Conservation Practices and Water Quality in Iowa's South Fork Watershed

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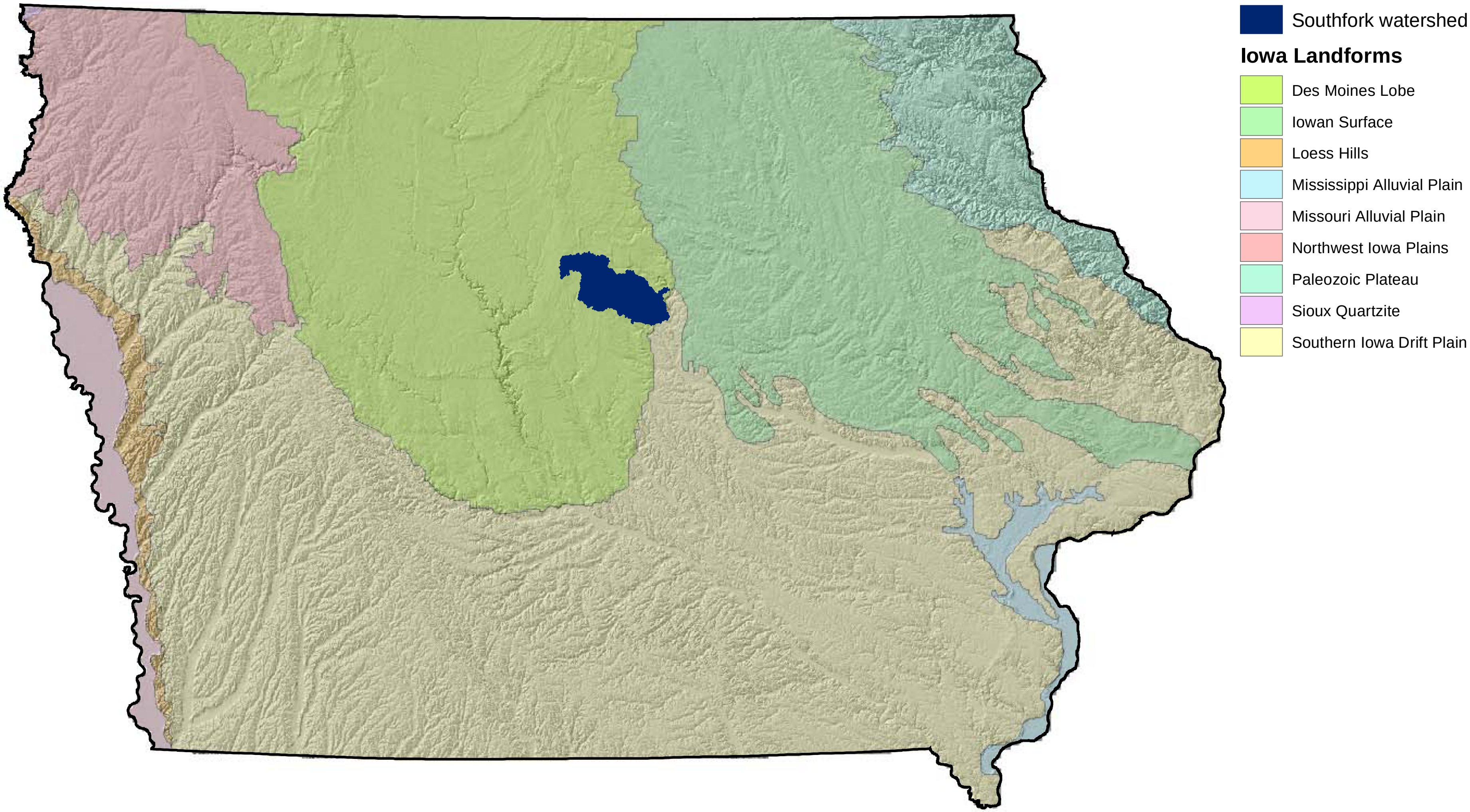
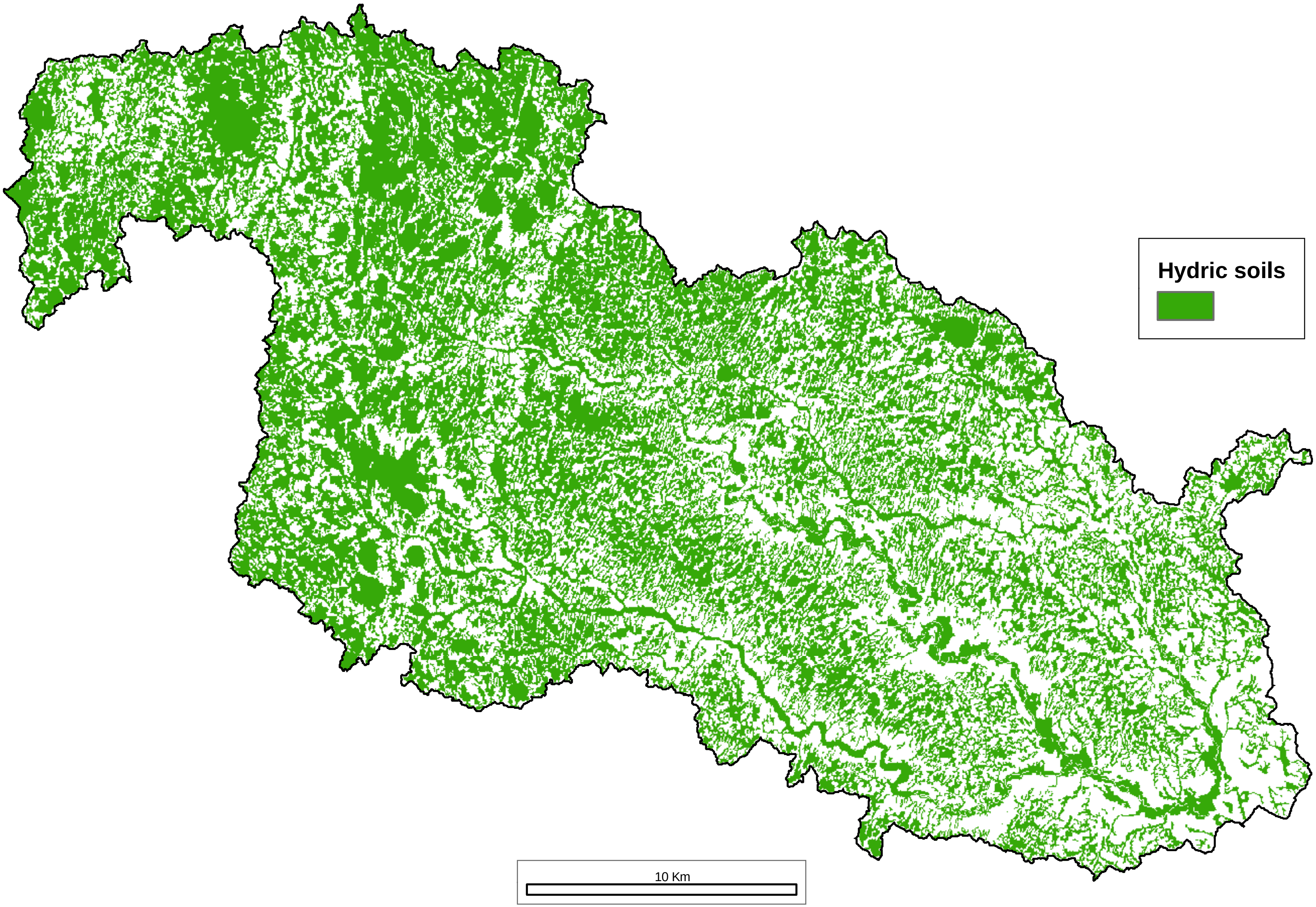
ARS CEAP Meeting, Ames IA, May 2006

National Soil Tilth Laboratory
Creating Agricultural Success

Outline

- Background: Setting and land use
- Hydrology and water quality
- Conservation practices inventory
- Implications for project planning

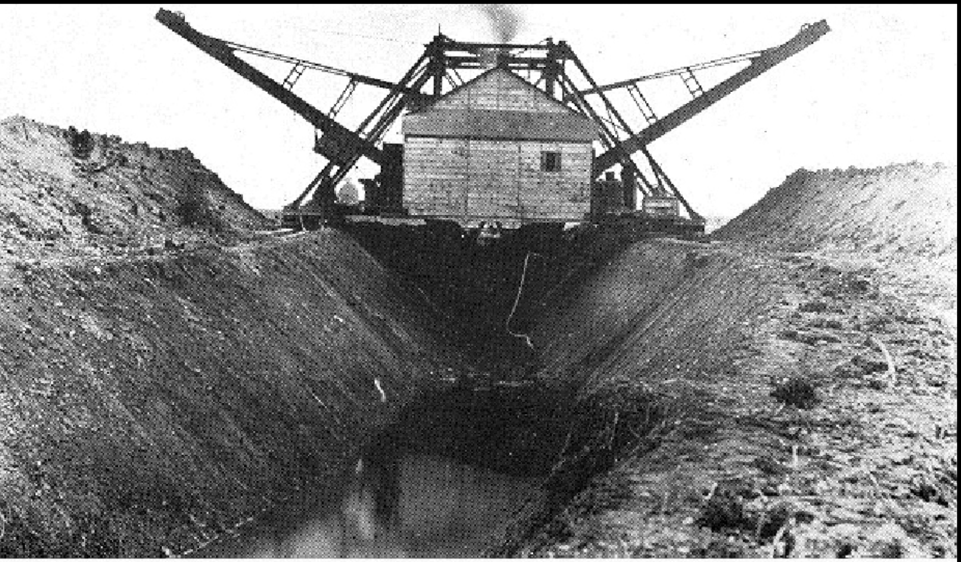

Southfork watershed
Iowa Landforms
Des Moines Lobe
Iowan Surface
Loess Hills
Mississippi Alluvial Plain
Missouri Alluvial Plain
Northwest Iowa Plains
Paleozoic Plateau
Sioux Quartzite
Southern Iowa Drift Plain



Hydric soils
10 Km

Drainage and agricultural development

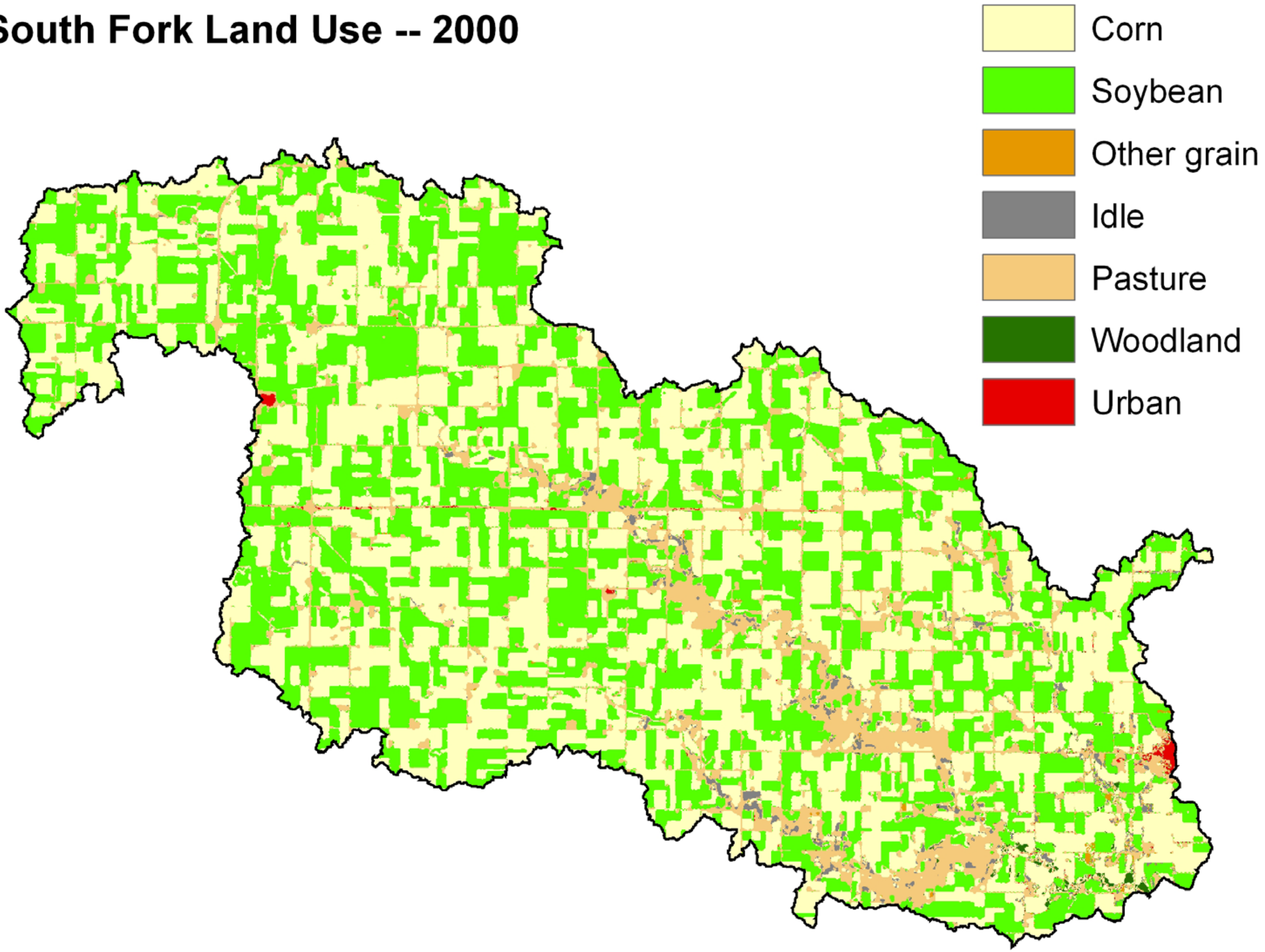
Subsurface drainage and ditching
established nearly 100 years ago



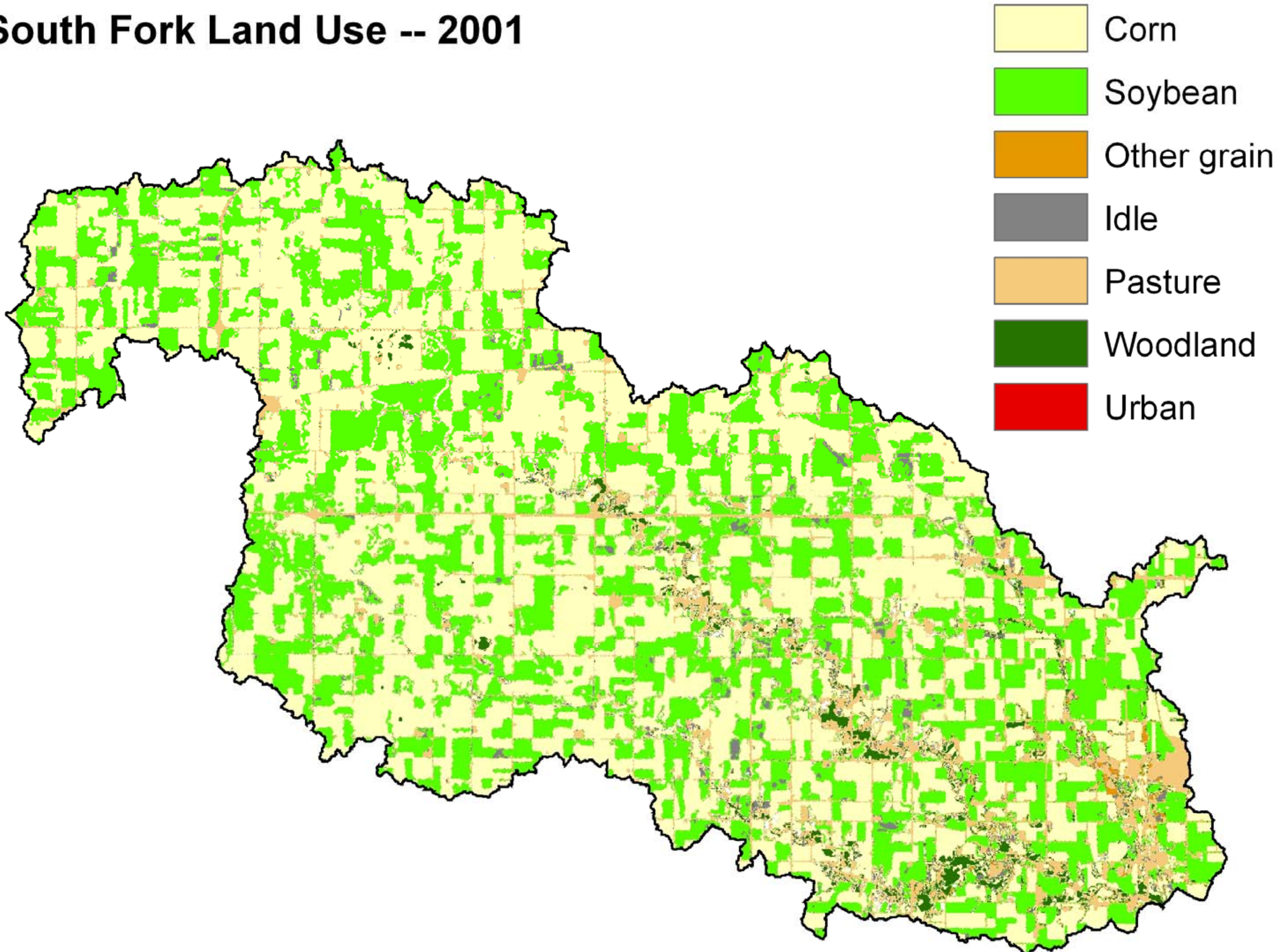
Excavating a large ditch using steam power, circa 1910.

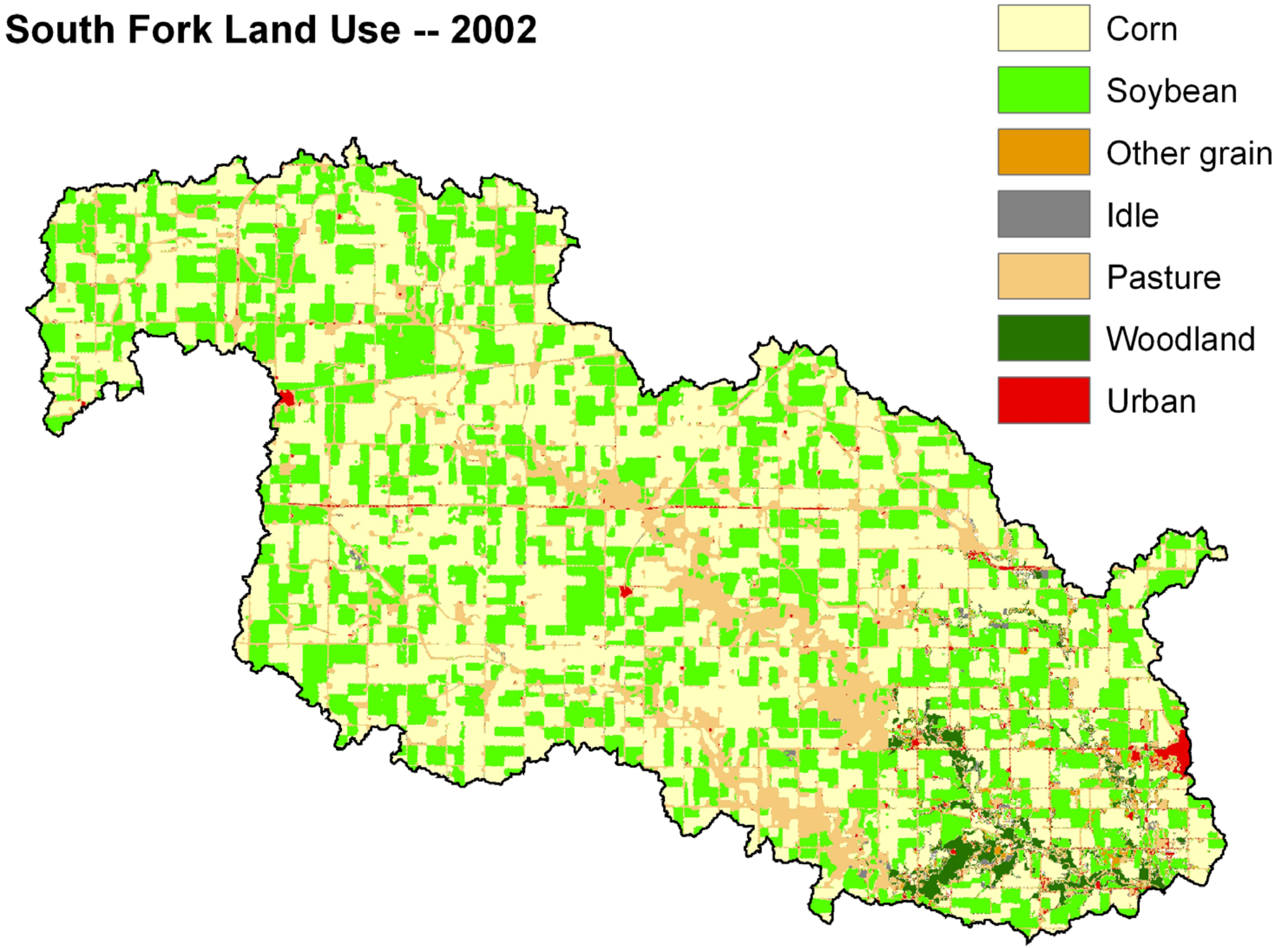
Hand digging tile, Boone Co. IA. ca 1914
Source: 'An Iowa album: a photographic history, 1860-1920' by M. J. Bennet, University of Iowa Press, Iowa City, Iowa

South Fork Land Use -- 2000

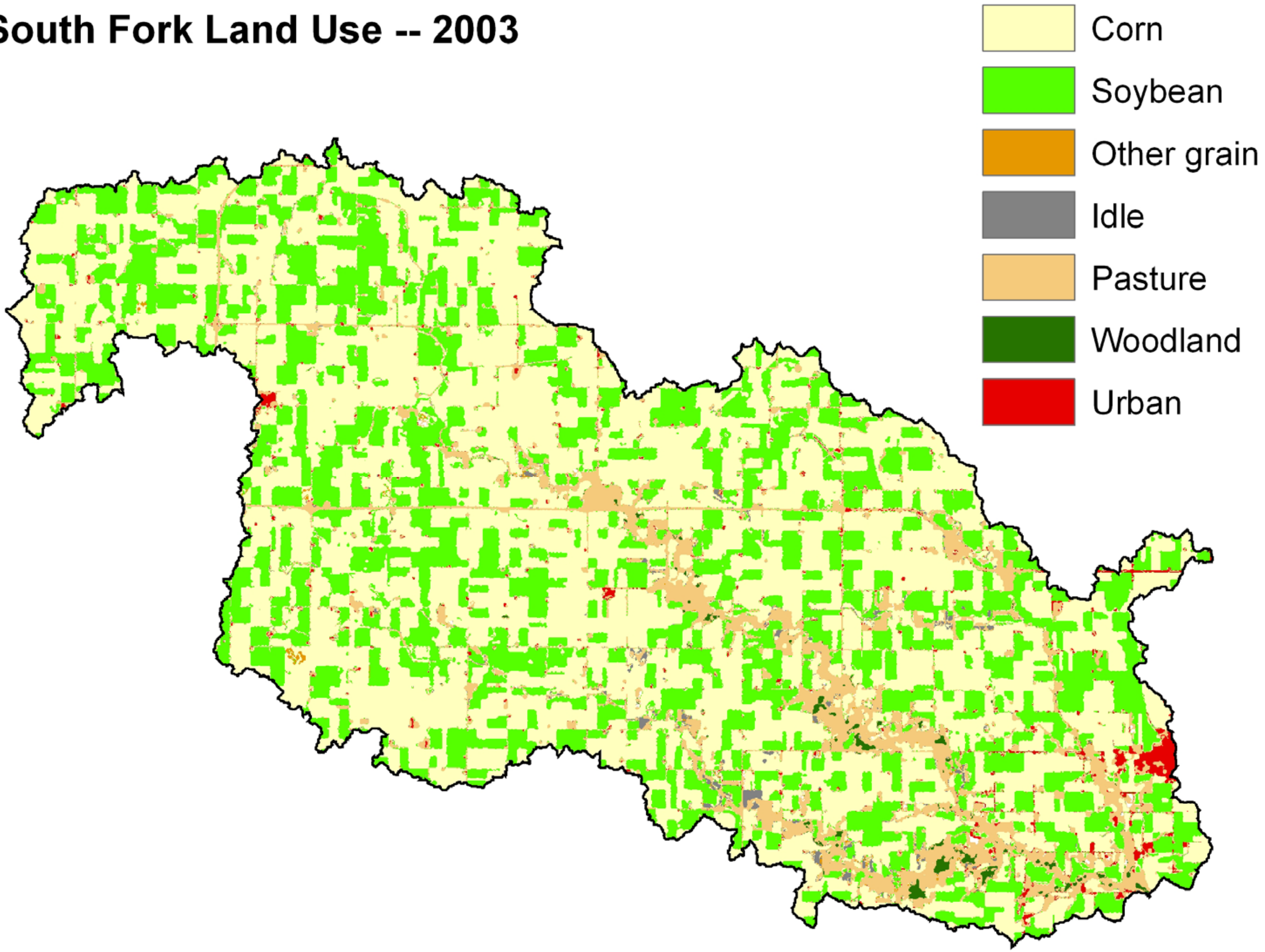


South Fork Land Use -- 2001

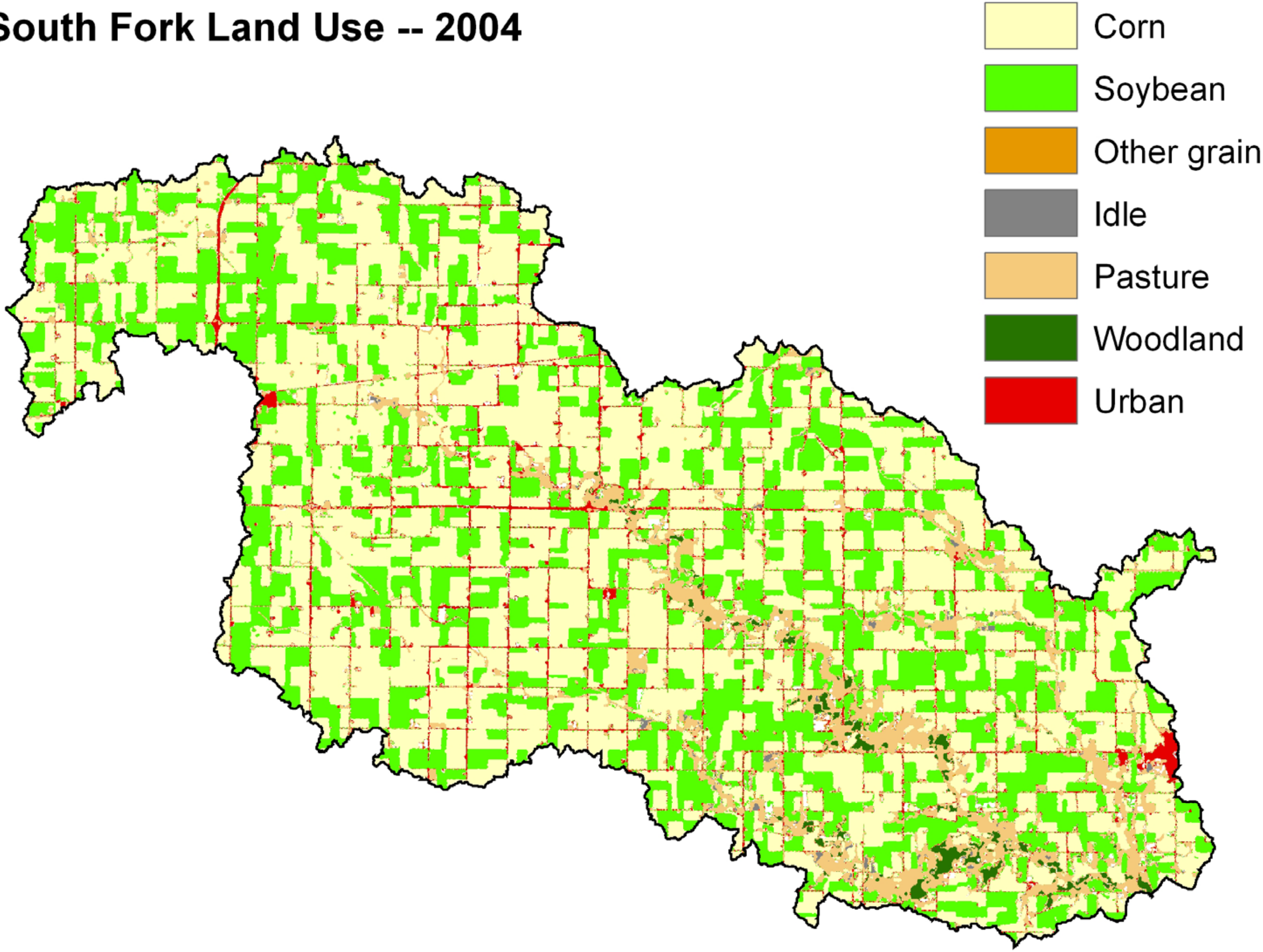



South Fork Land Use -- 2002
Corn
Soybean
Other grain
Idle
Pasture
Woodland
Urban

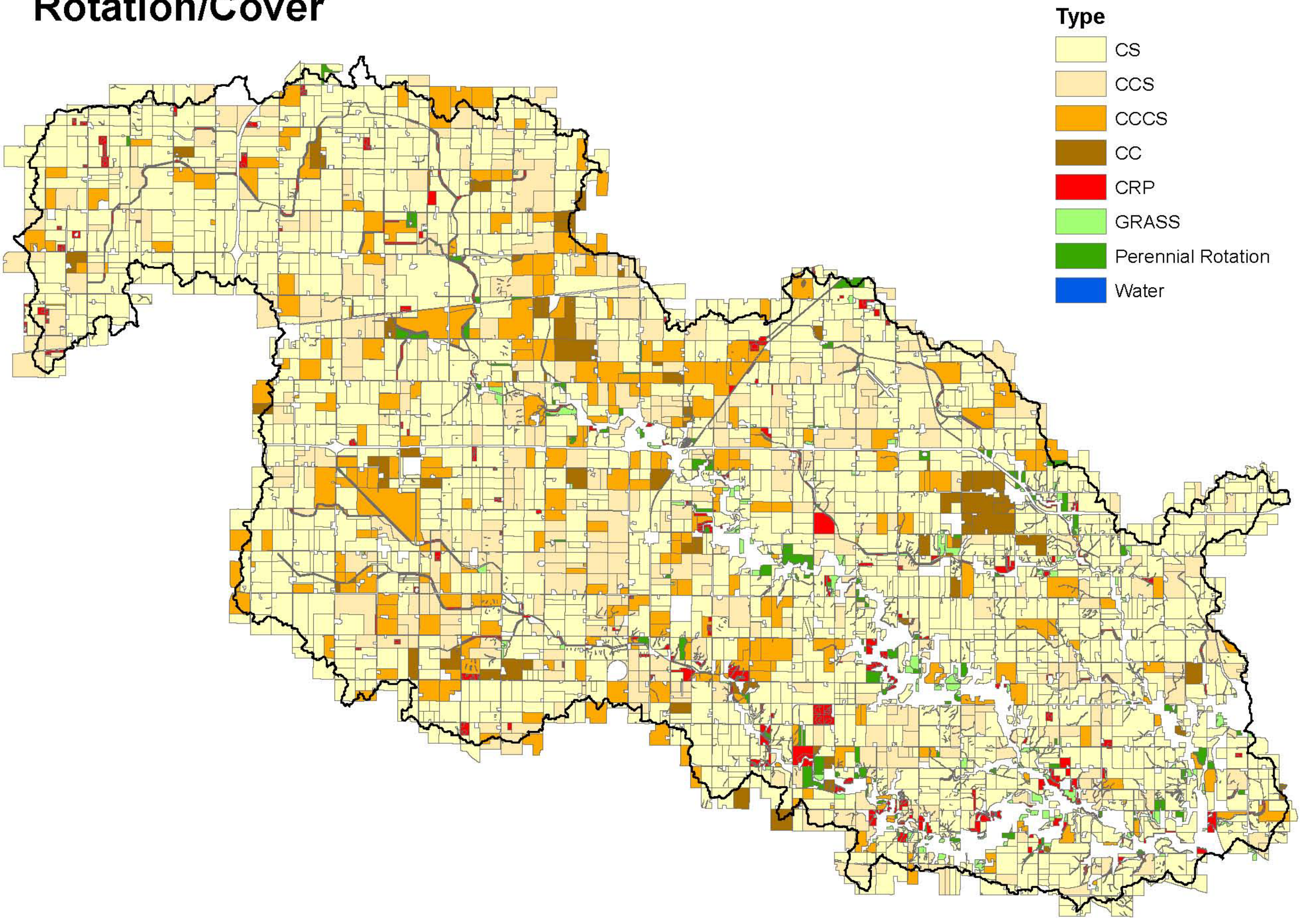
South Fork Land Use -- 2003

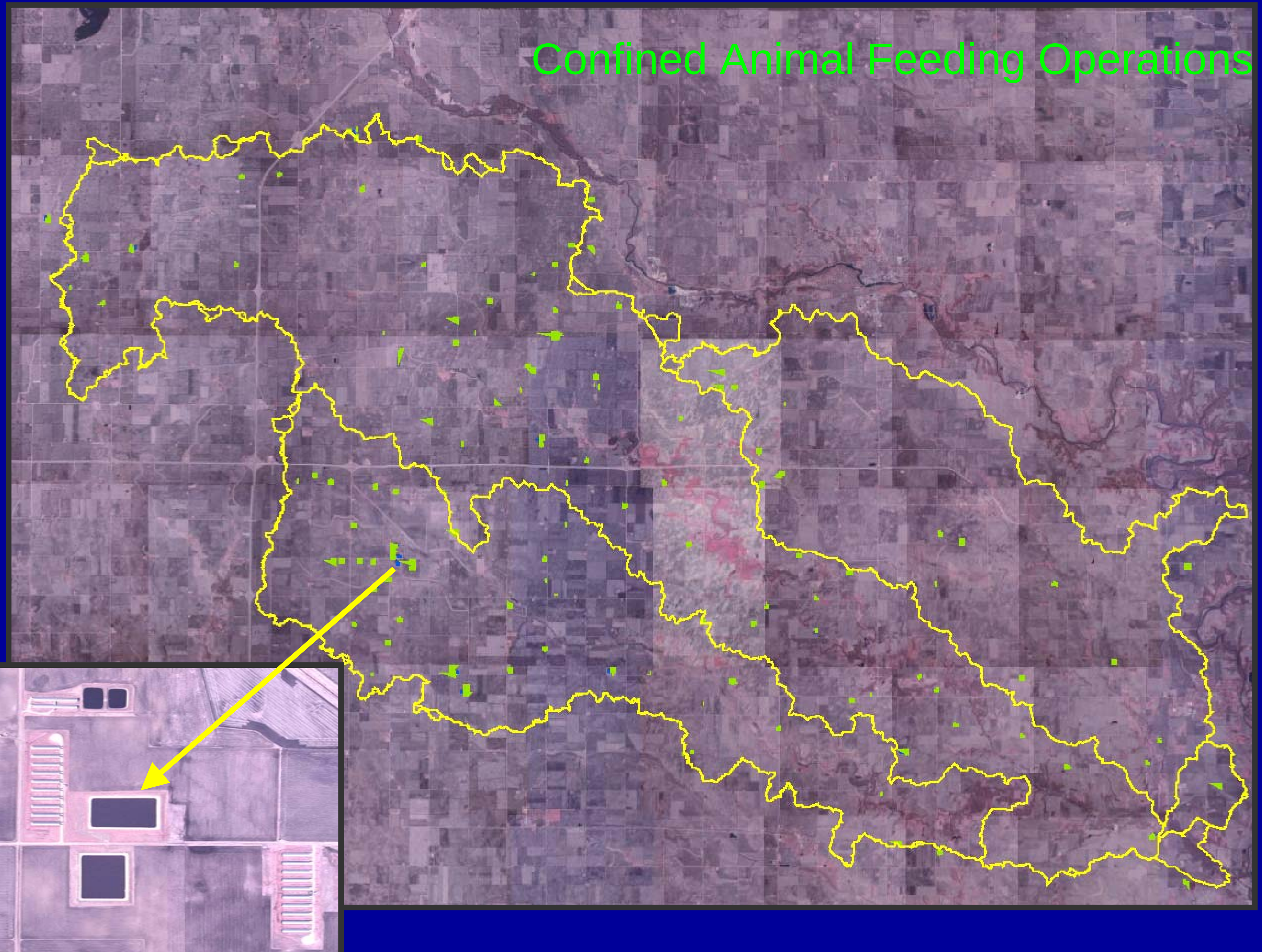


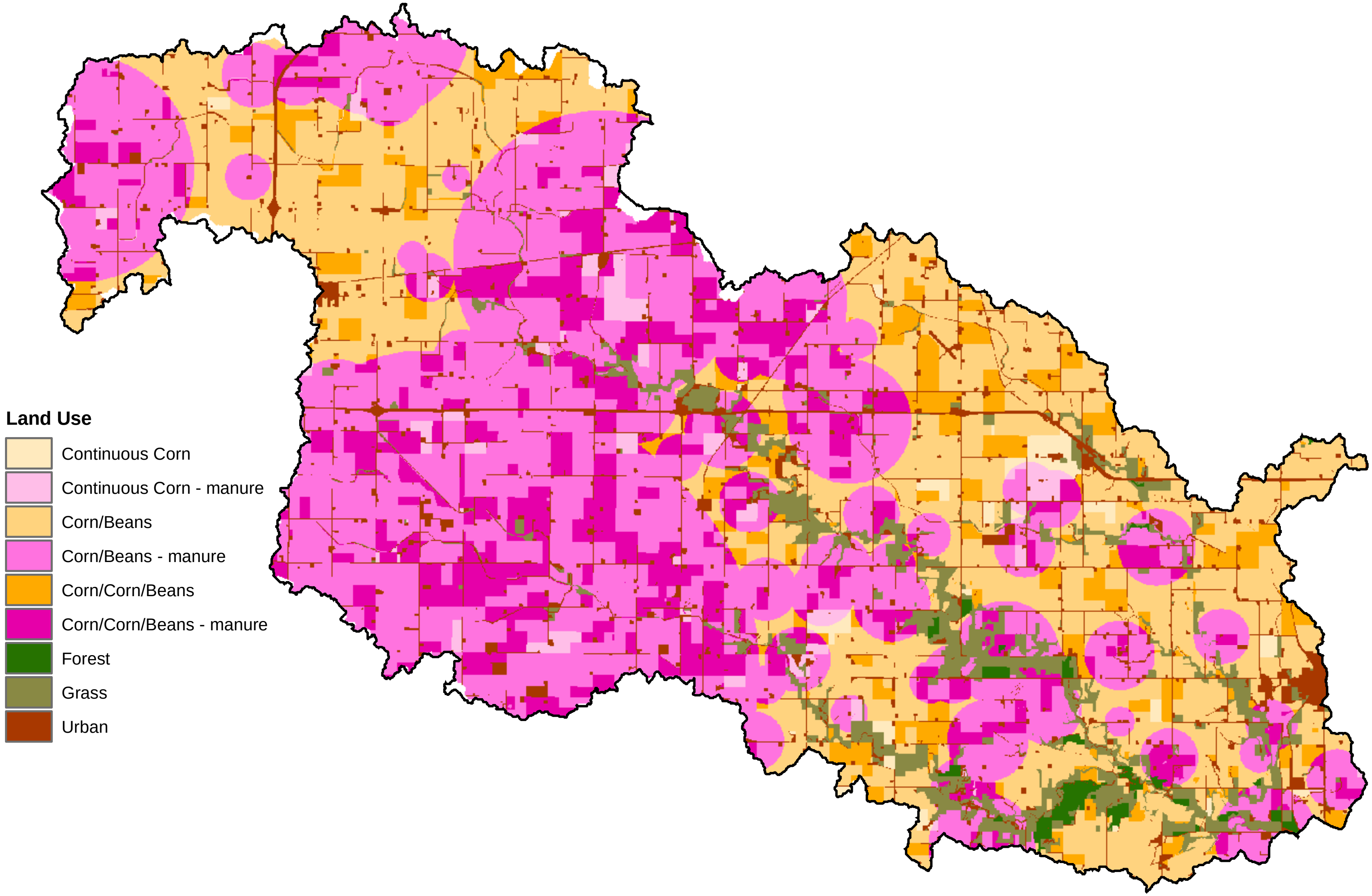
South Fork Land Use -- 2004



Rotation/Cover

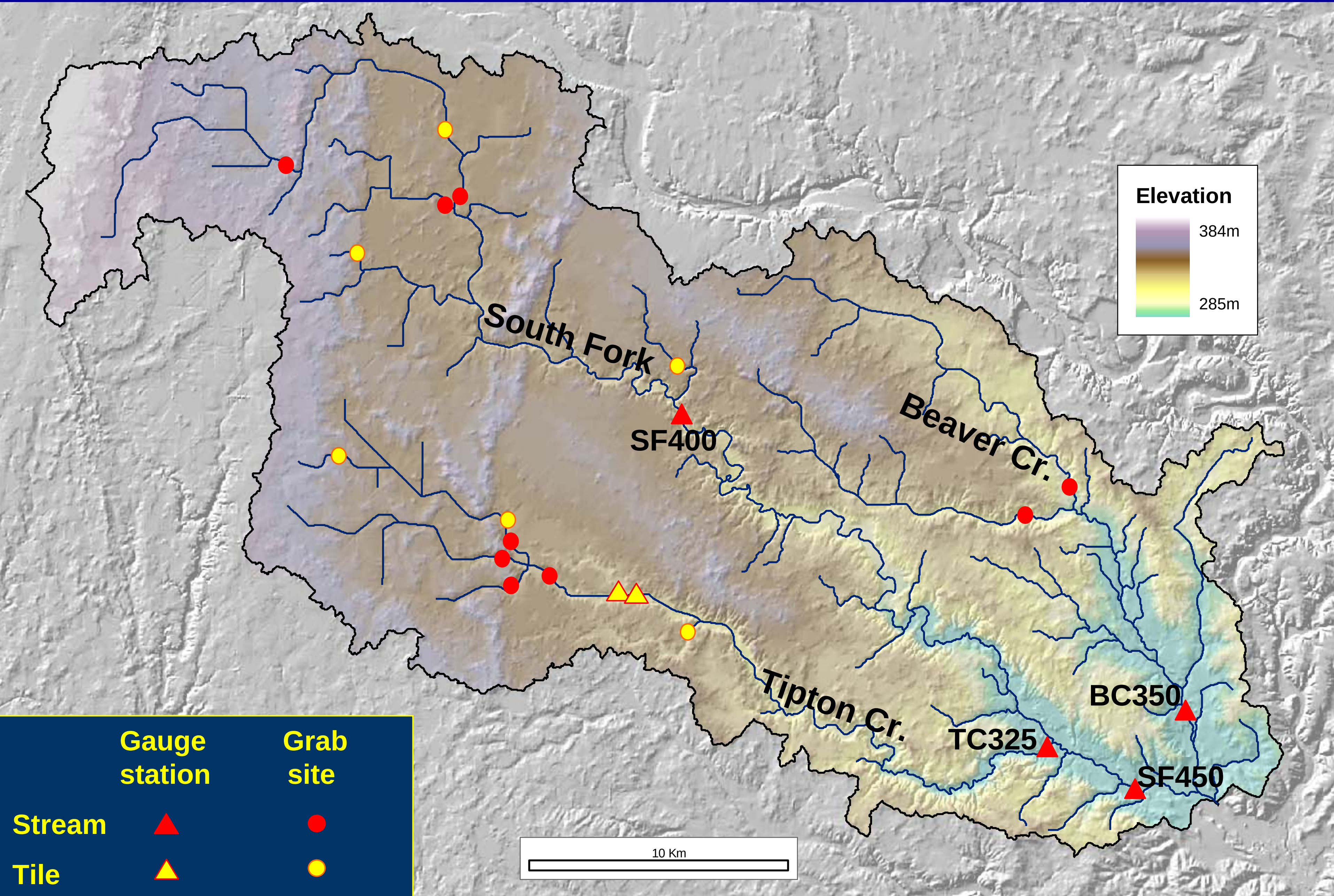



Confined Animal Feeding Operations

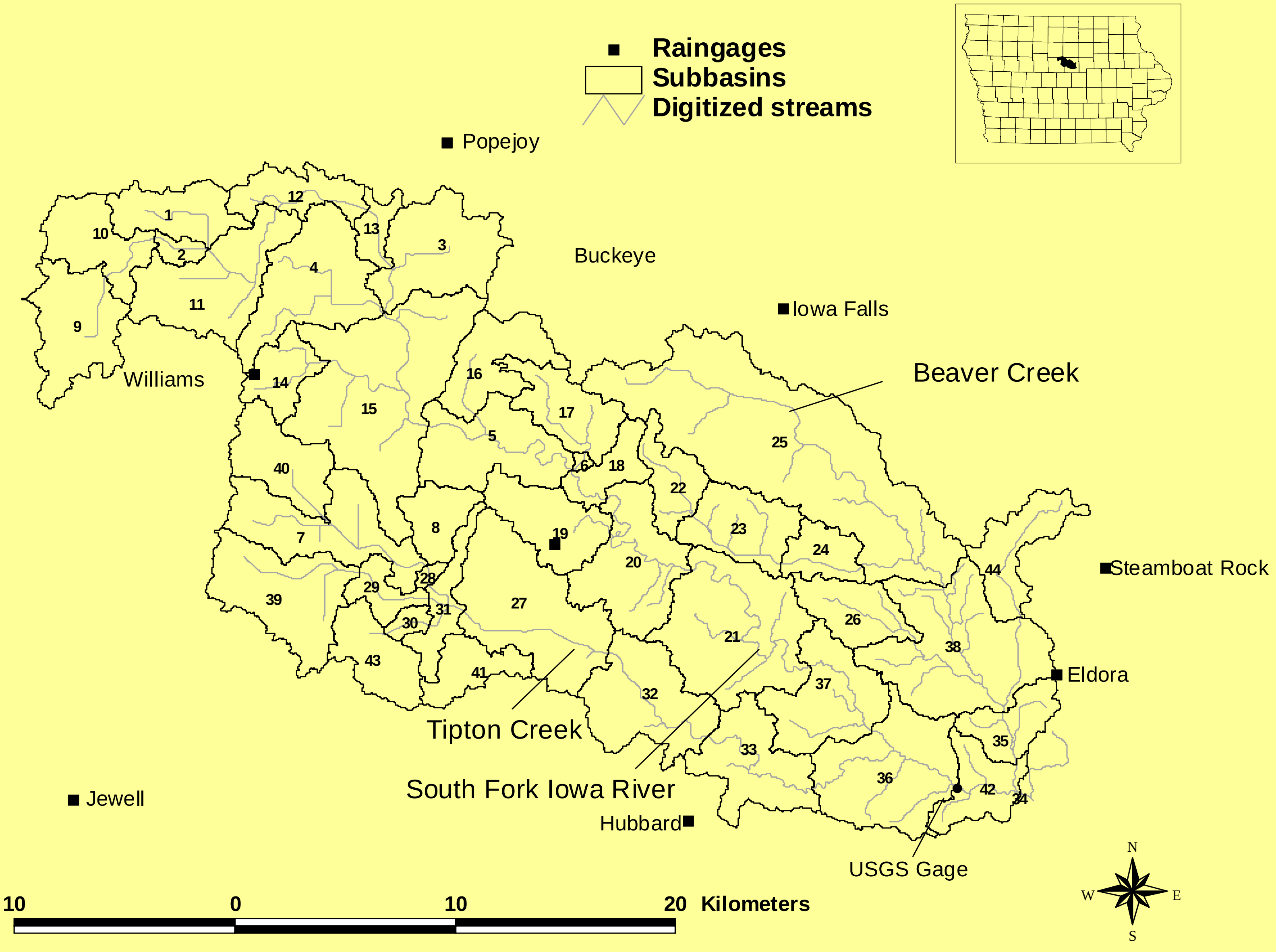

Land Use
Continuous Corn
Continuous Corn - manure
Corn/Beans
Corn/Beans - manure
Corn/Corn/Beans
Corn/Corn/Beans - manure
Forest
Grass
Urban

Discharge and Water Quality Monitoring

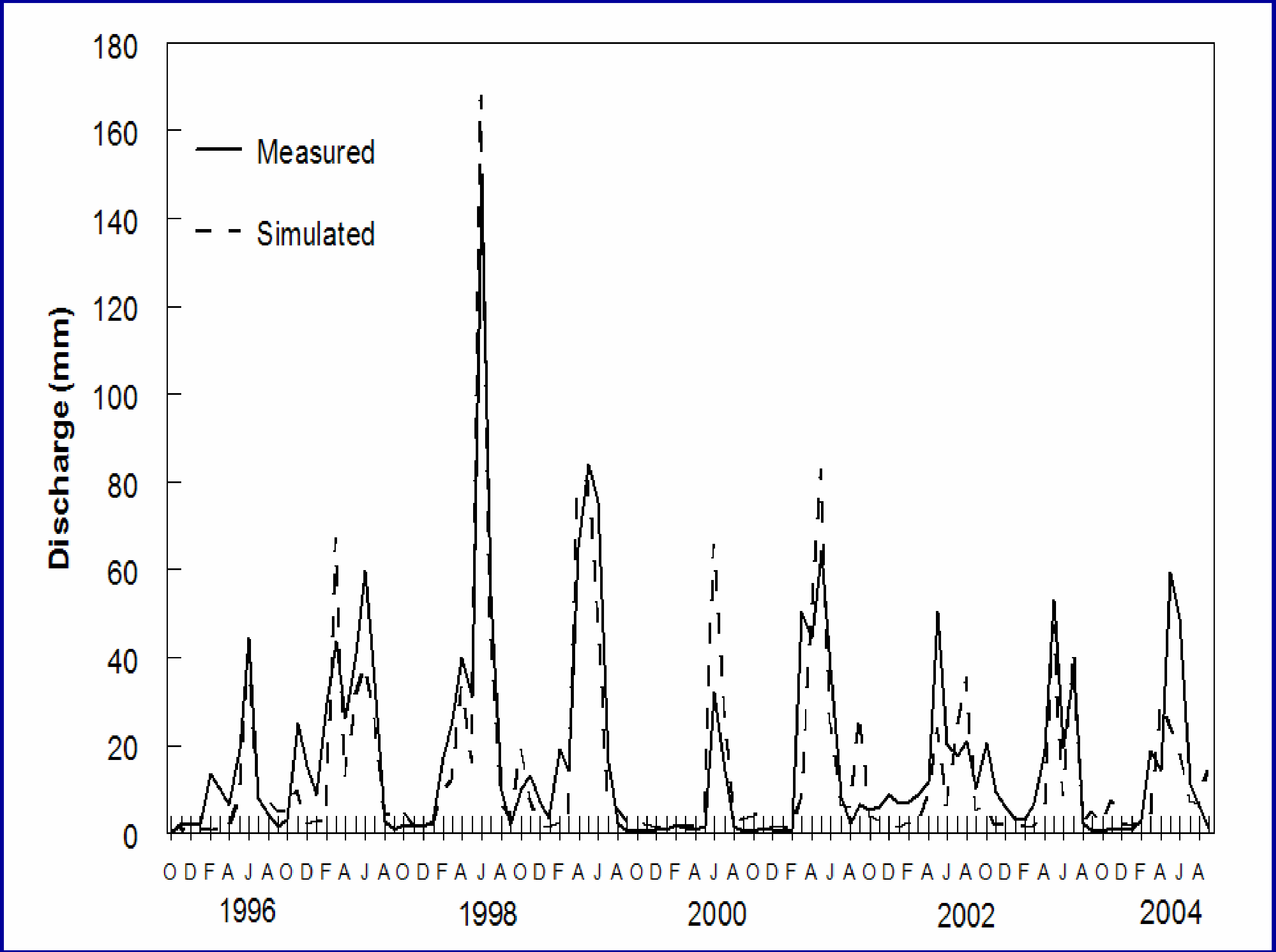
South Fork Watershed: Monitoring Sites



Sub-basin delineation for SWAT



Observed and SWAT-simulated monthly discharge at SF450 from October 1995 through September 2004.



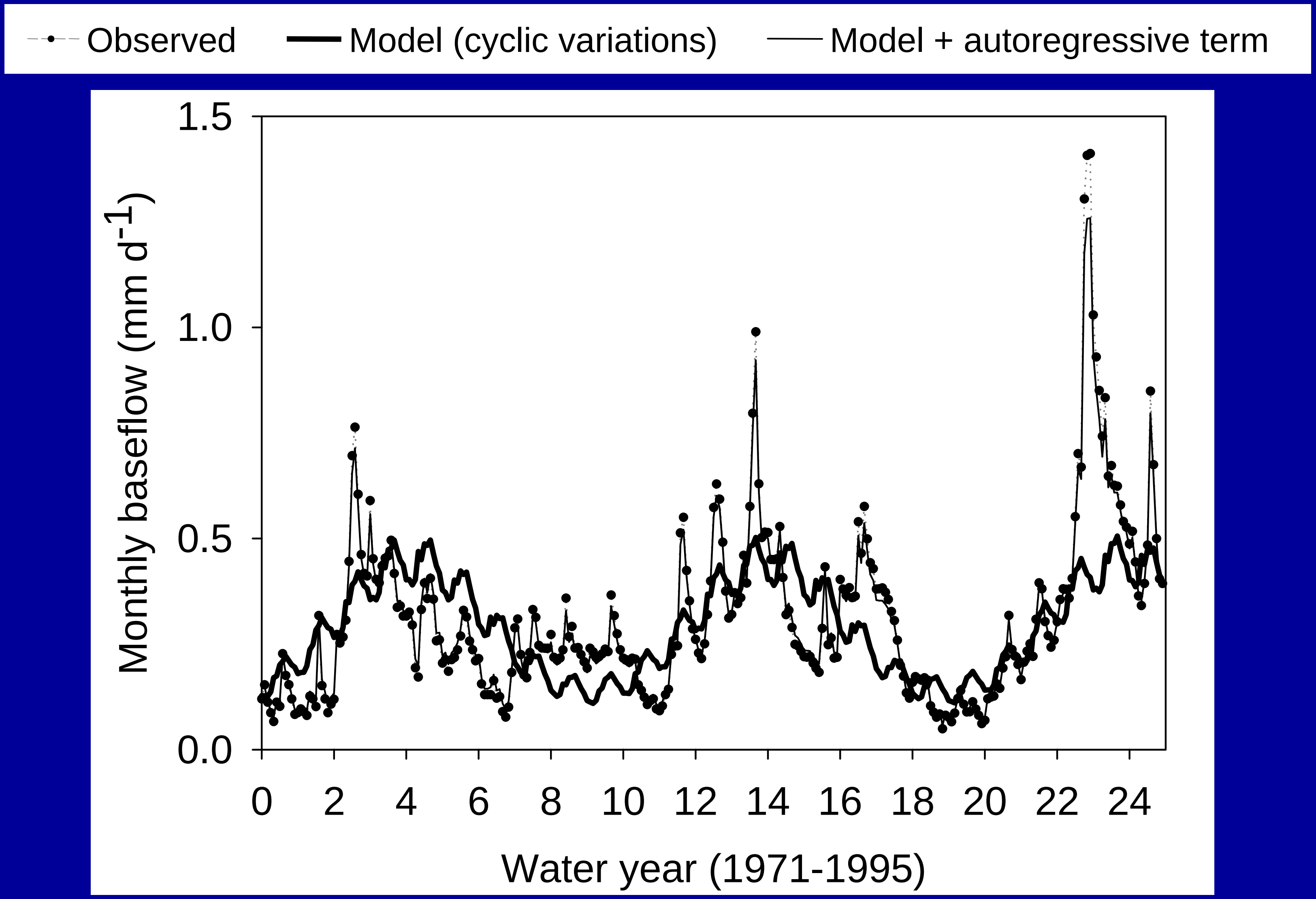
Predicted hydrologic budget for calibration and validation periods: 1995 through 2004.

Hydrologic Component	Calibration (mm) 1995-2000	Validation (mm) 2001-2004
Precipitation	770.0	748.4
Surface runoff	38.0	37.5
Lateral flow	6.7	6.0
Tile flow	**151.2**	**110.9**
Groundwater flow	10.3	9.4
Evapotranspiration	550.2	585.5
Potential ET	1150.4	1261.4

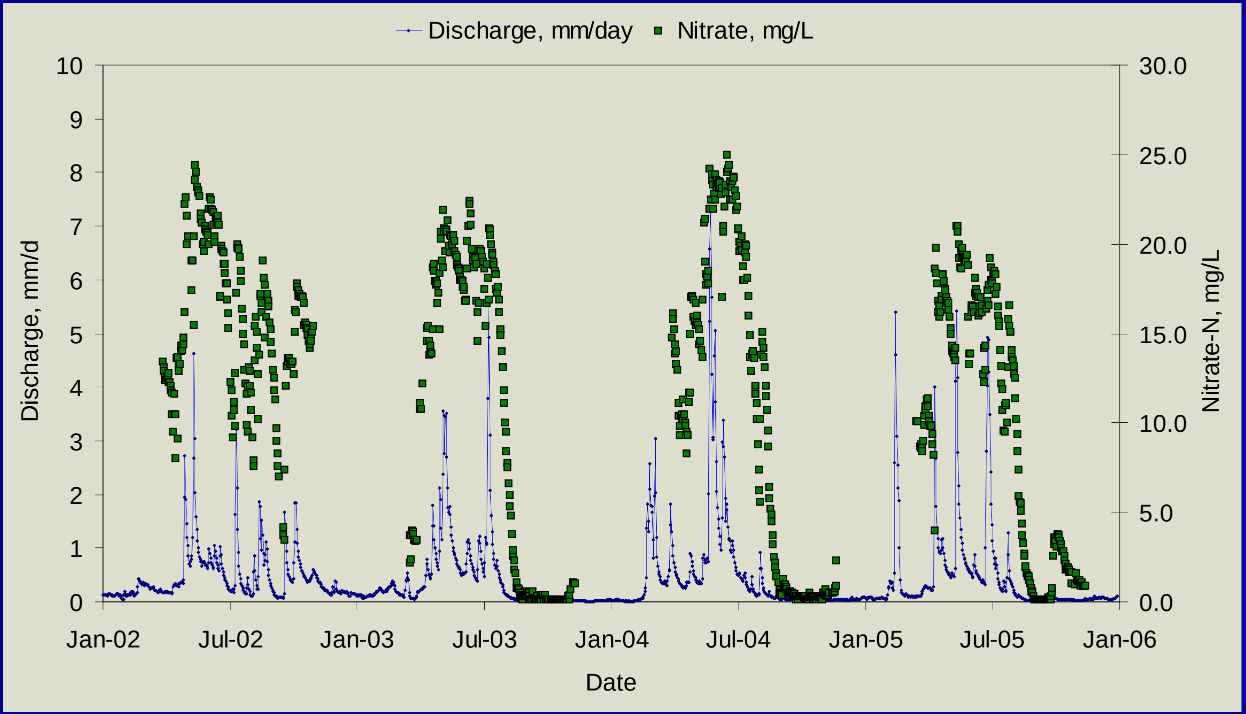
Annual, monthly and daily streamflow calibration and validation statistics of the measured and simulated data at SF450

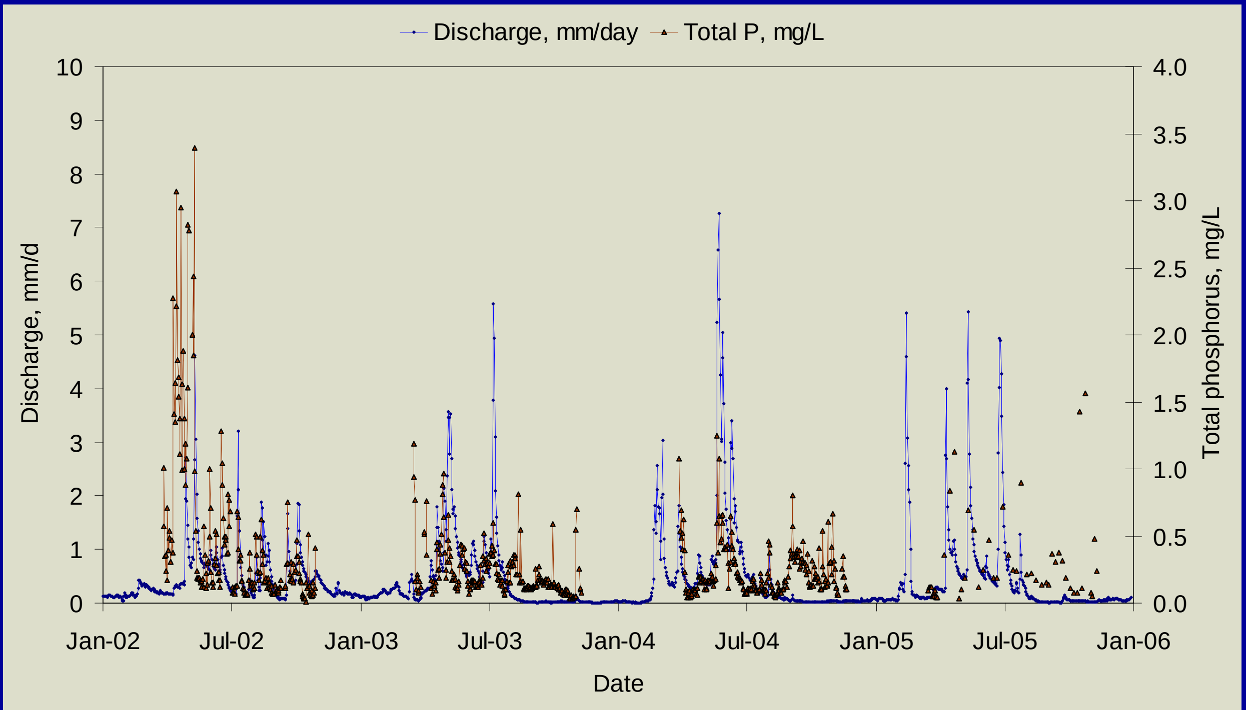
	Measured	Simulated	Measured	Simulated
	Annual (mm)		Monthly (mm)	
Calibration	1995-1998			
Mean	250	210	20.6	16.7
SD	100	120	27.8	28.1
r^2	1.0		0.9	
E_{NS}	0.7		0.9	
Validation	1999-2004			
Mean	180	200	13.9	13.4
SD	80	70	17.3	19.0
r^2	0.7		0.6	
E_{NS}	0.6		0.5	

Autoregressive modeling of hydrologic time series data: A potential model validation tool?

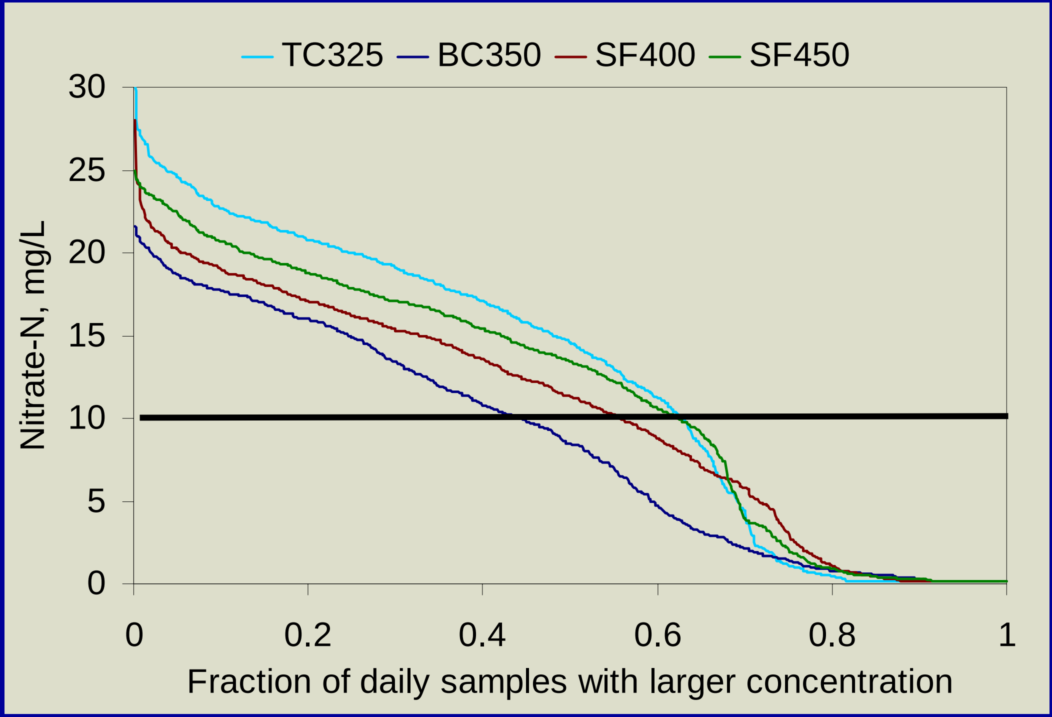


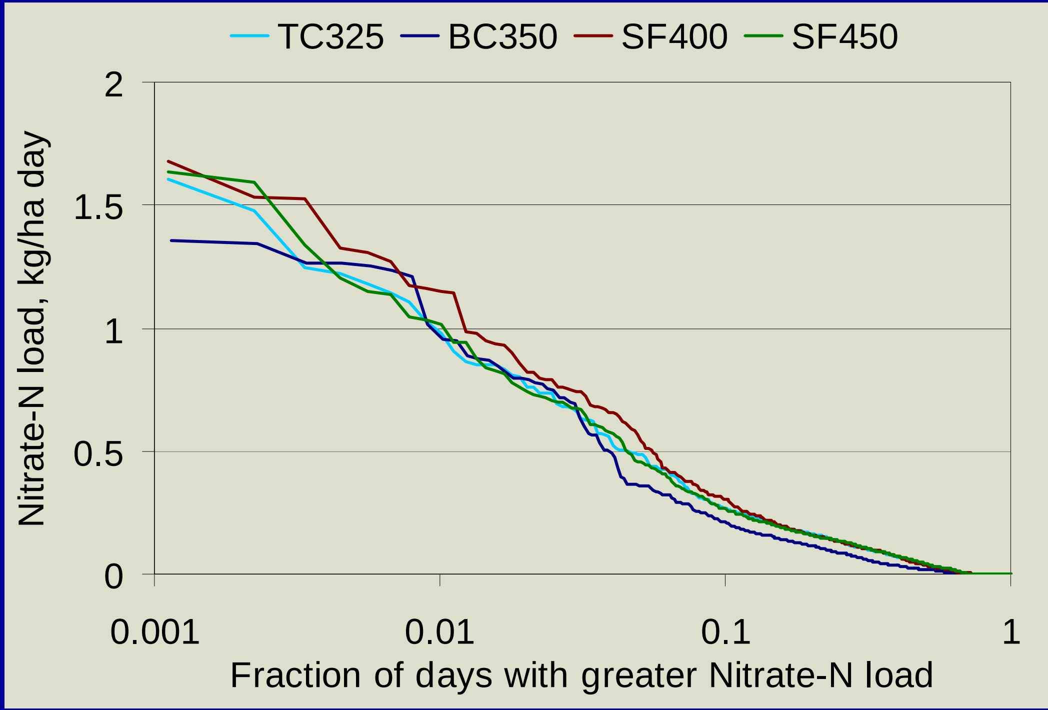
SF450


Discharge, mm/day
Nitrate, mg/L
Discharge, mm/d
Nitrate-N, mg/L
0
1
2
3
4
5
6
7
8
9
10
0.0
5.0
10.0
15.0
20.0
25.0
30.0
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05
Jul-05
Jan-06
Date

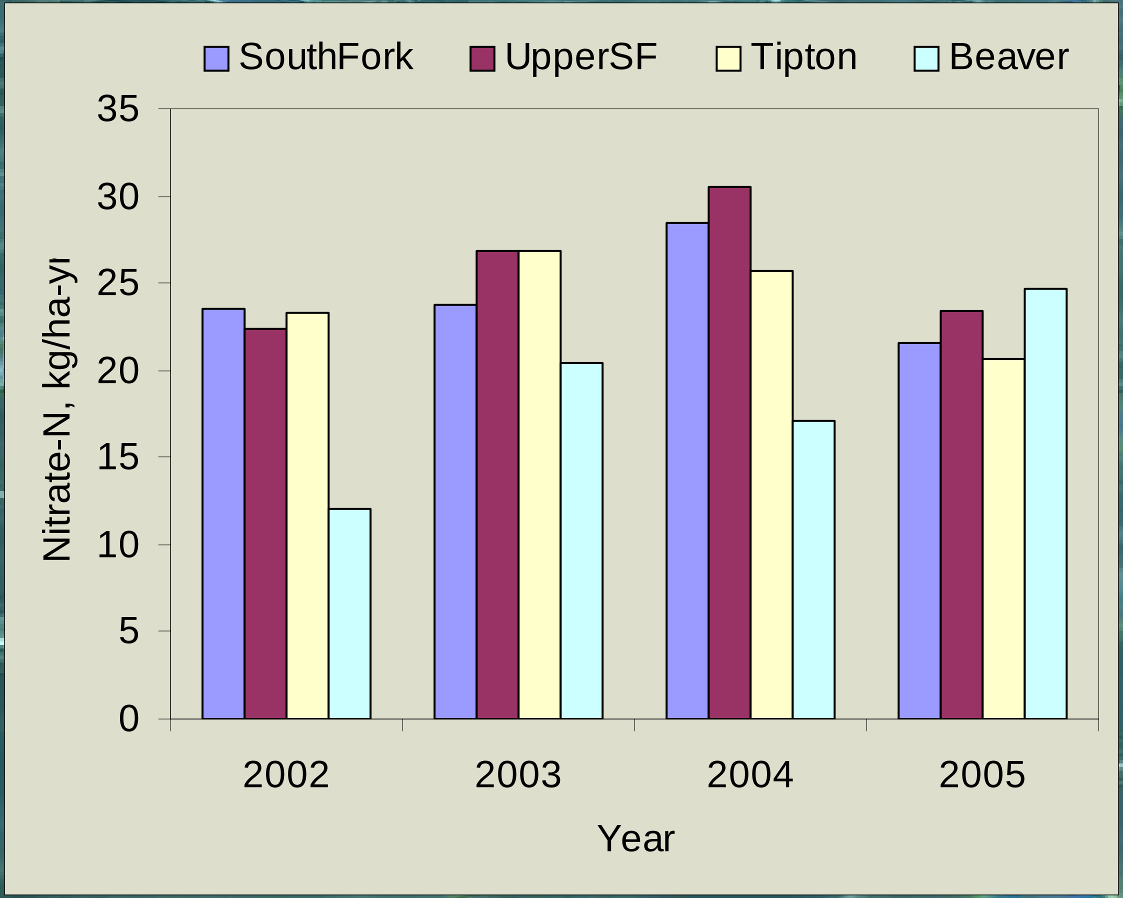

Discharge, mm/day
Total P, mg/L
Discharge, mm/d
Total phosphorus, mg/L
0
1
2
3
4
5
6
7
8
9
10
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05
Jul-05
Jan-06
Date

Water quality results: NO_3-N Frequency distributions for concentration and load (2002-2005)





Annual NO_3-N losses in stream flow, 2002-2005



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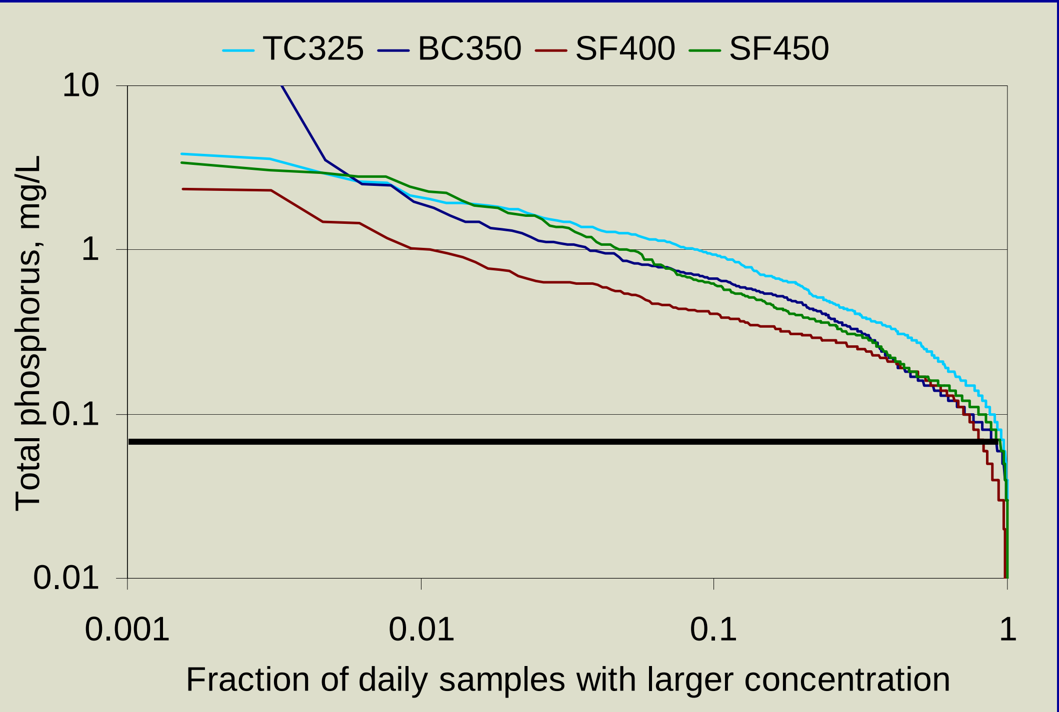
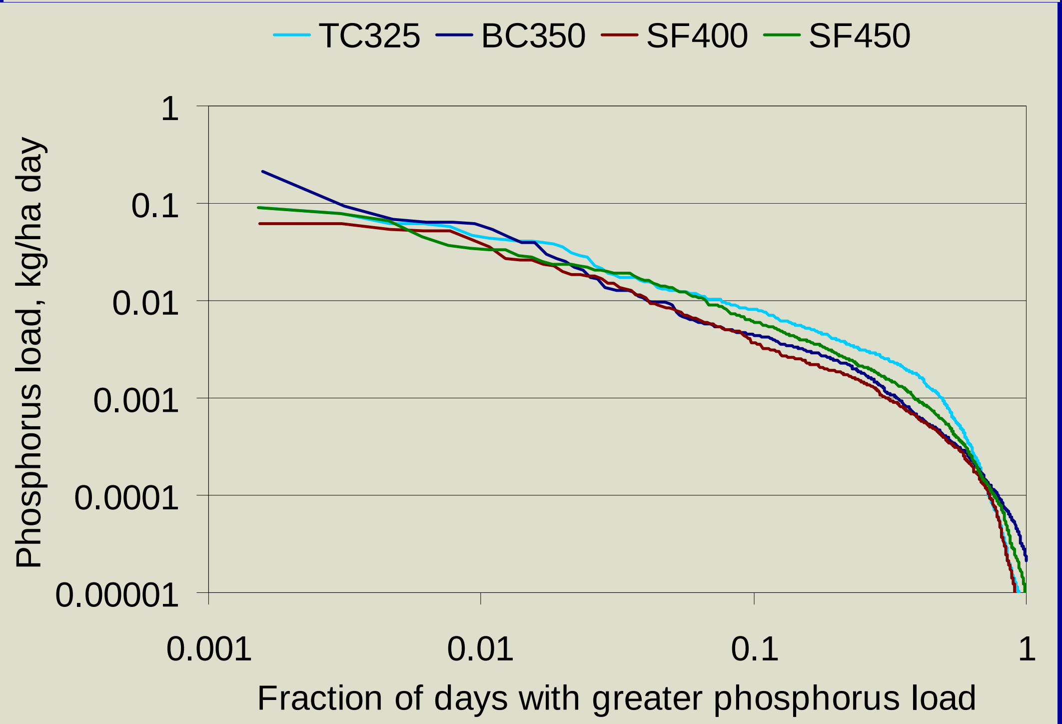
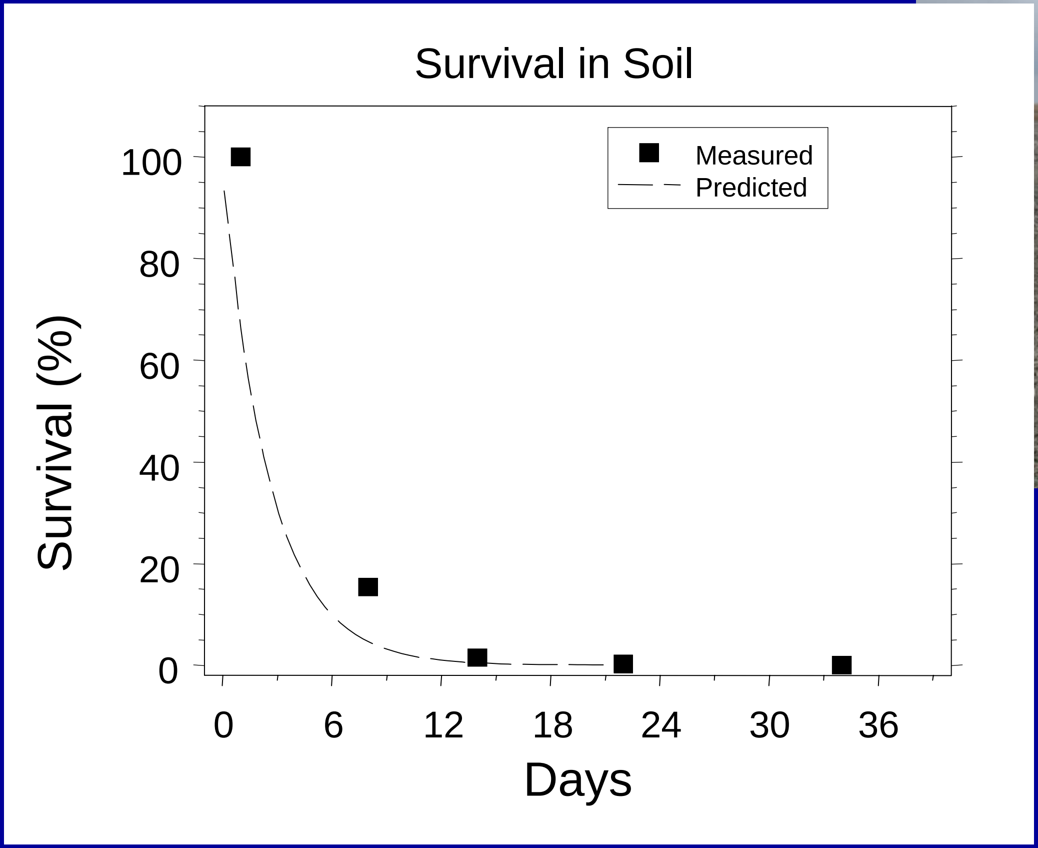
Water quality results: Total P concentration and load





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

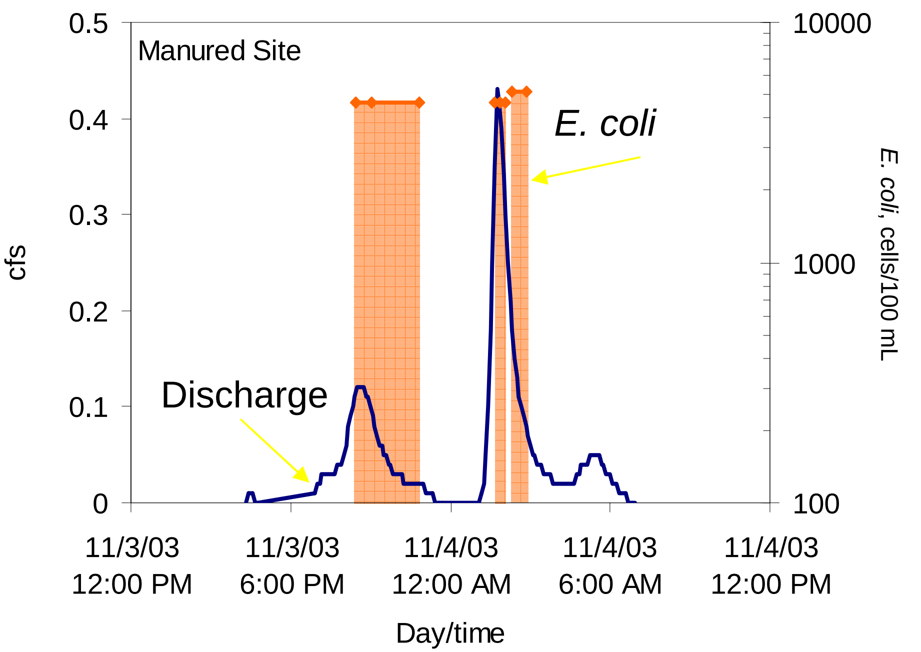
E. coli survival in soil after swine manure application November, 2003

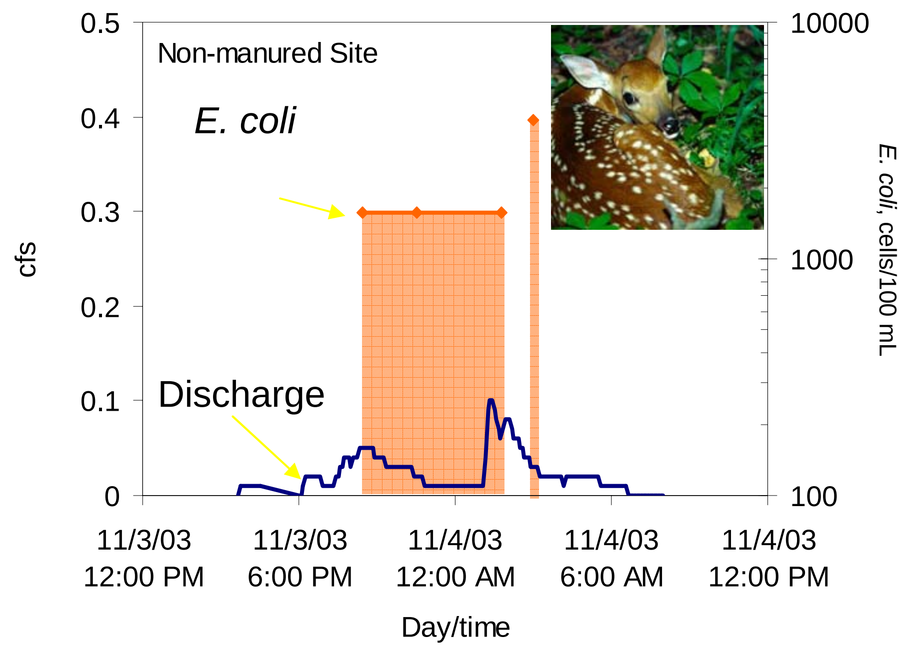


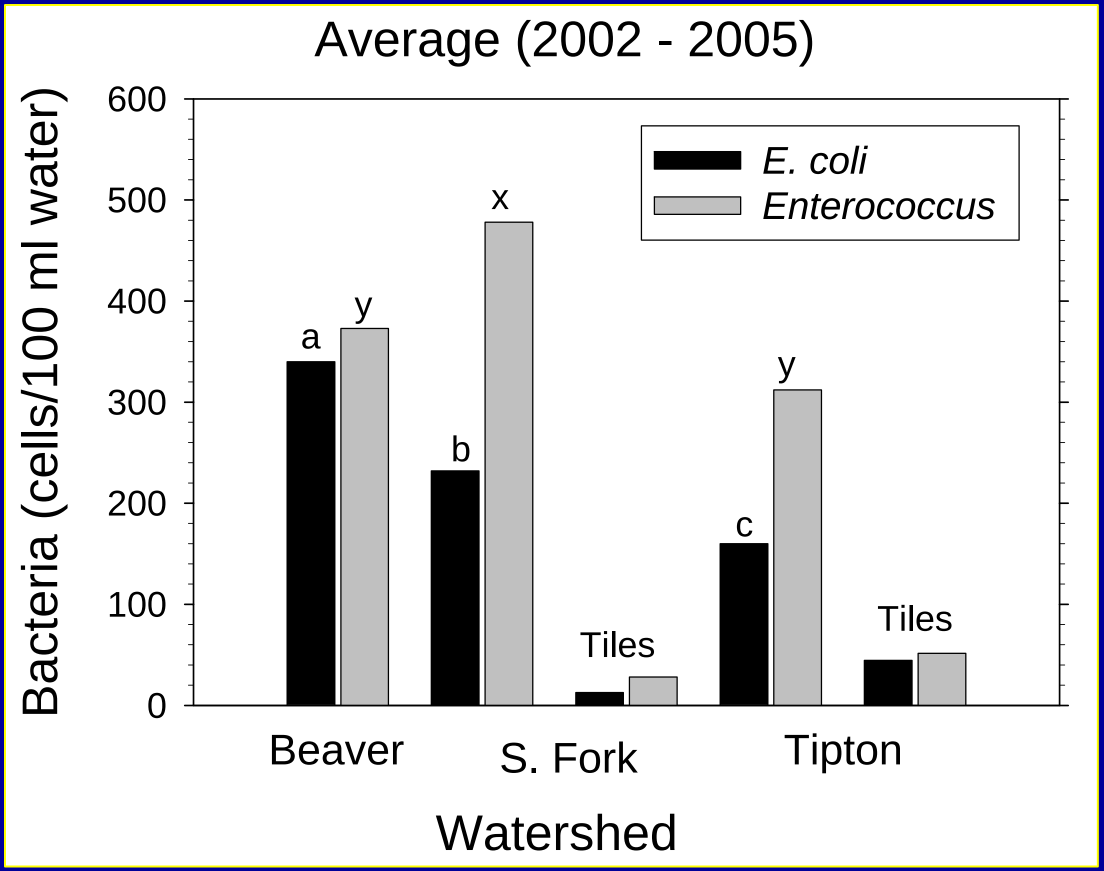
Runoff Event – Field Scale

November 2003, 6 days after swine manure application

Two sites: manured and non-manured

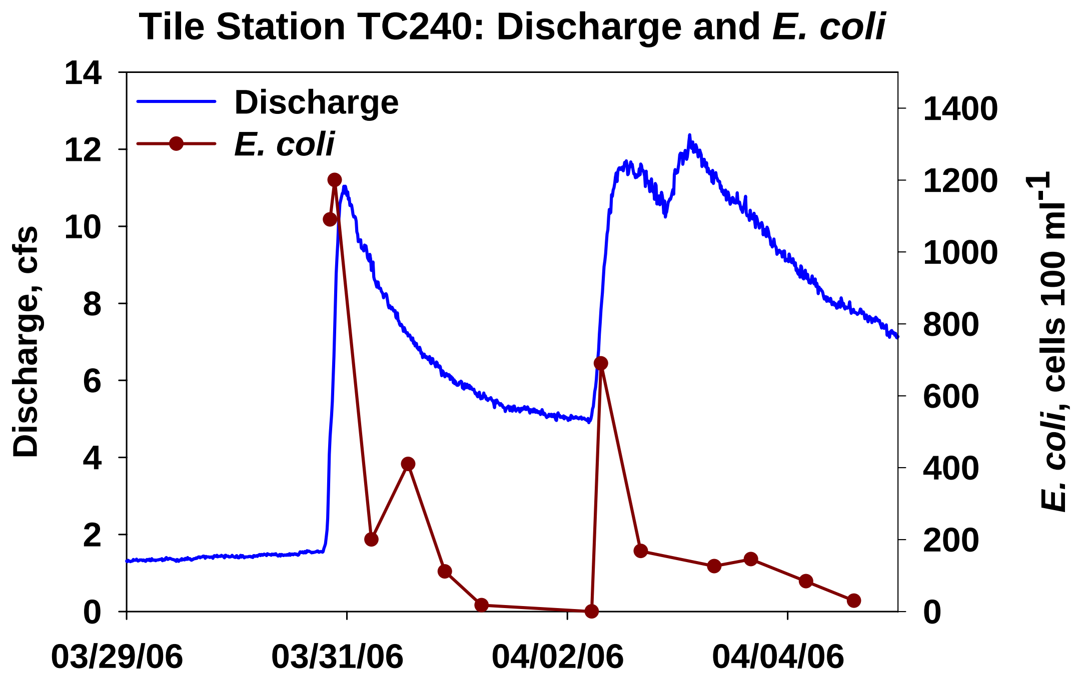


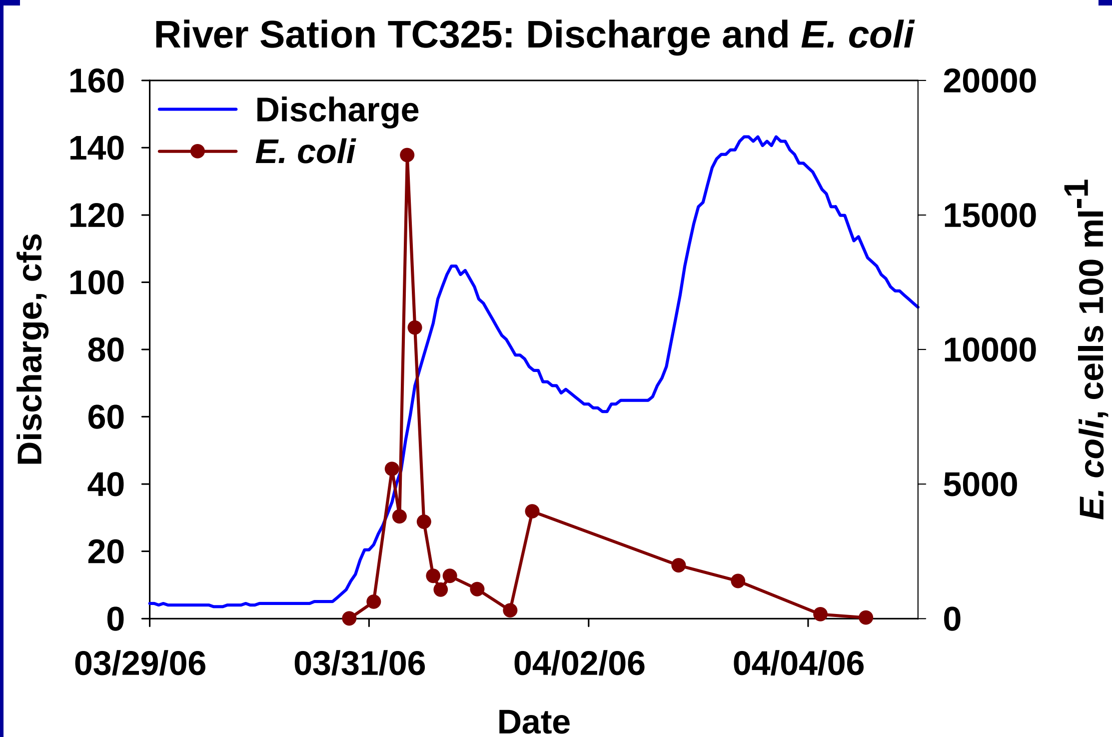




Average (2002 - 2005)
Bacteria (cells/100 ml water)
600
500
400
300
200
100
0
E. coli
Enterococcus
a
y
b
x
Tiles
c
y
Tiles
Beaver
S. Fork
Tipton
Watershed

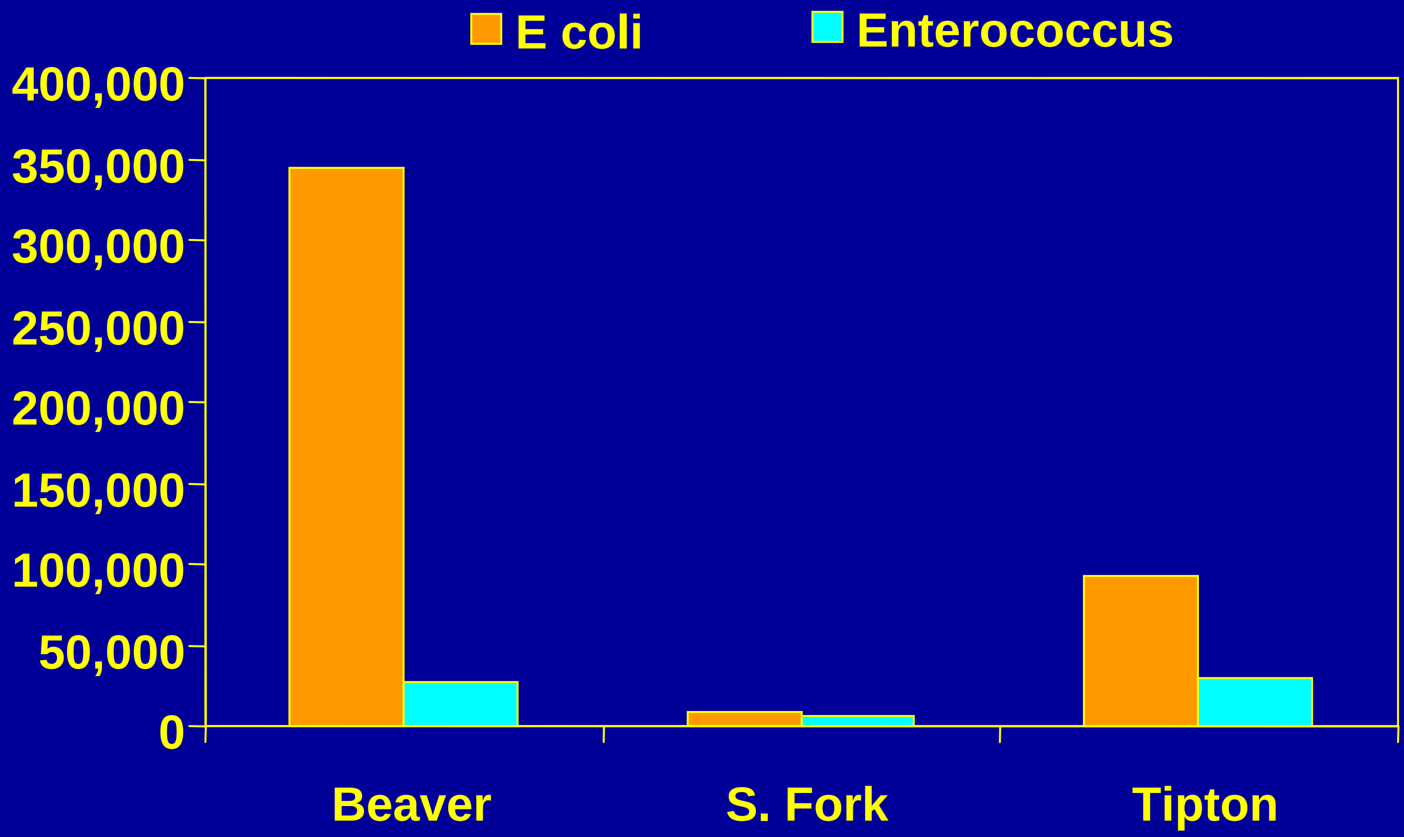
Timing of E. coli during an event



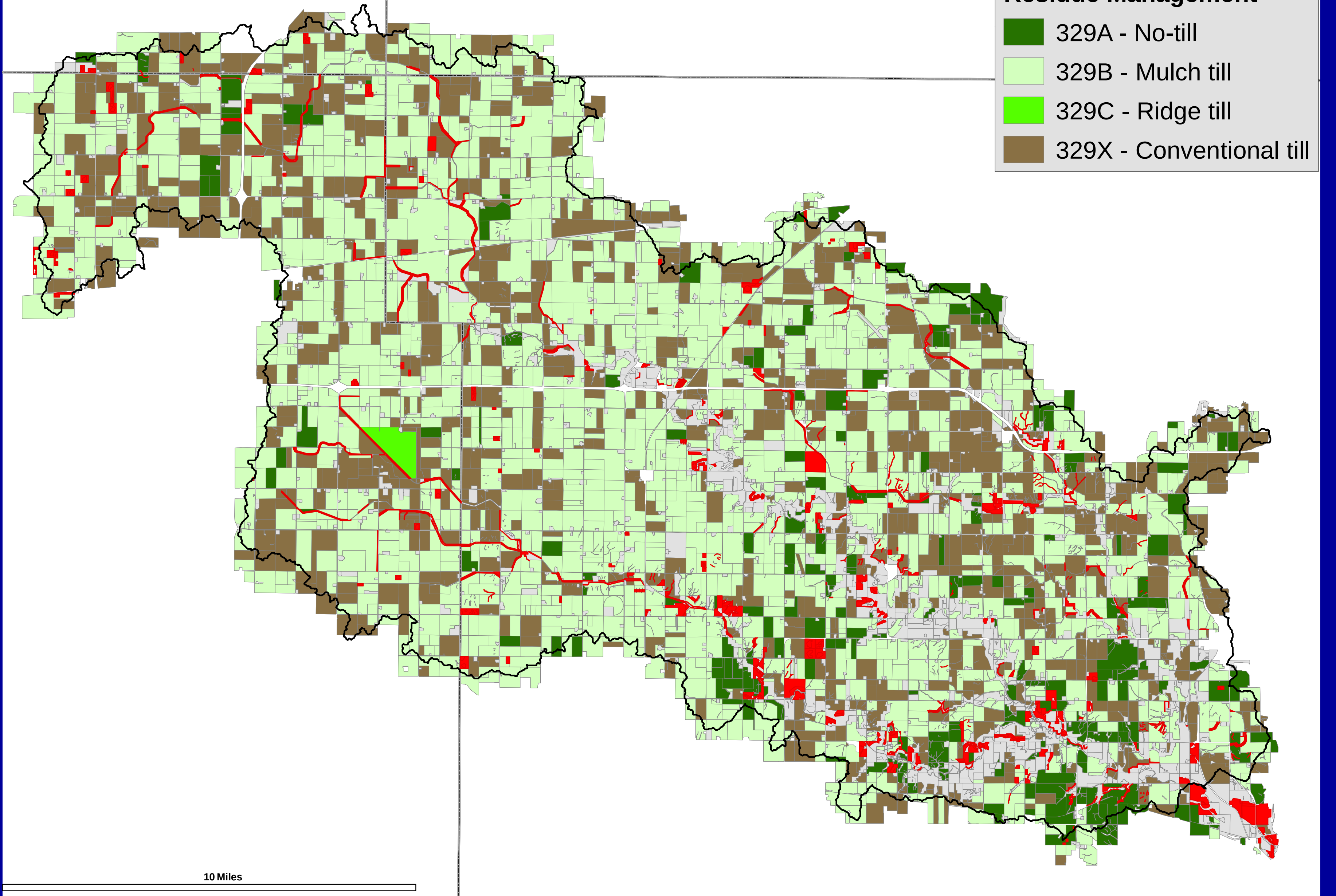


Stream Sediments

Sampled Sept. 05



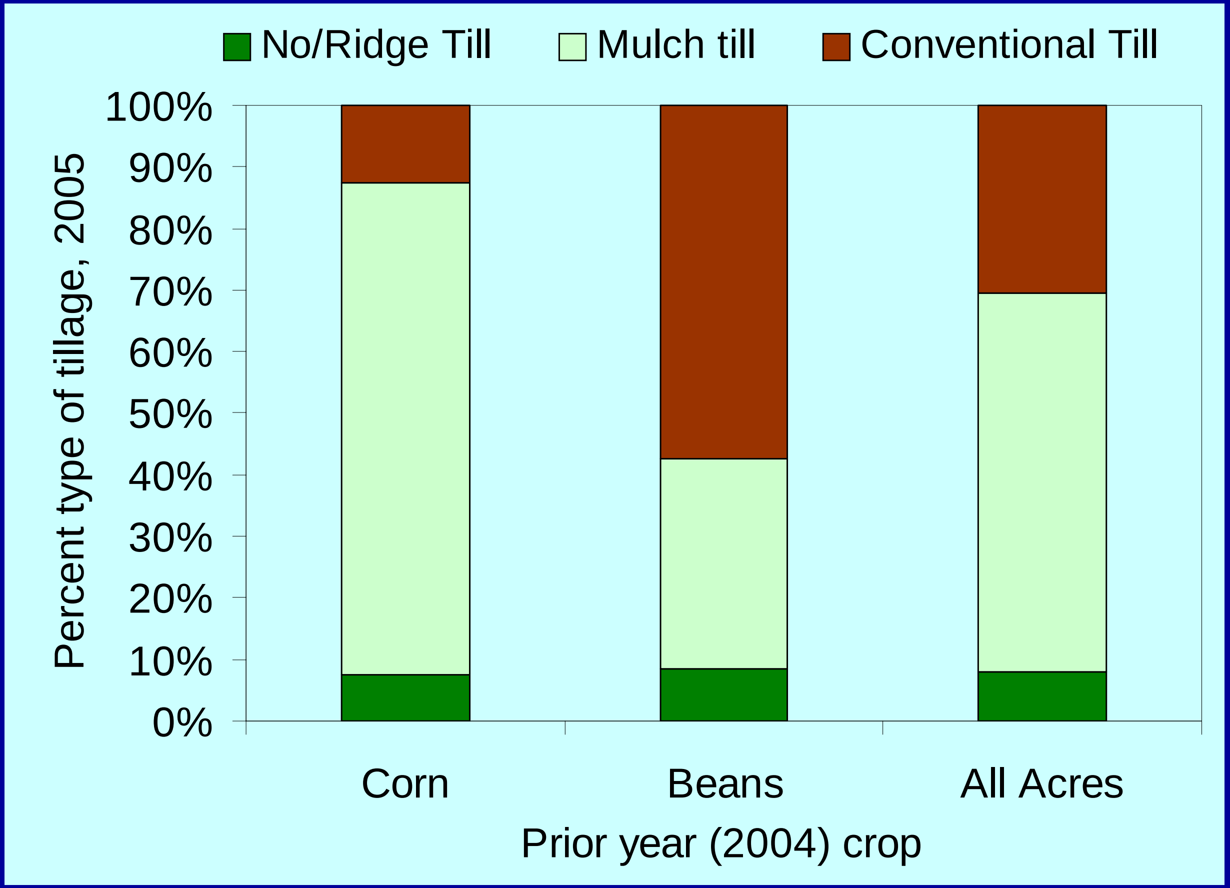
Inventory of Conservation Practices: Tillage/CRP



Residue cover at planting depends on the prior year's crop

Corn in 2004: 87% of acreage had adequate residue at next planting

Beans in 2004: 43% of acreage had adequate residue at next planting



Soil P content and residue cover have an interacting effect on P losses! How do we manage bean residue that is receiving manure?

Figure 2
Relationship between Mehlich-3 extractable soil P and the concentration of dissolved P in overland flow from cropped and grassed fields in Oklahoma (data adapted from Sharpley et al., 1991 and Smith et al., 1991).

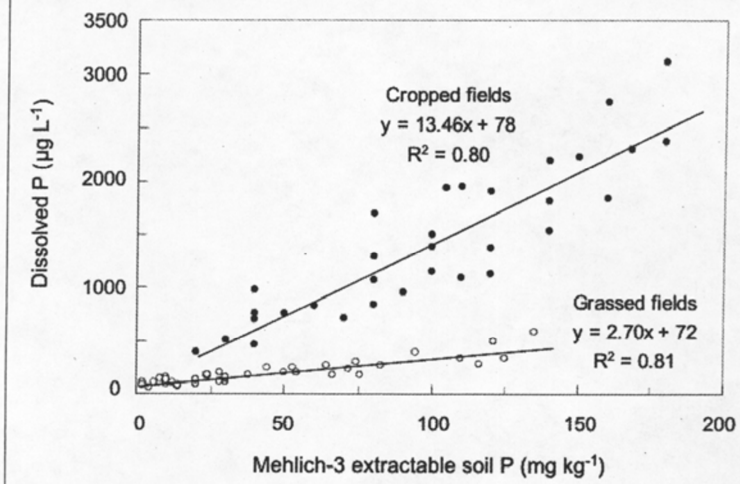
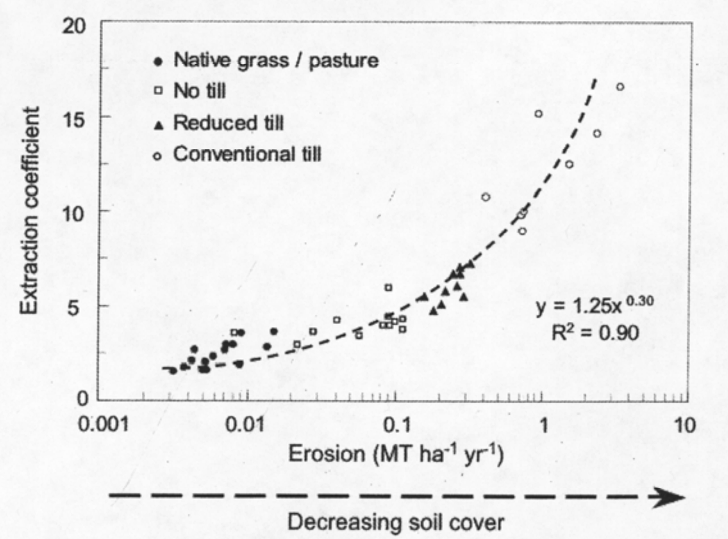


Figure 3
Extraction coefficient (slope of the relationship between soil test P and dissolved P in overland flow) as a function of erosion to represent soil vegetative cover for sites in Arkansas, Oklahoma, New York, and Pennsylvania (data adapted from Pote et al., 1999; McDowell and Sharpley, 2001a; and Sharpley and Smith, 1994).

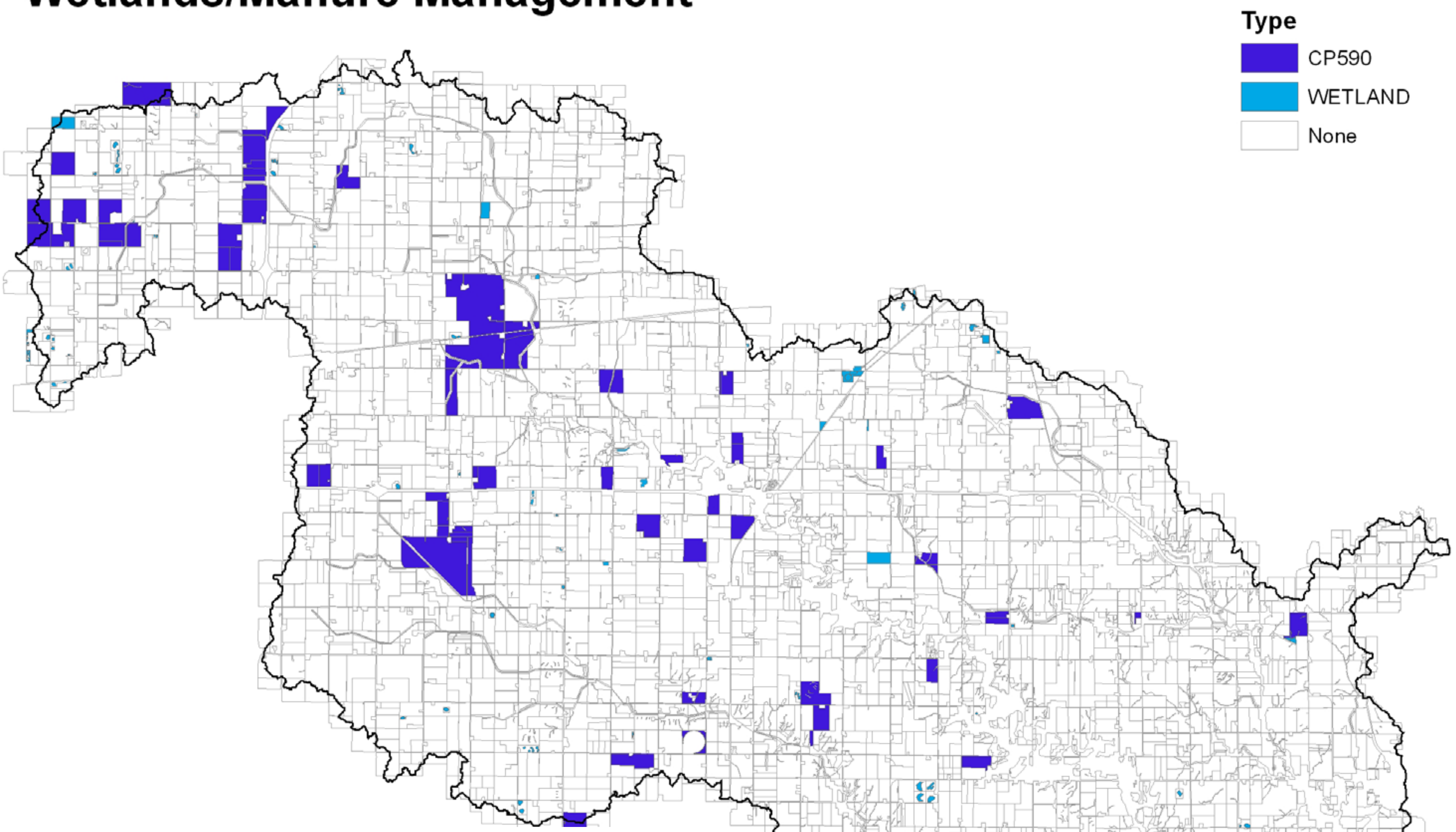


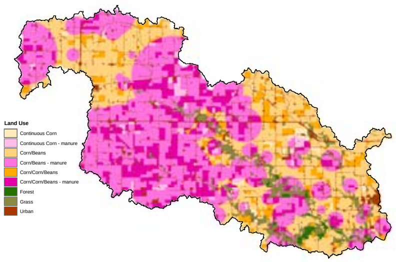
From: Sharpley, A.N, P.J.A. Kleinman, R.W. McDowell, M. Gitau, and R.B. Bryant. 2002. Modeling phosphorous transport in agricultural watersheds: Processes and possibilities. Journal of Soil and Water Conservation. 57:425-439.

South Fork Watershed – progress notes

- Significant WQ database 2002-2005
- Land use mapping and conservation practices inventory
- Hydrologic calibration of SWAT with tile drainage component – progressing on nutrient calibrations
- Conservation priorities:
  - Nutrient and manure management
  - Constructed wetlands / wetland reserves
  - Residue management when applying manure following soybeans

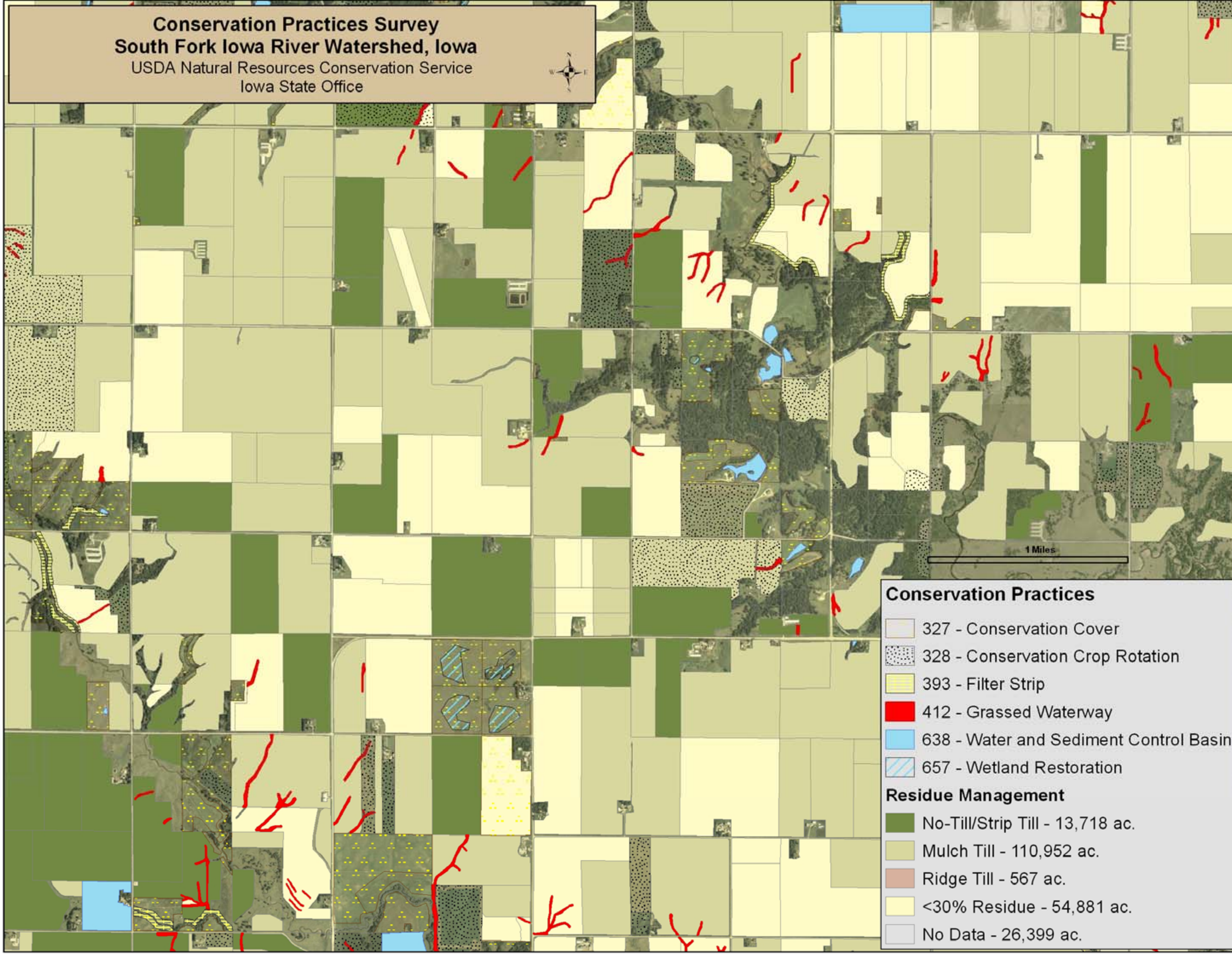
Wetlands/Manure Management





Quantifying Conservation Practices in the Southfork

agricultural land	76,320 ha	
C-S rotations	71,930 ha	(94%)
receives manure annually	~21,400 ha	(28%)
has recorded manure mange. plan	3,920 ha	(5%)
conventional tillage and no recorded CP	20,150 ha	(26%)
no-till or ridge tillage	5,780 ha	(8%)
CRP	1,840 ha	(2%)
perennial rotations	760 ha	(1%)
wetland restorations	280 ha	(0.4%)



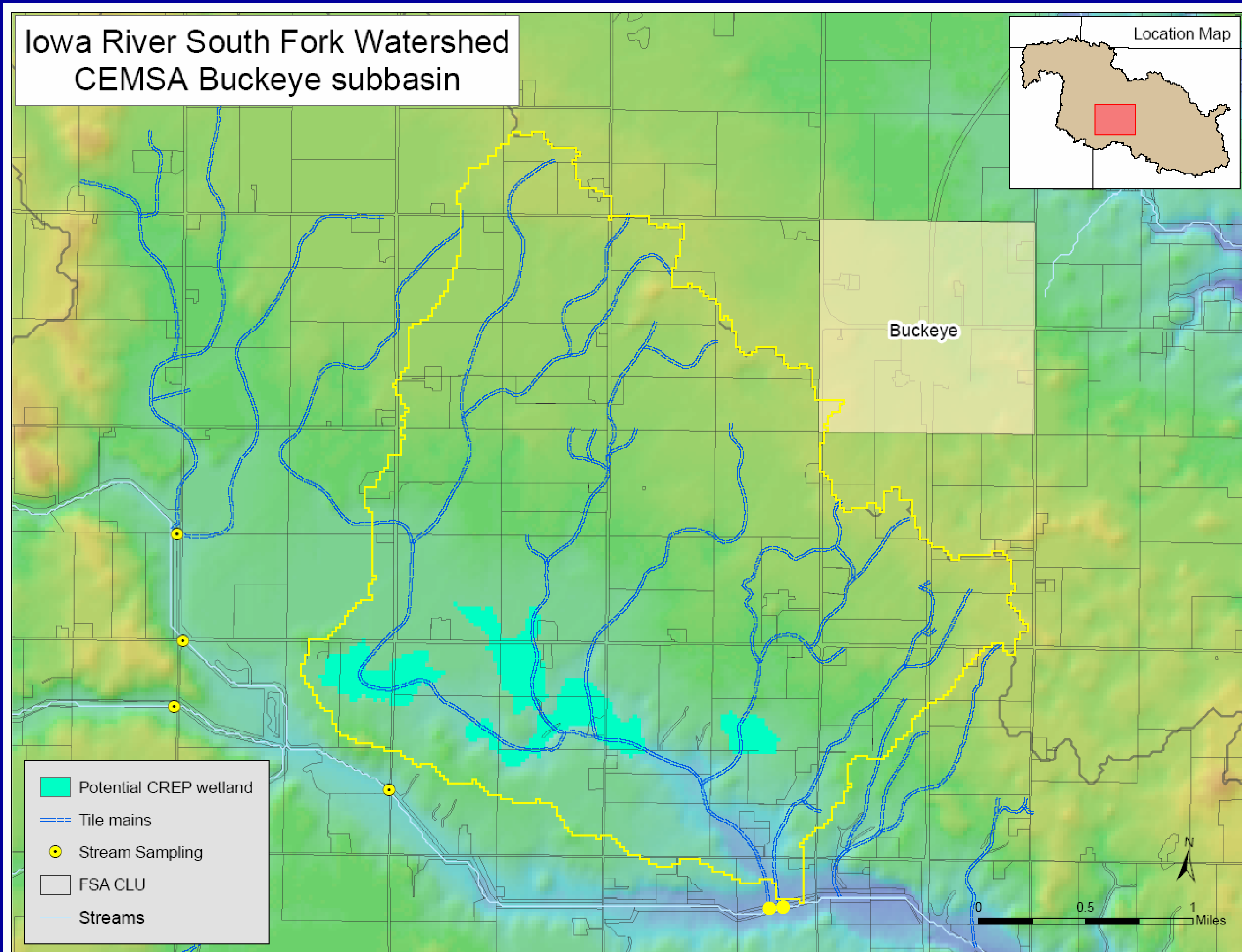
Conservation Practices Survey
South Fork Iowa River Watershed, Iowa
USDA Natural Resources Conservation Service
Iowa State Office
1 Miles
Conservation Practices
327 - Conservation Cover
328 - Conservation Crop Rotation
393 - Filter Strip
412 - Grassed Waterway
638 - Water and Sediment Control Basin
657 - Wetland Restoration
Residue Management
No-Till/Strip Till - 13,718 ac.
Mulch Till - 110,952 ac.
Ridge Till - 567 ac.
<30% Residue - 54,881 ac.
No Data - 26,399 ac.

The message to stakeholders (in part)

•Coupling nutrient and residue management within fields and “filter” practices at edges of fields may offer the best chance to optimize CP effectiveness at the watershed scale.

•Technologies to optimize the placement of practices are being developed. Watershed scale assessments can help prioritize and target practices for farm-scale conservation planning.

•Conservation practices may take decades to fully impact water quality at the watershed scale. A long term perspective is needed. But options to make measurable progress in shorter terms are also needed. Small watershed projects involving groups of landowners offer one good approach.


Iowa River South Fork Watershed
CEMSA Buckeye subbasin
Location Map
Buckeye
Potential CREP wetland
Tile mains
Stream Sampling
FSA CLU
Streams
N
0
0.5
1
Miles


Two posters have further info on SWAT modeling and *E. coli*.
Thanks to:
Colin Greenan
Amy Morrow
Kevin Cole
Jeff Nichols
Kelly Weichers
NRCS
Southfork Watershed Alliance
Iowa Soybean Association