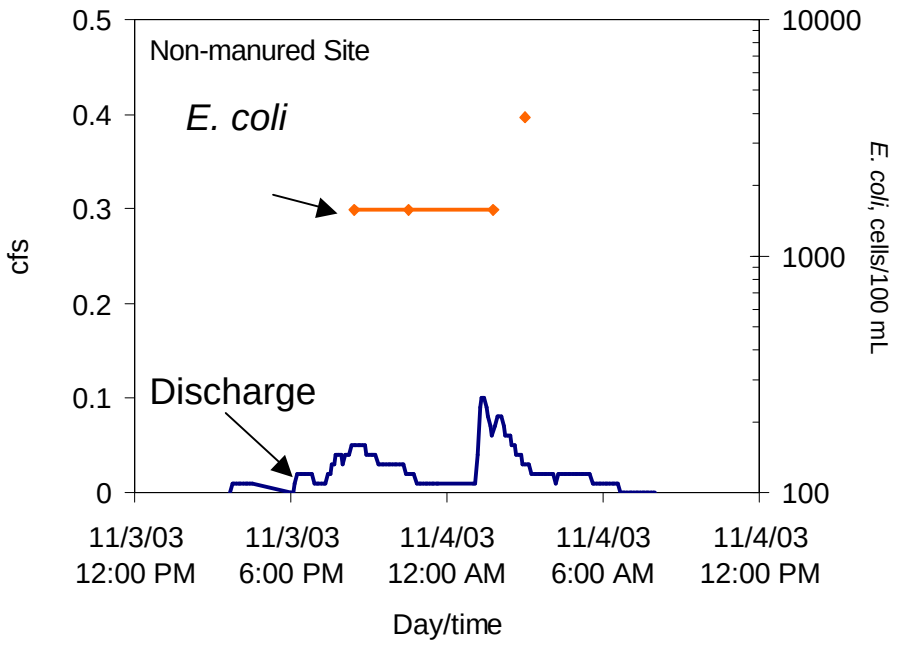


Runoff Event – Field Scale

November 2003, 6 days after swine manure application

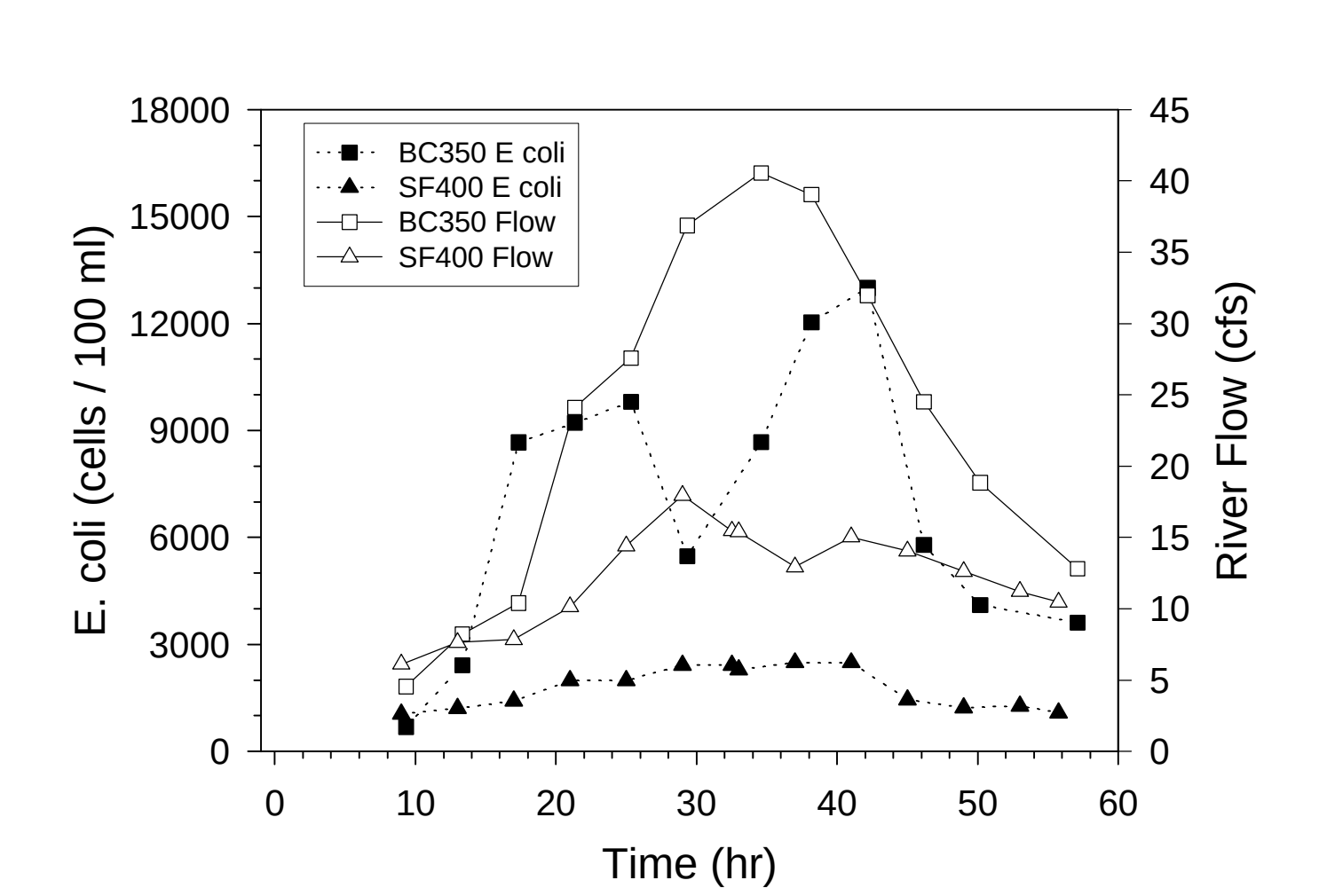
Two sites: manured and non-manured



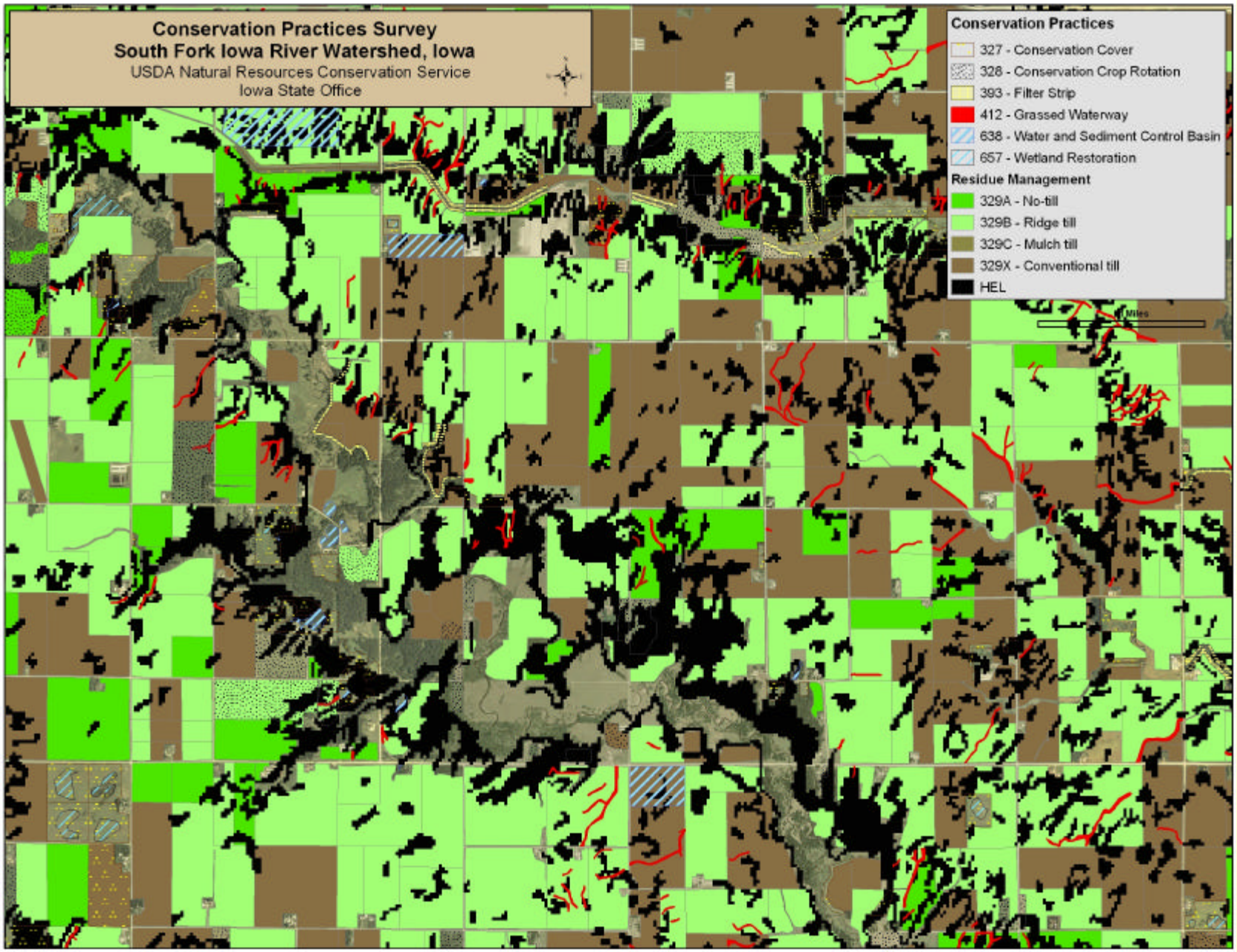


Runoff Event – Watershed Scale

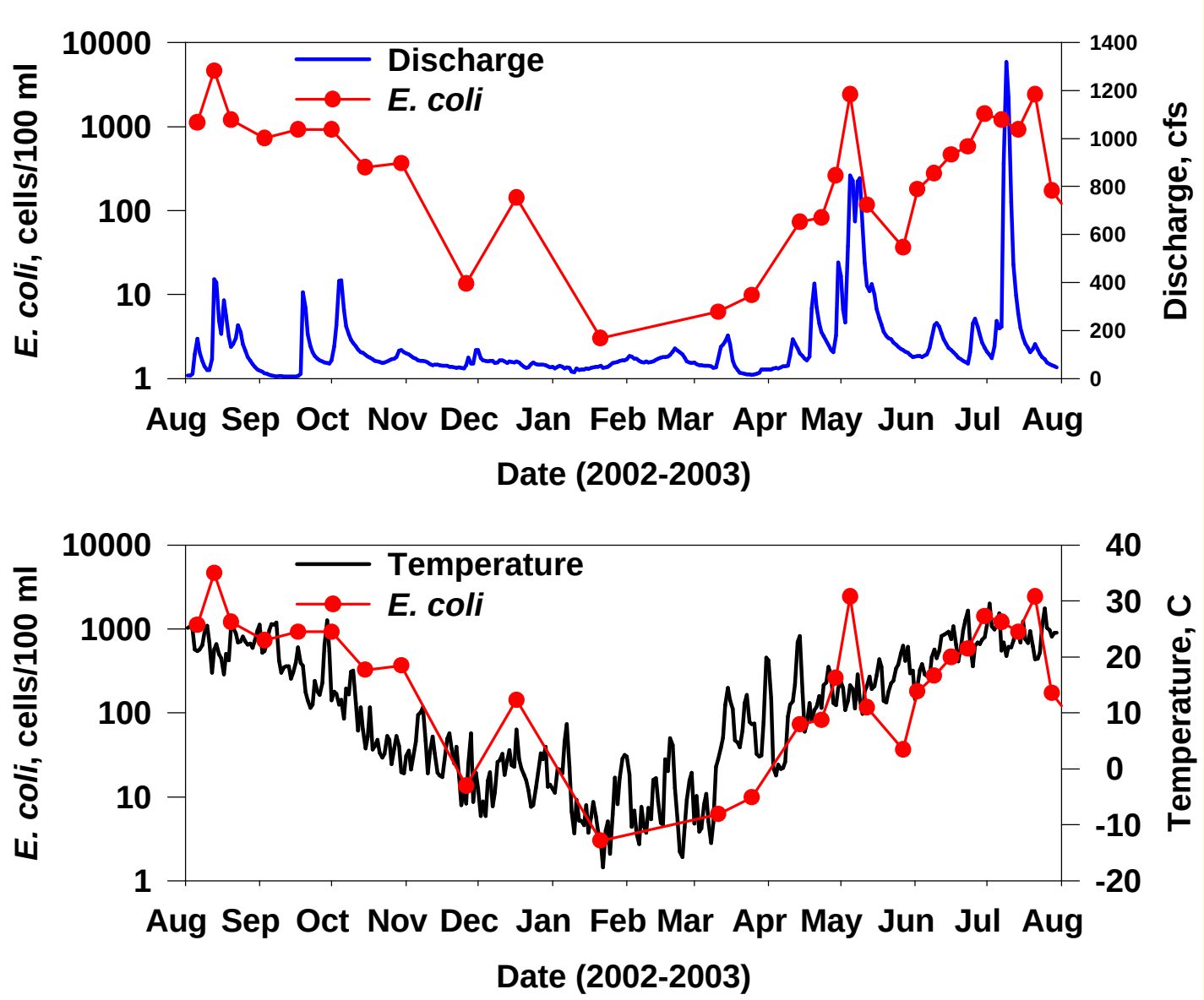
November 2003, 6 days after swine manure application

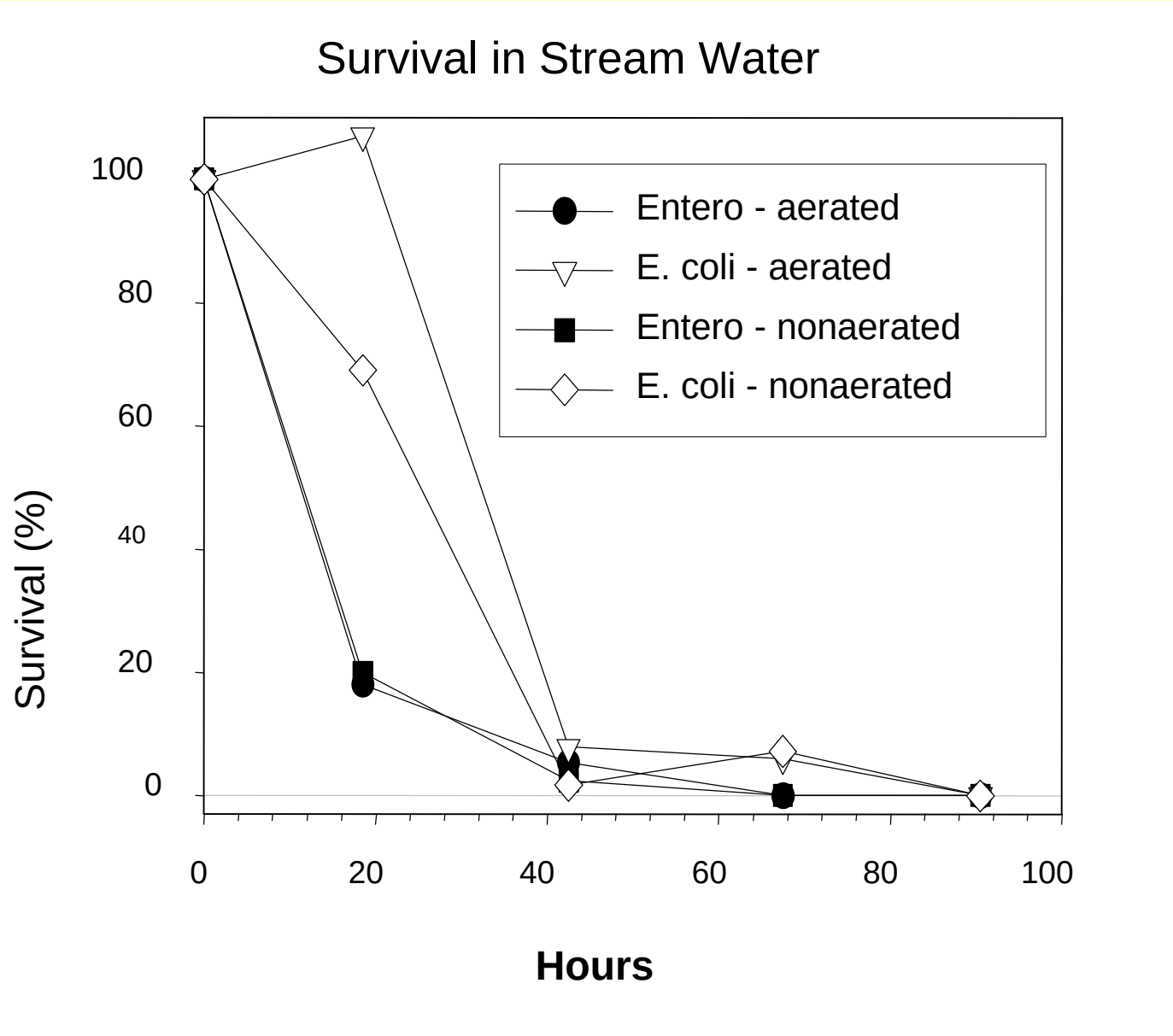


Where is runoff important?



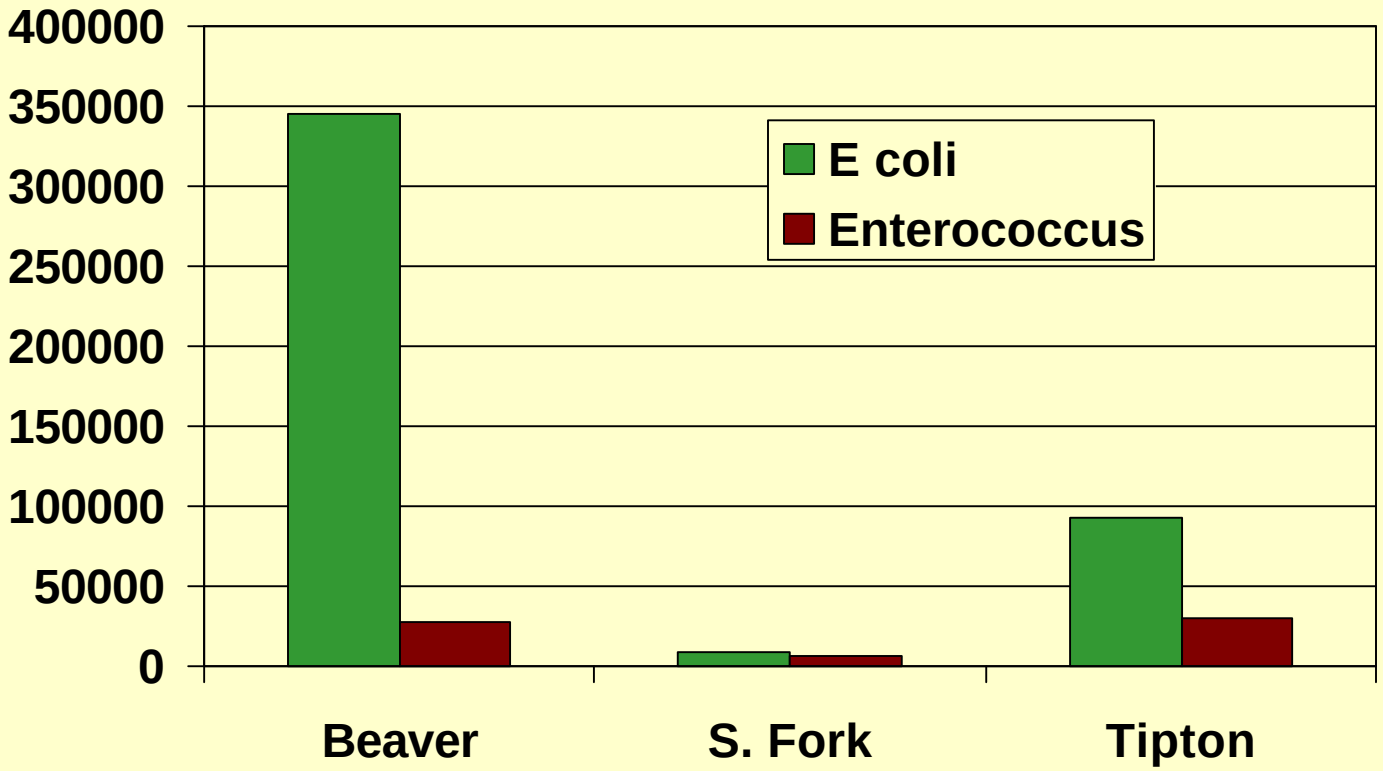
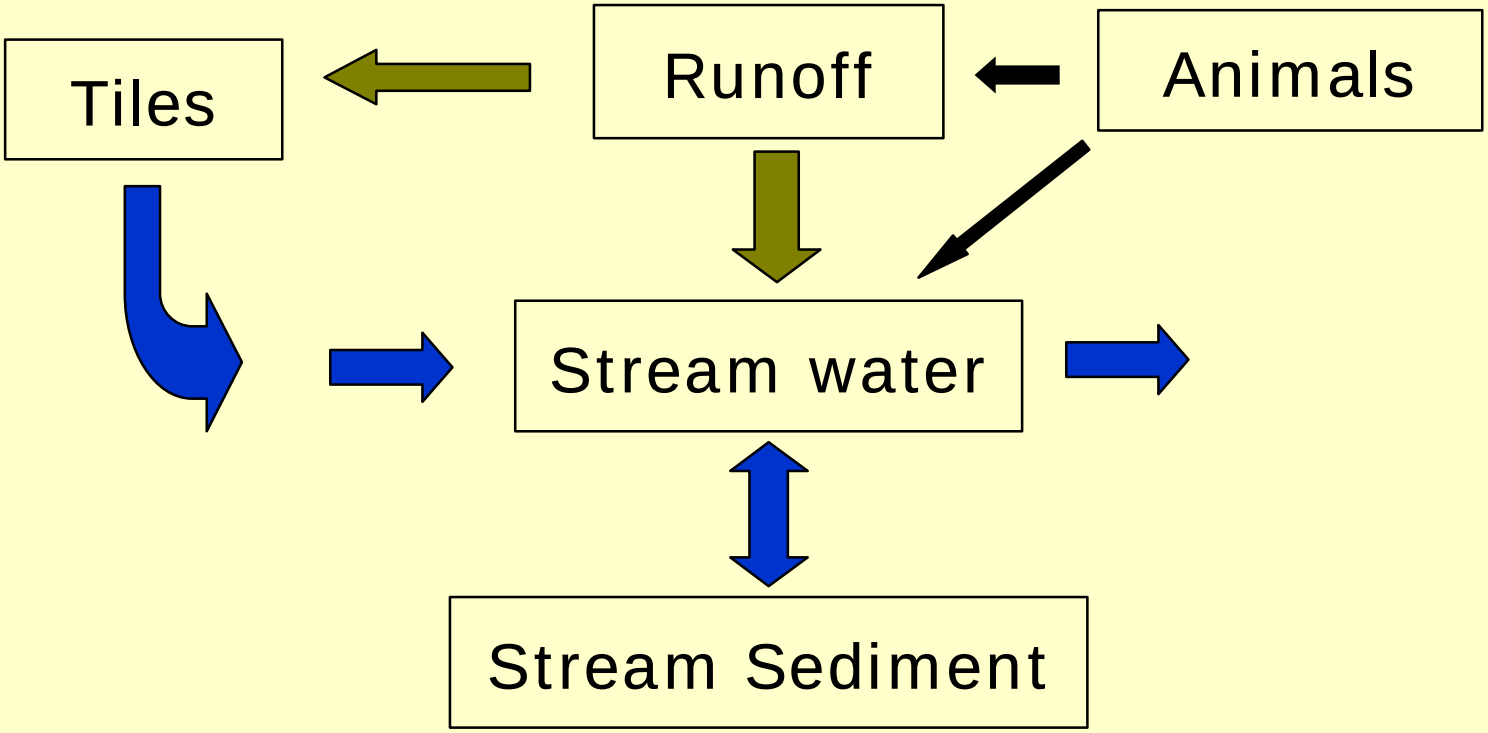
E. coli : Seasonal Variability




Survival in Stream Water
Survival (%)
100
80
60
40
20
0
0
20
40
60
80
100
Hours
Entero - aerated
E. coli - aerated
Entero - nonaerated
E. coli - nonaerated

Stream Sediments

Sampled Sept. 05



Targeting Source Tracking