# *RRWA*
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**Chris Jones, *Research Engineer***
**christopher-s-jones@uiowa.edu**

IIHR Hydroscience & Engineering
The University of Iowa College of Engineering

# Slides Available at:

## https://www.iihr.uiowa.edu/cjones/welcome/

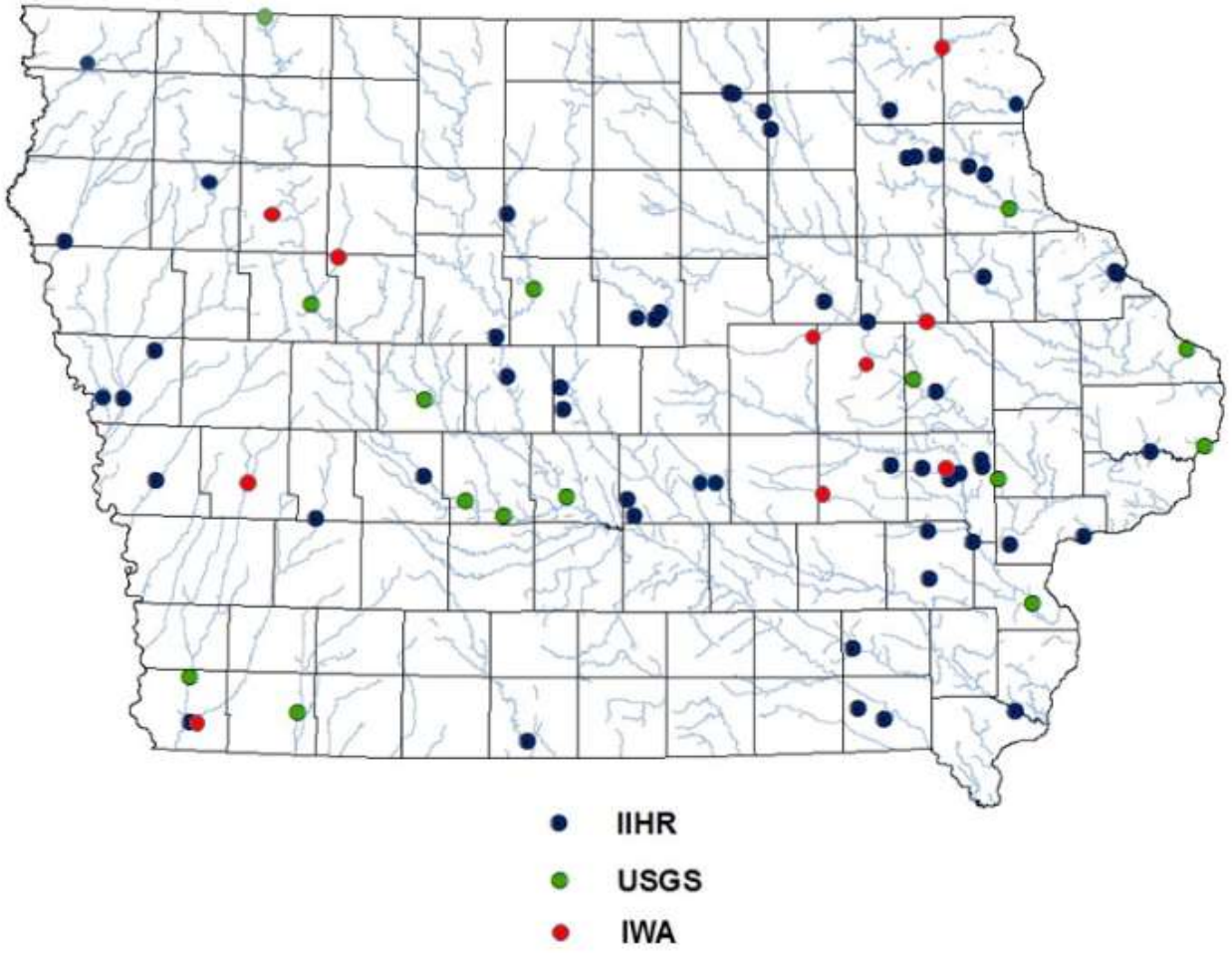
# IIHR Water Quality Sensor Network

# Sites

**70+ sites Nitrate-N**

**20-25 sites**

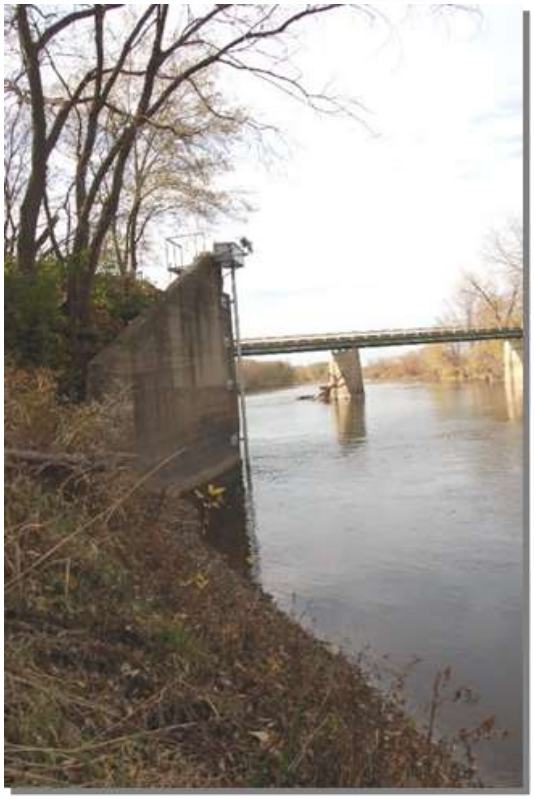
- Temperature
- pH
- SC
- DO
- Turbidity



## Site infrastructure

## Small Streams

IIHR Water Quality Sensor Setup



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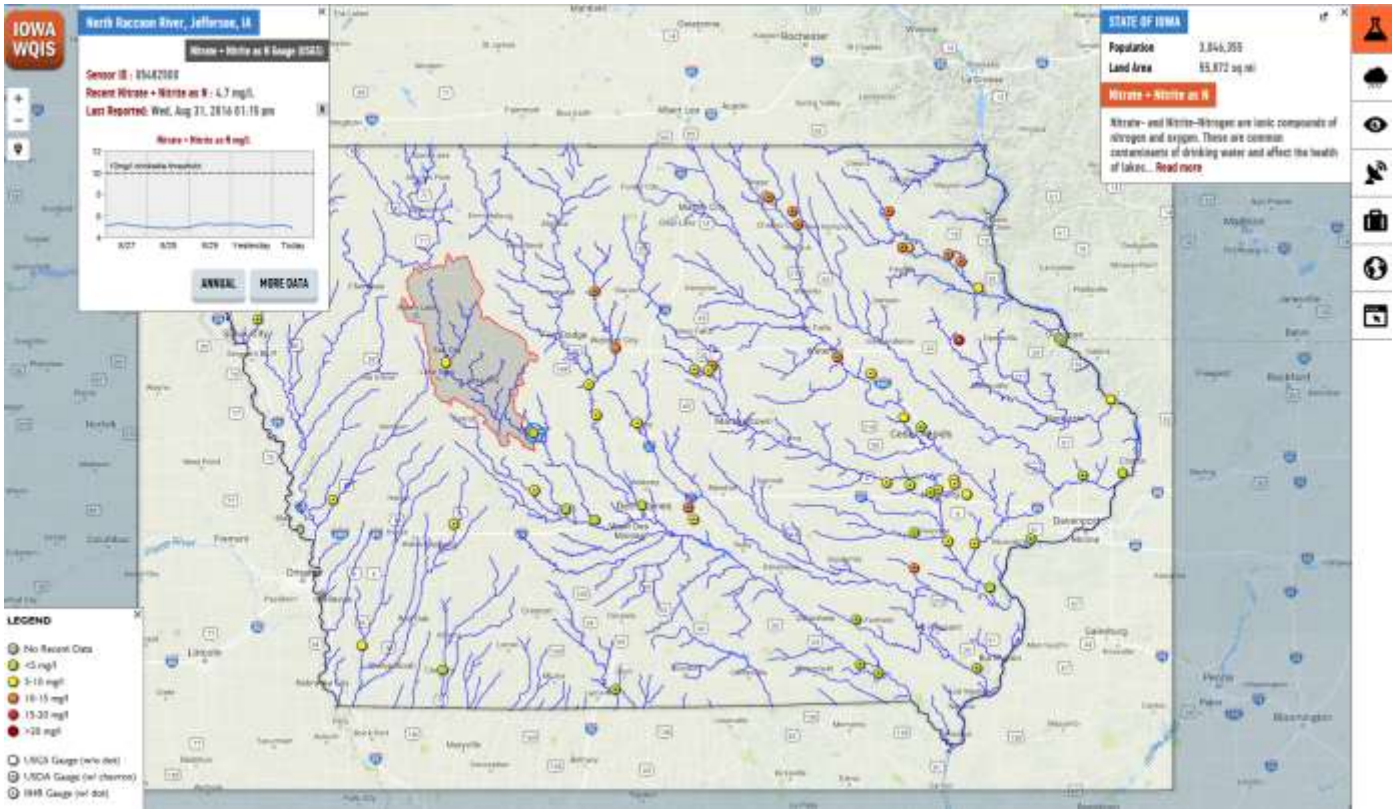
# Iowa Water Quality Information System




**iwqis.iowawis.org/**

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



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# Publications

- Practice Assessment: 11
- Wetland Research: 10
- Stream and Tile Drainage Hydrology: 6
- Nitrate Dynamics Within Streams and Reservoirs: 5
- Policy: 4
- Golf Course Soils and Nutrients: 3
- Phosphorus Transport: 4
- Watershed Nitrate Loading: 3
- Livestock and Water Quality: 1
- Groundwater Nitrate Dynamics: 1
- Carbon Transport in Tile Drainage: 1

The Problem:

- 70% of land in corn-soy rotation
- 25 million hogs
- 4 million beef cattle
- 80 million laying chickens
- 5 million turkeys
- 4 million broiler chickens
- 220,000 dairy cows

1941

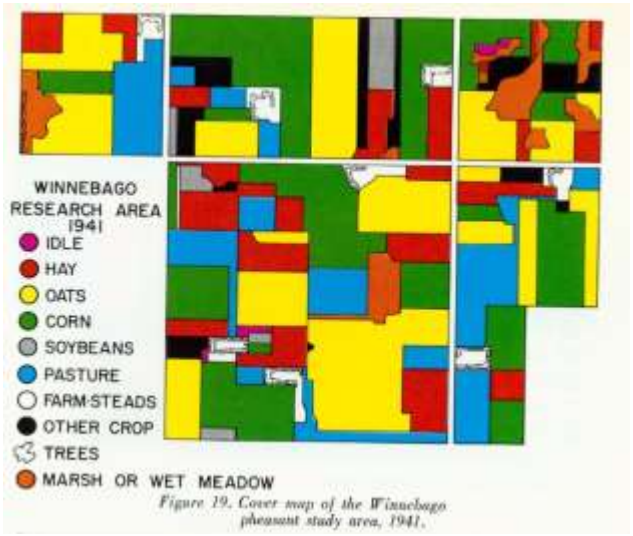


*Figure 19. Cover map of the Winnebago pheasant study area, 1941.*

1976

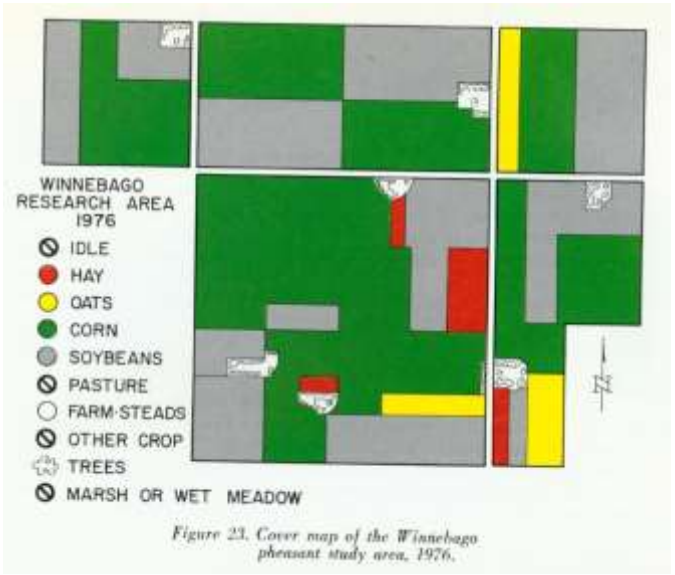
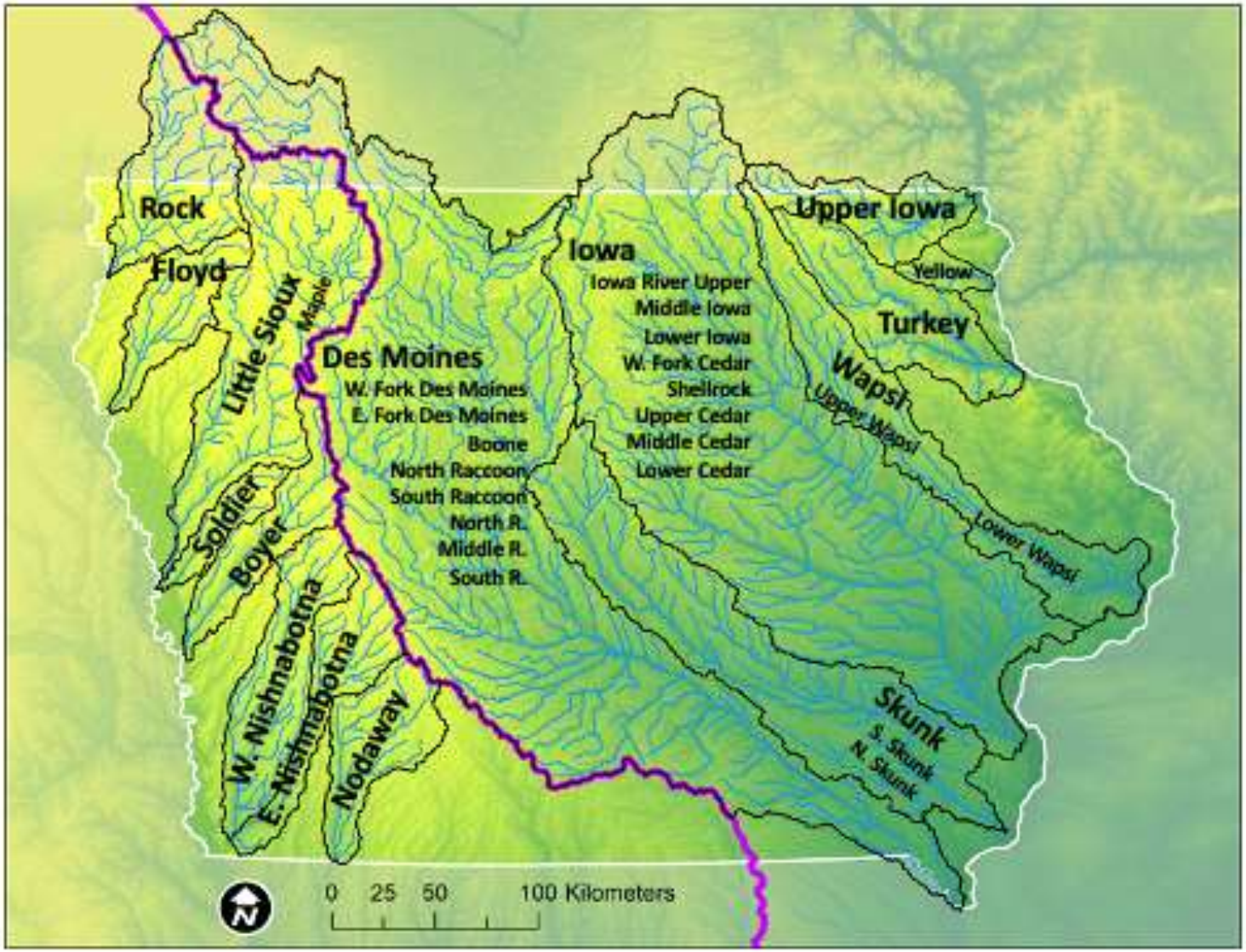


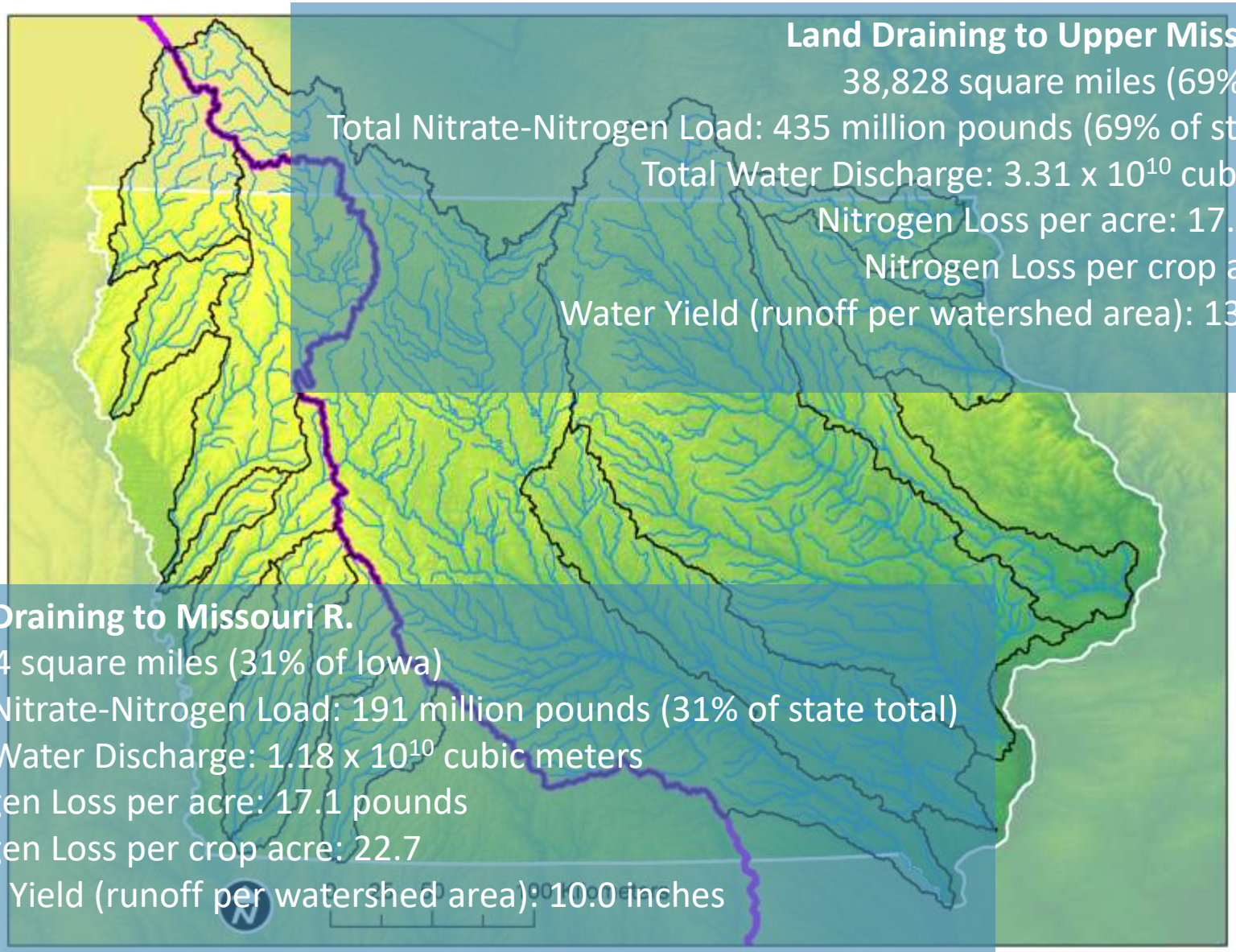
*Figure 23. Cover map of the Winnebago pheasant study area, 1976.*

# LEAKY SYSTEM

# Statewide N Loading 2020

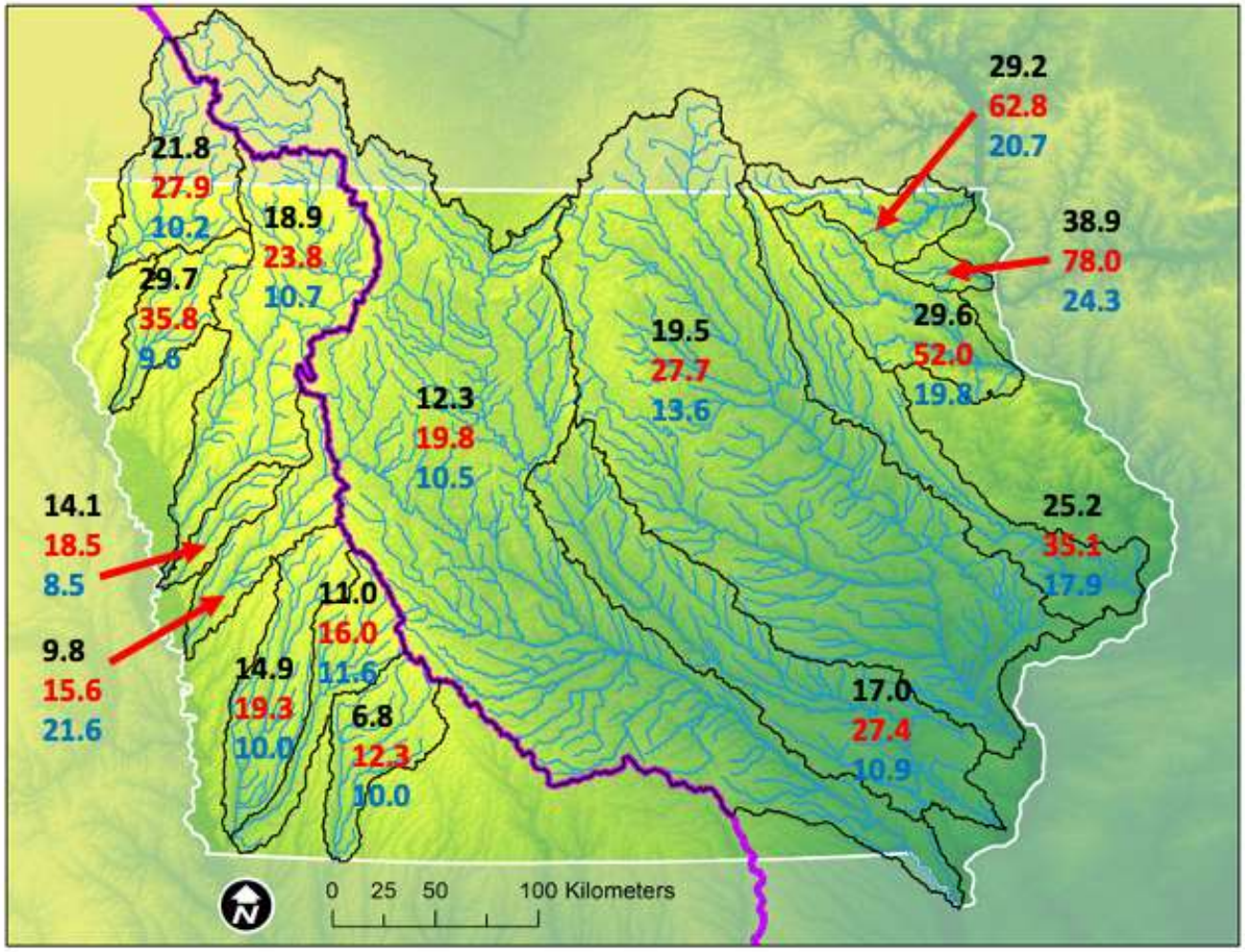
## 2020 Stream Nitrate Data





**Land Draining to Upper Mississippi R.**
38,828 square miles (69% of Iowa)
Total Nitrate-Nitrogen Load: 435 million pounds (69% of state total)
Total Water Discharge: 3.31 x $10^{10}$ cubic meters
Nitrogen Loss per acre: 17.5 pounds
Nitrogen Loss per crop acre: 27.0
Water Yield (runoff per watershed area): 13.0 inches

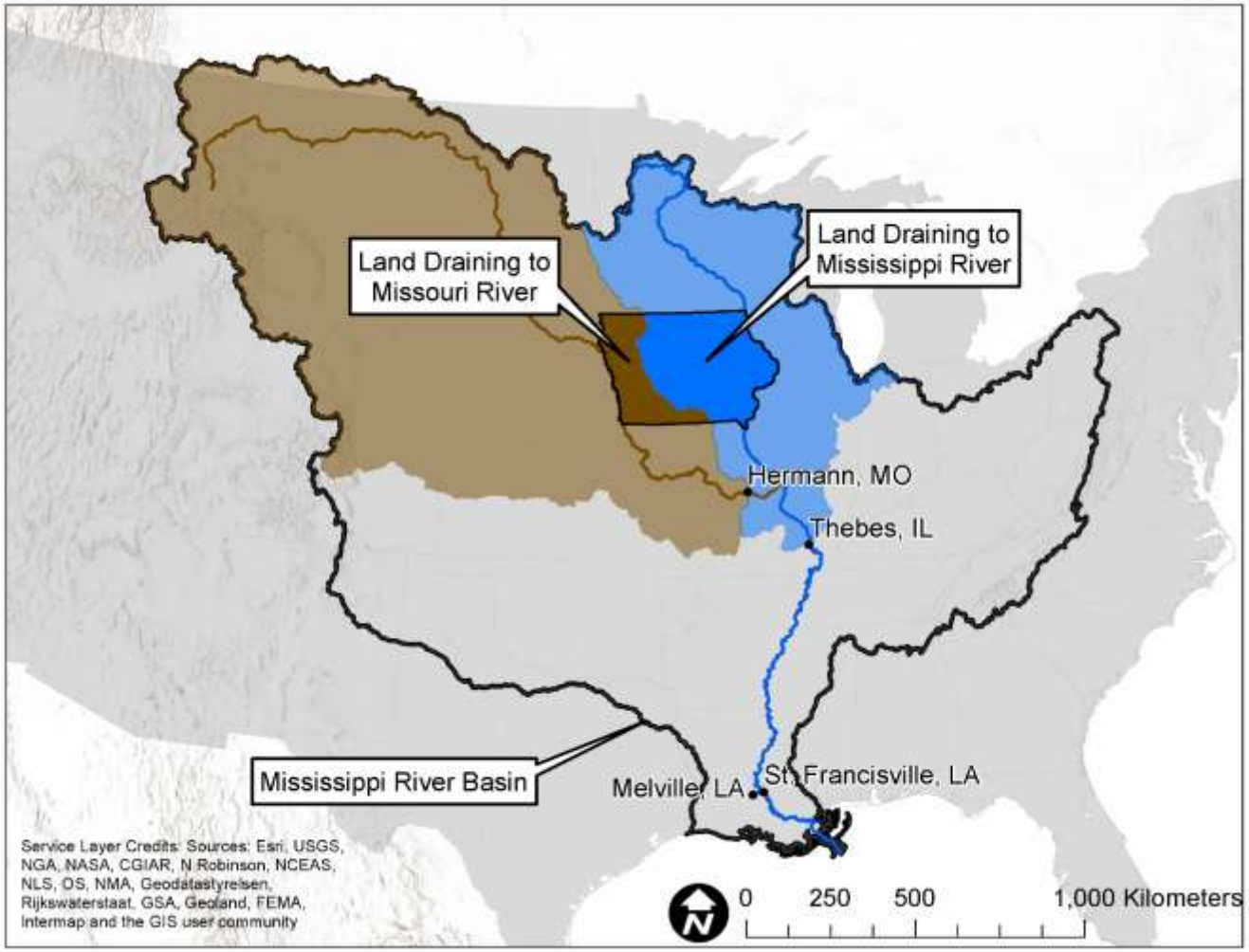
**Land Draining to Missouri R.**
17,444 square miles (31% of Iowa)
Total Nitrate-Nitrogen Load: 191 million pounds (31% of state total)
Total Water Discharge: 1.18 x $10^{10}$ cubic meters
Nitrogen Loss per acre: 17.1 pounds
Nitrogen Loss per crop acre: 22.7
Water Yield (runoff per watershed area): 10.0 inches



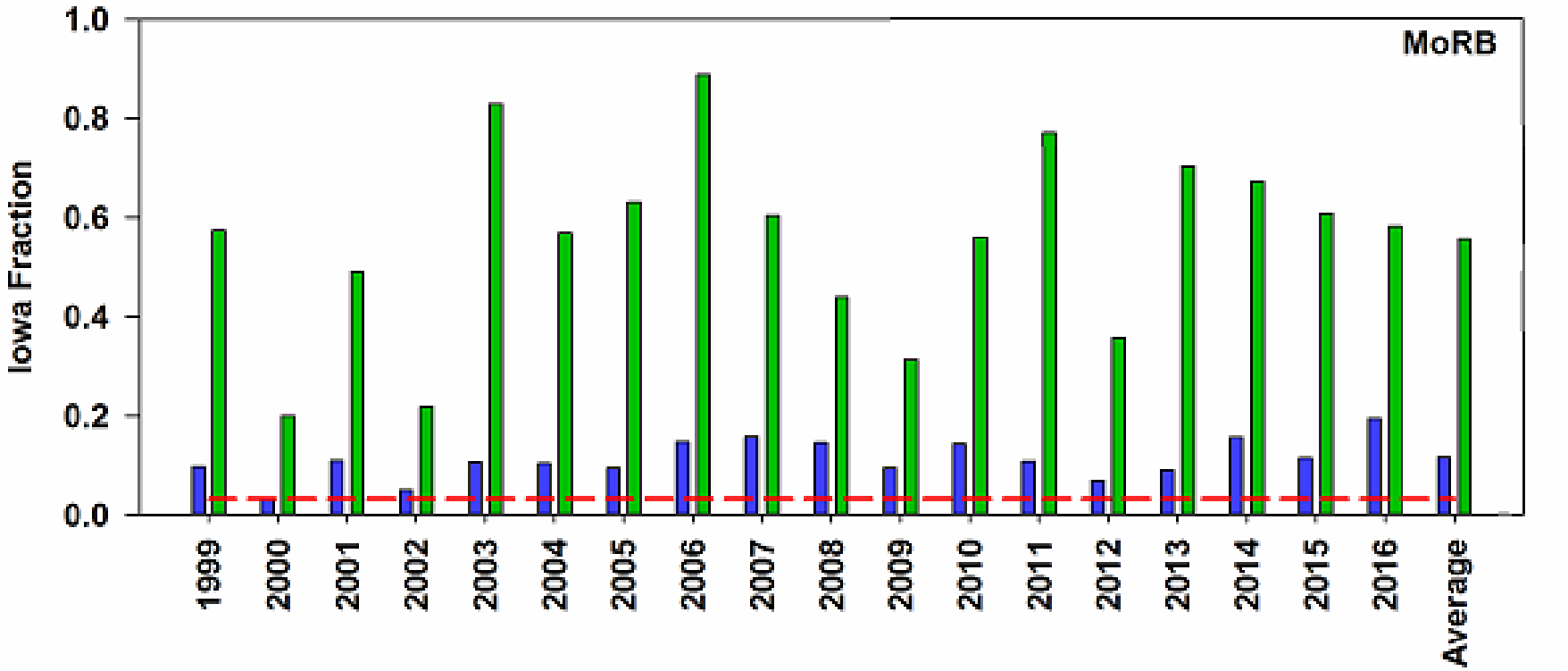

**Black: lbs/acre**

**Red: lbs/crop-acre**

**Blue: Runoff (inches)**

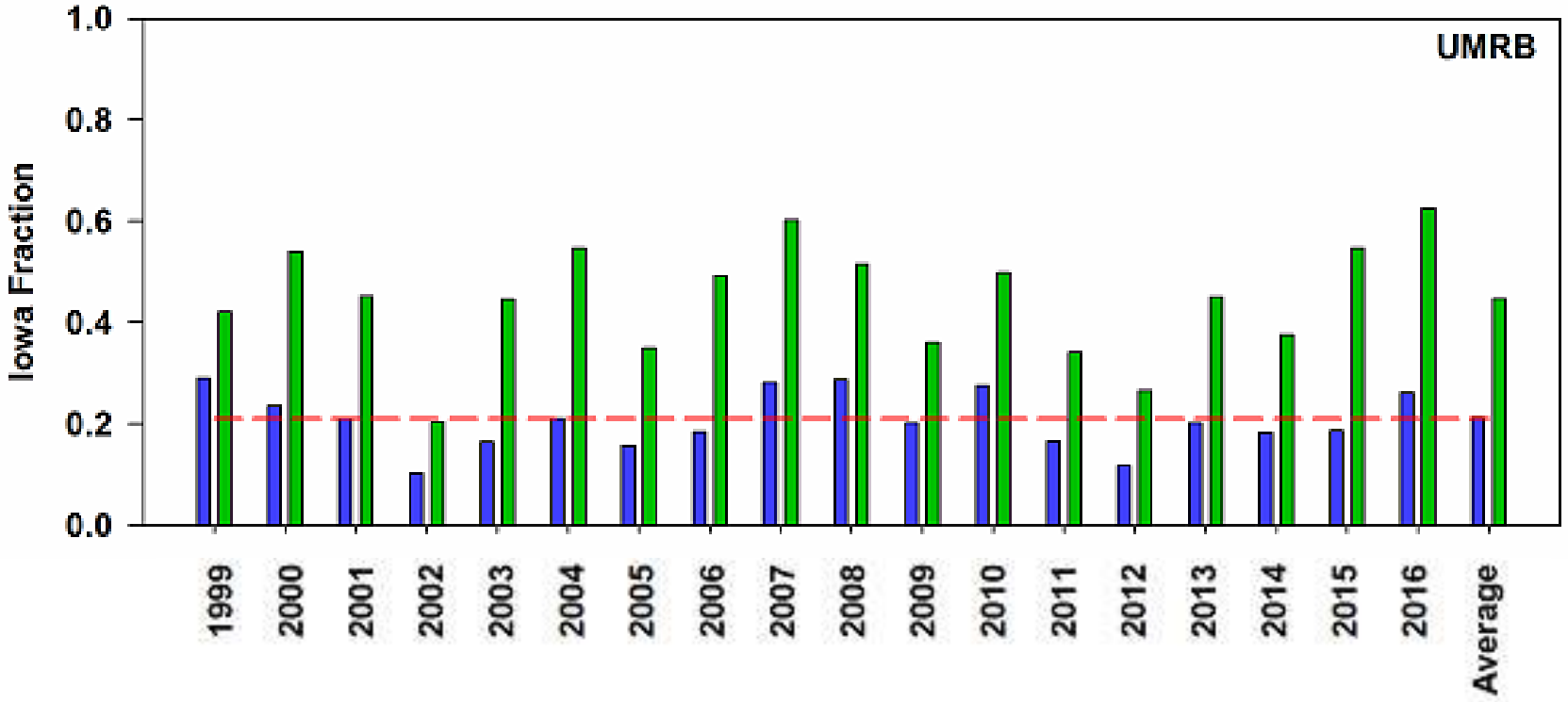


# Missouri



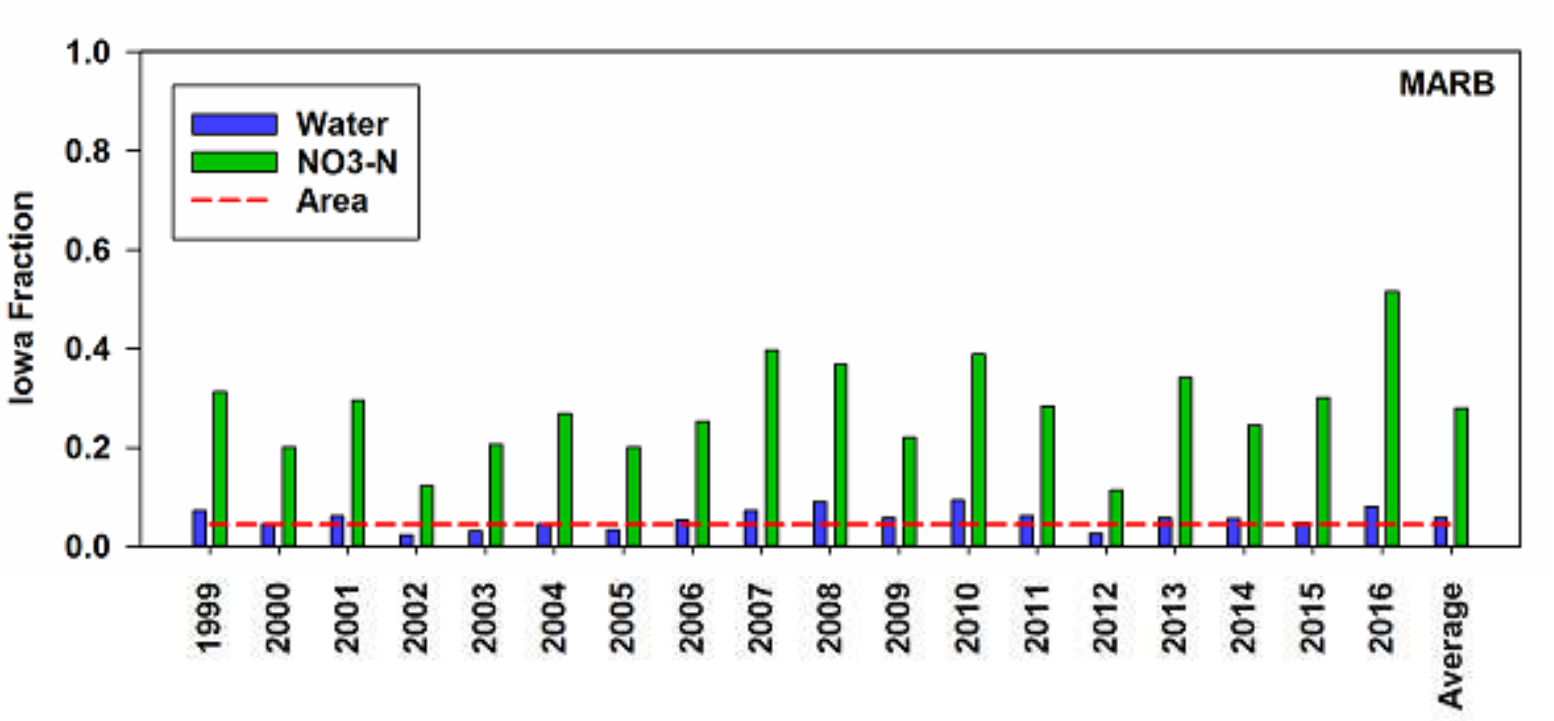

**3.3% of the land**
**12% of the water**
**55% of the nitrate**

# Upper Mississippi



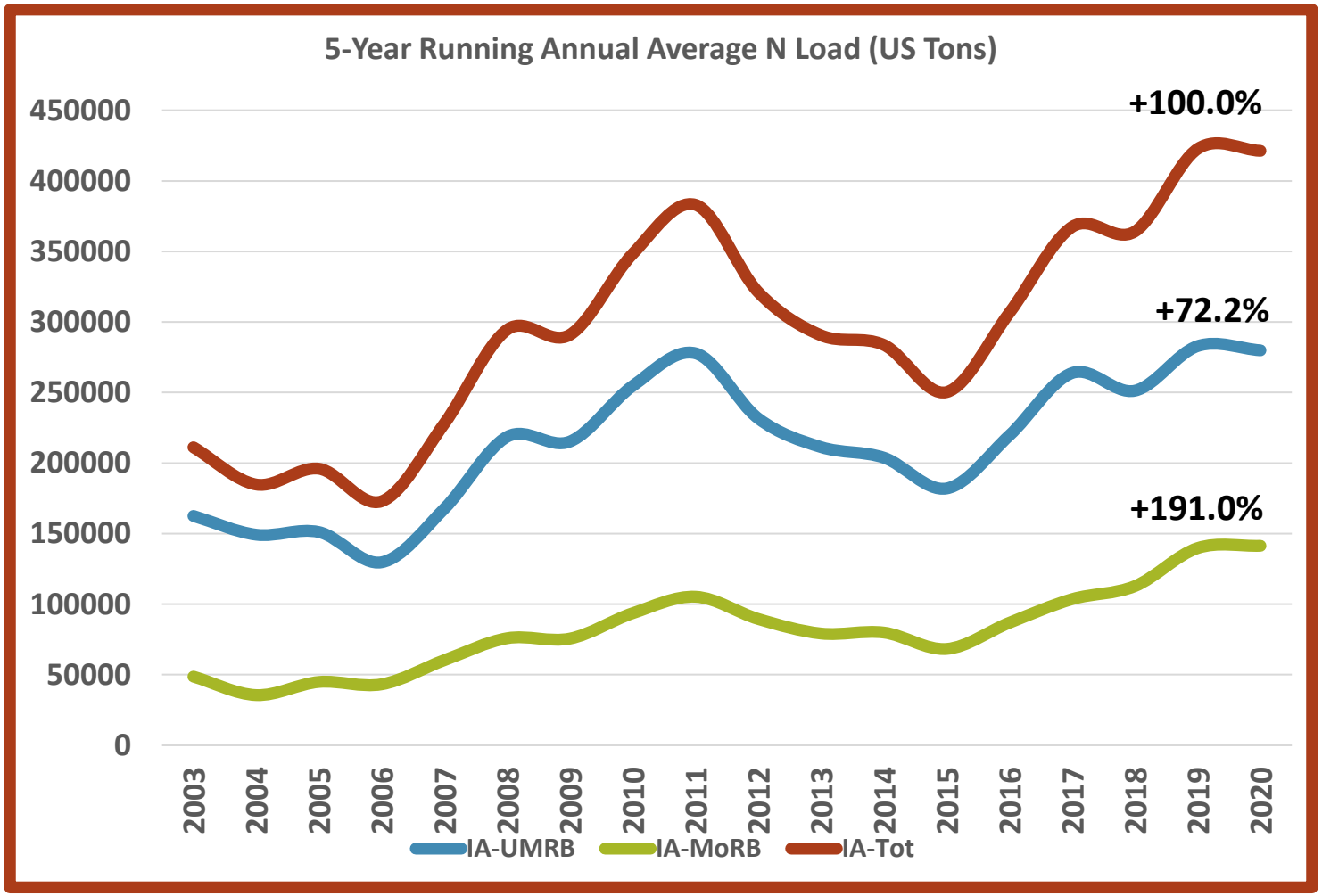

**21% of the land**
**21% of the water**
**45% of the nitrate**

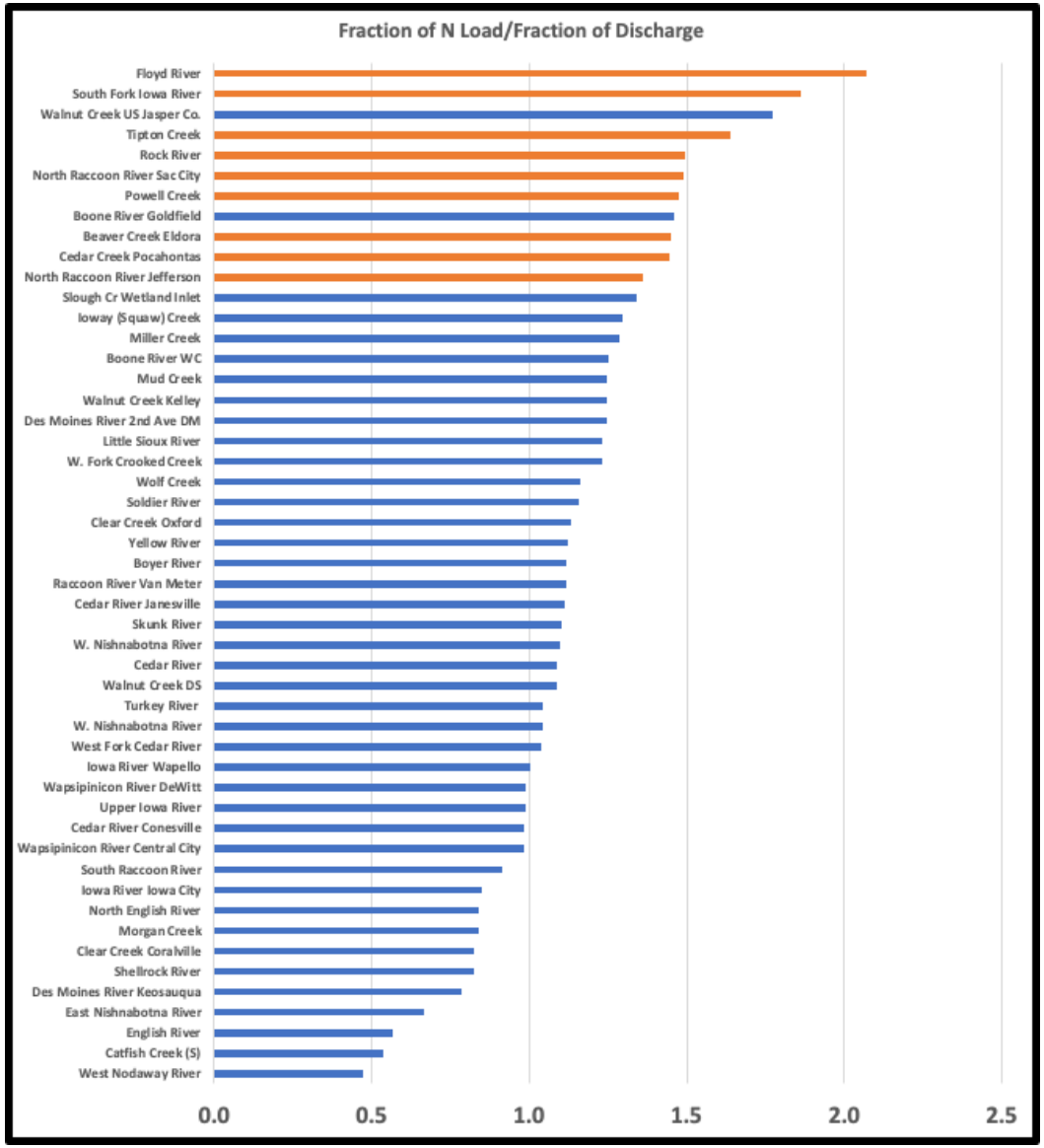
# Mississippi-Atchafalaya-Gulf of Mexico

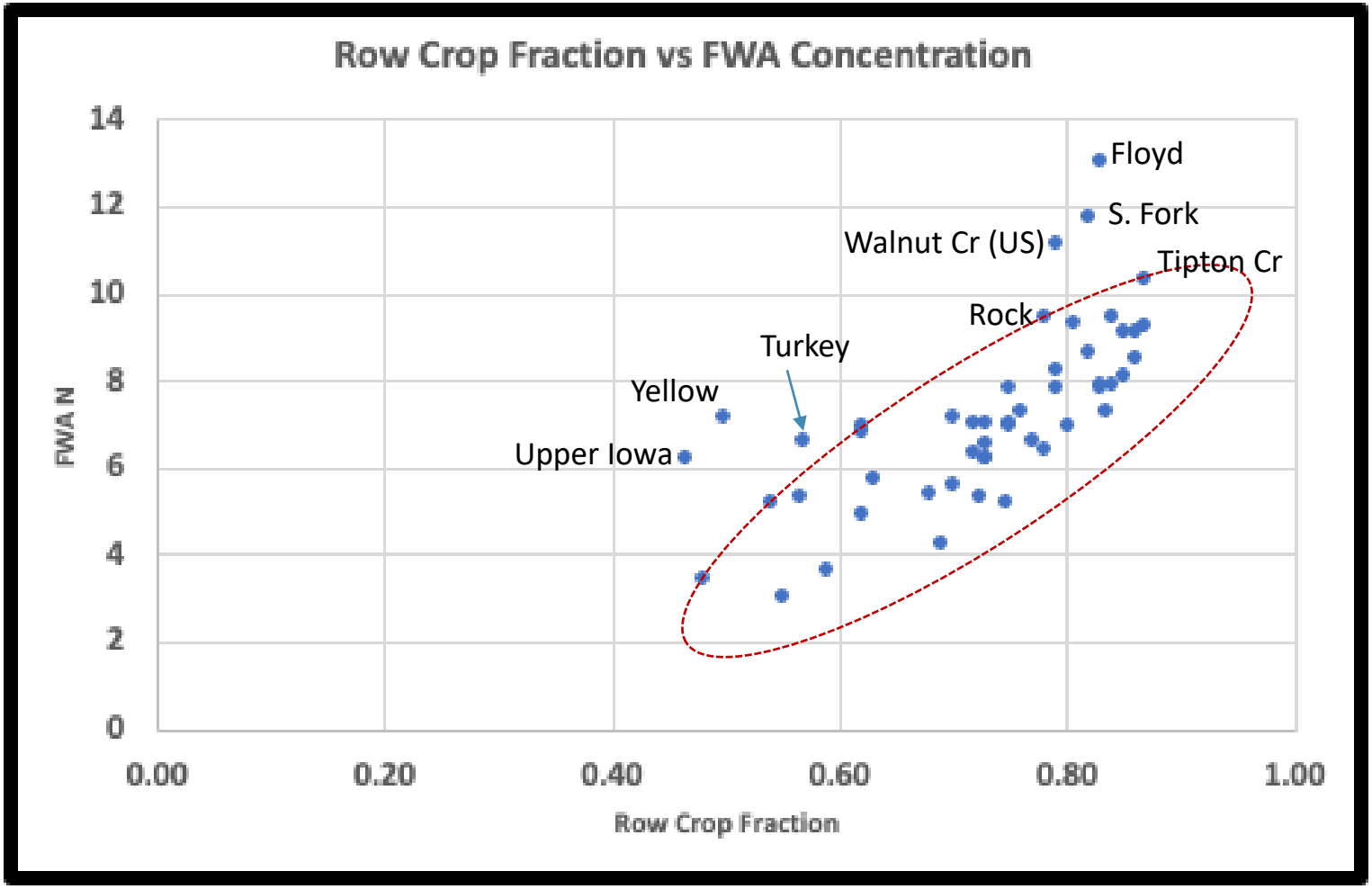


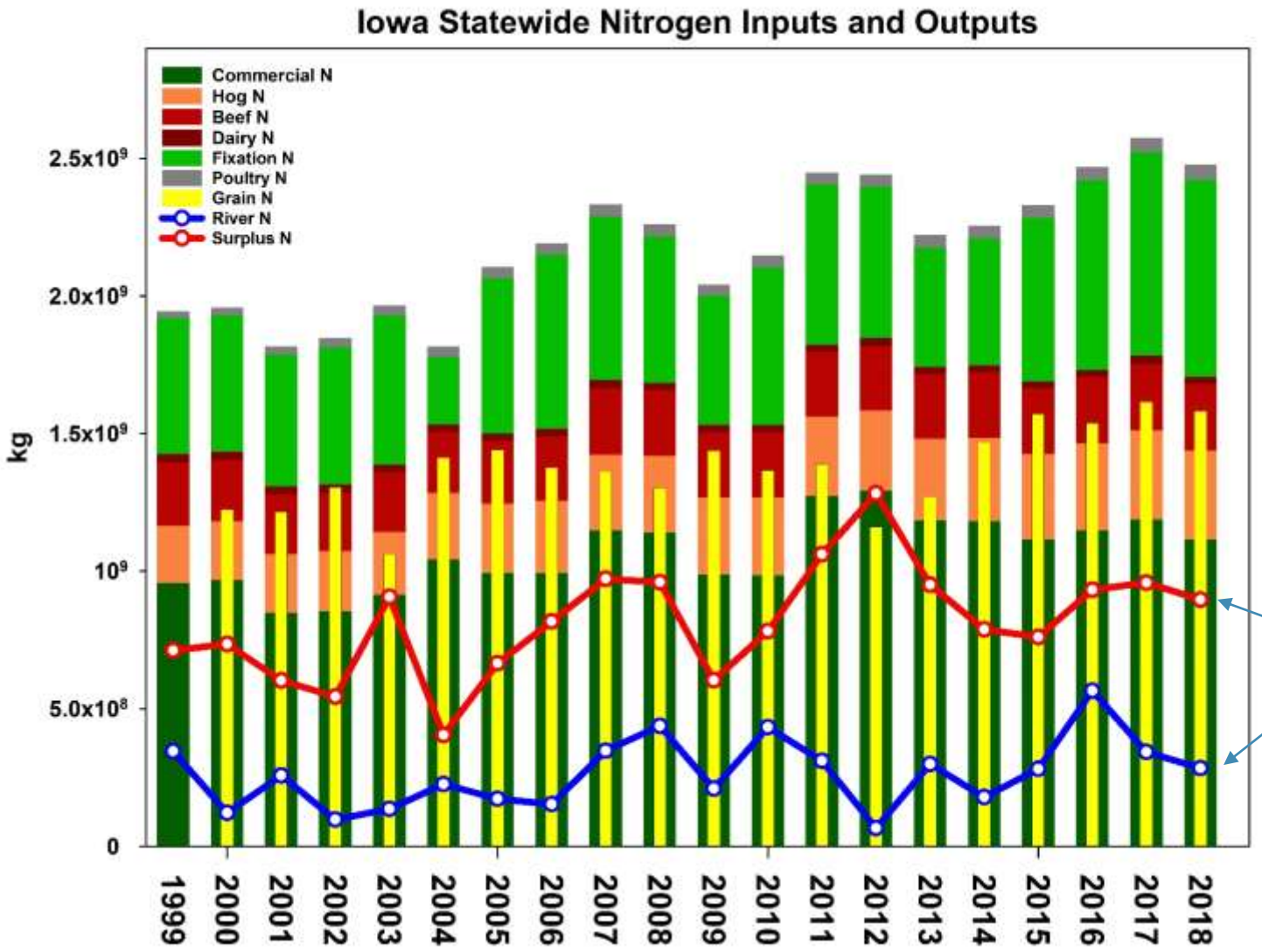

**4.5% of the land**
**5.9% of the water**
**29% of the nitrate**

# How Much Nitrogen Leaves Iowa?




Fraction of N Load/Fraction of Discharge
Floyd River
South Fork Iowa River
Walnut Creek US Jasper Co.
Tipton Creek
Rock River
North Raccoon River Sac City
Powell Creek
Boone River Goldfield
Beaver Creek Eldora
Cedar Creek Pocahontas
North Raccoon River Jefferson
Slough Cr Wetland Inlet
Ioway (Squaw) Creek
Miller Creek
Boone River WC
Mud Creek
Walnut Creek Kelley
Des Moines River 2nd Ave DM
Little Sioux River
W. Fork Crooked Creek
Wolf Creek
Soldier River
Clear Creek Oxford
Yellow River
Boyer River
Raccoon River Van Meter
Cedar River Janesville
Skunk River
W. Nishnabotna River
Cedar River
Walnut Creek DS
Turkey River
W. Nishnabotna River
West Fork Cedar River
Iowa River Wapello
Wapsipinicon River DeWitt
Upper Iowa River
Cedar River Conesville
Wapsipinicon River Central City
South Raccoon River
Iowa River Iowa City
North English River
Morgan Creek
Clear Creek Coralville
Shellrock River
Des Moines River Keosauqua
East Nishnabotna River
English River
Catfish Creek (S)
West Nodaway River
0.0
0.5
1.0
1.5
2.0
2.5


Row Crop Fraction vs FWA Concentration
FWA N
Row Crop Fraction
0
2
4
6
8
10
12
14
0.00
0.20
0.40
0.60
0.80
1.00
Floyd
S. Fork
Walnut Cr (US)
Tipton Cr
Rock
Turkey
Yellow
Upper Iowa




About 32% of "surplus" makes it to streams

Can we "soil health" our way out of this?

## 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 |

PERSPECTIVE
https://doi.org/10.1038/s41893-019-0393-0
nature sustainability

# Sustainable intensification of agricultural drainage

Michael J. Castellano[1,2*], Sotirios V. Archontoulis[1], Matthew J. Helmers[3], Hanna J. Poffenbarger[4] and Johan Six[2]

**Artificial drainage is among the most widespread land improvements for agriculture. Drainage benefits crop production, but also promotes nutrient losses to water resources. Here, we outline how a systems perspective for sustainable intensification of drainage can mitigate nutrient losses, increase fertilizer nitrogen-use efficiency and reduce greenhouse-gas emissions. There is an immediate opportunity to realize these benefits because agricultural intensification and climate change are increasing the extent and intensity of drainage systems. If a systems-based approach to drainage can consistently increase nitrogen-use efficiency, while maintaining or increasing crop production, farmers and the environment will benefit.**

*"Losses of SOC to CO2 cease within 10–20 years of changes in land use or management as the SOC pool re-equilibrates at a lower level"*

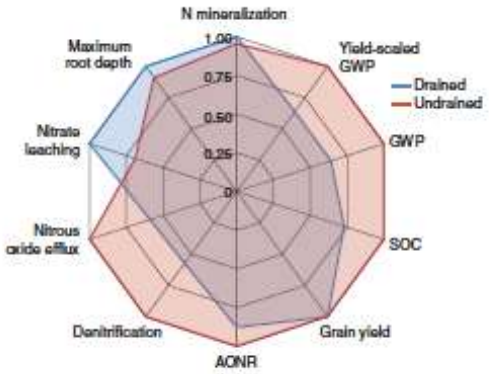
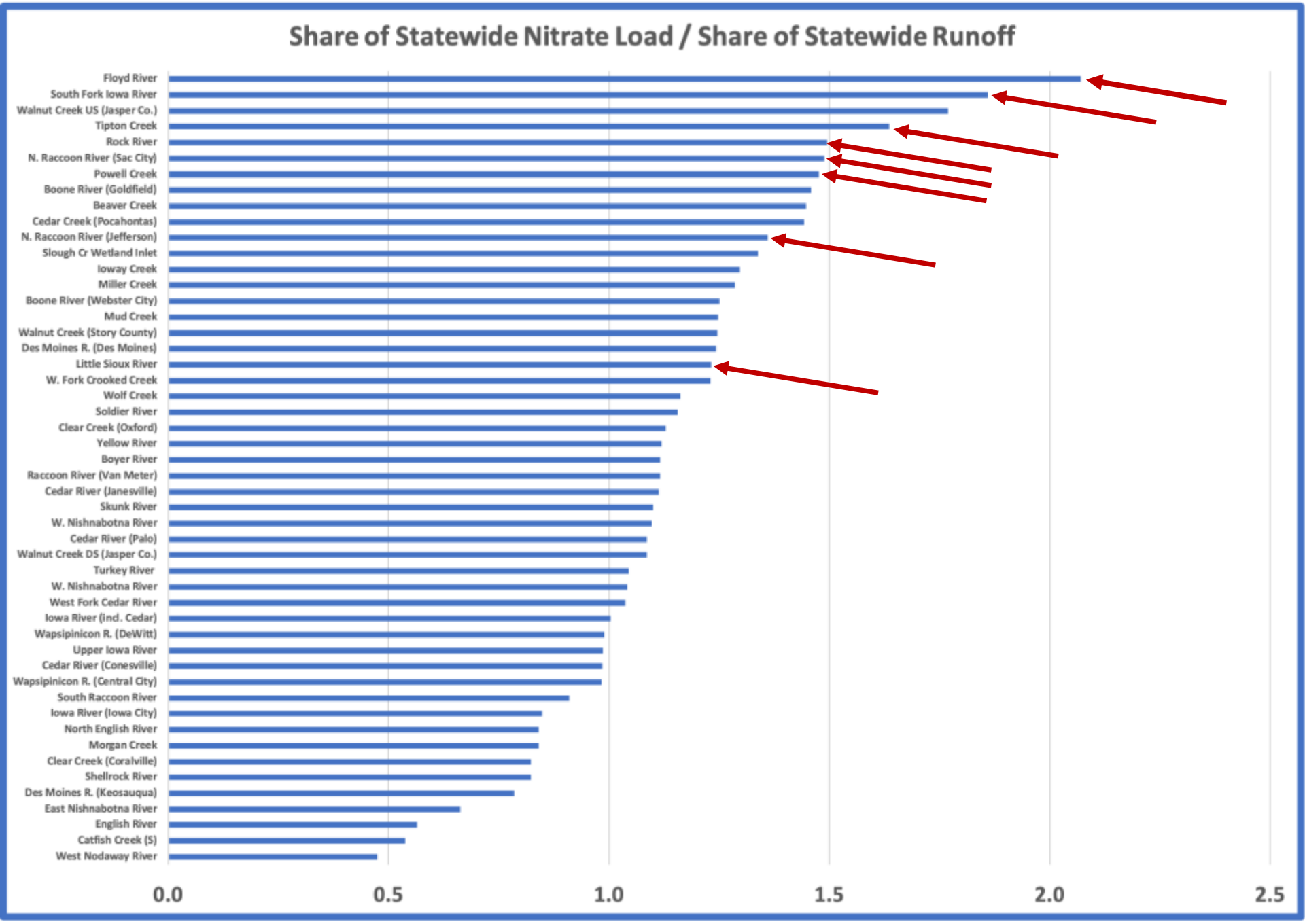
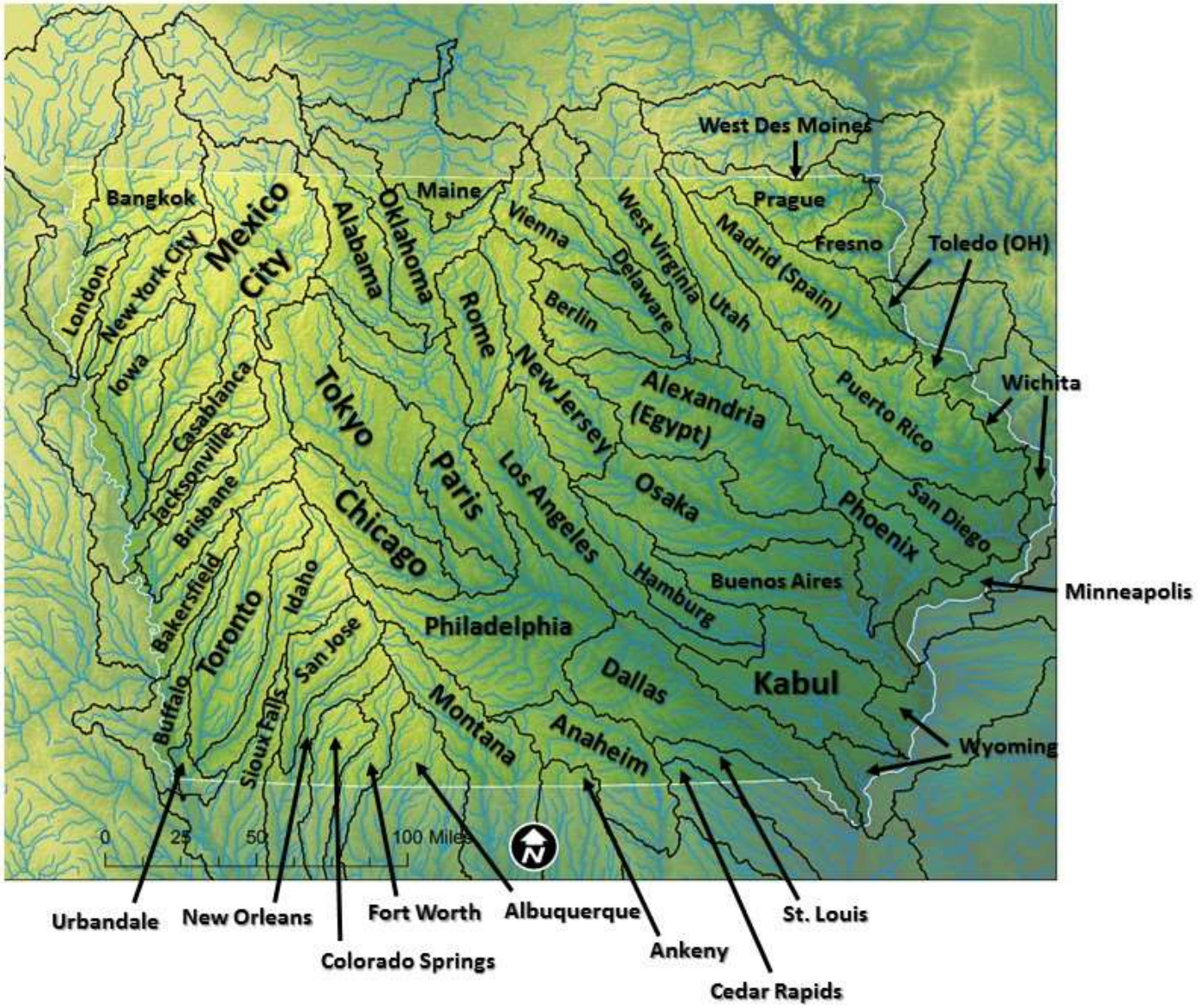



**Fig. 3 | Relative differences in ecosystem properties and processes between drained and undrained continuous maize cropping systems in southeast Iowa, USA.** All data other than SOC represent the mean annual simulated value across 18 weather-years. Relative differences in SOC represent the estimated difference in equilibrium SOC stock of 27,000 kg C $ha^{-1}$ (Supplementary Information).


Share of Statewide Nitrate Load / Share of Statewide Runoff
Floyd River
South Fork Iowa River
Walnut Creek US (Jasper Co.)
Tipton Creek
Rock River
N. Raccoon River (Sac City)
Powell Creek
Boone River (Goldfield)
Beaver Creek
Cedar Creek (Pocahontas)
N. Raccoon River (Jefferson)
Slough Cr Wetland Inlet
Ioway Creek
Miller Creek
Boone River (Webster City)
Mud Creek
Walnut Creek (Story County)
Des Moines R. (Des Moines)
Little Sioux River
W. Fork Crooked Creek
Wolf Creek
Soldier River
Clear Creek (Oxford)
Yellow River
Boyer River
Raccoon River (Van Meter)
Cedar River (Janesville)
Skunk River
W. Nishnabotna River
Cedar River (Palo)
Walnut Creek DS (Jasper Co.)
Turkey River
W. Nishnabotna River
West Fork Cedar River
Iowa River (ind. Cedar)
Wapsipinicon R. (DeWitt)
Upper Iowa River
Cedar River (Conesville)
Wapsipinicon R. (Central City)
South Raccoon River
Iowa River (Iowa City)
North English River
Morgan Creek
Clear Creek (Coralville)
Shellrock River
Des Moines R. (Keosauqua)
East Nishnabotna River
English River
Catfish Creek (S)
West Nodaway River
0.0
0.5
1.0
1.5
2.0
2.5


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
Jacksonville
Paris
Los Angeles
Osaka
Brisbane
Chicago
Phoenix
San Diego
Buenos Aires
Minneapolis
Bakersfield
Idaho
Hamburg
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

## What Can Be Done?

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