Chris Jones, Research Engineer, IIHR Hydroscience and Engineering

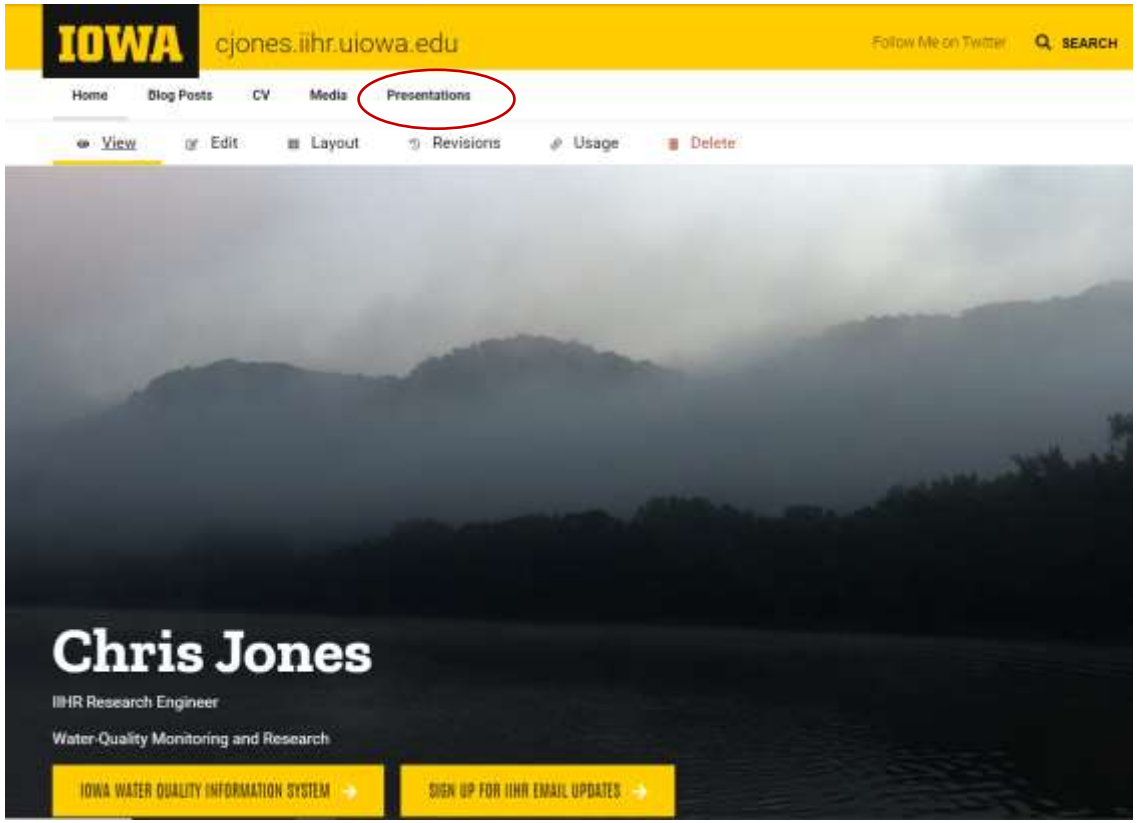
Drivers of Water Quality in the Corn-Soy-Ethanol-CAFO Production System

March 9, 2023

IFU

Slides Available at:

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



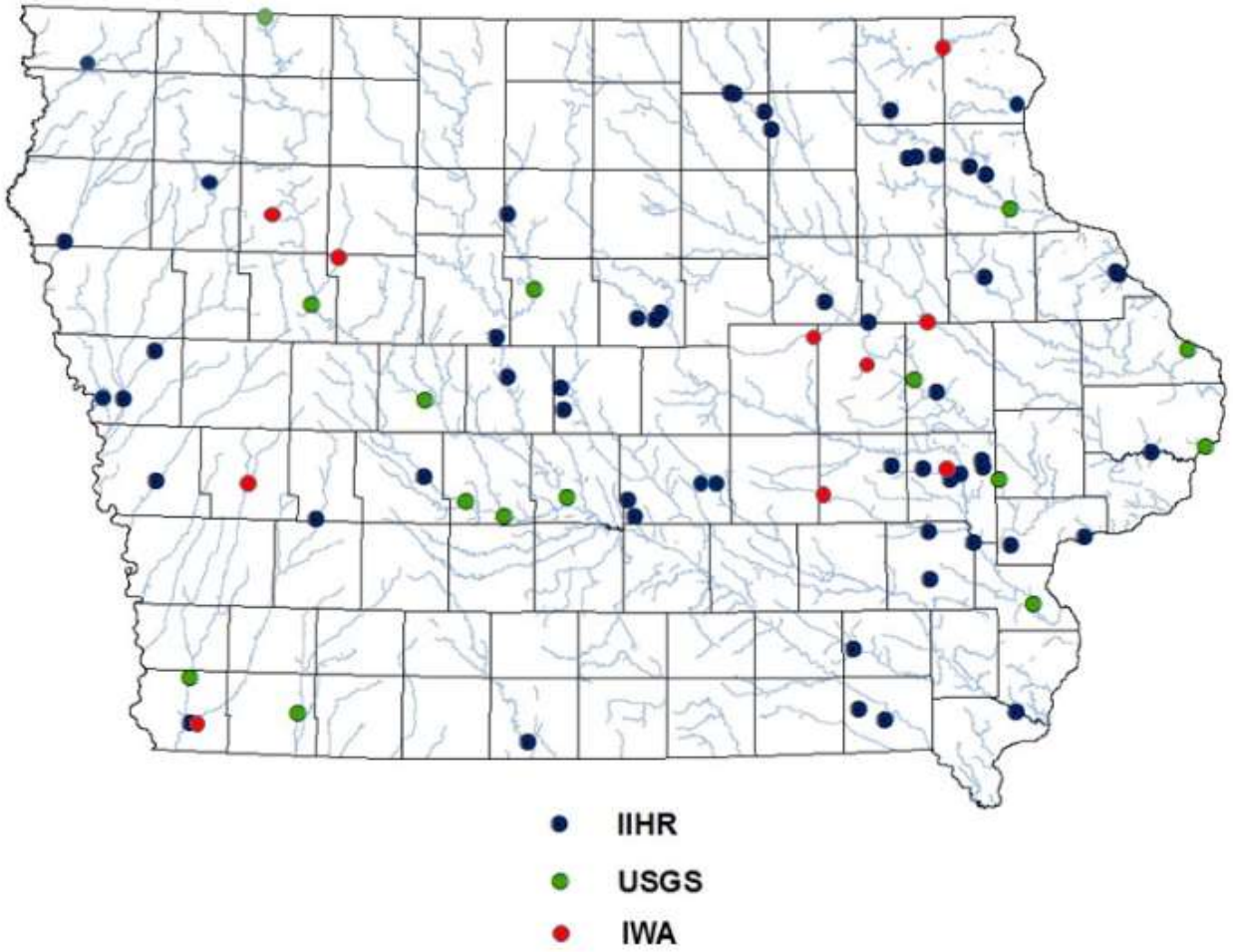
IIHR Water Quality Sensor Network

Sites

70+ sites
Nitrate-N

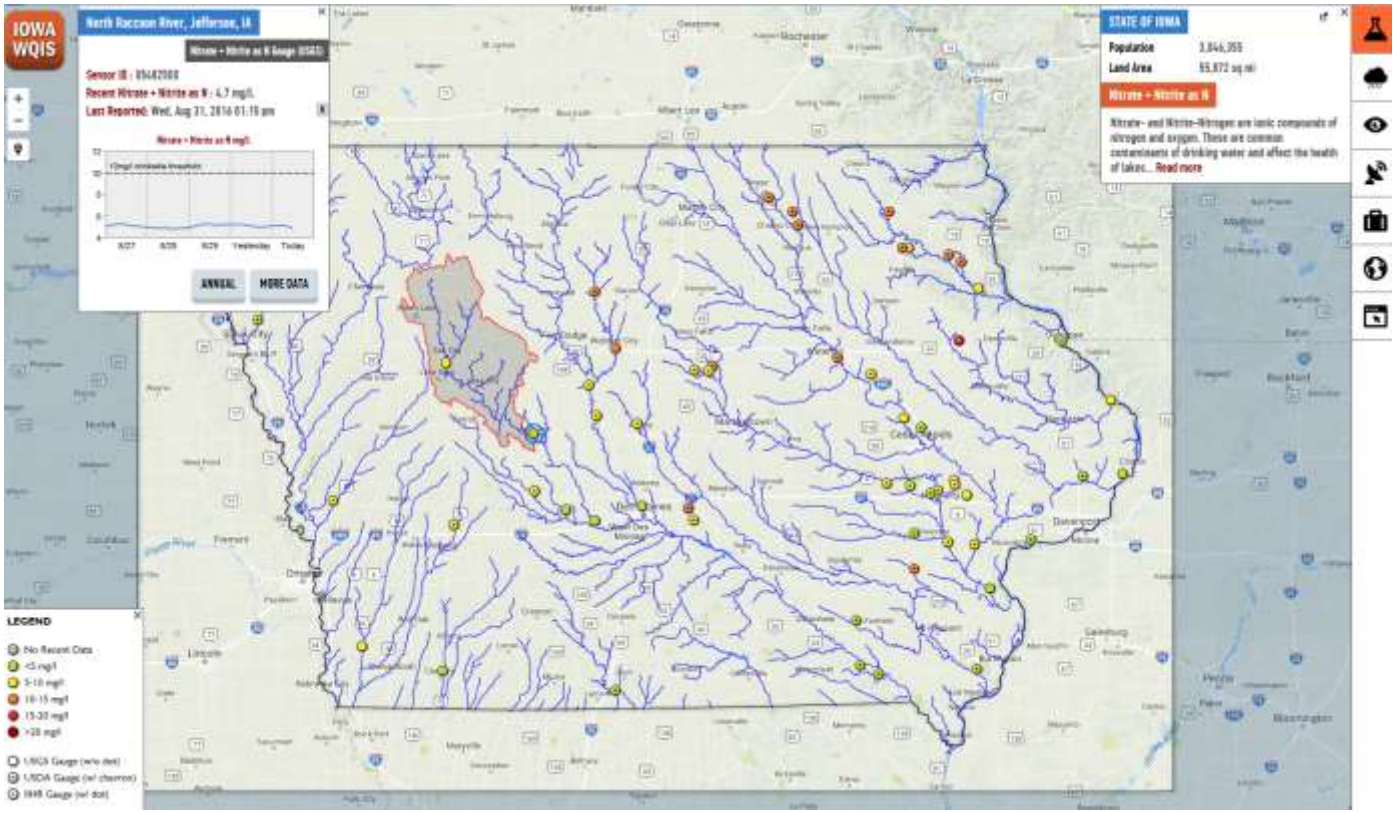
20-25 sites

- Temperature
- pH
- SC
- DO
- Turbidity



Site infrastructure

Iowa Water Quality Information System



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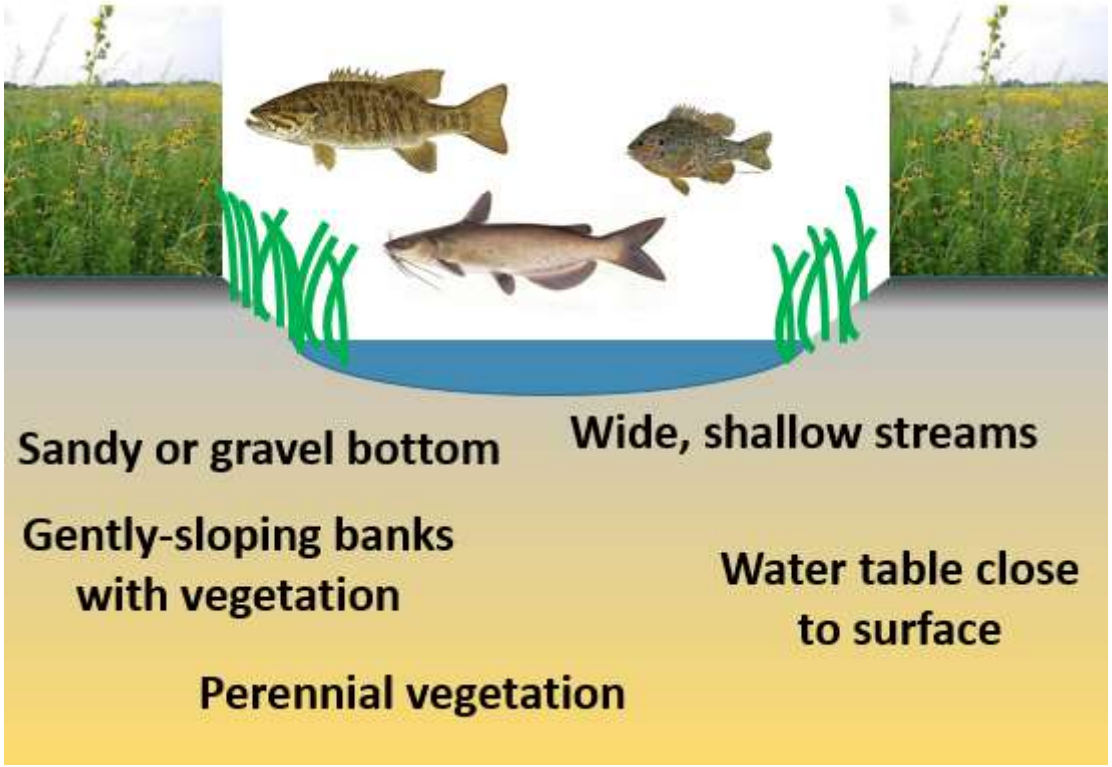
Pre-European Settlement Streams



Breaking the prairie

Photo courtesy of Deere and Company

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

Source of the Iowa River

Stream Straightening, 1930-1975

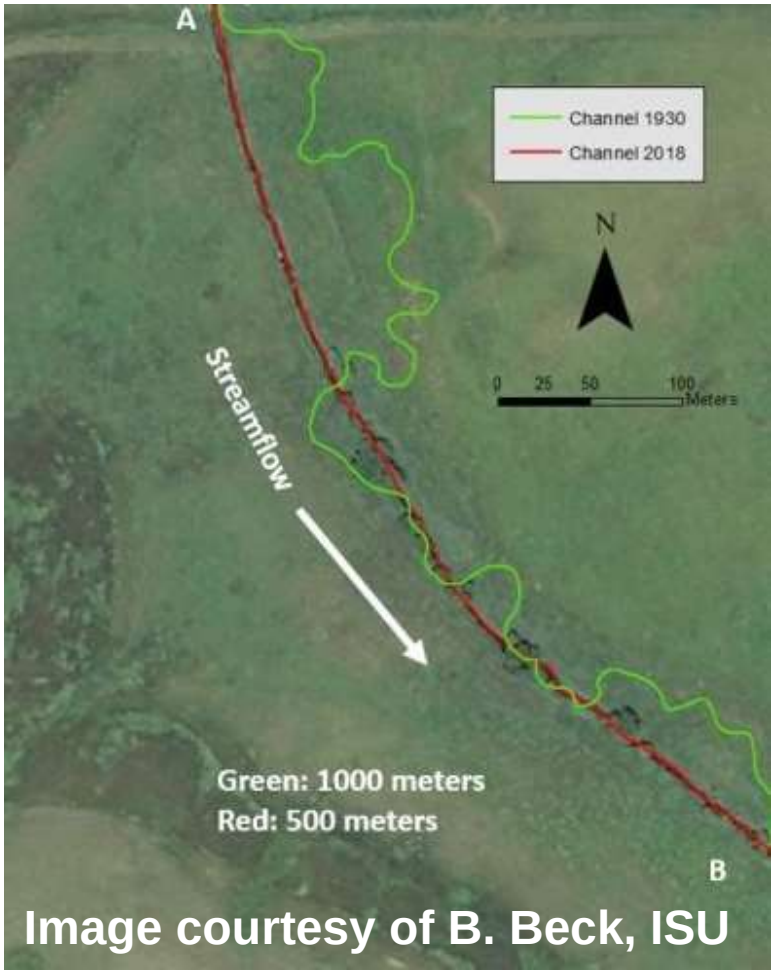


Image courtesy of B. Beck, ISU

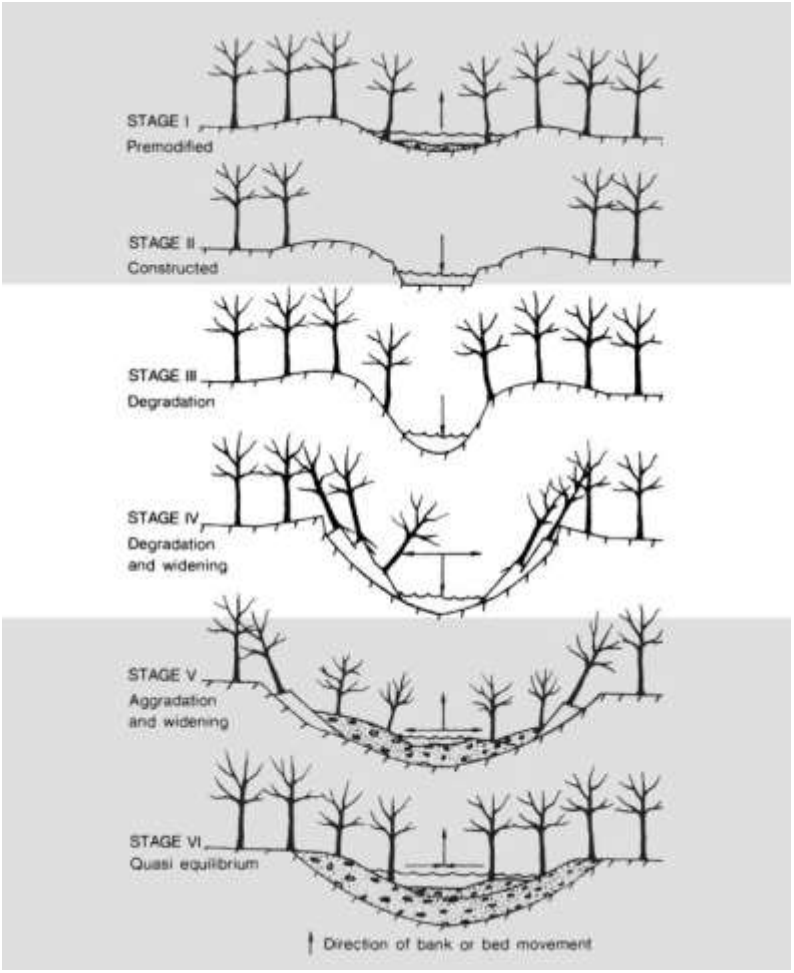
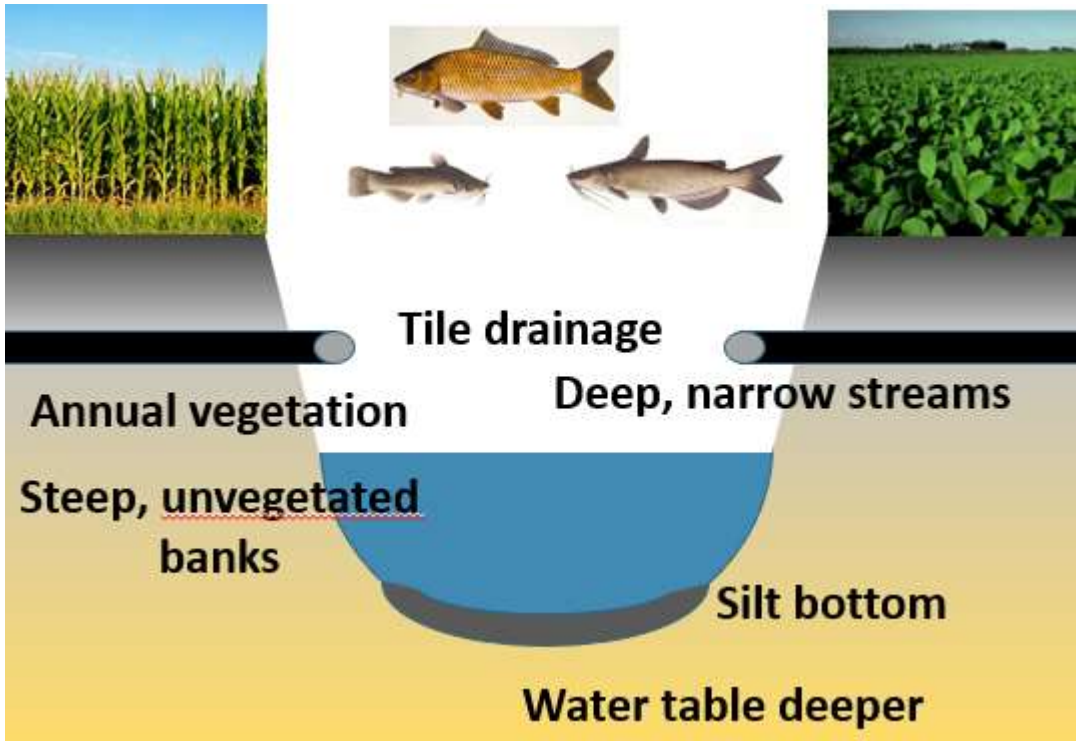


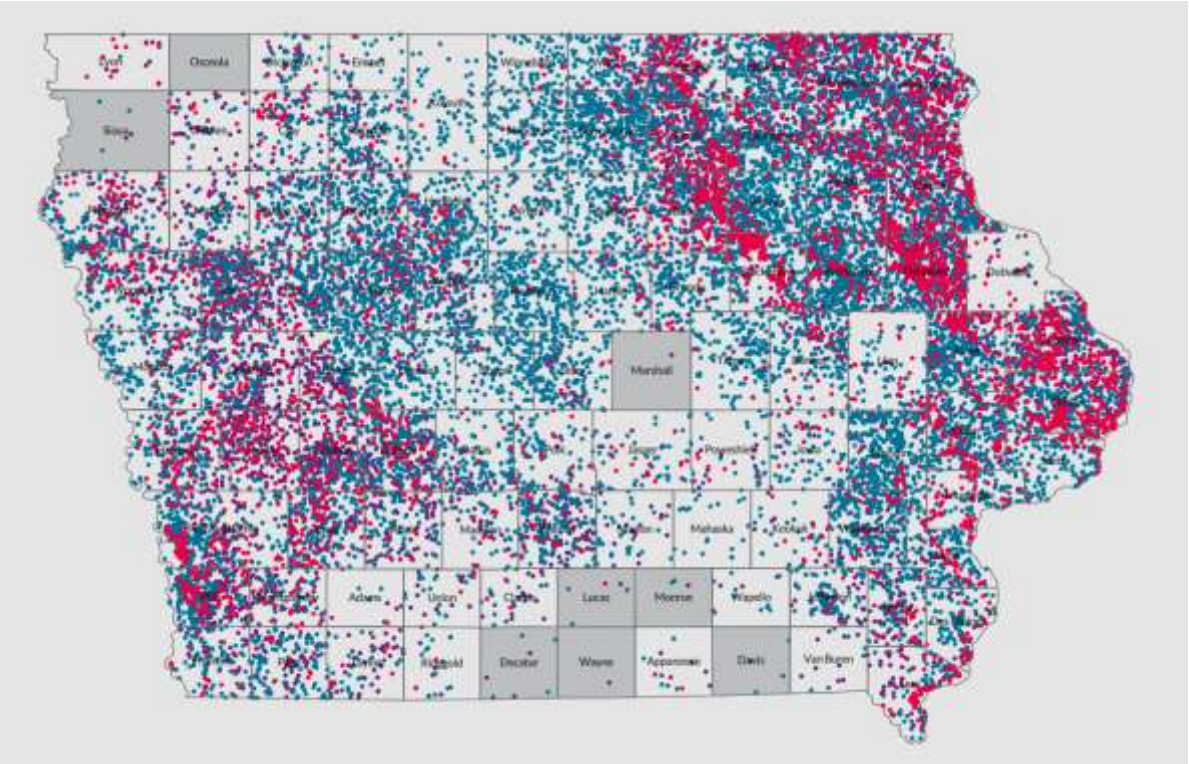
Image courtesy of
B. Beck, ISU

Modified Streams



Water Quality Consequences

Drinking Water



7000 private wells have tested above the safe drinking water level of 10 mg/L nitrate since 2000

1/3 of Iowa's Public Water Supplies are vulnerable to nitrate contamination

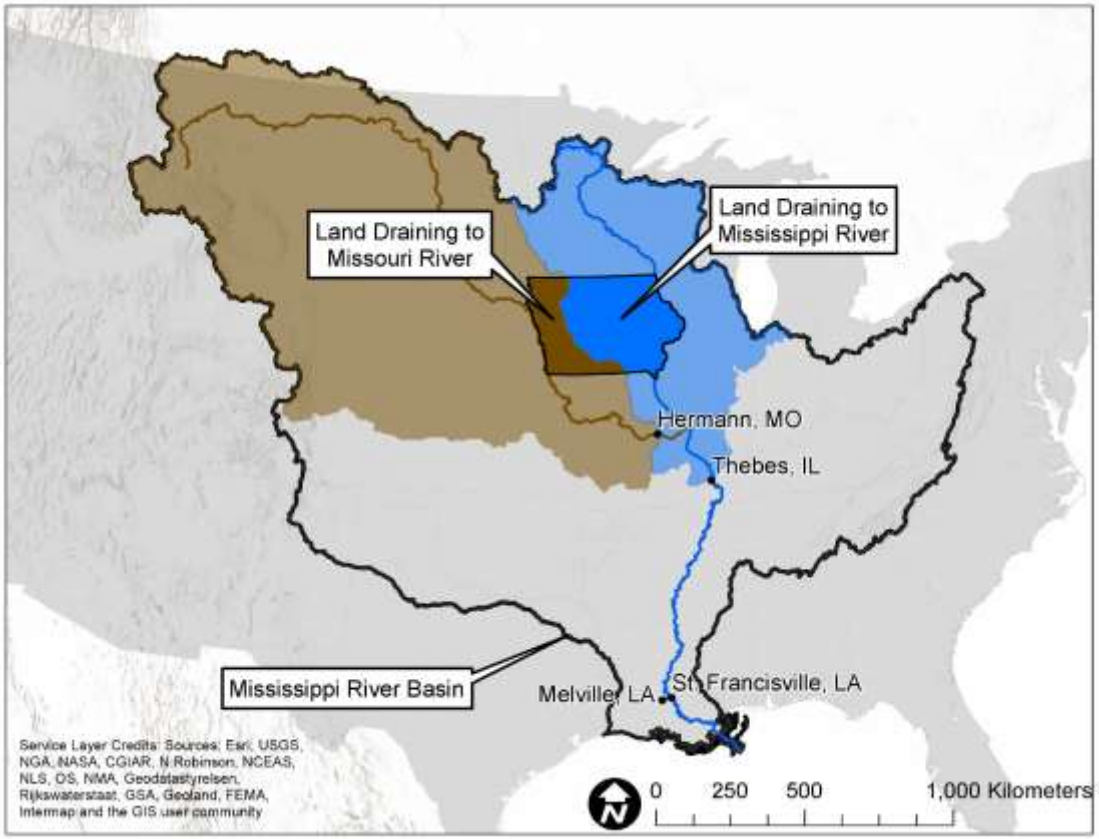
60 PWSs are removing nitrate

25% of Iowa drink water that has been treated for nitrate reduction

Problem of Scale

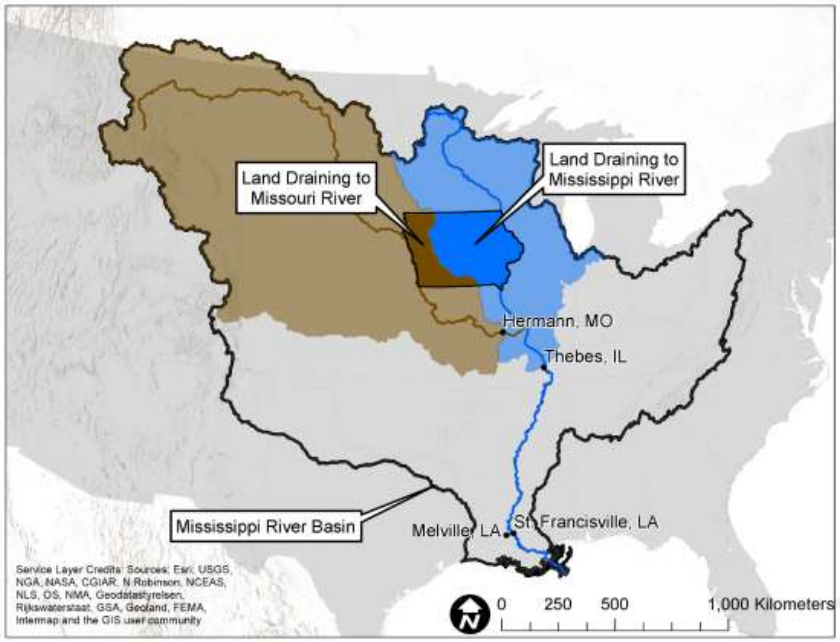
- 70% of land in corn-soy rotation
- 11,000 square miles used for ethanol production
- 25 million hogs
- 4 million beef cattle
- 80 million laying chickens
- 5 million turkeys
- 4 million broiler chickens
- 220,000 dairy cows

Iowa Contributions



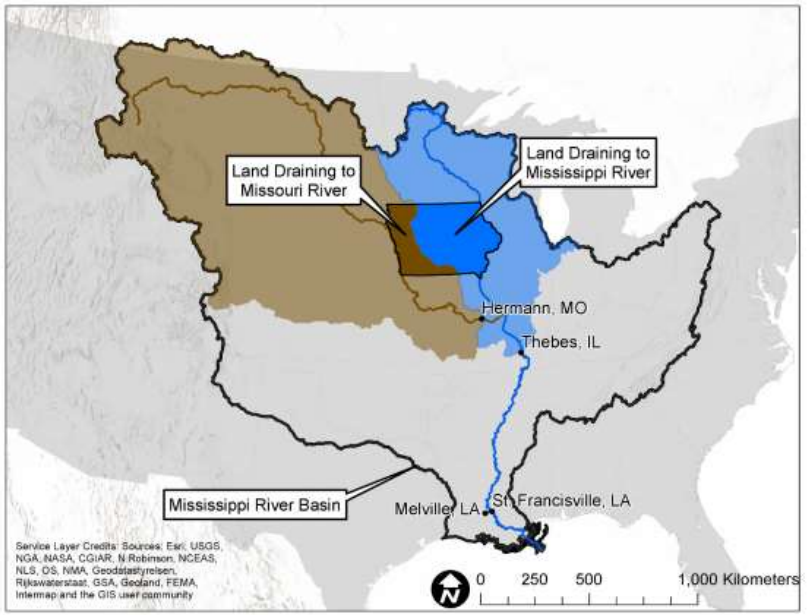
Missouri Basin: Nitrogen

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



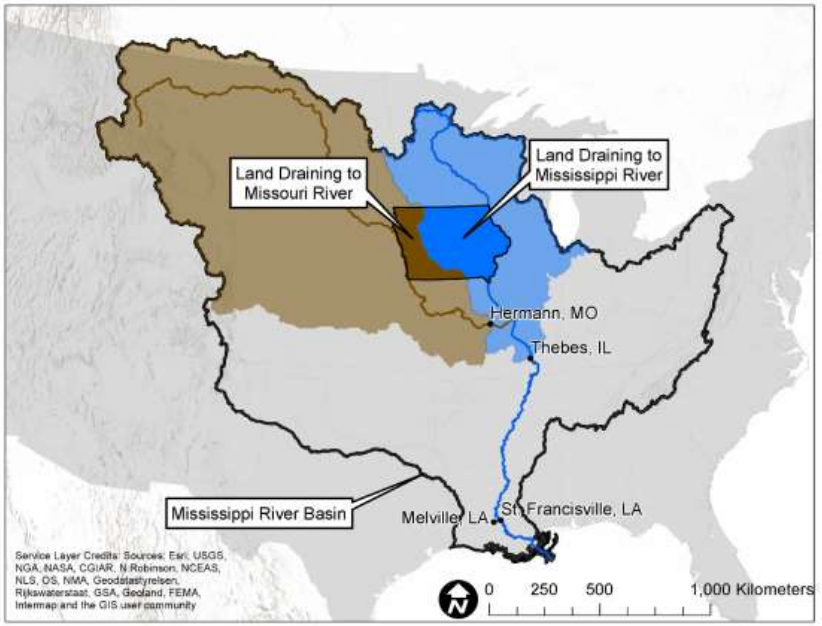
Upper Mississippi: Nitrogen

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

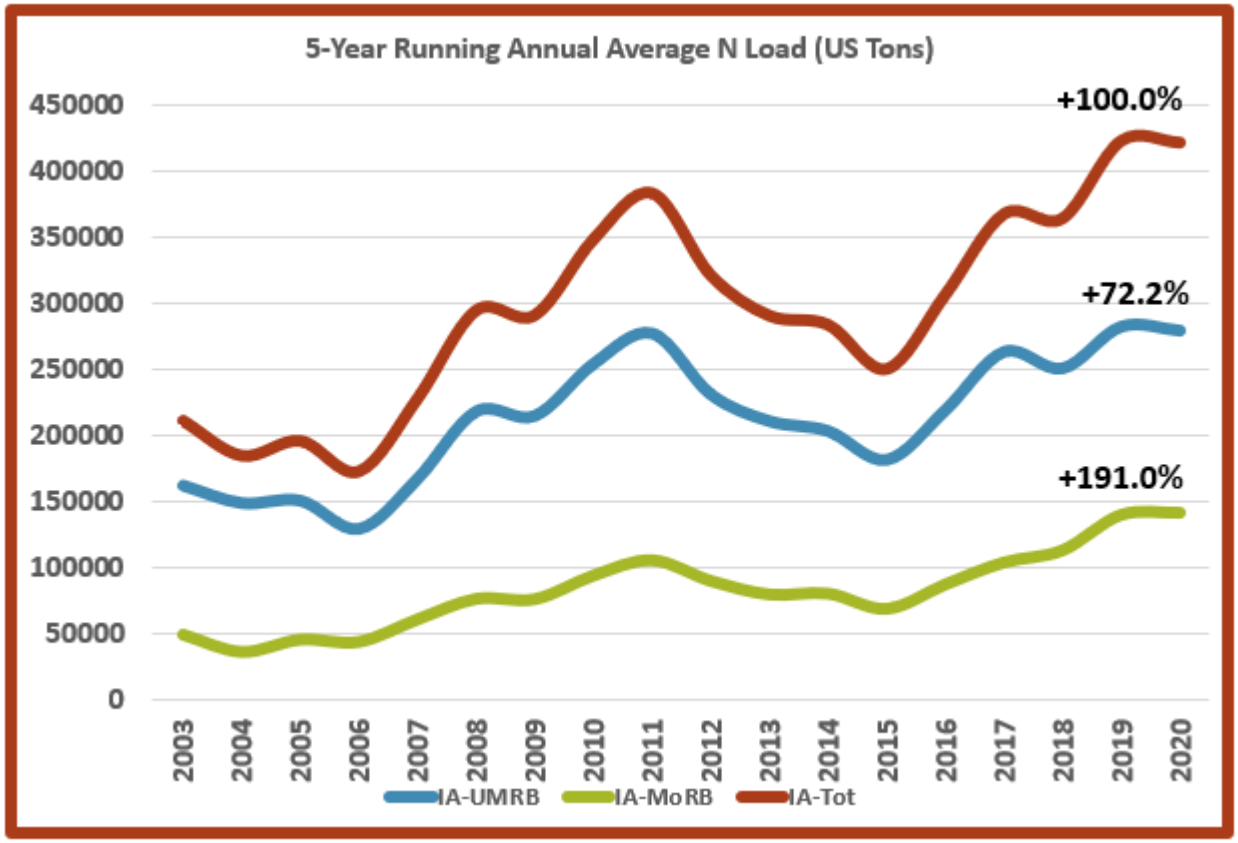


Mississippi-Atchafalaya: Nitrogen

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



How Much Nitrogen Leaves Iowa?



PLOS ONE

RESEARCH ARTICLE

Iowa stream nitrate and the Gulf of Mexico

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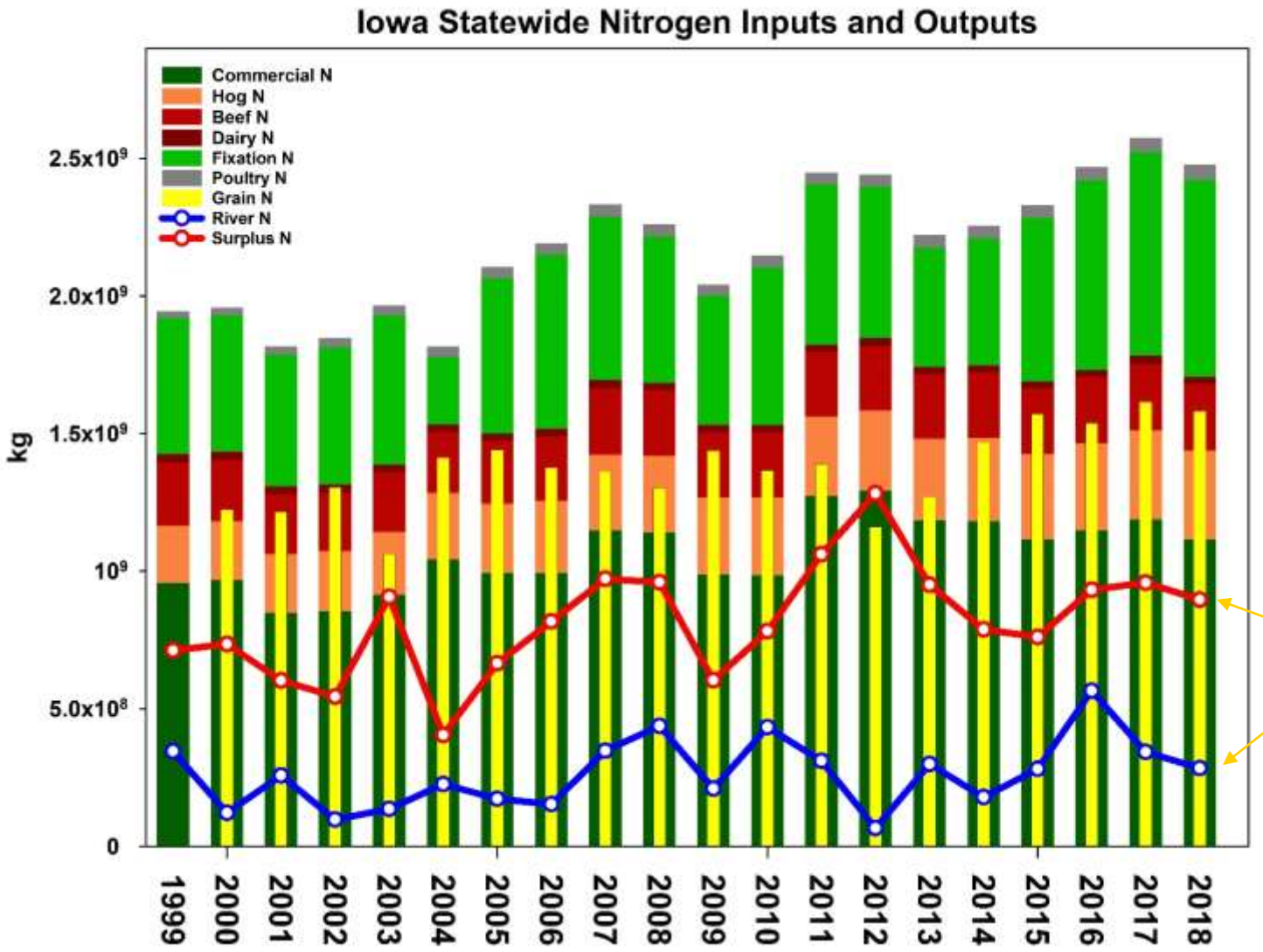
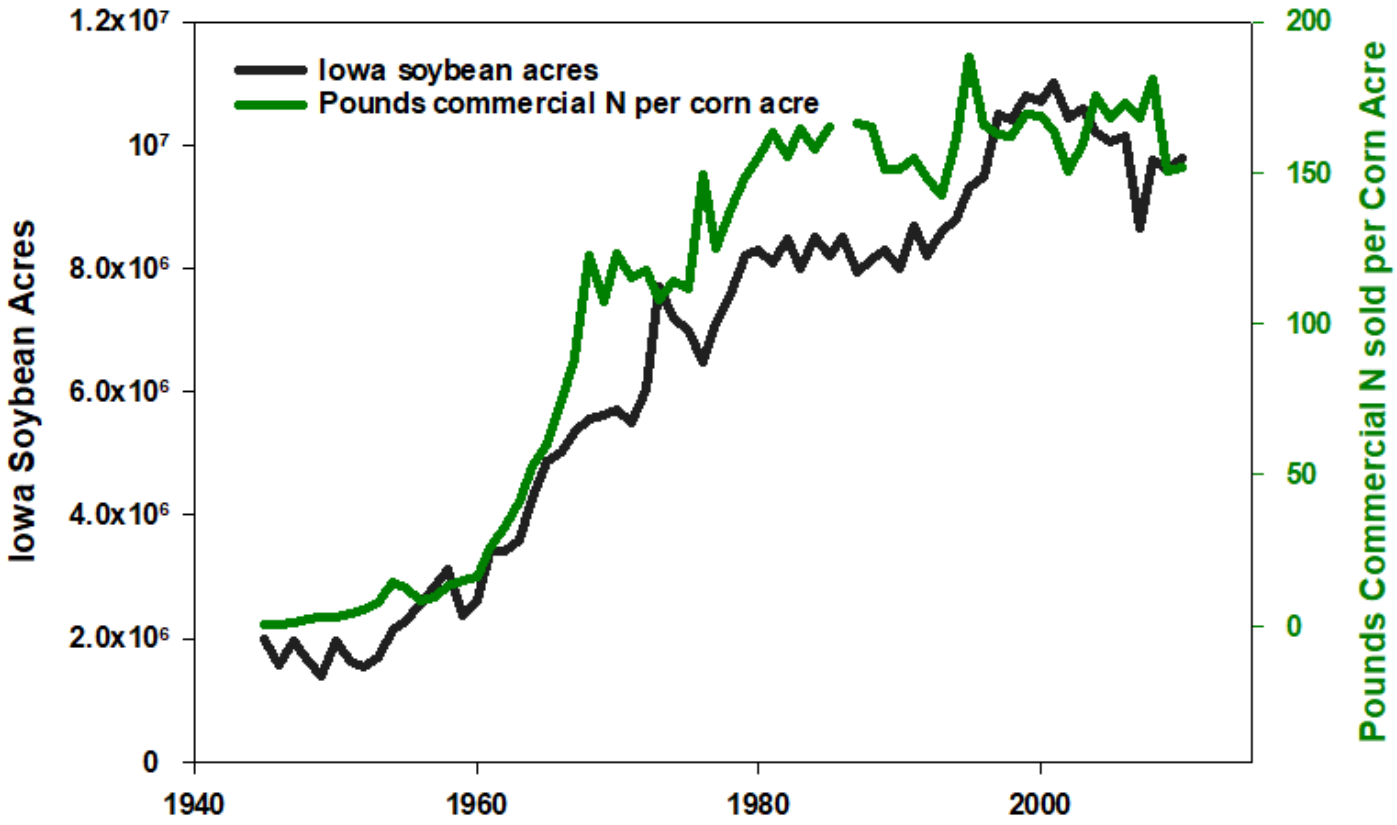
☯ These authors contributed equally to this work.
* Christopher-s-jones@uiowa.edu



About 32% of "surplus" makes it to streams

Role of Soybeans



Phosphorus

Iowa contributes 15% of Phosphorus Load to Gulf of Mexico (4.5% of Area)

“P concentrations in Iowa streams are likely 2–3 times higher than Illinois streams on average”

“P loads 43% higher in 2017 than in 2004”

Journal of Hydrology 583 (2020) 124397

Contents lists available at ScienceDirect

Journal of Hydrology

journal homepage: www.elsevier.com/locate/jhydrol

Research papers

Total phosphorus export from Iowa agricultural watersheds: Quantifying the scope and scale of a regional condition

Keith E. Schilling, Matthew T. Streeter, Anthony Seeman, Christopher S. Jones, Calvin F. Wolter

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Mississippi River/Gulf of Mexico Hypoxia Task Force

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Iowa Nutrient Reduction Strategy

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Iowa Nutrient Reduction Strategy

The Iowa Nutrient Reduction Strategy is a science and technology-based framework to assess and reduce nutrients to Iowa waters and the Gulf of Mexico. It is designed to direct efforts to reduce nutrients in surface water from both point and nonpoint sources in a scientific, reasonable and cost effective manner.

The Mississippi River/Gulf of Mexico Watershed Nutrient Task Force was established in 1997 to coordinate activities to reduce the size, severity and duration of hypoxia in the Gulf. Hypoxia is a large area of low oxygen that can't sustain marine life. Nutrients that lead to algae growth are the main culprit.

In its 2008 Action Plan, the task force called upon each of the 12 states along the Mississippi River to develop its own nutrient reduction strategy.

Working together, the Iowa Department of Agriculture and Land Stewardship, the Iowa Department of Natural Resources, and the Iowa State University College of Agriculture and Life Sciences developed this proposed strategy.

The Iowa Nutrient Reduction Strategy was developed by:

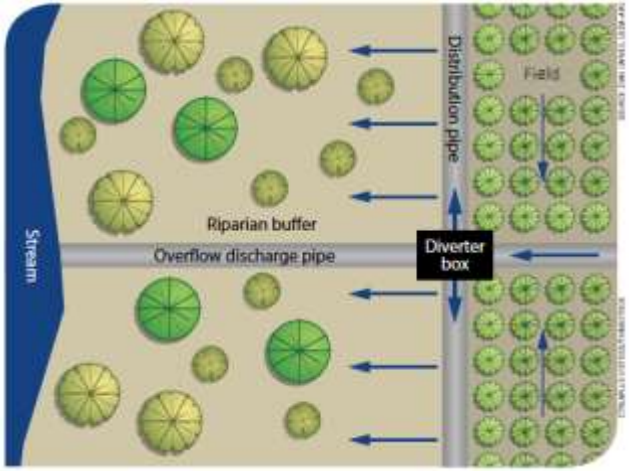
IOWA DEPARTMENT OF AGRICULTURE & LAND STEWARDSHIP

IOWA DEPARTMENT OF NATURAL RESOURCES

IOWA STATE UNIVERSITY

Practices

Cover crops



Saturated
Buffer

Economics of N loss

Cost of Nitrogen: today about $0.86/lb

Cost to remove nitrogen using BMPs: $2-$10/pound

Average statewide load: 600 million lbs

45% reduction = 270 million lbs/year

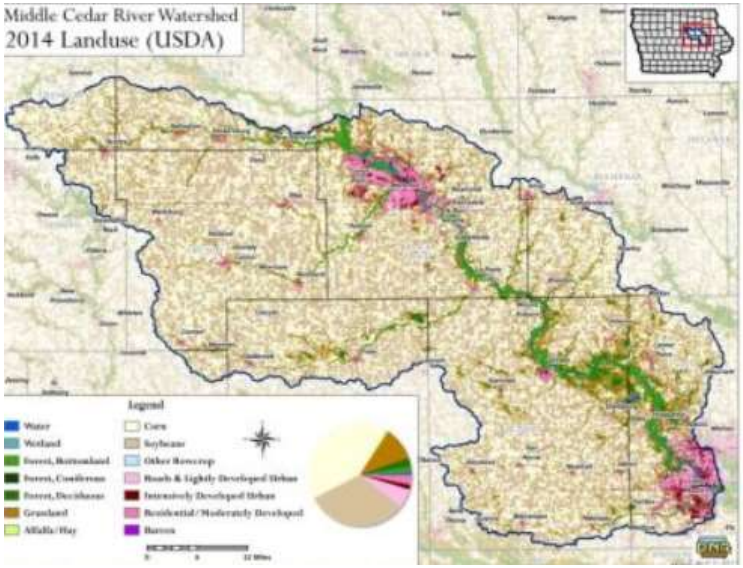
$540M to $2.7B/year

New Tile

2 million miles of tile in Iowa

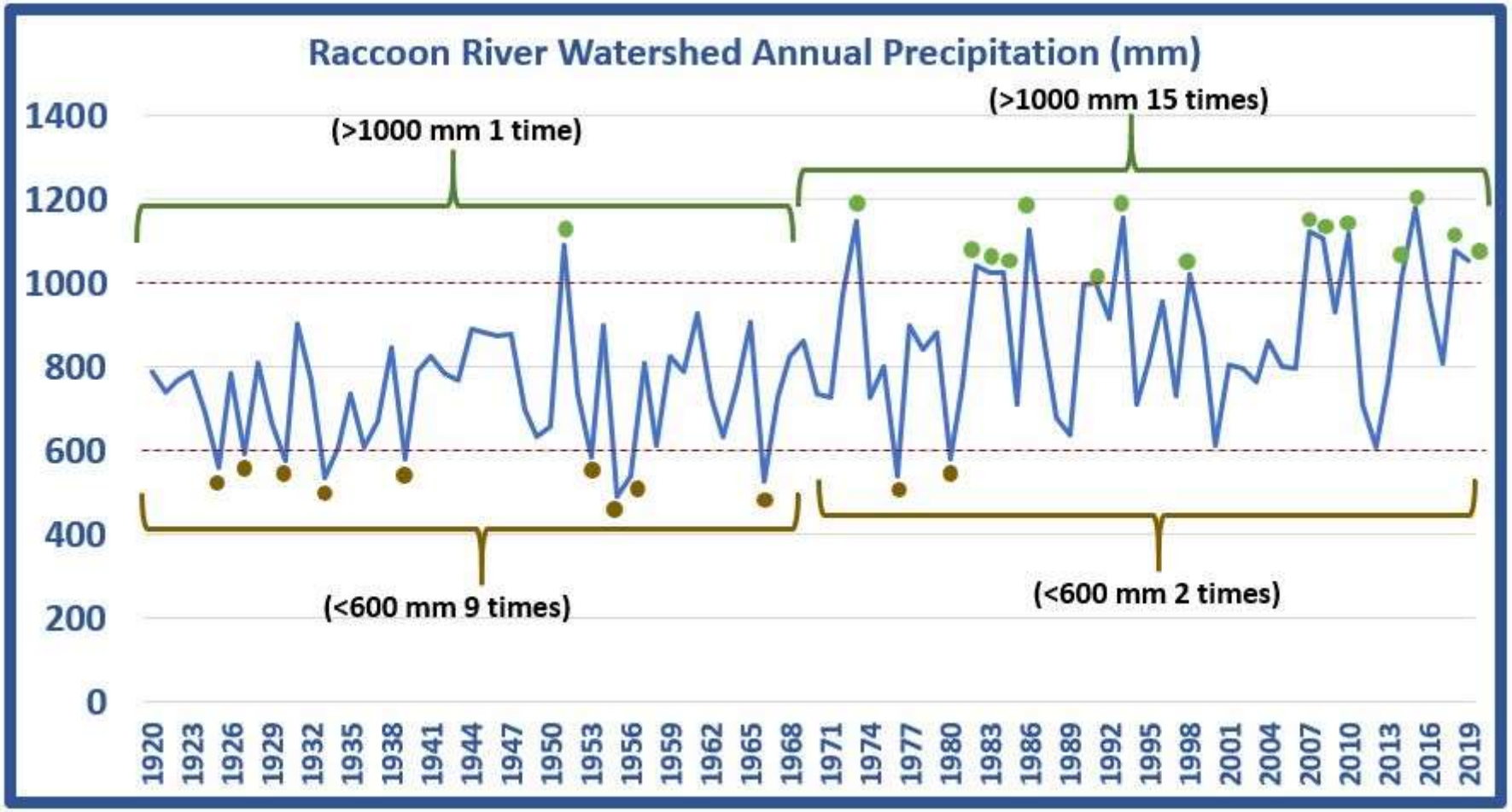
Landform	% of Iowa's Area	$/year spent on new tile
Iowan Surface	16.9	$24,500,000
Des Moines Lobe	21.4	$5,845,000
Northwest Iowa Plains	8.3	$2,272,545
Paleozoic Plateau	4.6	$3,580,862
Southern Iowa Drift Plain	41.3	$33,837,580
Total	92.5	$70,064,878

Table 2: Estimated amounts spent in 2016 on new drainage tile in five of Iowa's landforms.



1200 miles new tile/year!

Climate Change



More Diverse Farming Systems

Marsden Long Term Rotation Study- ISU

How Do You Overcome Structural Drivers to Bad Water Quality?

Matt Liebman

N fertilizer use 91% lower
Herbicide use 97% lower
Weed biomass similar
Soybean sudden death syndrome much lower
Soil health is better
Tile nitrate 57% lower

Soil erosion 50% lower
Fossil Fuel use 60% lower
Net returns similar (revenue lower but input costs also lower)

Regulations?

1. Ban cropping in the 2-year Flood Plain

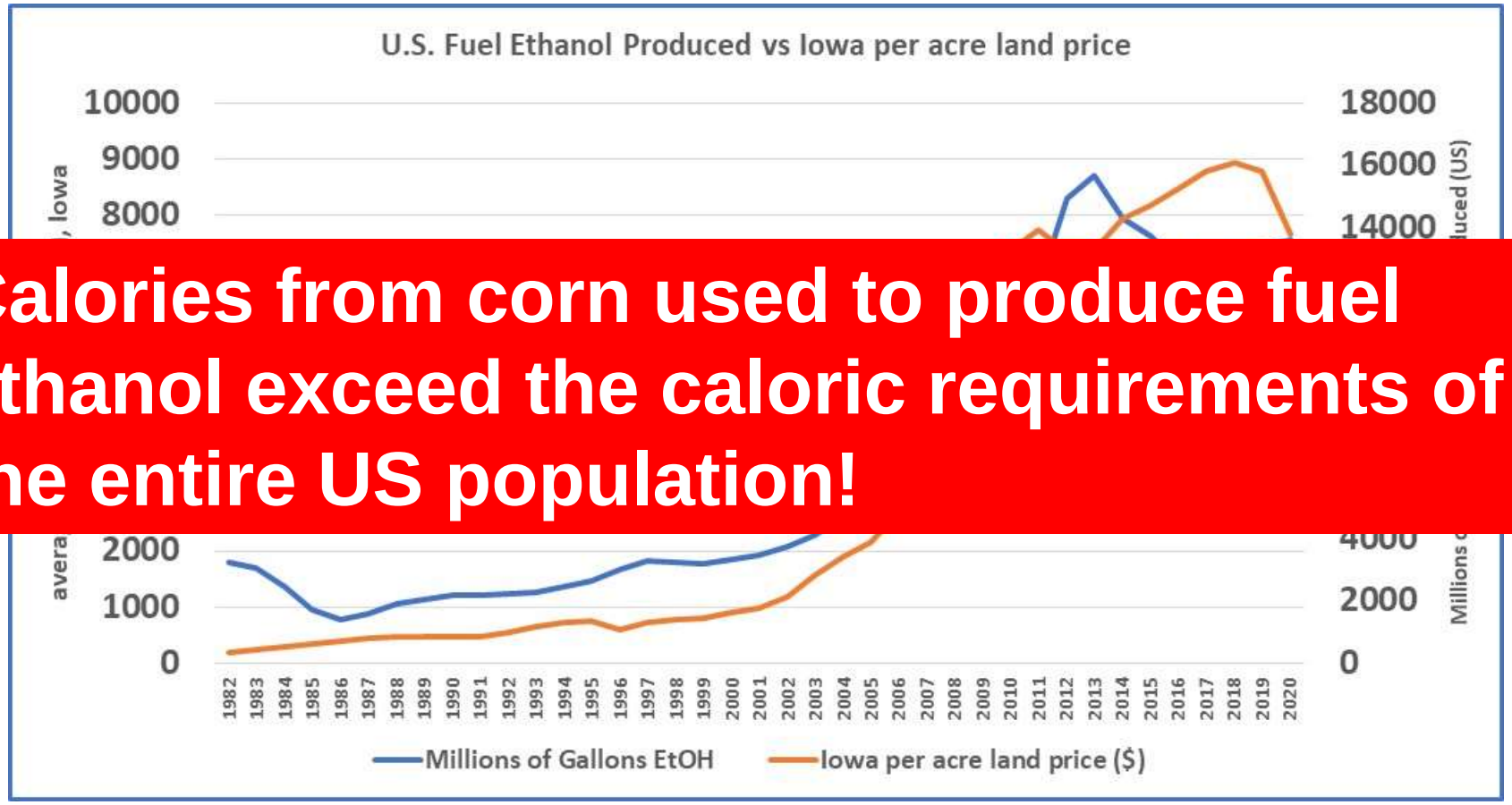
2. Ban fall tillage

3. Ban manure on snow and frozen ground

4. Make farmers adhere to ISU fertilization guidelines

5. Reformulate CAFO Regulations

Fuel Ethanol



Calories from corn used to produce fuel ethanol exceed the caloric requirements of the entire US population!

Ethanol creates perversity in US Agriculture

- Corn Grown in Arid Areas for Ethanol and Livestock

6000 years to naturally replenish

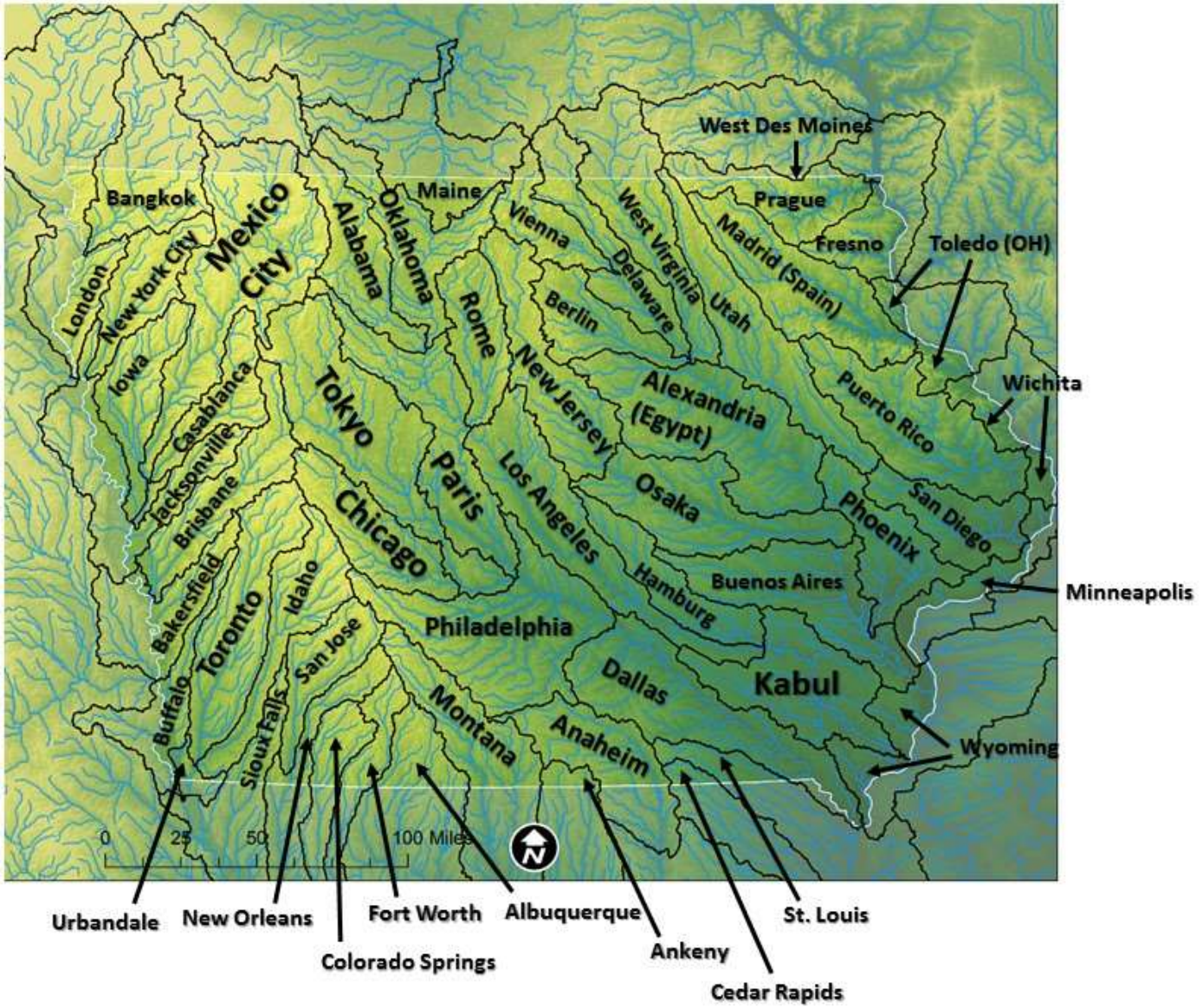
- Irrigated Alfalfa Uses ½ of the Colorado River

Exported to China, Saudi Arabia, etc.

What do we want our production system to look like?

Commerce

Nutrition?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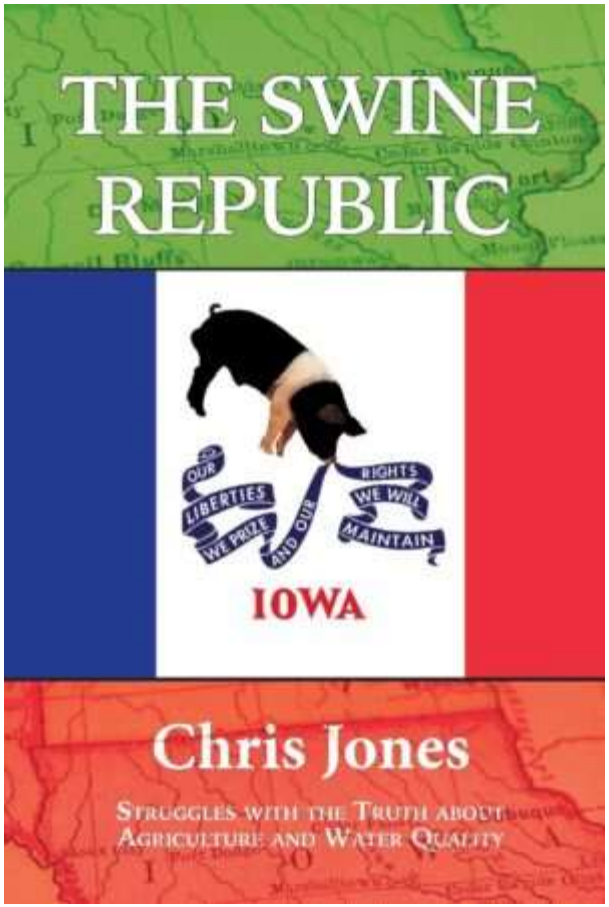
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Struggles with the Truth about Agriculture and Water Quality

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