Research, Education, and Service

IIHR—Hydroscience & Engineering

Environmental Programs Seminar

September 9, 2021

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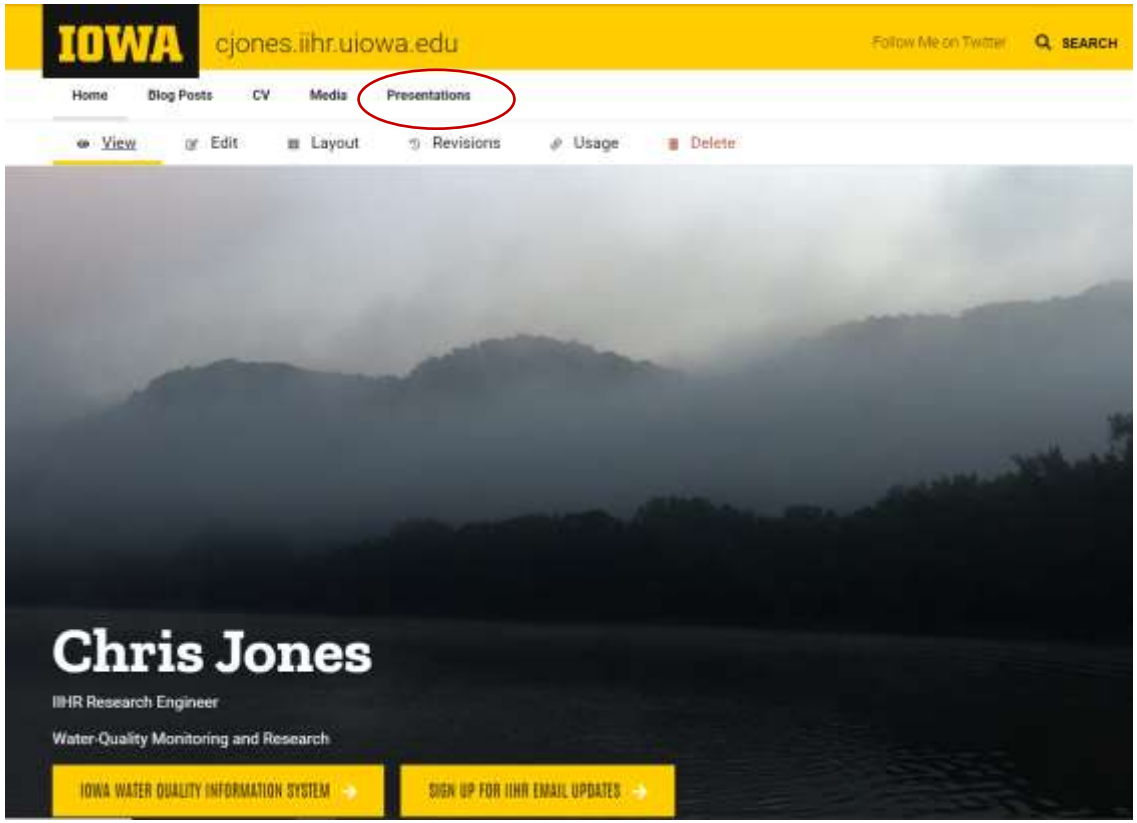
IIHR Hydroscience & Engineering

The University of Iowa College of Engineering

Slides Available at:

https://cjones.iihr.uiowa.edu/

- Grew up in Ankeny, IA
- Went to Simpson College in Indianola, IA
- PhD work at Montana State University (1987)
- Managed commercial analytical testing laboratory in MN, 1988-1999
- Consulting work for water and wastewater utilities, MN, 1999-2003
- Des Moines Water Works, supervisor of water quality, 2003-2011
- Iowa Soybean Association, environmental scientists, 2011-2015
- UI, 2015-present



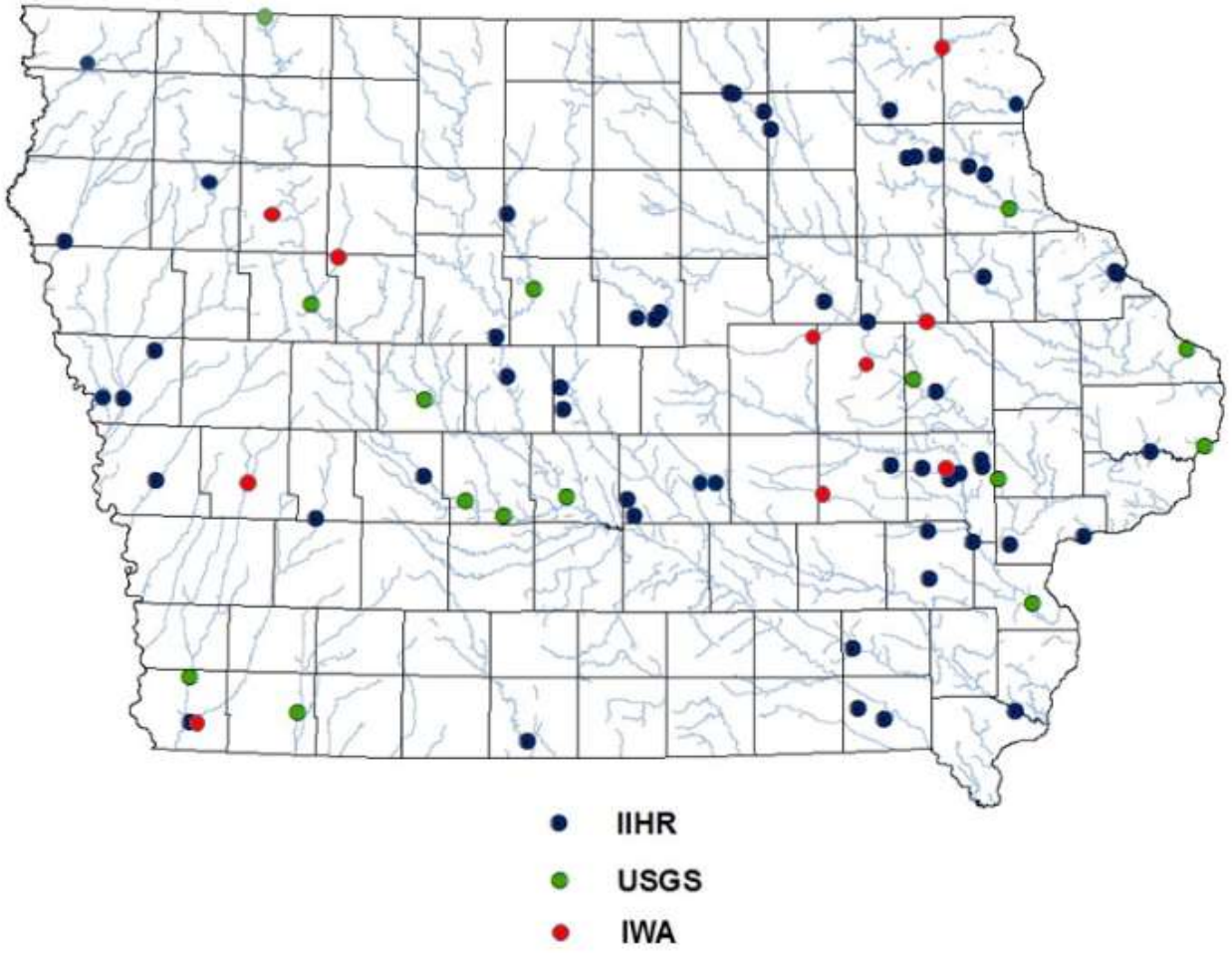
IIHR Water Quality Sensor Network

Sites

70+ sites Nitrate-N

20-25 sites

- Temperature
- pH
- SC
- DO
- Turbidity

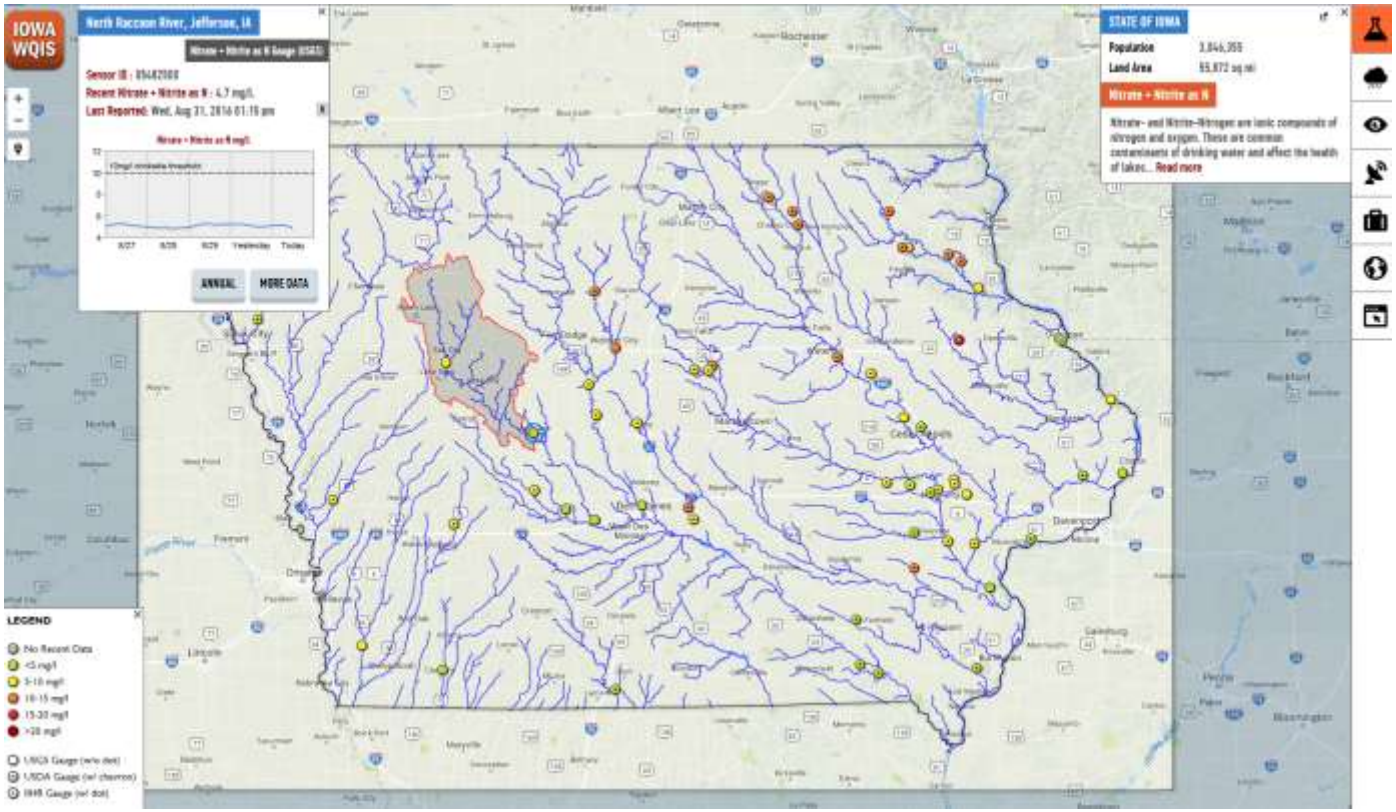


Site infrastructure

Small Streams

IIHR Water Quality Sensor Setup

Iowa Water Quality Information System



iwqis.iowawis.org/

http://iwqis.iowawis.org/app/?datetime=2017-06-06T13:00

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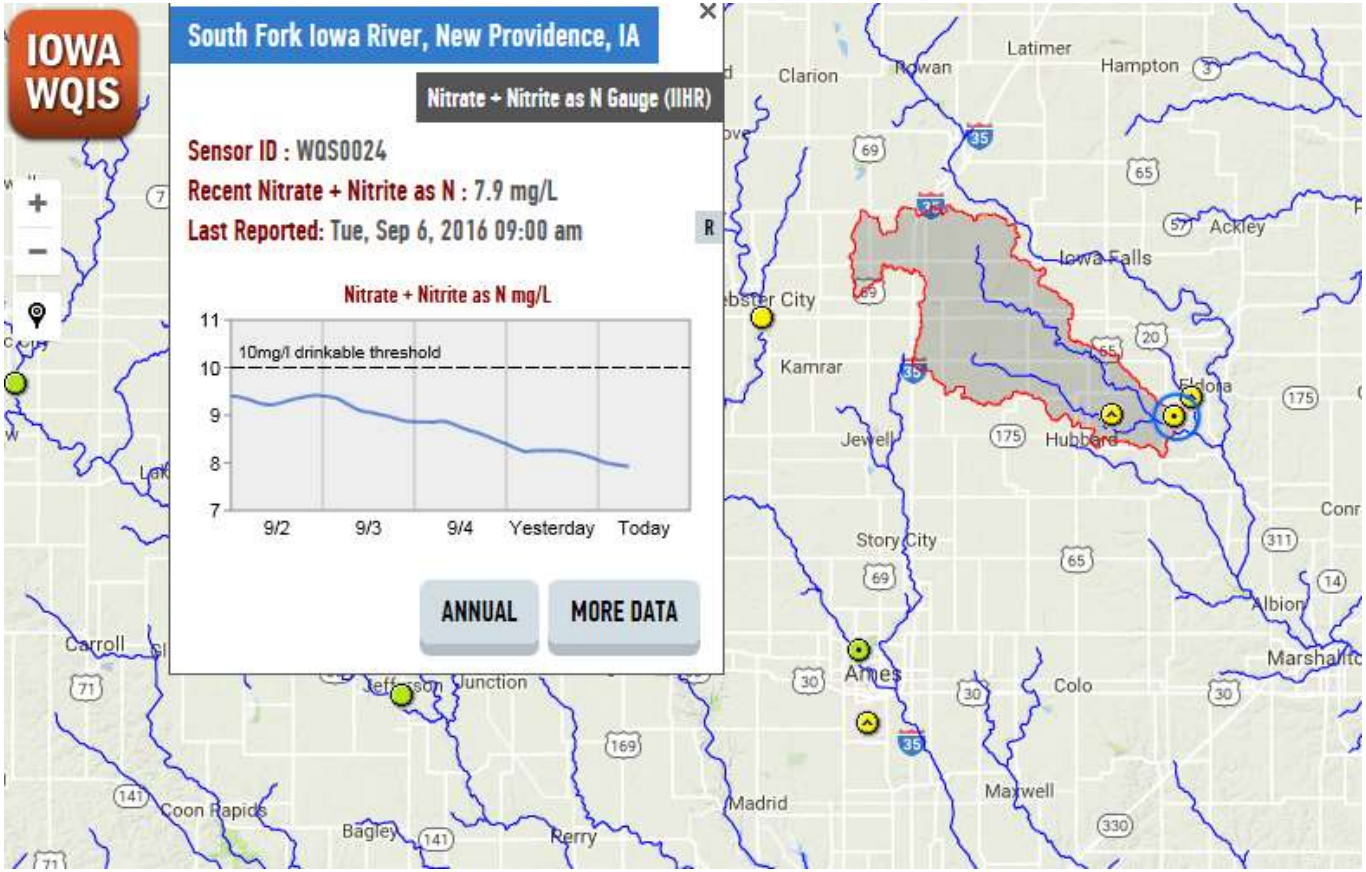
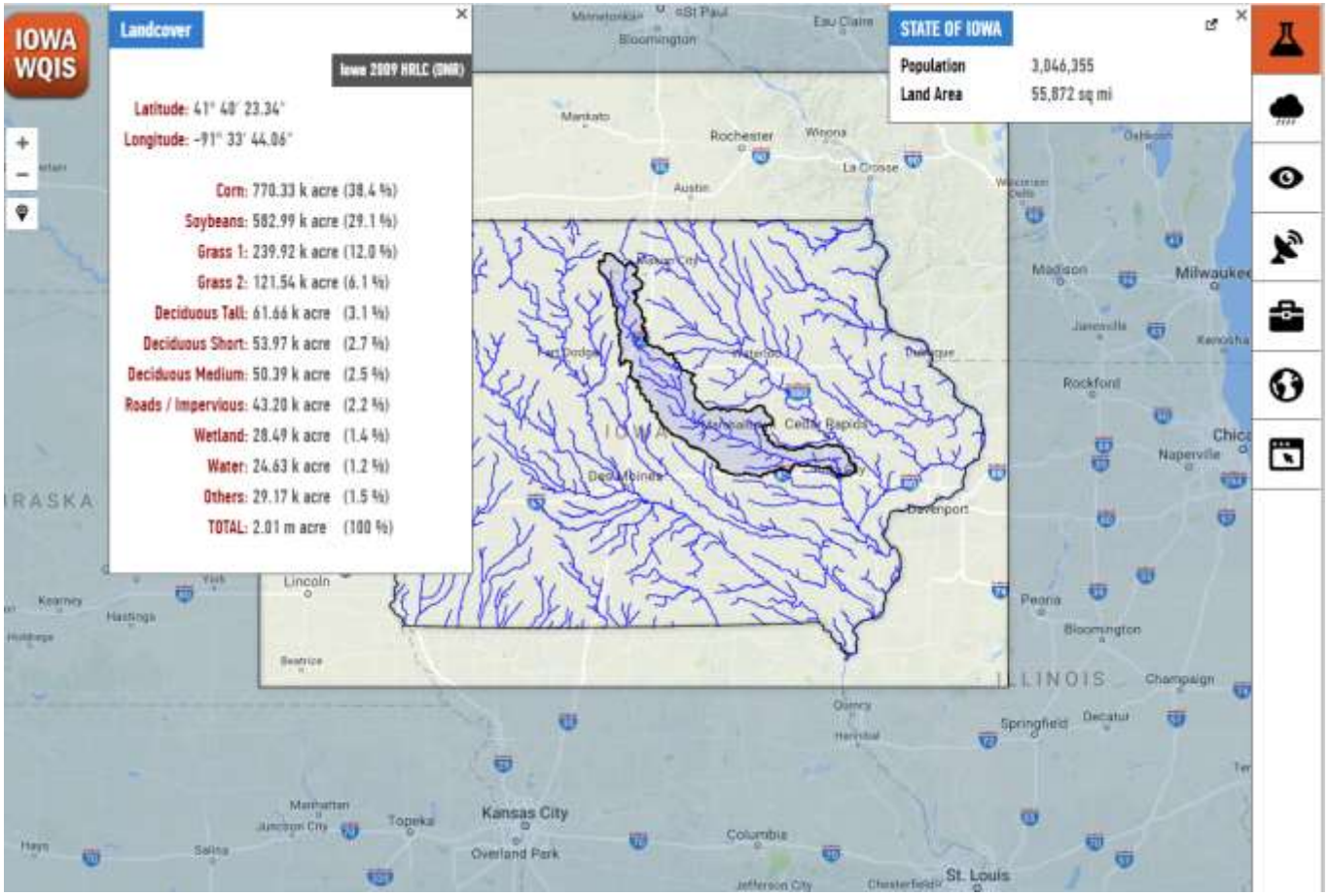

IOWA WQIS
South Fork Iowa River, New Providence, IA
Nitrate + Nitrite as N Gauge (IIHR)
Sensor ID : WQS0024
Recent Nitrate + Nitrite as N : 7.9 mg/L
Last Reported: Tue, Sep 6, 2016 09:00 am
Nitrate + Nitrite as N mg/L
10mg/l drinkable threshold
11
10
9
8
7
9/2
9/3
9/4
Yesterday
Today
ANNUAL
MORE DATA
Latimer
Clarion
Hampton
Ackley
Iowa Falls
Kamrar
Jewell
Hubbard
Eldora
Story City
Ames
Colo
Albion
Carroll
Coon Rapids
Bagley
Madrid
Maxwell

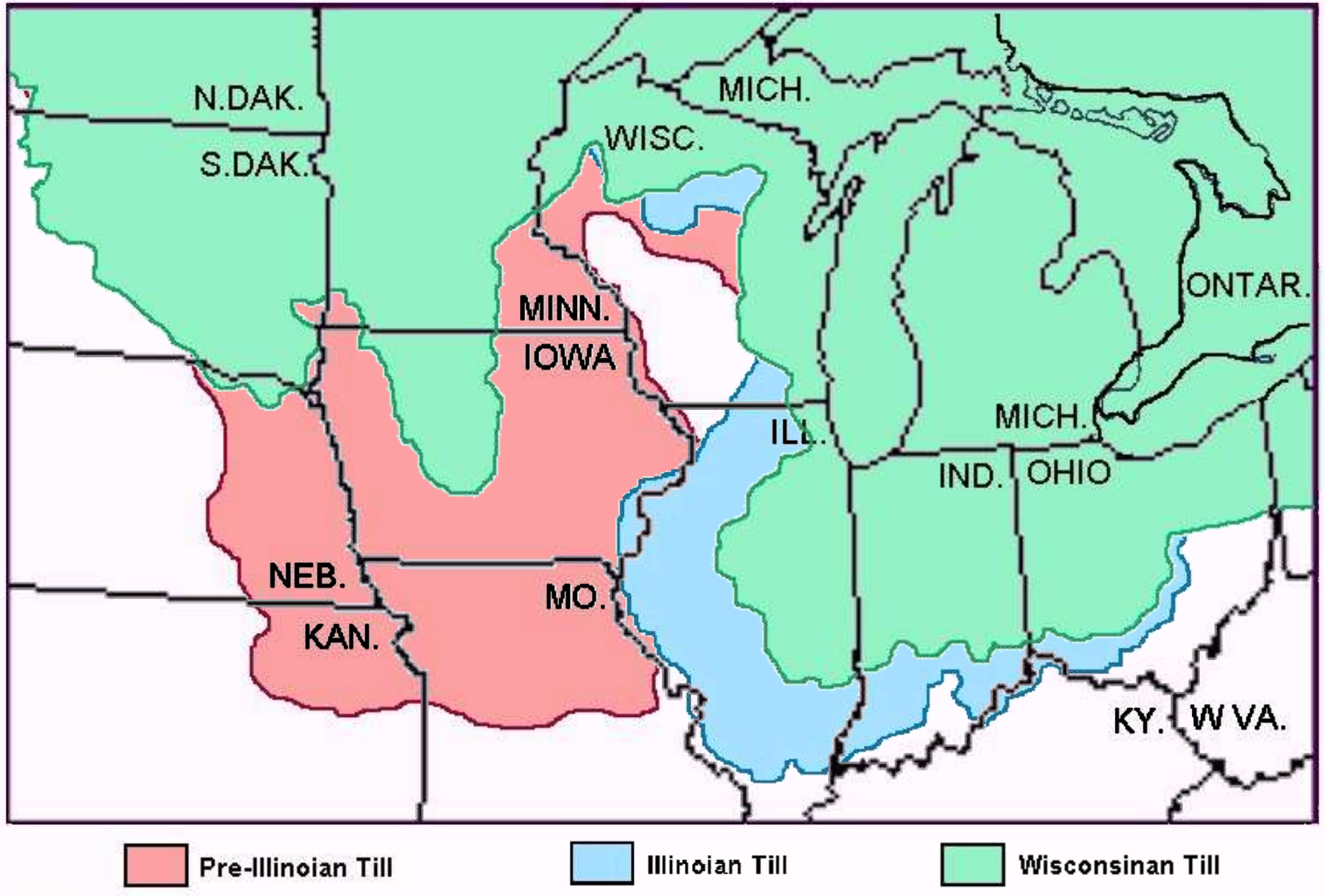
Landcover Tool



Publications

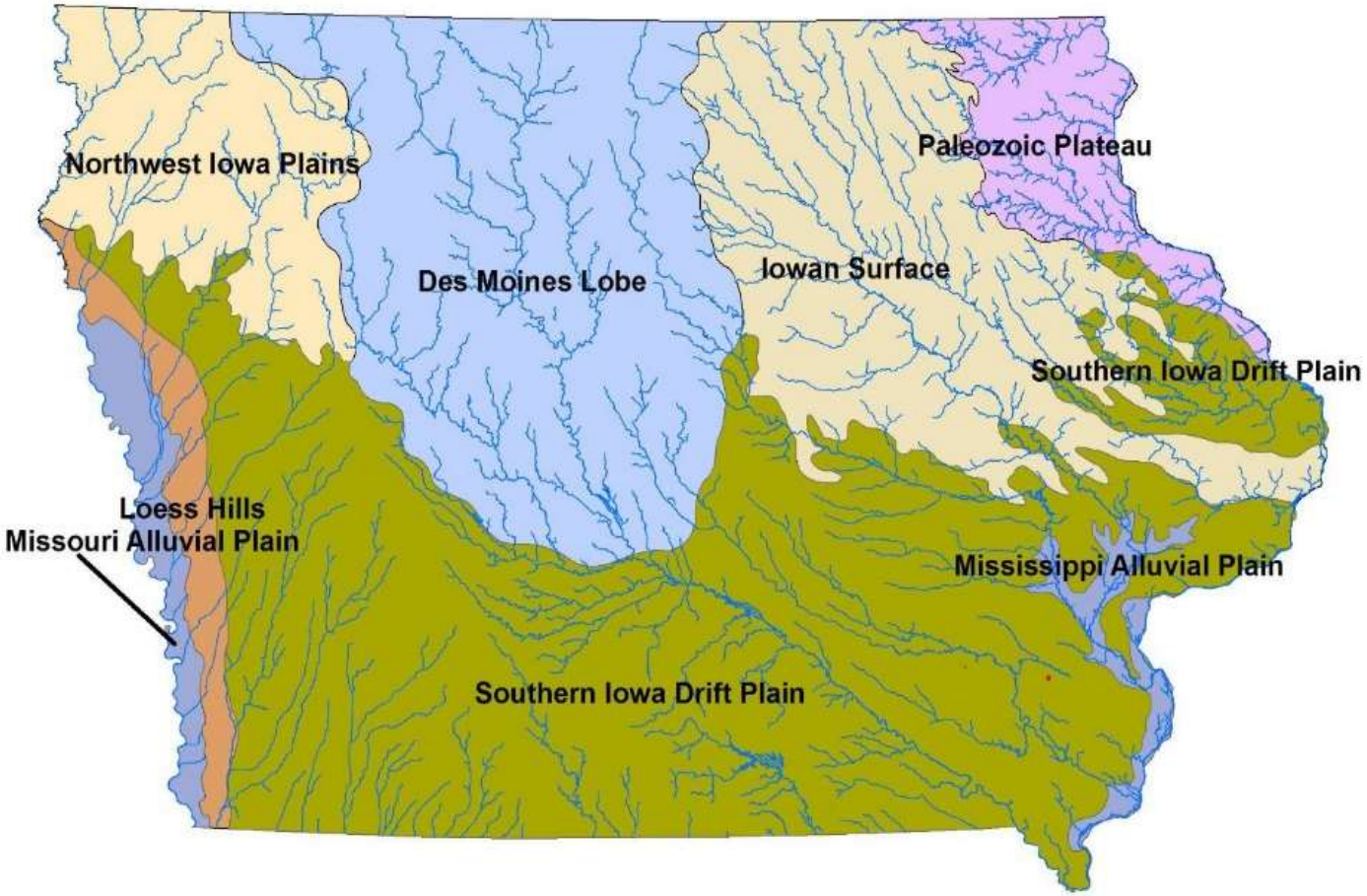
- Practice Assessment: 12
- Wetland Research: 11
- Stream and Tile Drainage Hydrology: 6
- Nitrate Dynamics Within Streams and Reservoirs: 8
- Policy: 4
- Golf Course Soils and Nutrients: 3
- Phosphorus Transport: 5
- Watershed Nitrate Loading: 4
- Livestock and Water Quality: 2
- Groundwater Nitrate Dynamics: 2
- Carbon Transport in Tile Drainage: 2
- Climate/Hydrology: 2
- Water Quality Indices: 1

30,000 – 10,500 years



Slide courtesy of K. Schilling, Iowa Geological Survey

Iowa Landforms

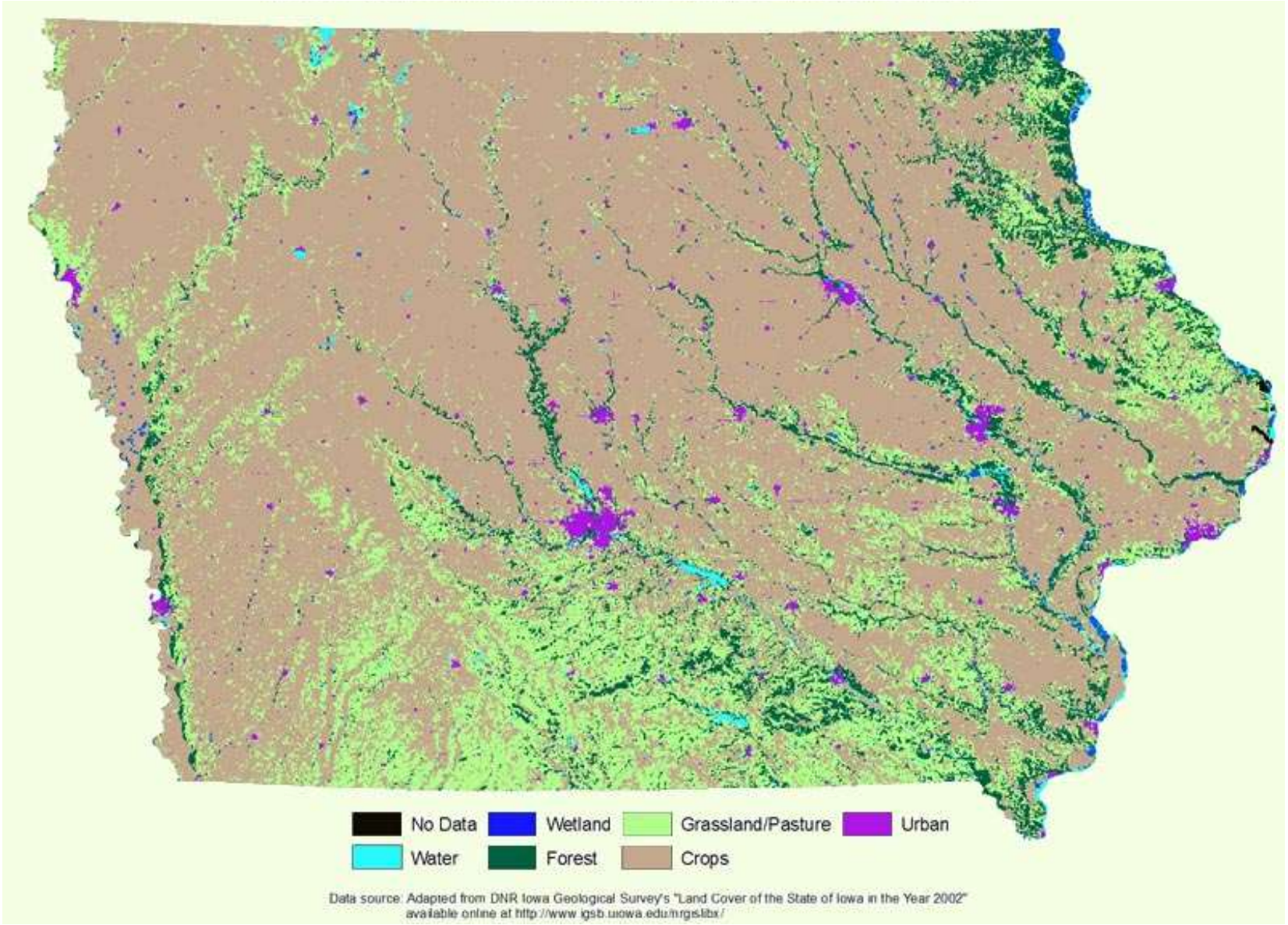


Climate

Millett, B., Johnson, W.C. and Guntenspergen, G., 2009. Climate trends of the North American prairie pothole region 1906–2000. *Climatic Change*, *93*(1-2), pp.243-267.

Fig. 1 Map of the Prairie Pothole Region (PPR) of North America based on ecoregion classificati
(Omernik 1987, 1995)

Iowa Land Cover



Pre-1850

Sandy or gravel bottom

Wide, shallow streams

Gently-sloping banks with vegetation

Water table close to surface

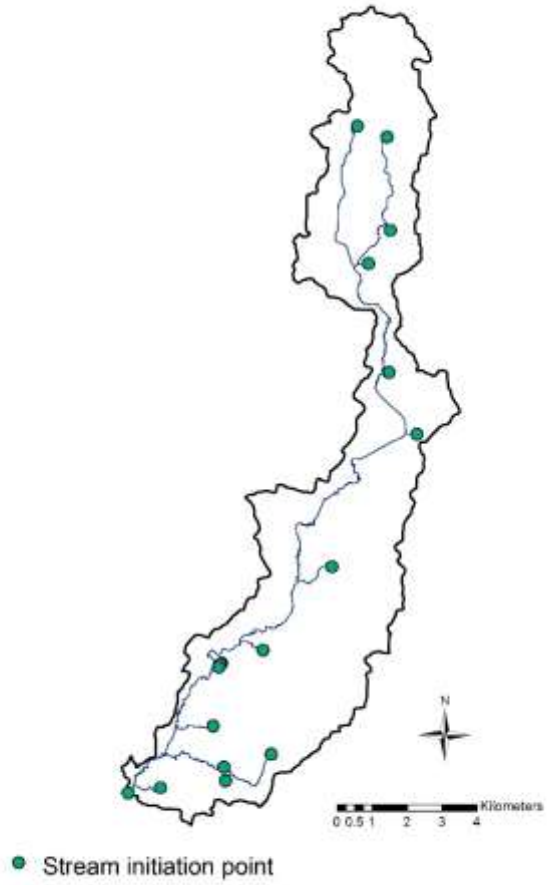
Perennial vegetation

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

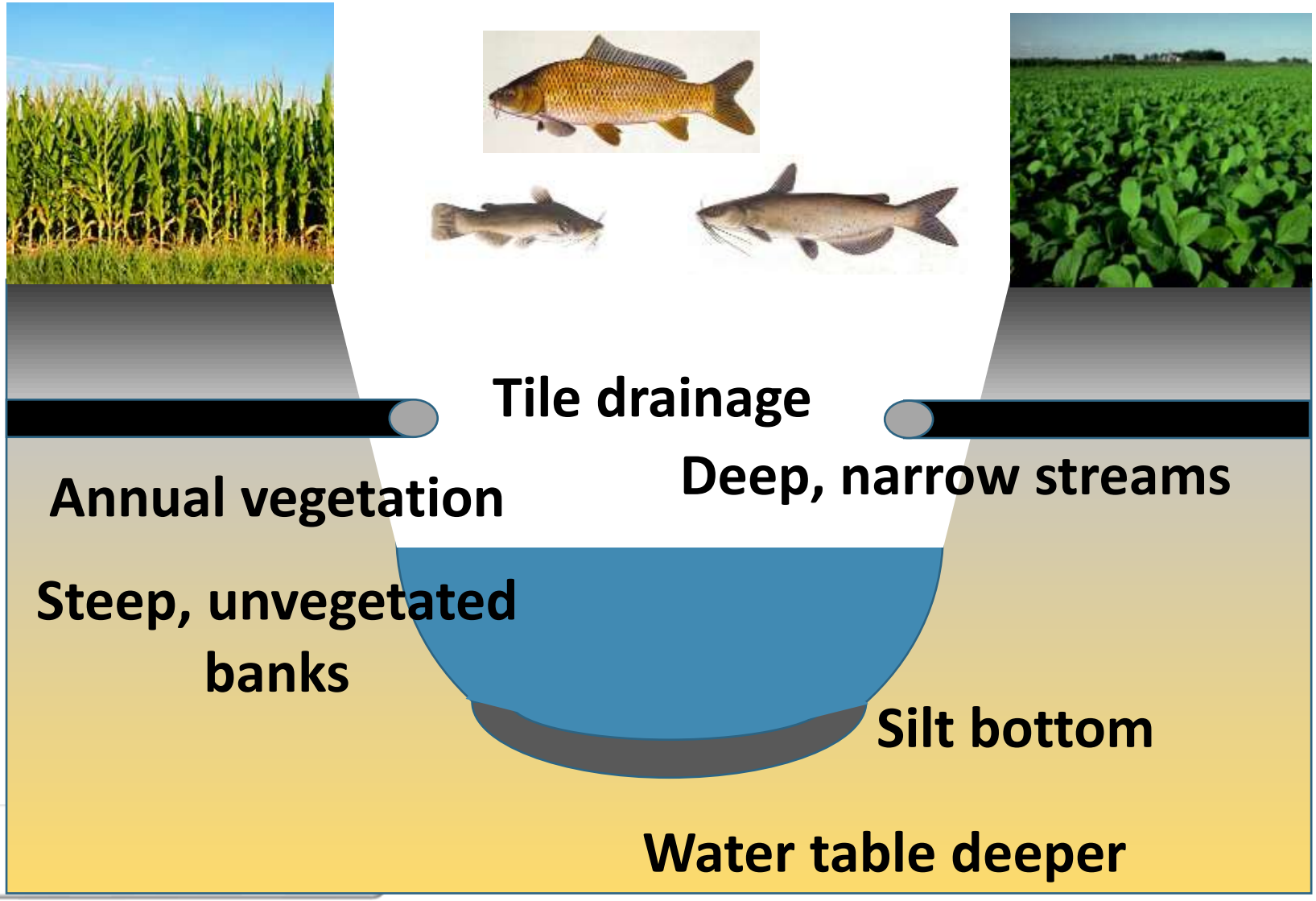
Where do streams begin?

Tile outfalls!

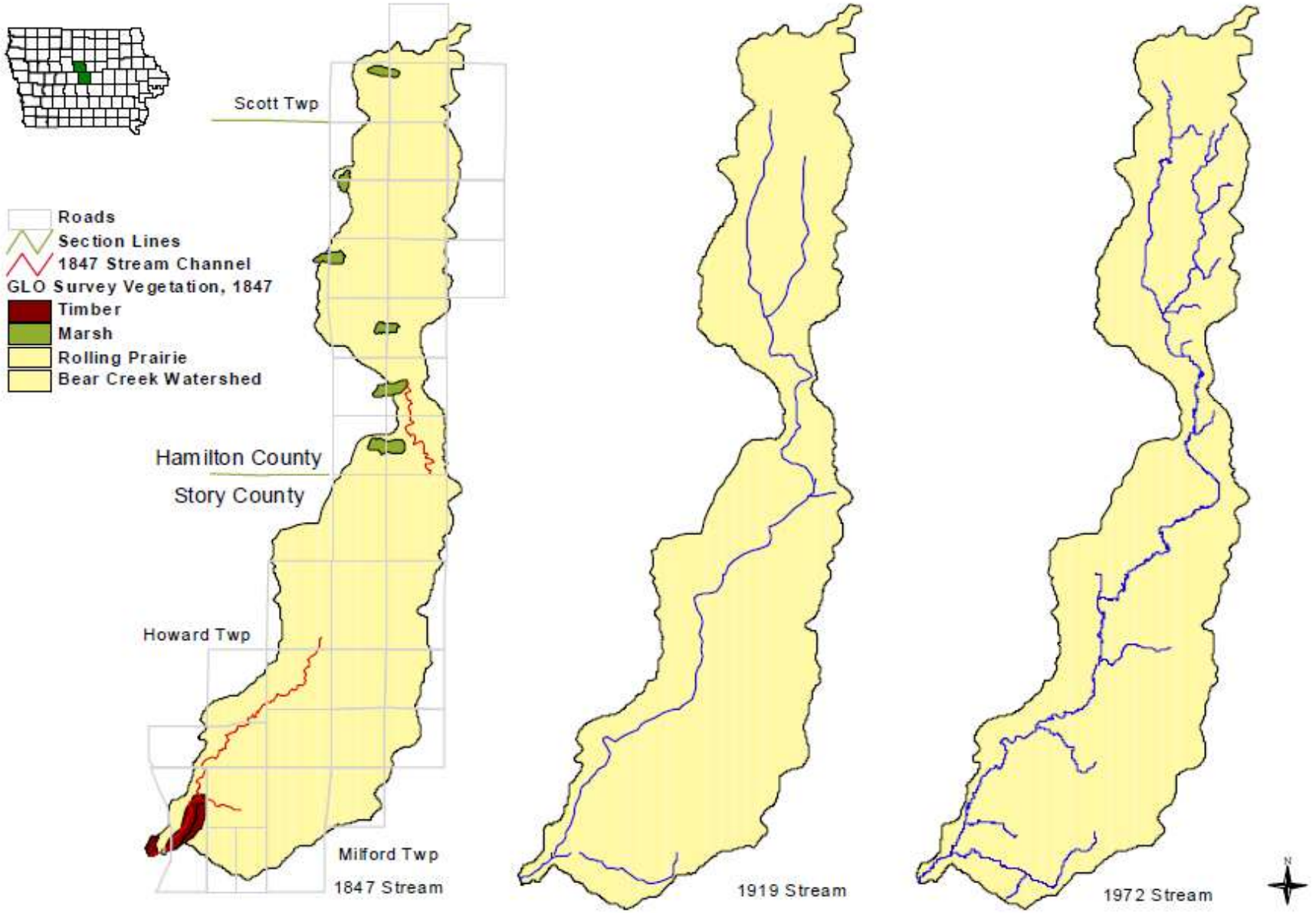


Slide courtesy of K. Schilling, Iowa Geological Survey

Now


Tile drainage
Annual vegetation
Deep, narrow streams
Steep, unvegetated banks
Silt bottom
Water table deeper

Extension of river drainage network from 1847 to 1972



Slide courtesy of K. Schilling, Iowa Geological Survey

Walnut Creek: Jasper County

Slide courtesy of K. Schilling, Iowa Geological Survey

Extension of the drainage network

Table 1. Comparison of morphological characteristics of Walnut Creek in 1847 and 1972 (after Anderson, 2000)

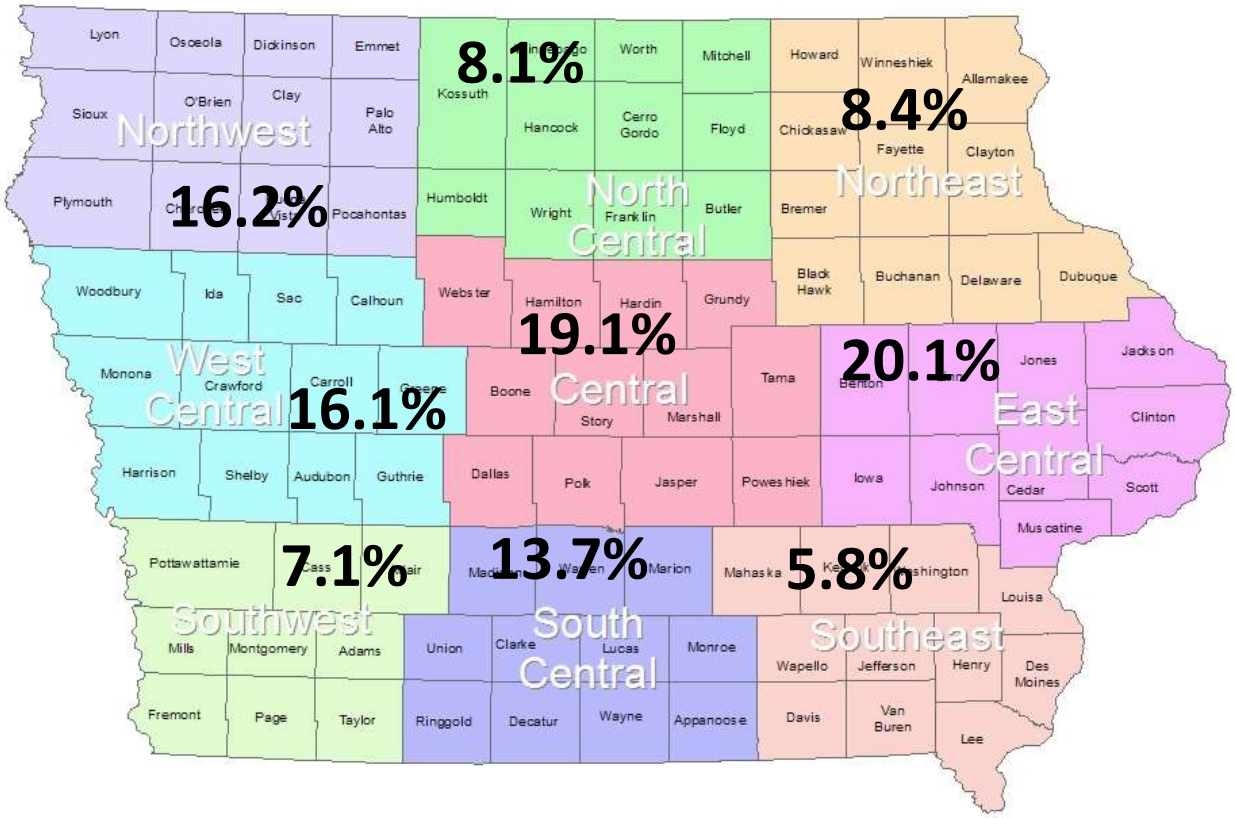
Property	GLO Survey (1847)	1972 USGS Streams
Stream length (m)	37,185	60,286
Drainage density[1]	0.9	1.52
Channel frequency[2]	0.32	1.20

[1]Total length of drainage system divided by watershed area
[2]Total number of stream segments per unit area

Stream length nearly doubled
Greater density and number of stream channels

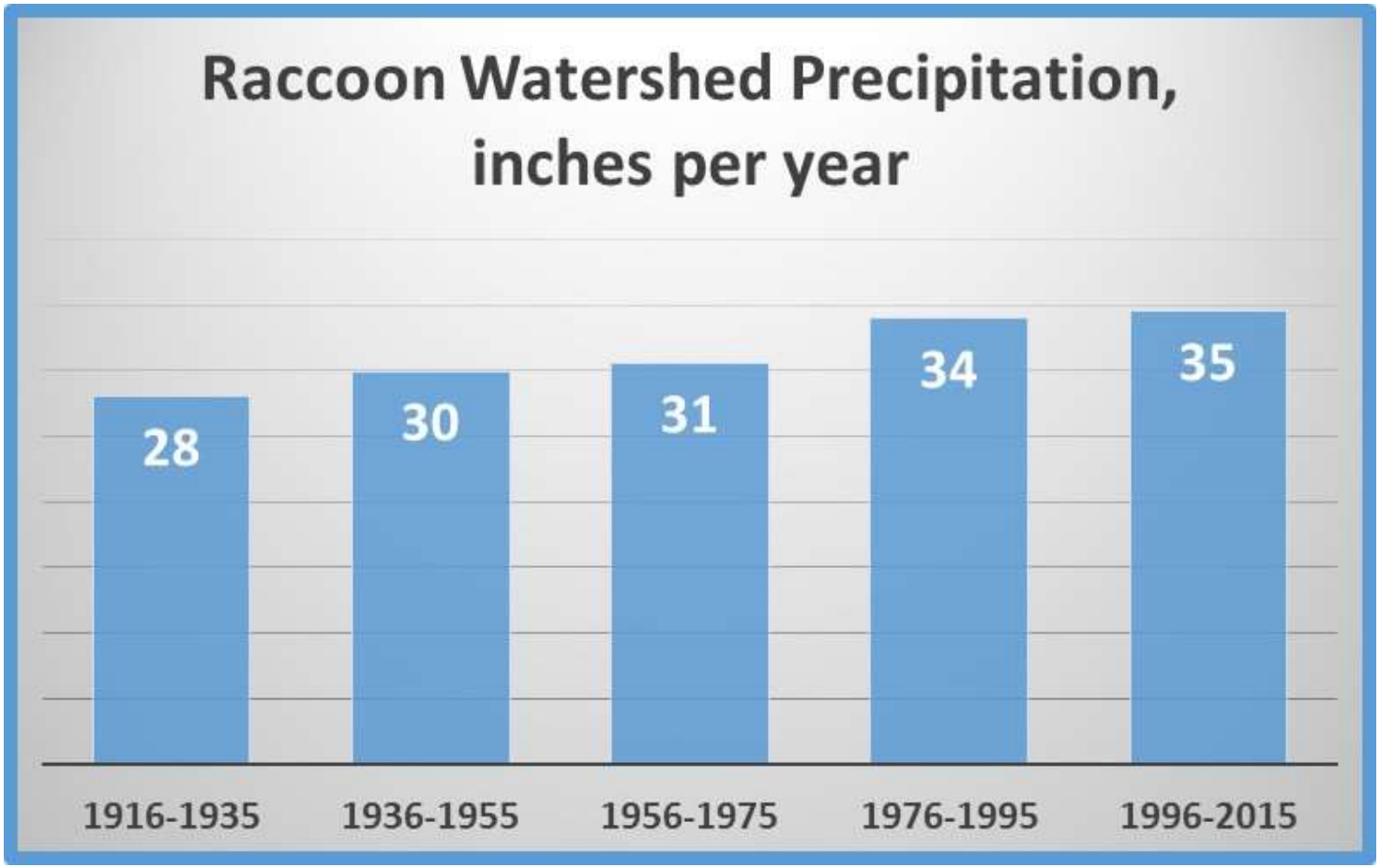
Slide courtesy of K. Schilling, Iowa Geological Survey

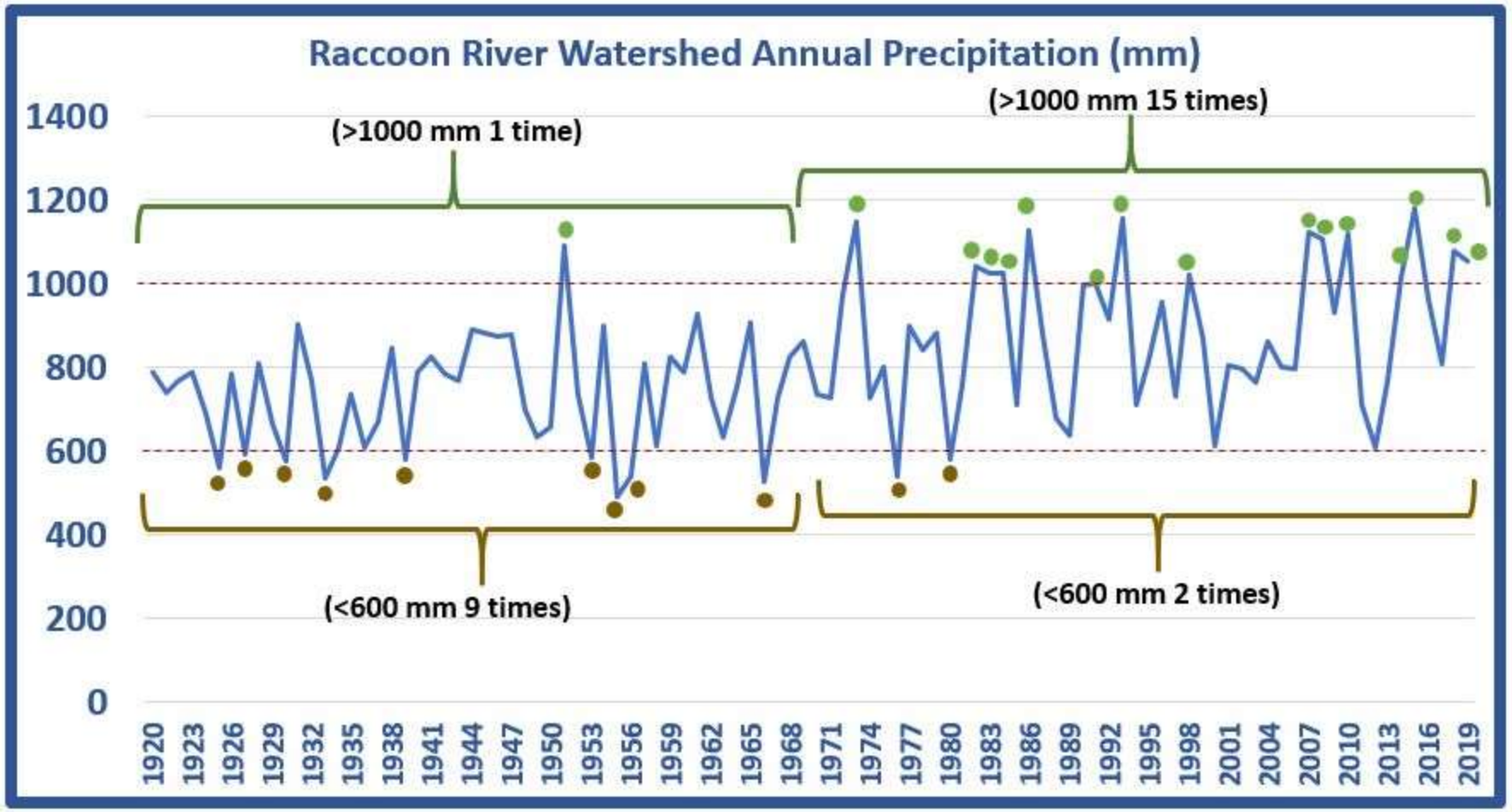
It's Wetter: Increase over last century



U.S. Department of Agriculture Crop Reporting Districts

It's Wetter


Raccoon Watershed Precipitation, inches per year
28
30
31
34
35
1916-1935
1936-1955
1956-1975
1976-1995
1996-2015


Raccoon River Watershed Annual Precipitation (mm)
(>1000 mm 1 time)
(>1000 mm 15 times)
(<600 mm 9 times)
(<600 mm 2 times)
1400
1200
1000
800
600
400
200
0
1920
1923
1926
1929
1932
1935
1938
1941
1944
1947
1950
1953
1956
1959
1962
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019

Hypoxia, Aquatic Life

IIHR Hydroscience & Engineering

Drinking Water

Toledo, OH

Des Moines, IA

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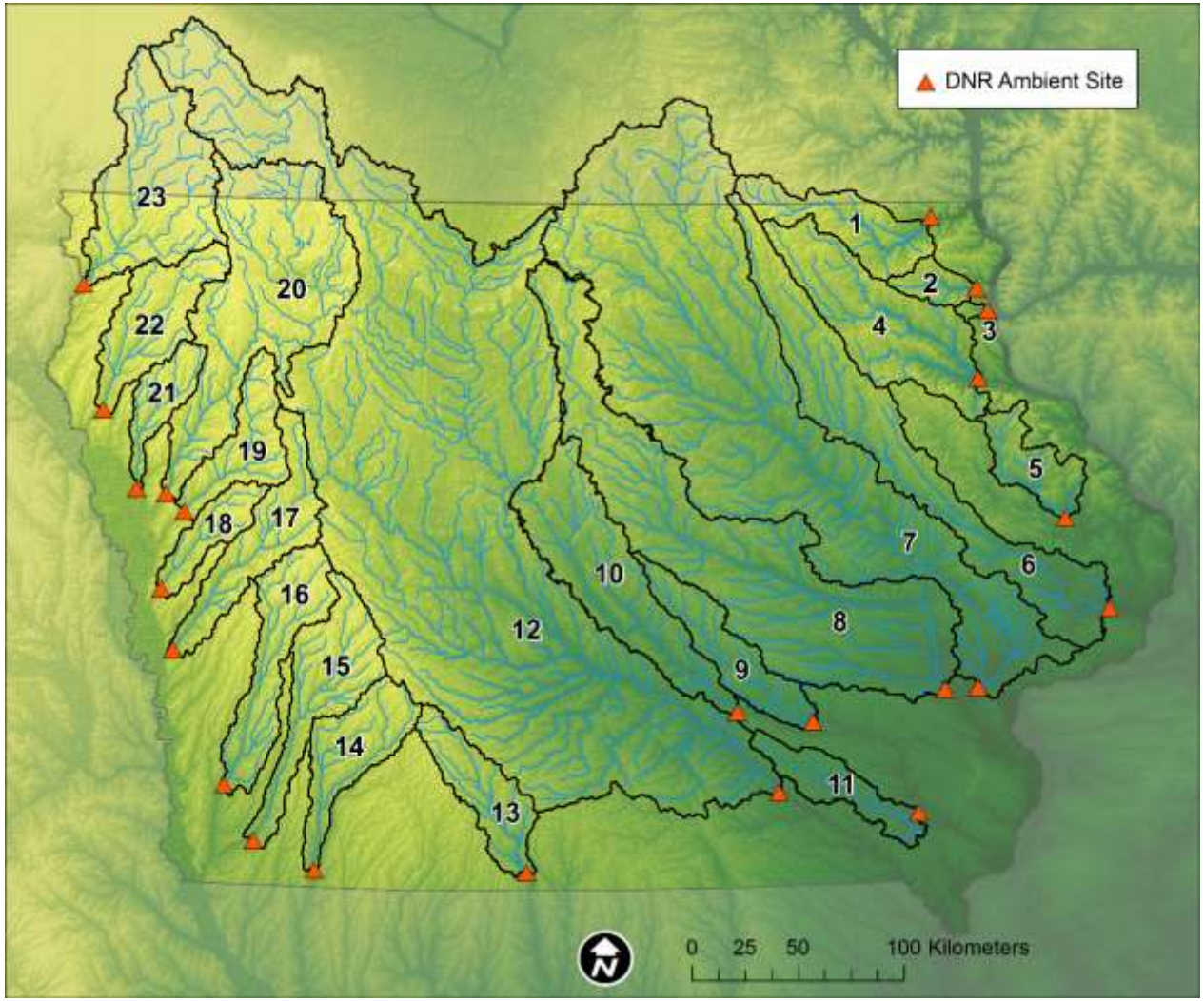
RESEARCH ARTICLE

Iowa stream nitrate and the Gulf of Mexico

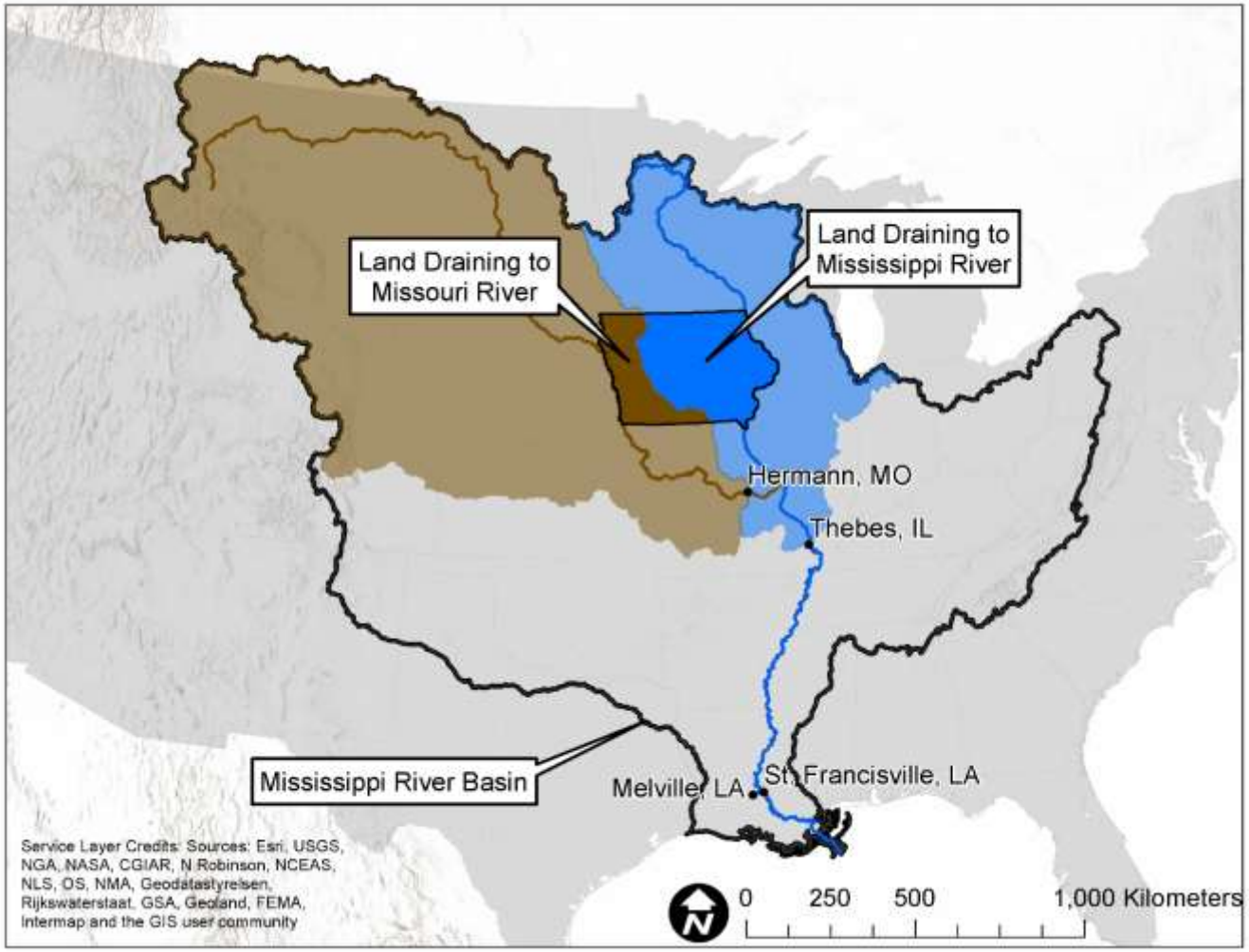
Christopher S. Jones, Jacob K. Nielsen, Keith E. Schilling, Larry J. Weber

Published: April 12, 2018 • https://doi.org/10.1371/journal.pone.0195930

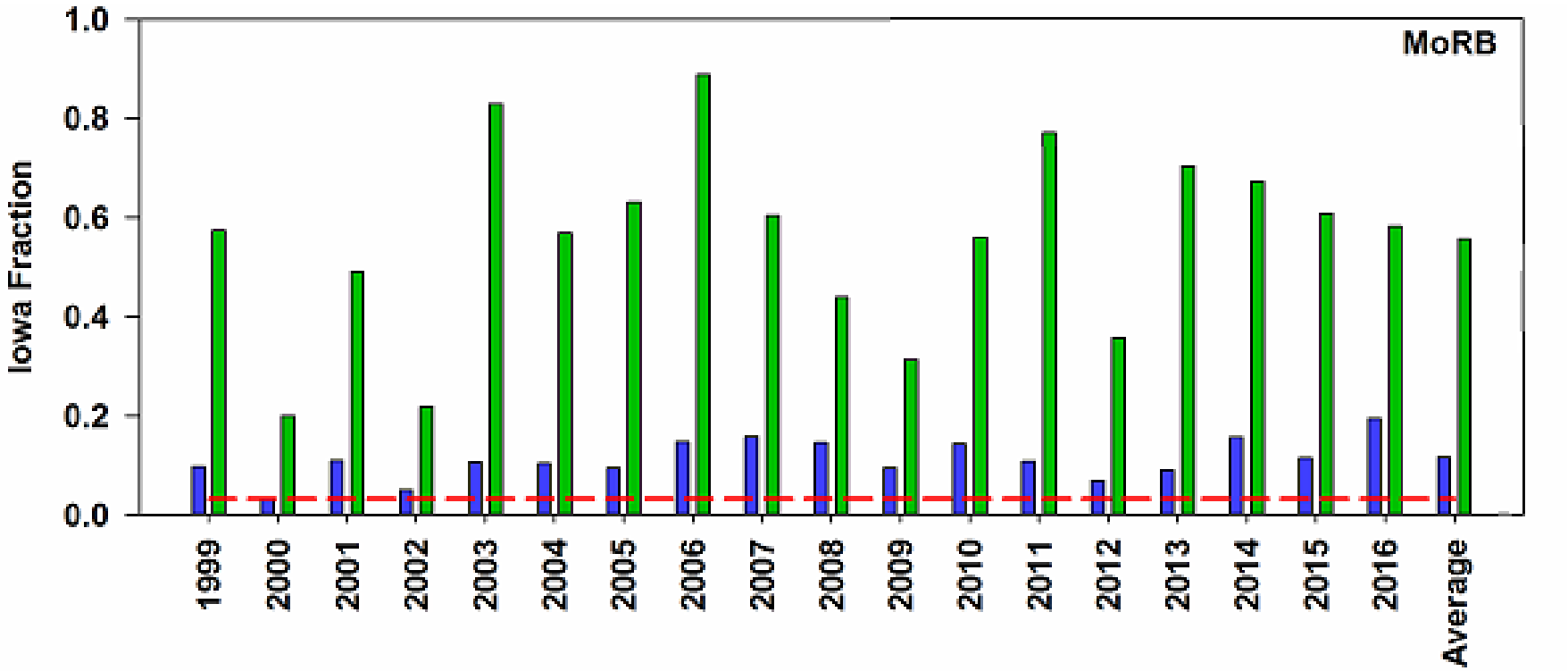


DNR Ambient Water Monitoring Data: 1999-2016

IOWA DEPARTMENT OF NATURAL RESOURCES

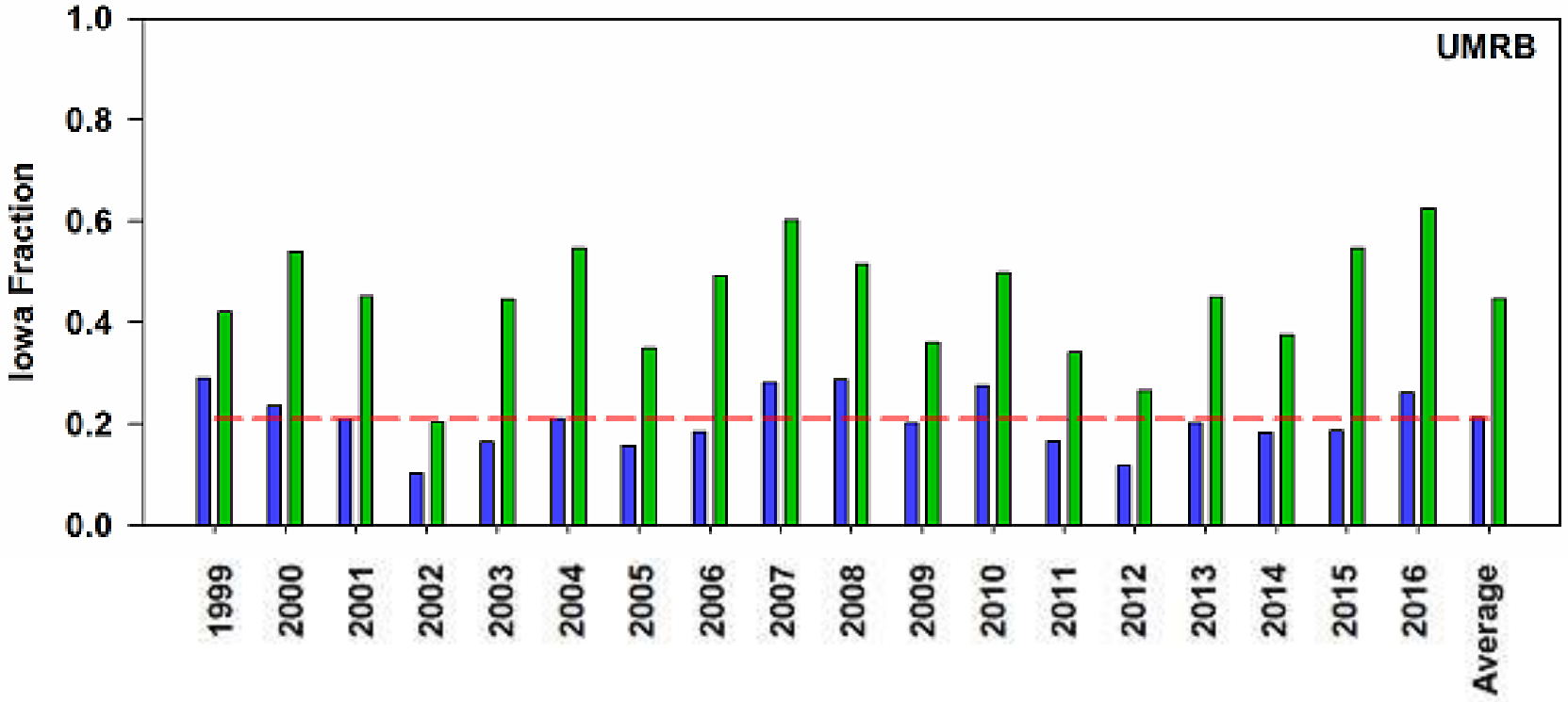


Missouri



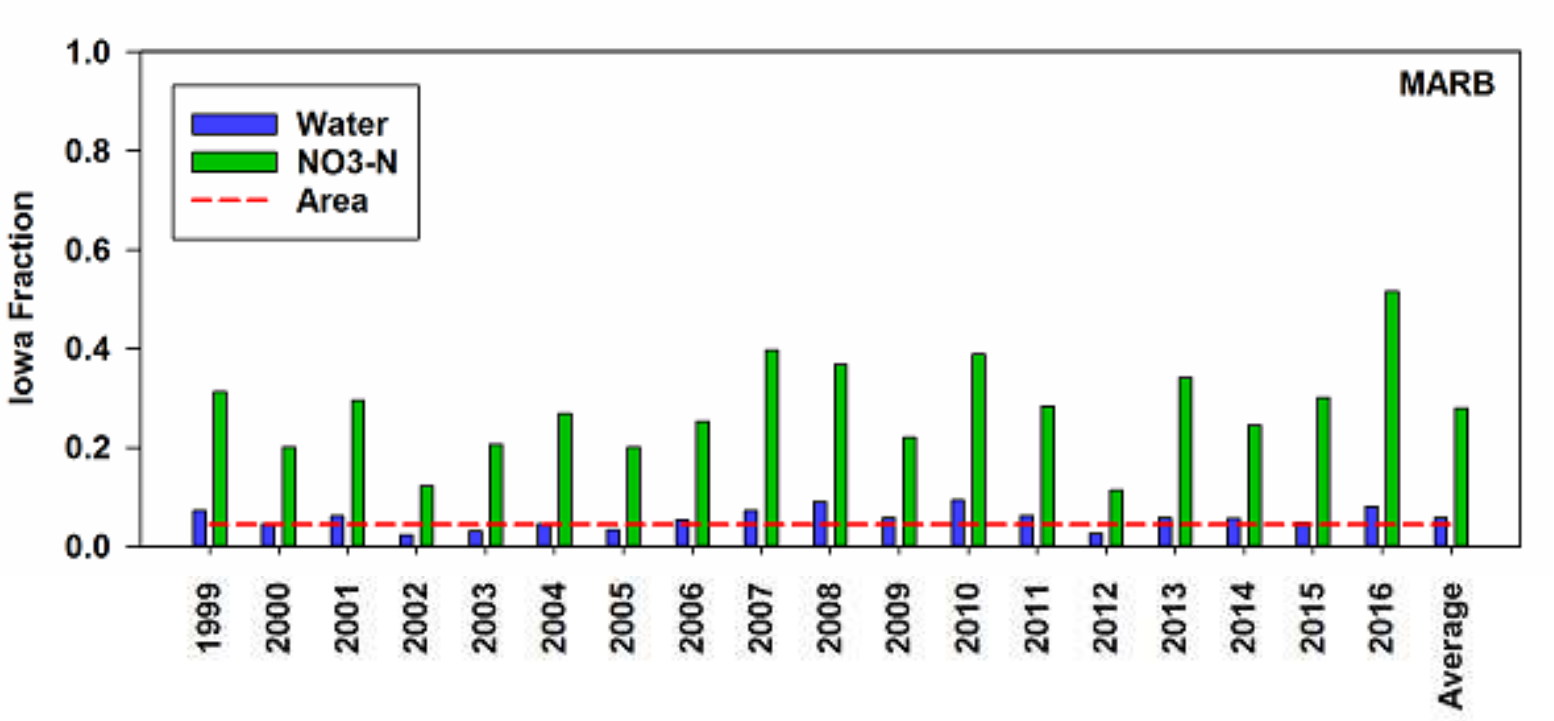
3.3% of the land
12% of the water
55% of the nitrate

Upper Mississippi

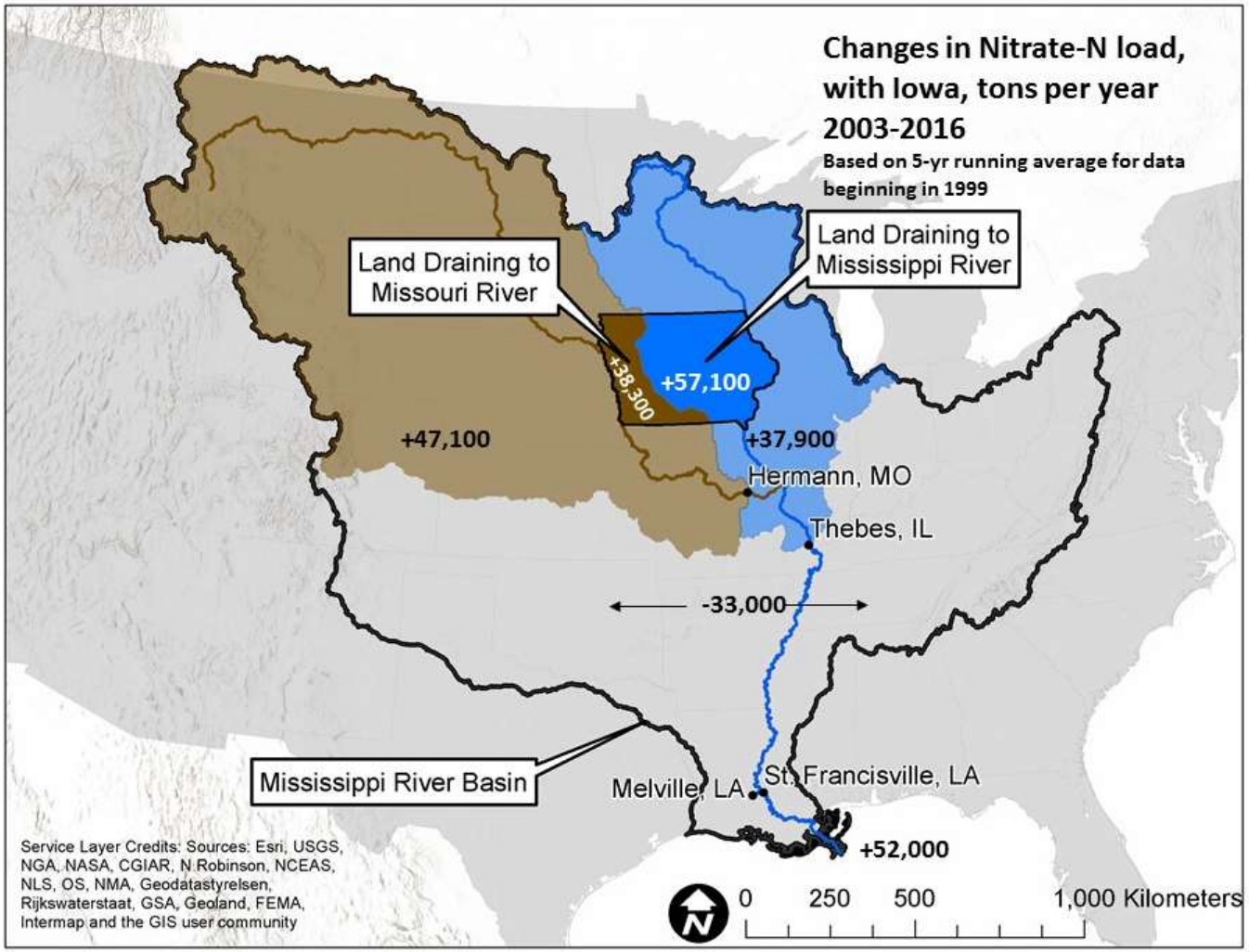


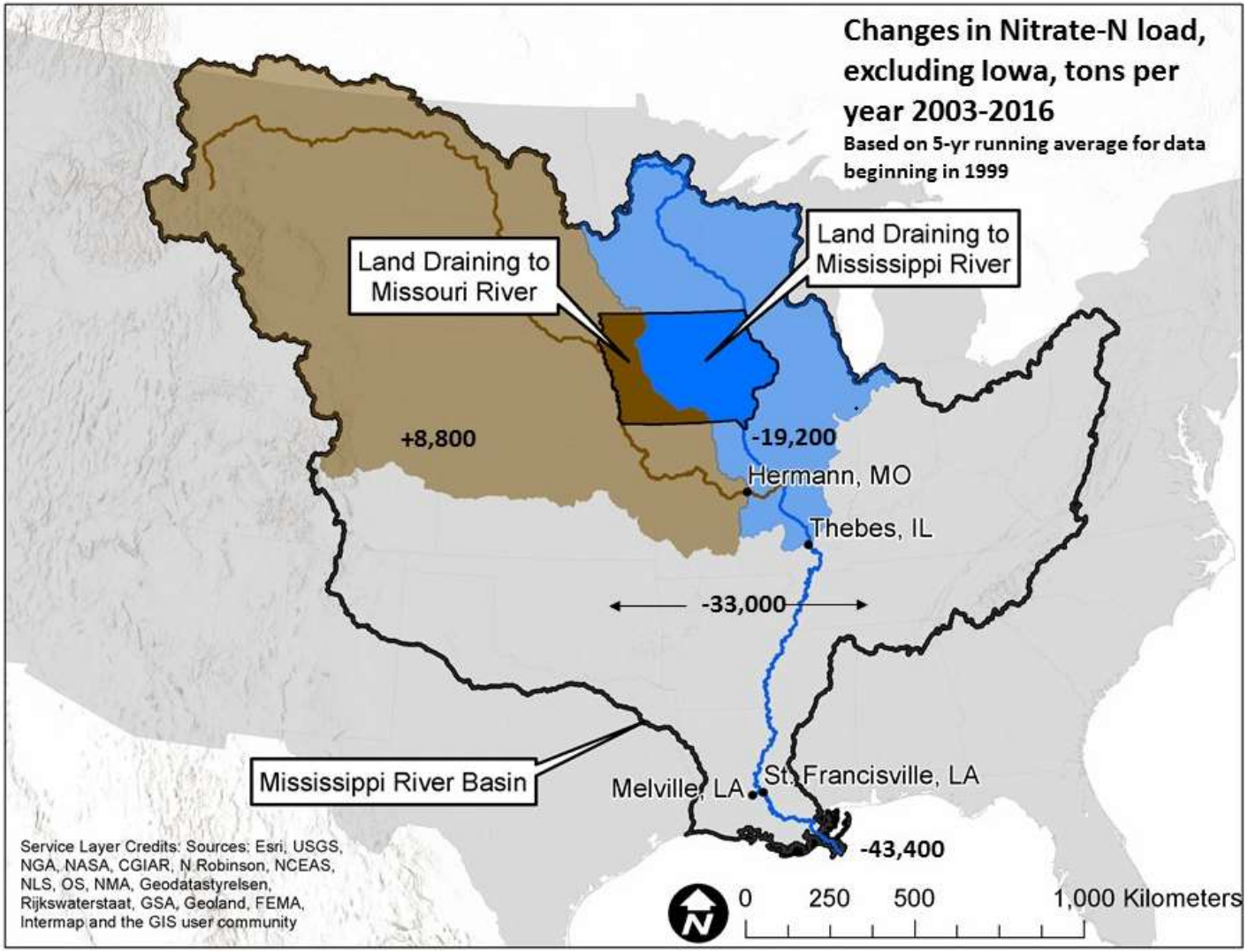
21% of the land
21% of the water
45% of the nitrate

Mississippi-Atchafalaya-Gulf of Mexico

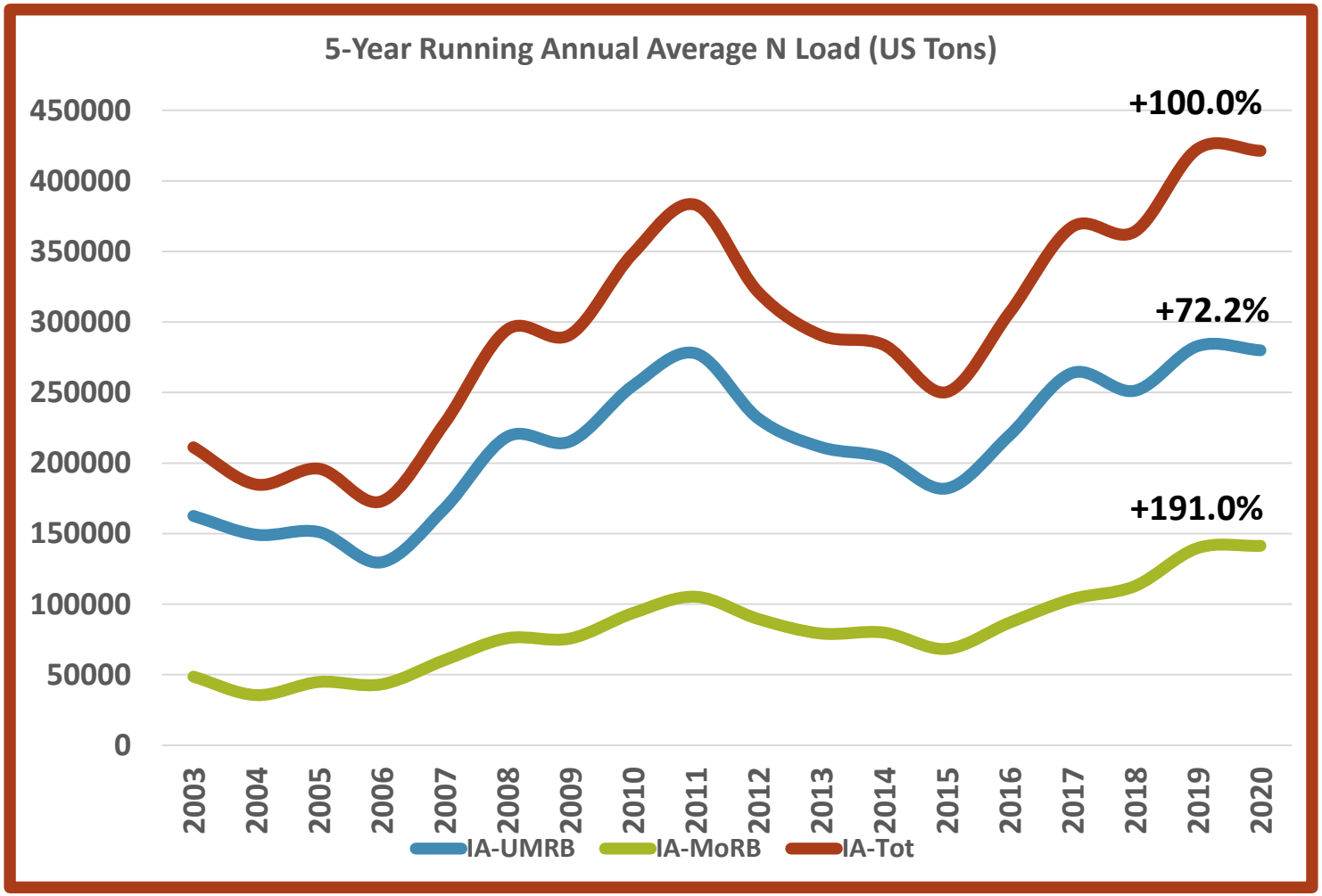


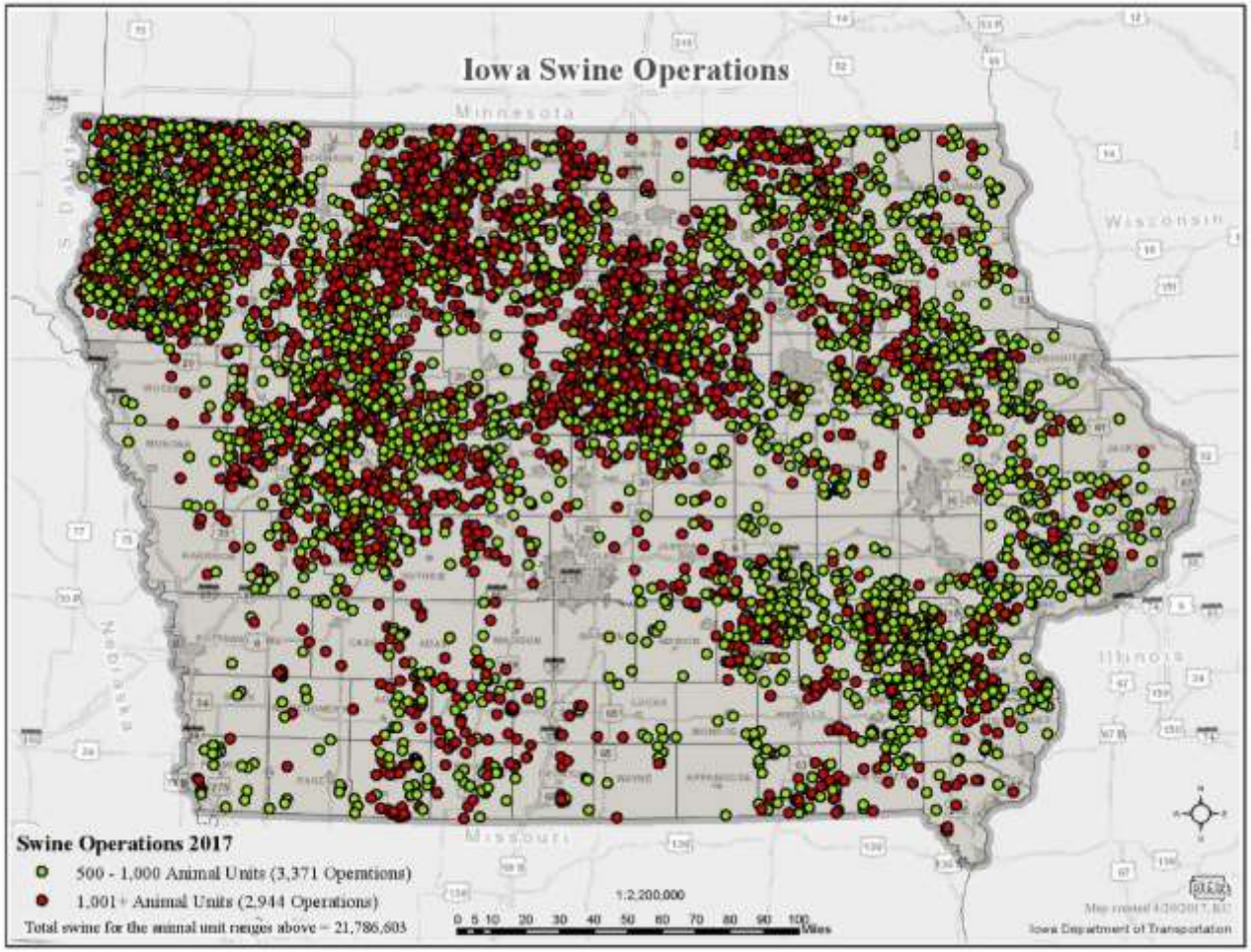
4.5% of the land
5.9% of the water
29% of the nitrate

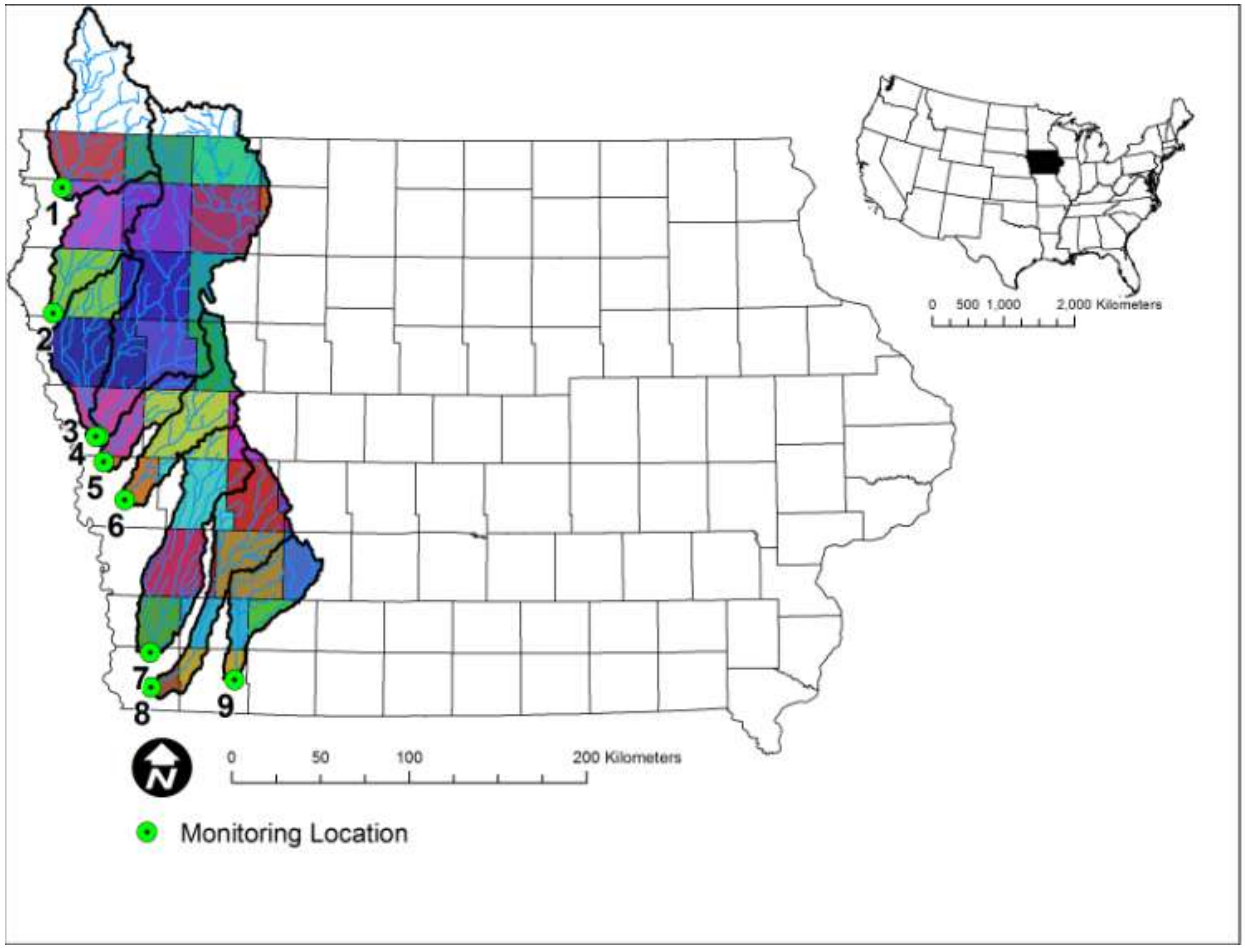

Changes in Nitrate-N load, with Iowa, tons per year 2003-2016
Based on 5-yr running average for data beginning in 1999
Land Draining to Missouri River
Land Draining to Mississippi River
+38,300
+57,100
+47,100
+37,900
Hermann, MO
Thebes, IL
-33,000
Mississippi River Basin
Melville, LA
St. Francisville, LA
+52,000
Service Layer Credits: Sources: Esri, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community
0 250 500 1,000 Kilometers


Changes in Nitrate-N load, excluding Iowa, tons per year 2003-2016
Based on 5-yr running average for data beginning in 1999
Land Draining to Missouri River
Land Draining to Mississippi River
+8,800
-19,200
Hermann, MO
Thebes, IL
-33,000
Mississippi River Basin
Melville, LA
St. Francisville, LA
-43,400
Service Layer Credits: Sources: Esri, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community
0 250 500 1,000 Kilometers

How Much Nitrogen Leaves Iowa?




Iowa Swine Operations
Minnesota
Wisconsin
Illinois
Missouri
Swine Operations 2017
500 - 1,000 Animal Units (3,371 Operations)
1,001+ Animal Units (2,944 Operations)
Total swine for the animal unit ranges above = 21,786,803
1:2,200,000
0 5 10 20 30 40 50 60 70 80 90 100 Miles
Iowa Department of Transportation


1
2
3
4
5
6
7
8
9
0 500 1,000 2,000 Kilometers
N
0 50 100 200 Kilometers
Monitoring Location

USGS
science for a changing world

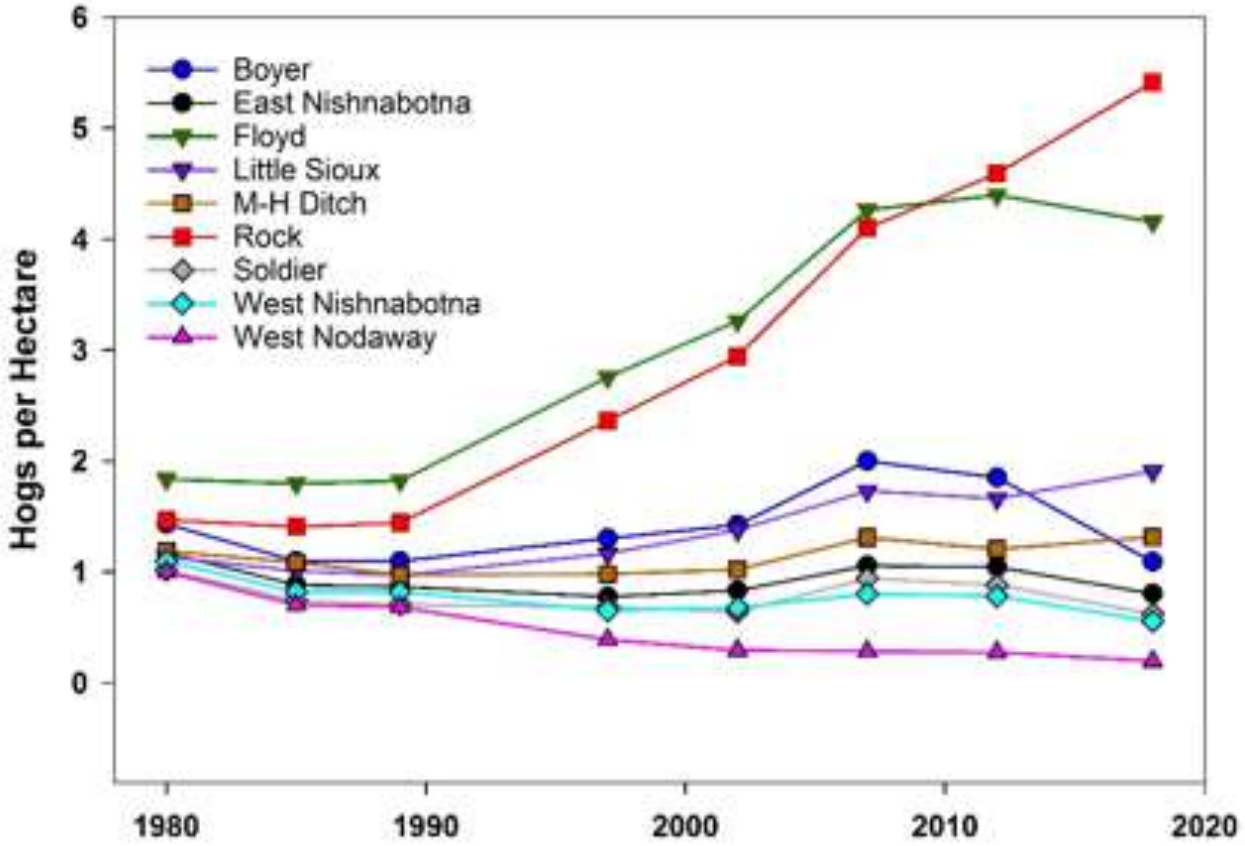
ScienceBase-Catalog Communities Help

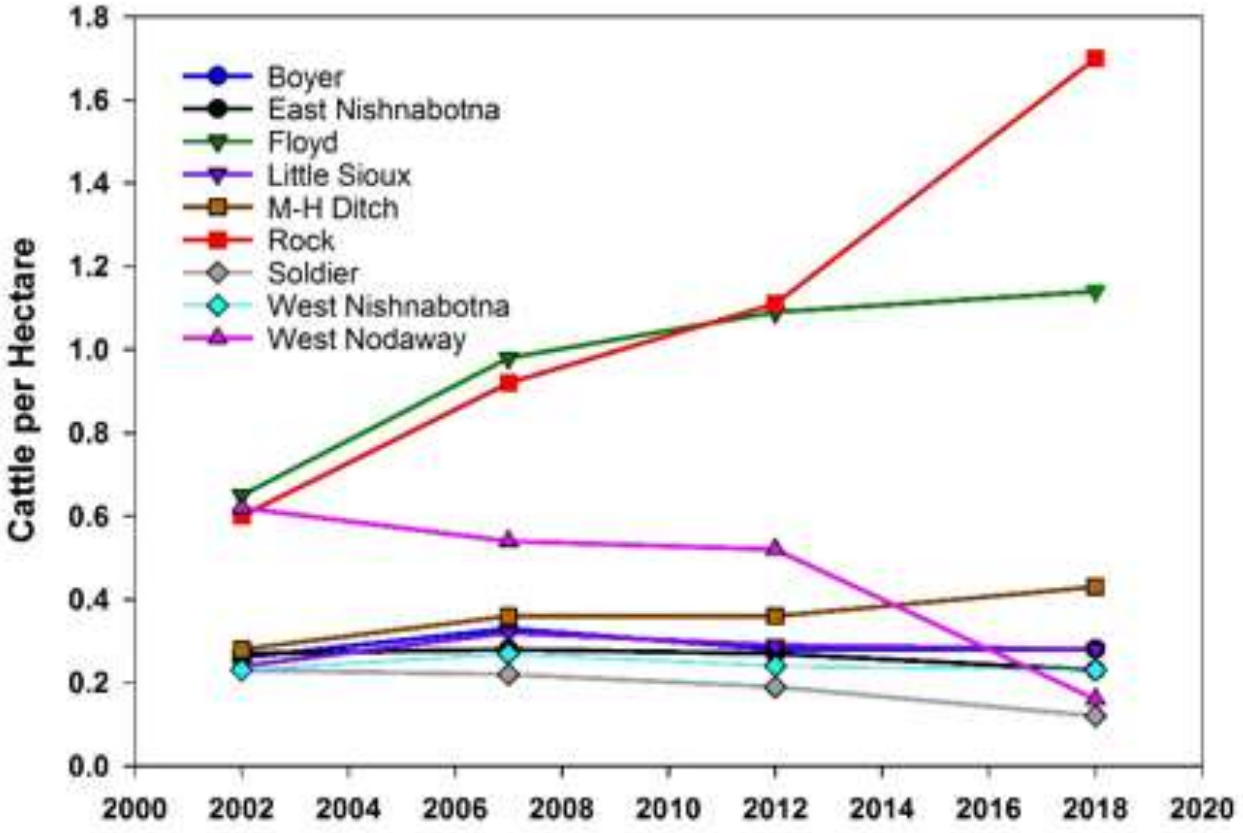
ScienceBase Catalog → USGS Data Release Products → County-Level Estimates of N...

County-Level Estimates of Nitrogen and Phosphorus from Commercial Fertilizer for the Conterminous United States, 1987-2012

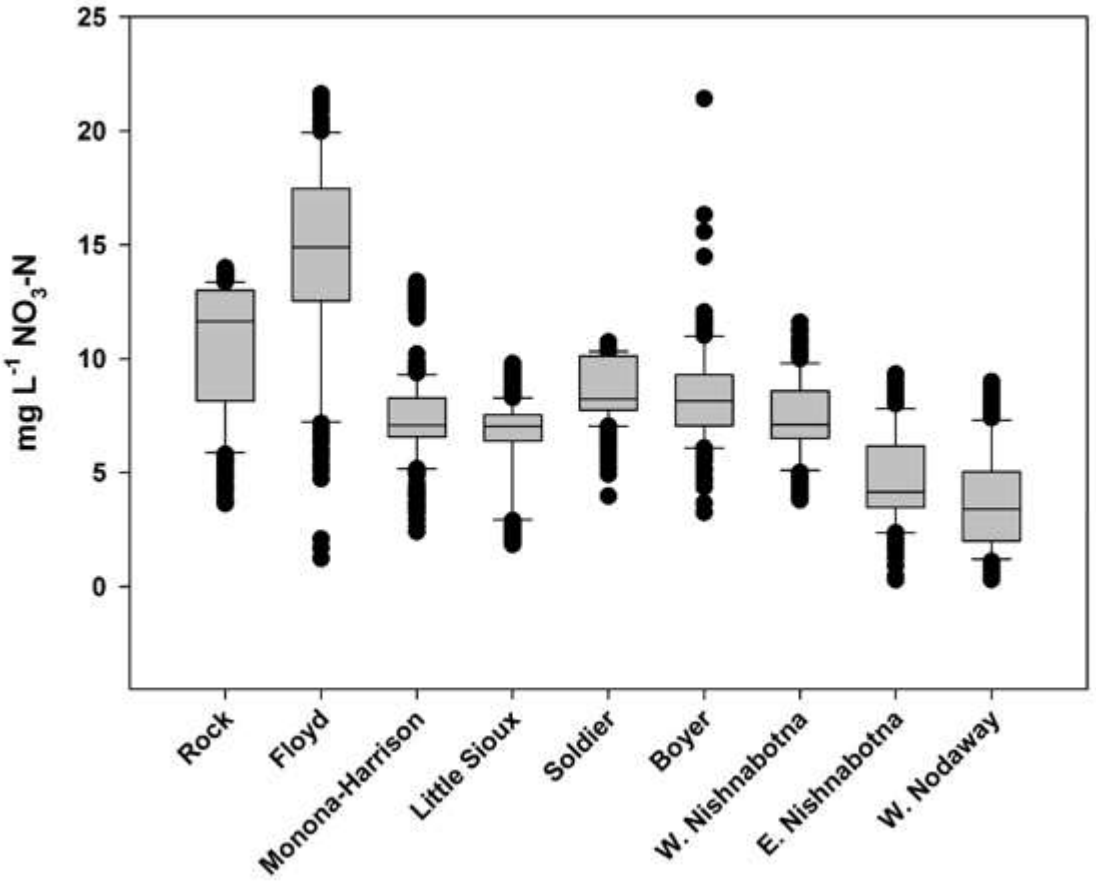
USGS
science for a changing world

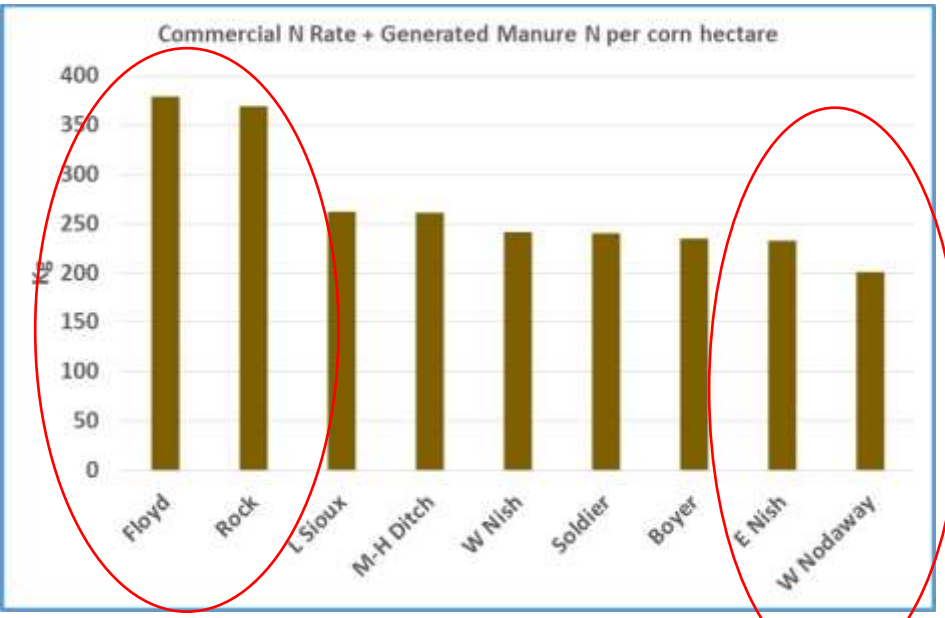
County-Level Estimates of Nitrogen and Phosphorus from Animal Manure for the Conterminous United States, 2007 and 2012

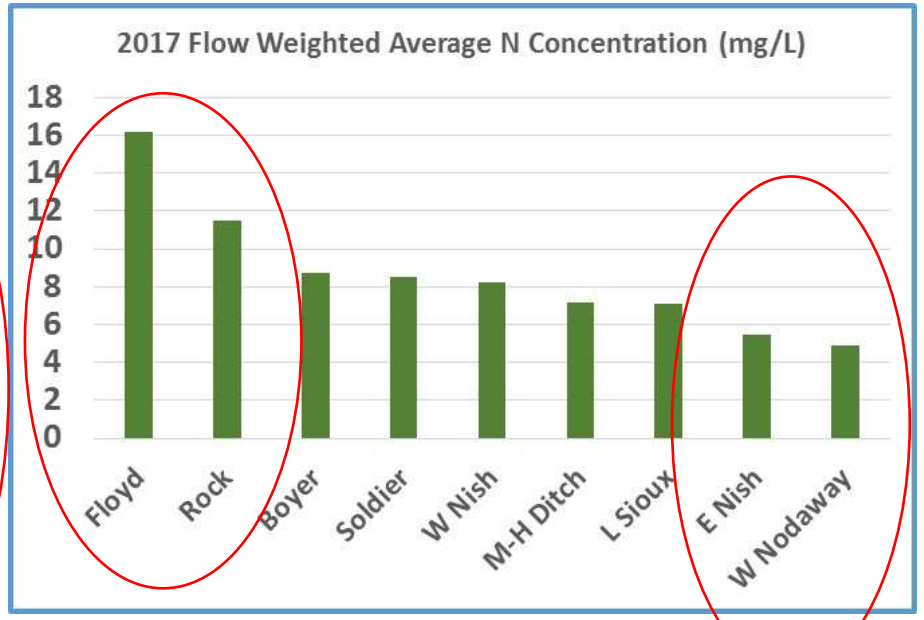

Hogs per Hectare
0
1
2
3
4
5
6
1980
1990
2000
2010
2020
Boyer
East Nishnabotna
Floyd
Little Sioux
M-H Ditch
Rock
Soldier
West Nishnabotna
West Nodaway


Cattle per Hectare
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Boyer
East Nishnabotna
Floyd
Little Sioux
M-H Ditch
Rock
Soldier
West Nishnabotna
West Nodaway

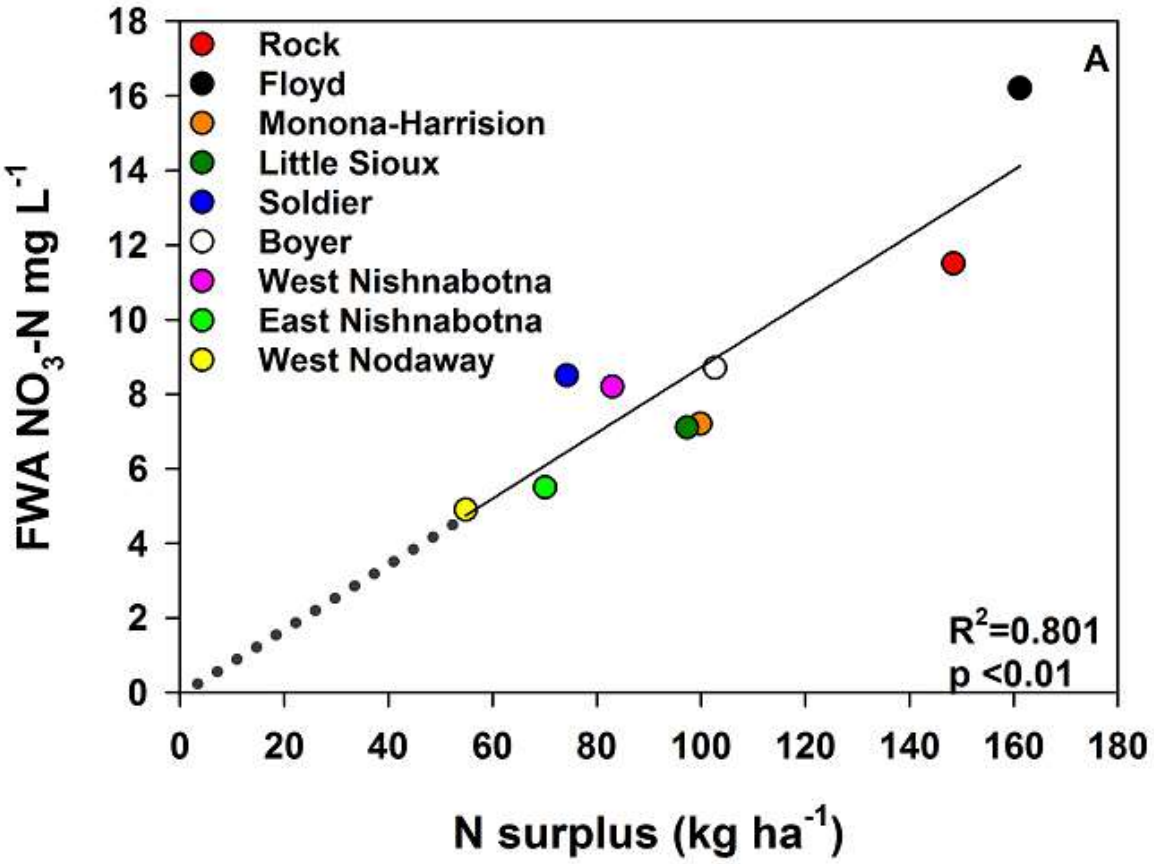
Stream Nitrate



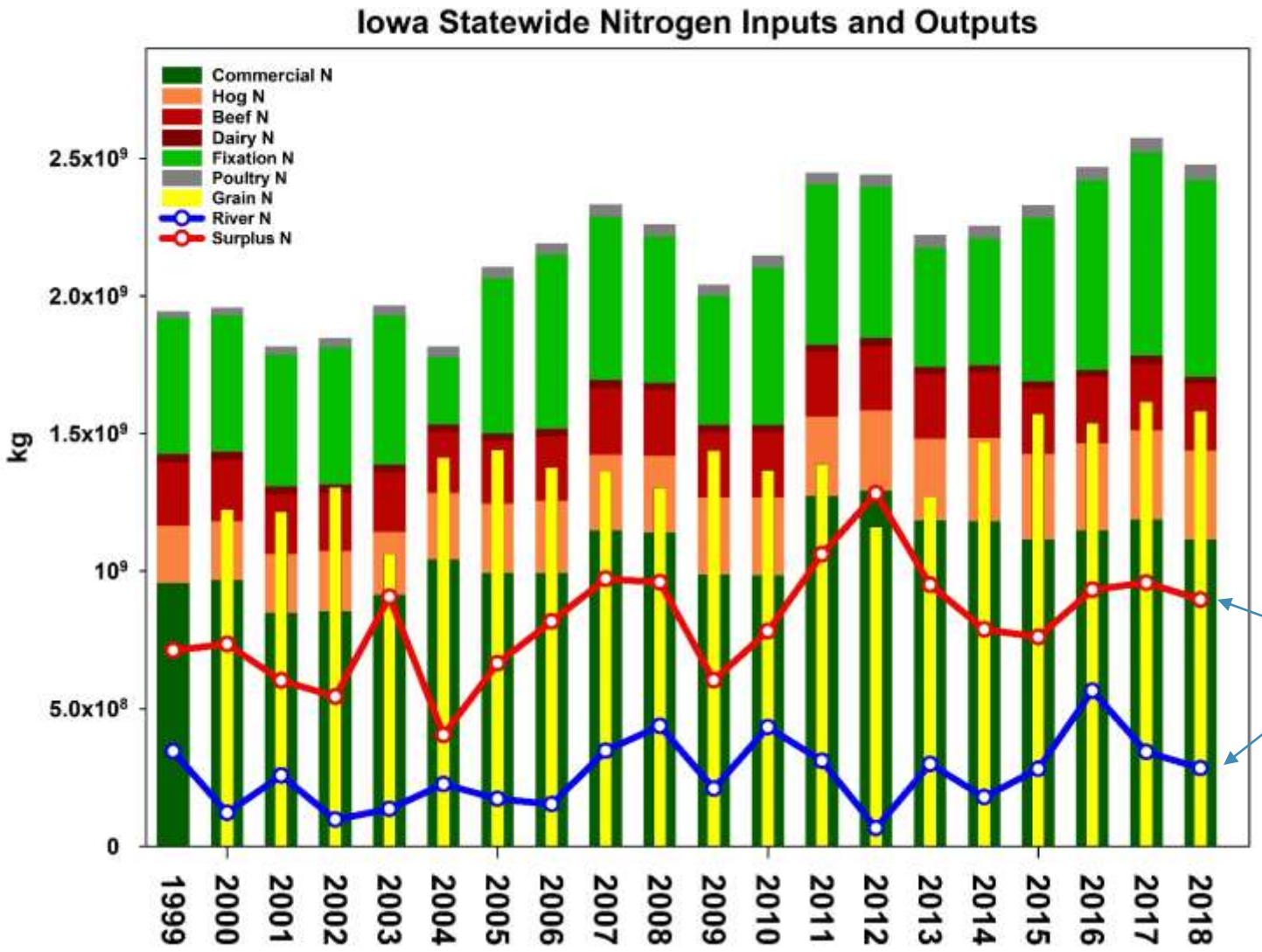




Input amounts to corn calculated assuming statewide average of 15.7 kg/ha to soybeans applies. (USDA 2014).



Surplus = Commercial N + Manure N + Fixation N – Grain N



About 32% of "surplus" makes it to streams

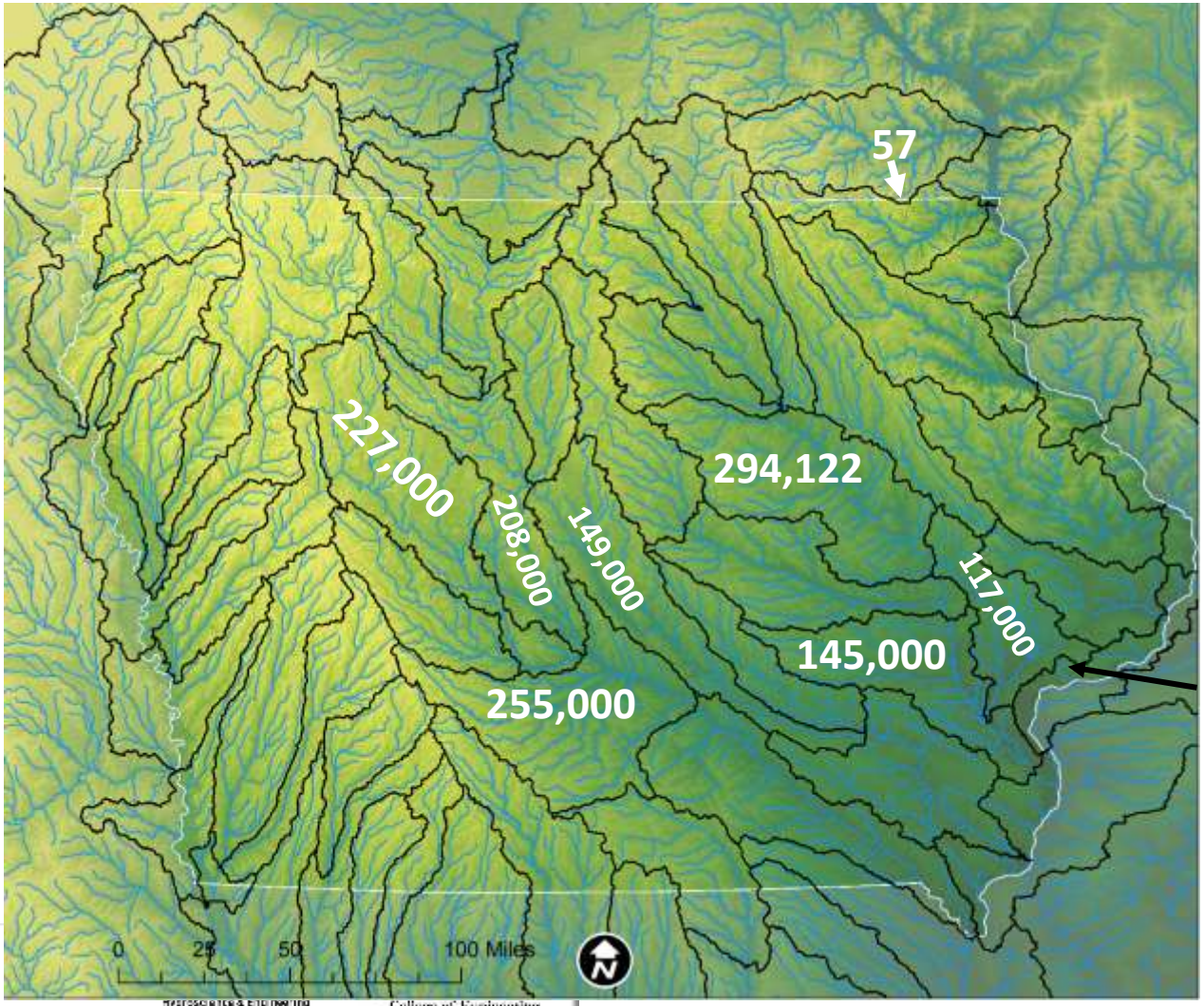
Nitrogen Change (Metric Tons) Since 1999

N Category	Difference (Mg)
total inputs	661,370
Surplus	332,553
Grain N	328,817
Commercial	310,291
Fixation	186,845
River	154,254
Hogs	122,916
Beef	22,464
Chicken	17,997
Turkey	4,144
Dairy	-3,287

Nitrogen Change (%) Since 1999

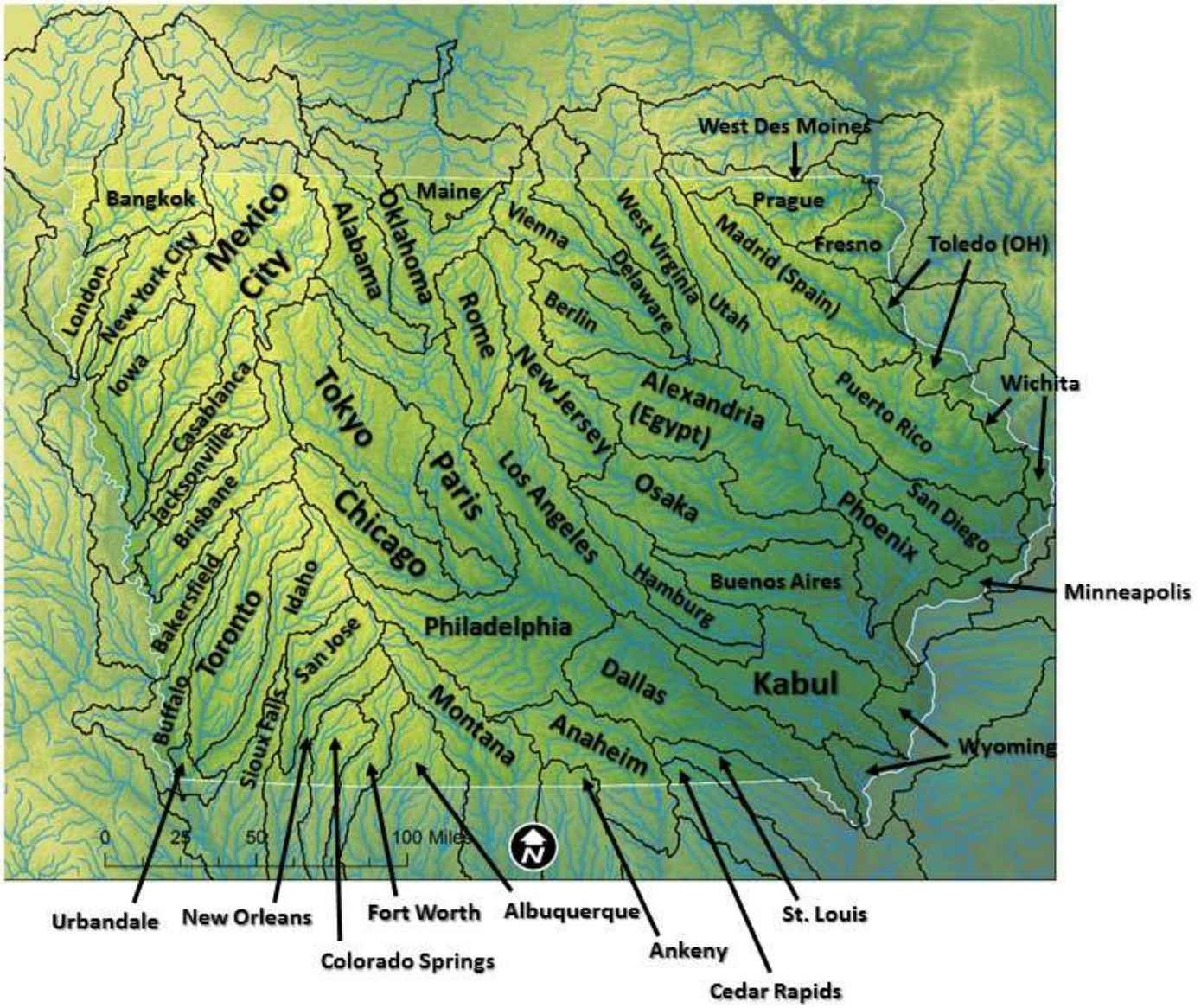
N Category	% change
River	83
Chicken	76
Turkey	59
Hogs	59
Surplus	51
Fixation	41
total inputs	36
Commercial	34
Grain N	27
Beef	10
Dairy	-11

Iowa HUC 8 Watersheds

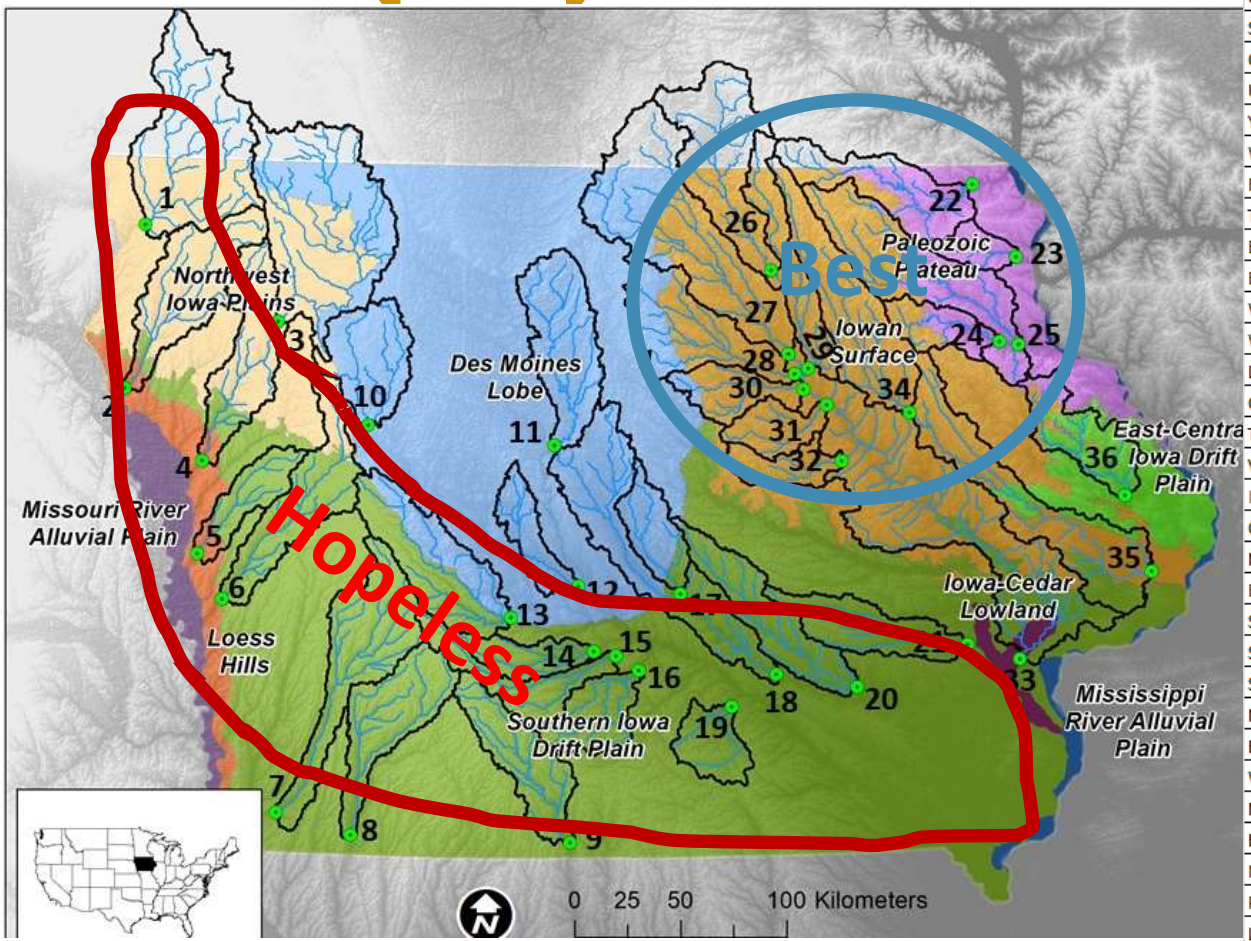


Half of Iowa's Population lives in 8 watersheds:

- Middle Cedar
- Lake Red Rock
- North Raccoon
- Copperas-Duck
- Middle Des Moines
- South Skunk
- Lower Iowa
- Lower Cedar


West Des Moines
Bangkok
Maine
Prague
Vienna
Fresno
Toledo (OH)
Mexico City
Alabama
Oklahoma
West Virginia
Madrid (Spain)
London
New York City
Delaware
Utah
Berlin
Rome
Iowa
Tokyo
New Jersey
Alexandria (Egypt)
Puerto Rico
Wichita
Casablanca
Paris
Los Angeles
Osaka
Jacksonville
Brisbane
Chicago
Phoenix
San Diego
Buenos Aires
Minneapolis
Idaho
Hamburg
Bakersfield
Toronto
Philadelphia
San Jose
Dallas
Kabul
Buffalo
Sioux Falls
Montana
Anaheim
Wyoming
0
25
50
100 Miles
N
Urbandale
New Orleans
Fort Worth
Albuquerque
St. Louis
Colorado Springs
Ankeny
Cedar Rapids

Water Quality Index



Site	Rank	Map #	00-20
Wapsipinicon River at Independence	1	34	53.7
Cedar River at Janesville	2	29	51.7
Shellrock River at Shellrock	3	27	51.7
Cedar River at Charles City	4	26	48.9
Upper Iowa River at Dorchester	5	22	48.1
Yellow River at Ion	6	23	48.1
W. Fork of the Cedar River at Finchford	7	28	47.9
Boone River at Stratford	8	11	45.0
Turkey River at Garber	9	25	43.2
Beaver Creek at Cedar Falls	10	30	42.7
Blackhawk Creek at Waterloo	11	31	42.3
Wapsipinicon River at DeWitt	12	35	41.1
Wolf Creek at LaPorte City	13	32	41.0
Little Sioux River at Larrabee	14	3	40.3
Cedar River at Conesville	15	33	40.1
Thompson River at Davis City	16	9	40.0
Volga River at Elkport	17	24	39.9
Indian Creek at Colfax	18	17	37.9
Cedar Creek at Oakland Mills	19	19	37.4
North Skunk River at Sigourney	20	20	37.1
Beaver Creek at Grimes	21	12	36.8
South Raccoon River at Redfield	22	13	36.4
South River at Ackworth	23	15	36.2
South Skunk River at Oskaloosa	24	18	36.1
North Raccoon at Sac City	25	10	35.0
English River at Riverside	26	21	33.5
W. Nodaway at Shambaugh	27	8	33.3
North River at Norwalk	28	14	33.1
E. Nishnabotna at Shenandoah	29	7	32.8
Middle River at Indianola	30	15	32.4
Rock River at Rock Valley	31	1	32.2
Little Sioux River at Smithland	32	4	31.6
N. Fork Maquoketa R. at Hurtsville	33	36	29.9
Floyd River at Sioux City	34	2	26.8
Soldier River at Pisgah	35	5	26.4
Boyer River at Missouri Valley	36	6	26.0