Water Quality Index

October 13, 2021

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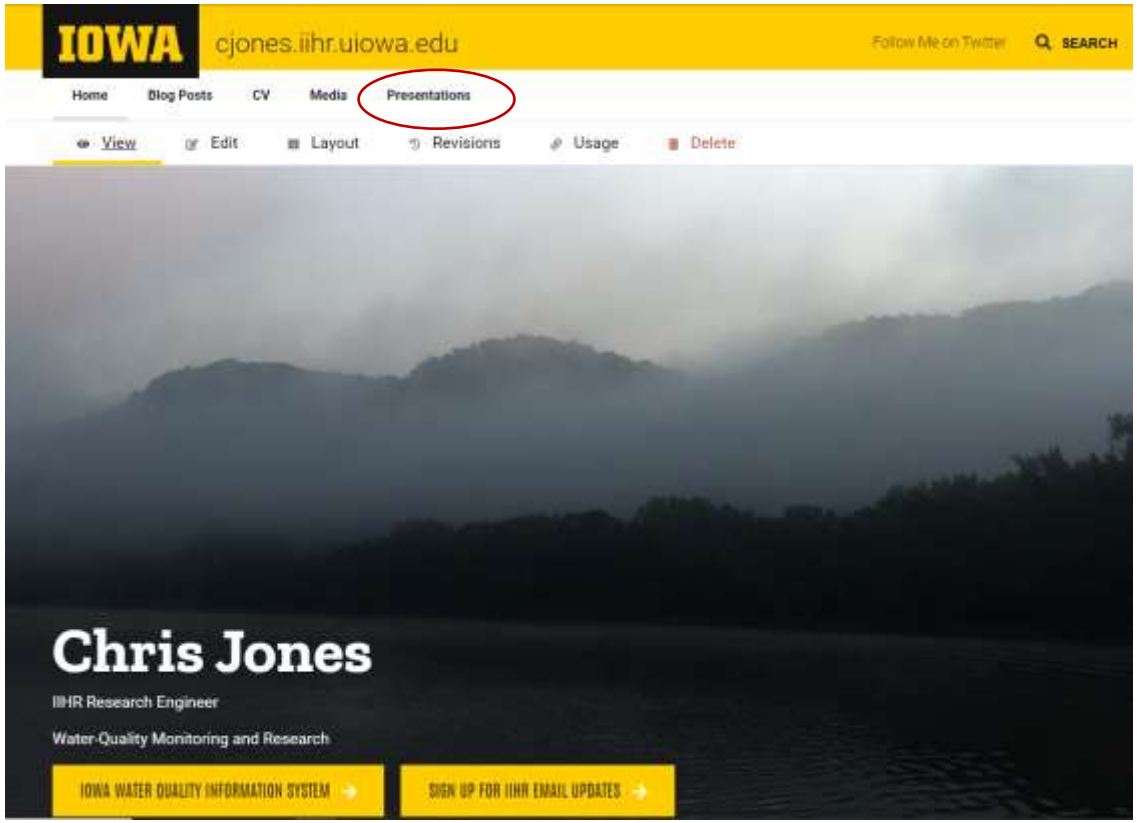
Slides Available at:

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



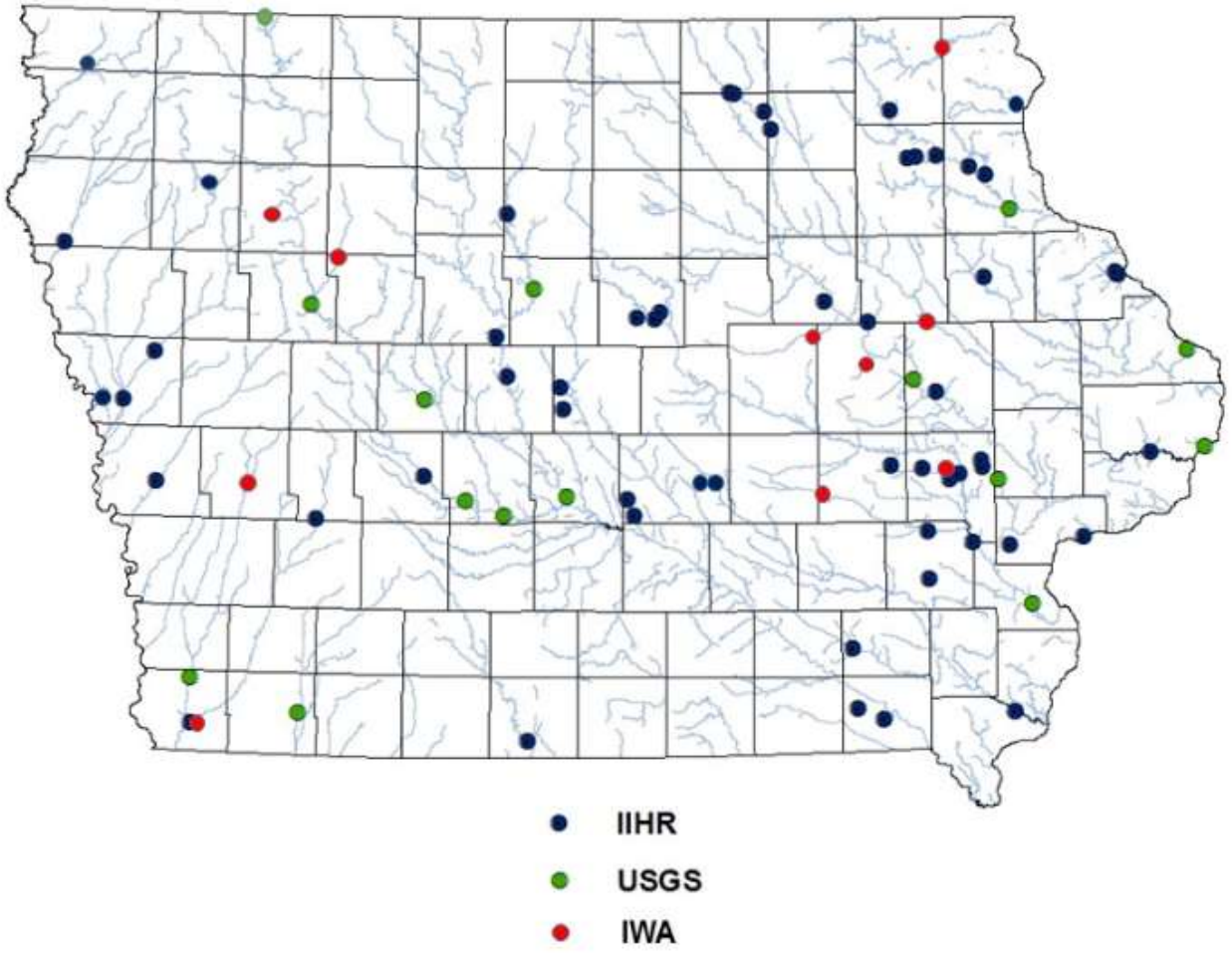
IIHR Water Quality Sensor Network

Sites

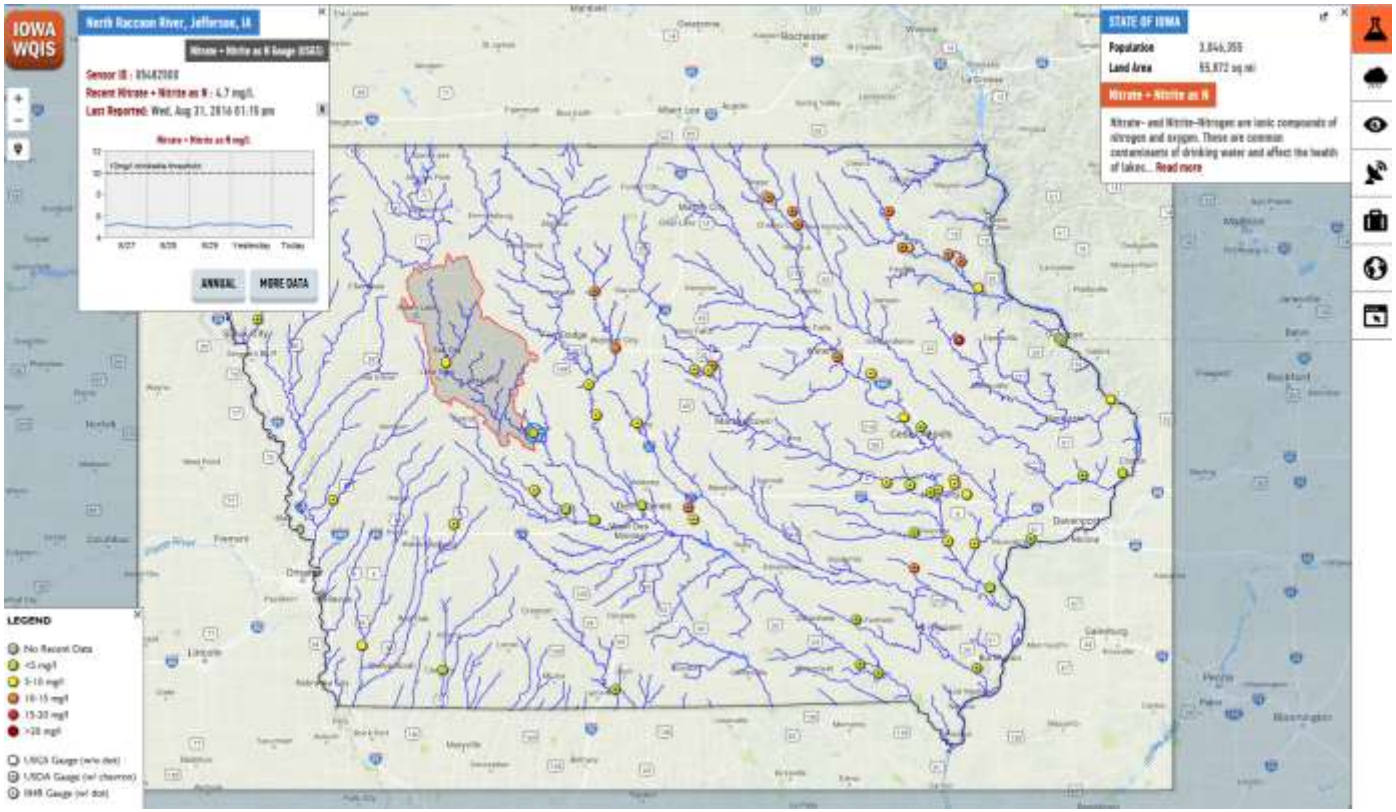
70+ sites Nitrate-N

20-25 sites

- Temperature
- pH
- SC
- DO
- Turbidity



Iowa Water Quality Information System



iwqis.iowawis.org/

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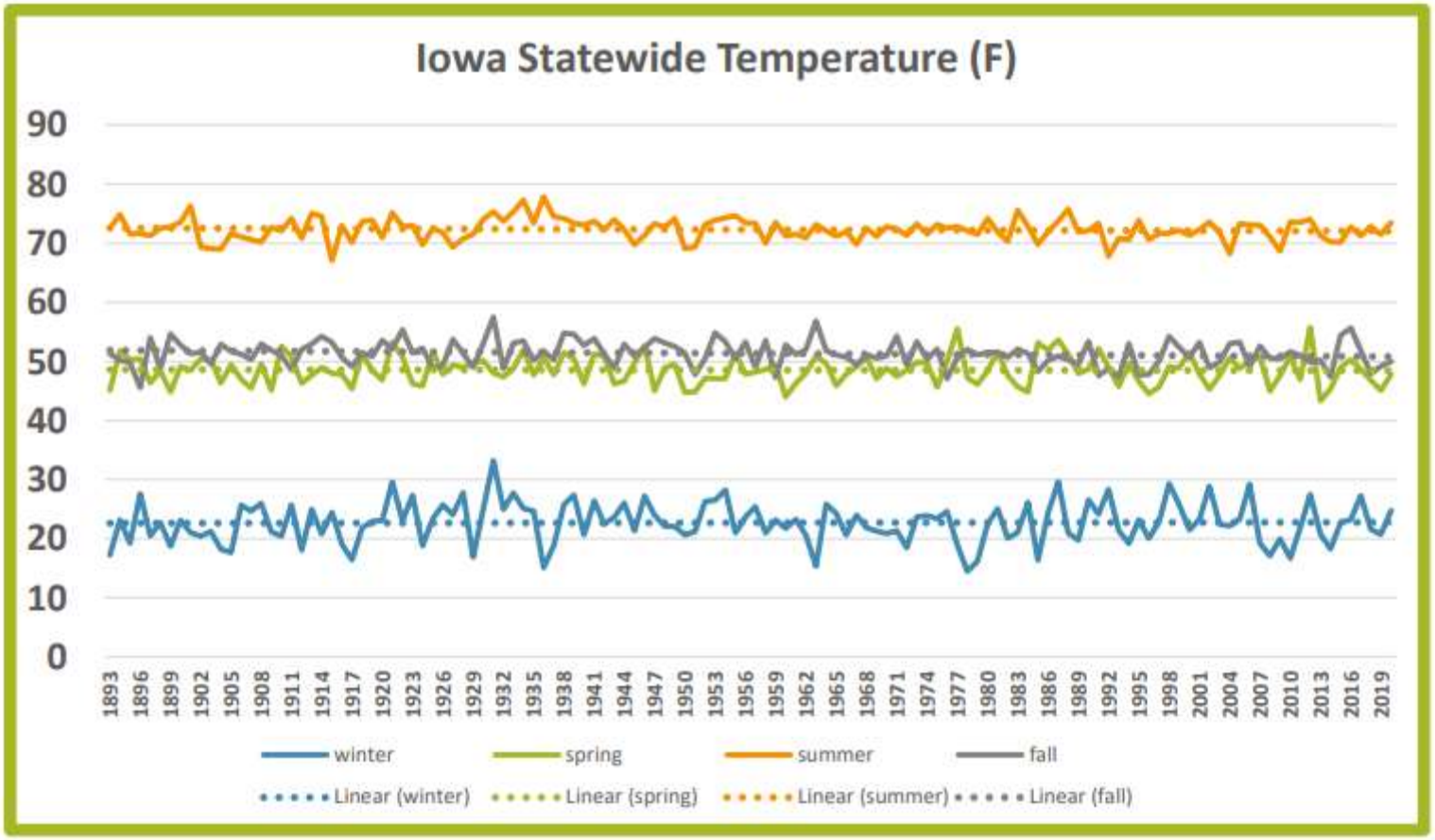
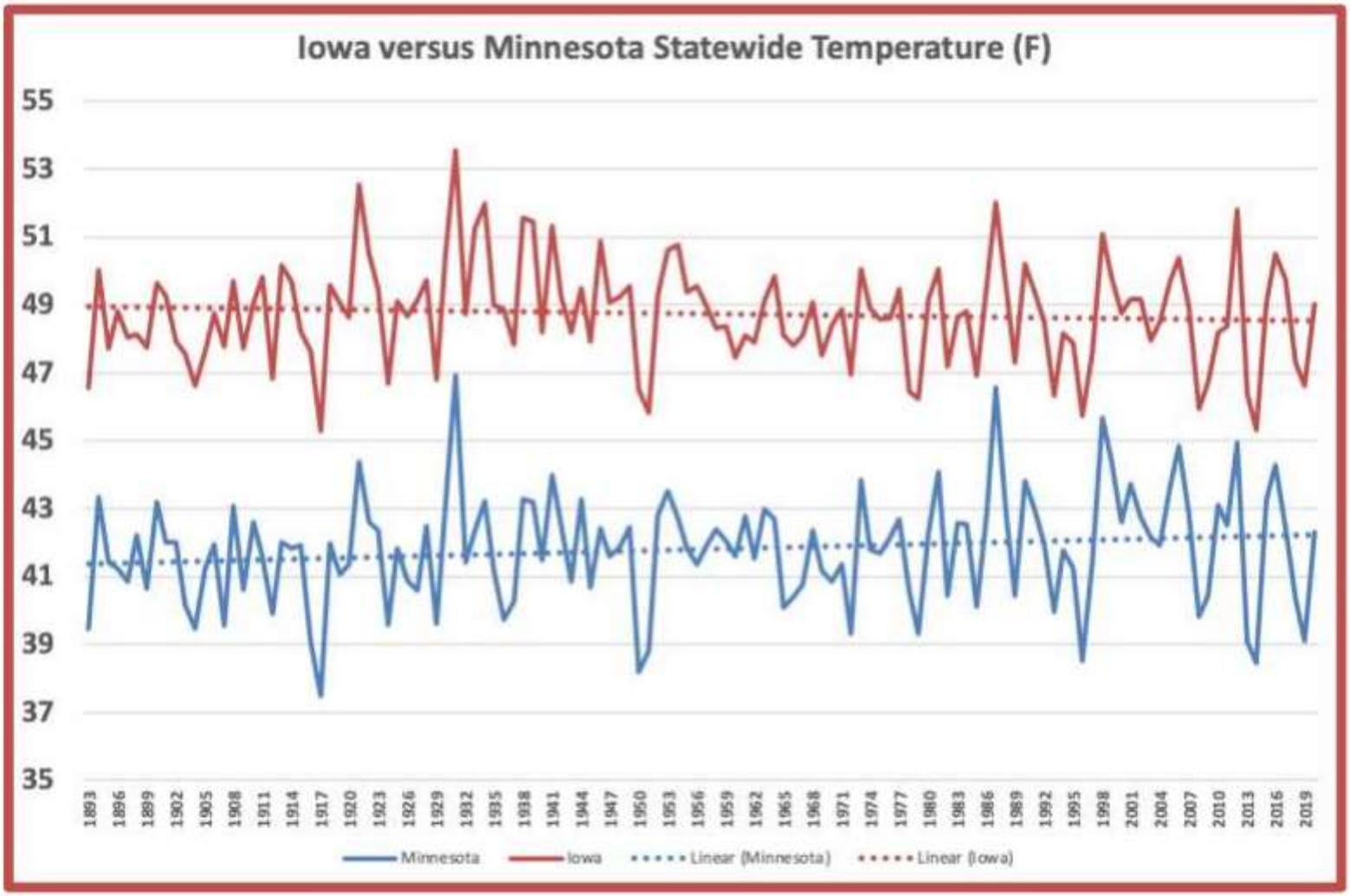
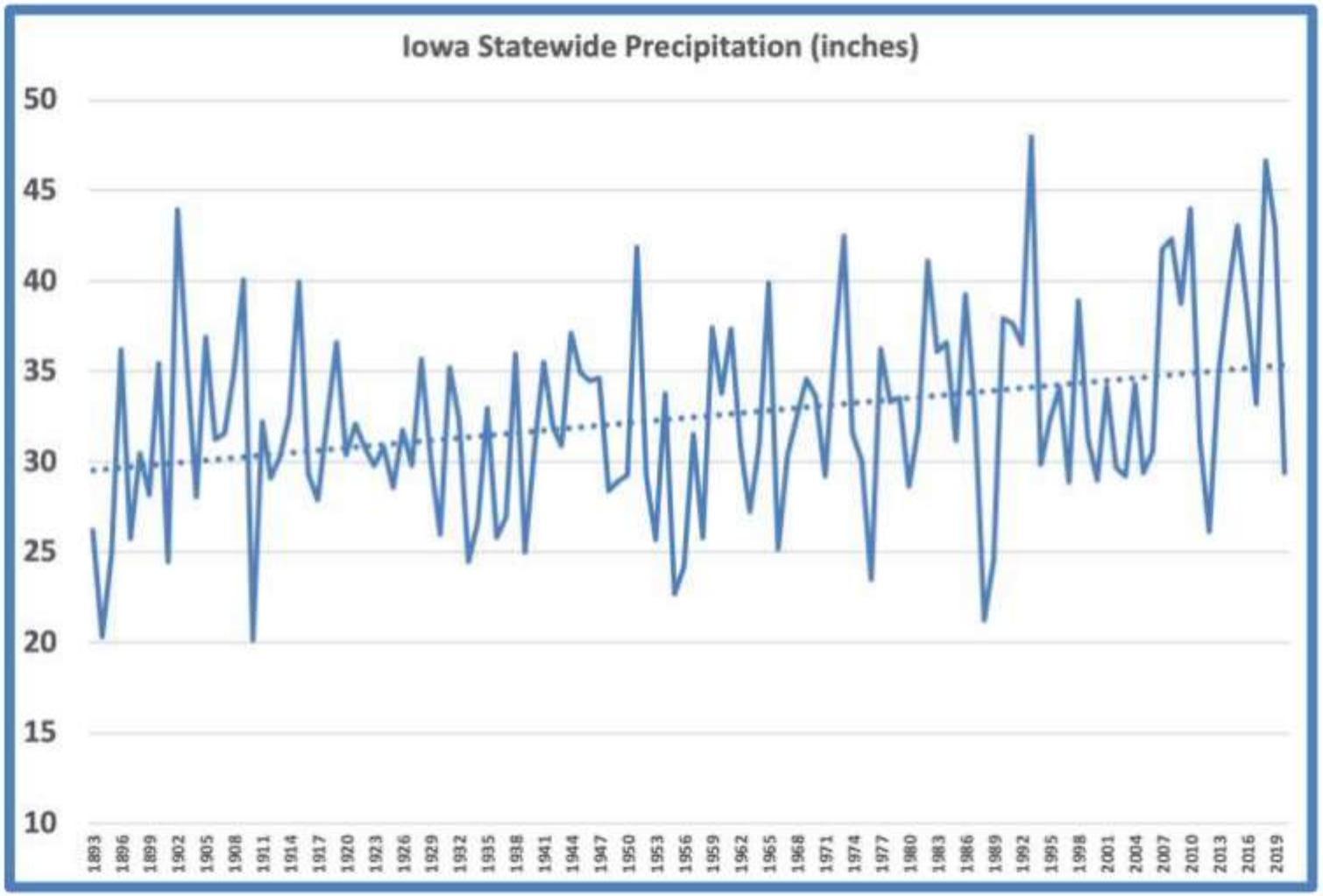
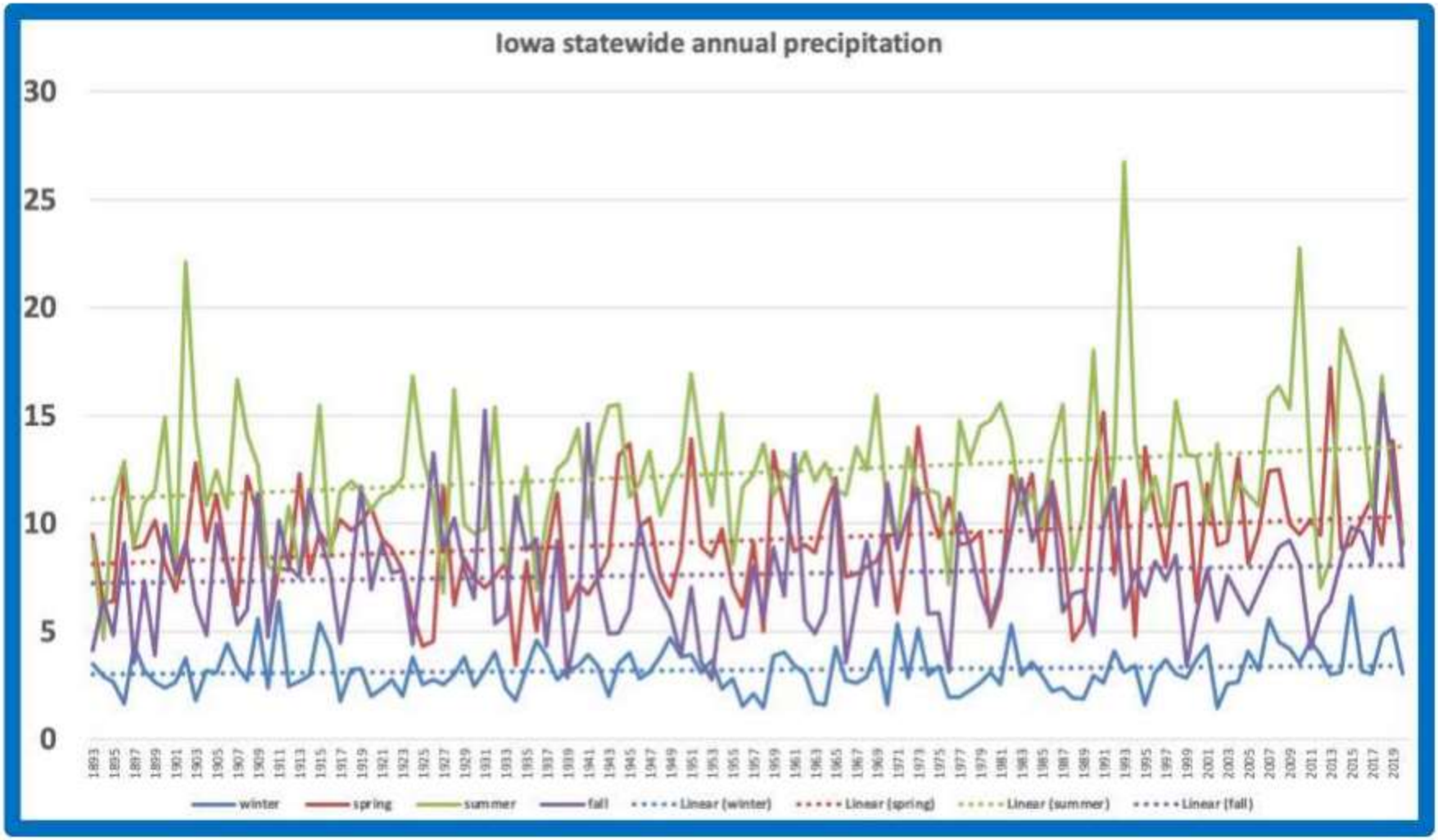
IIHR Hydroscience & Engineering
The University of Iowa College of Engineering

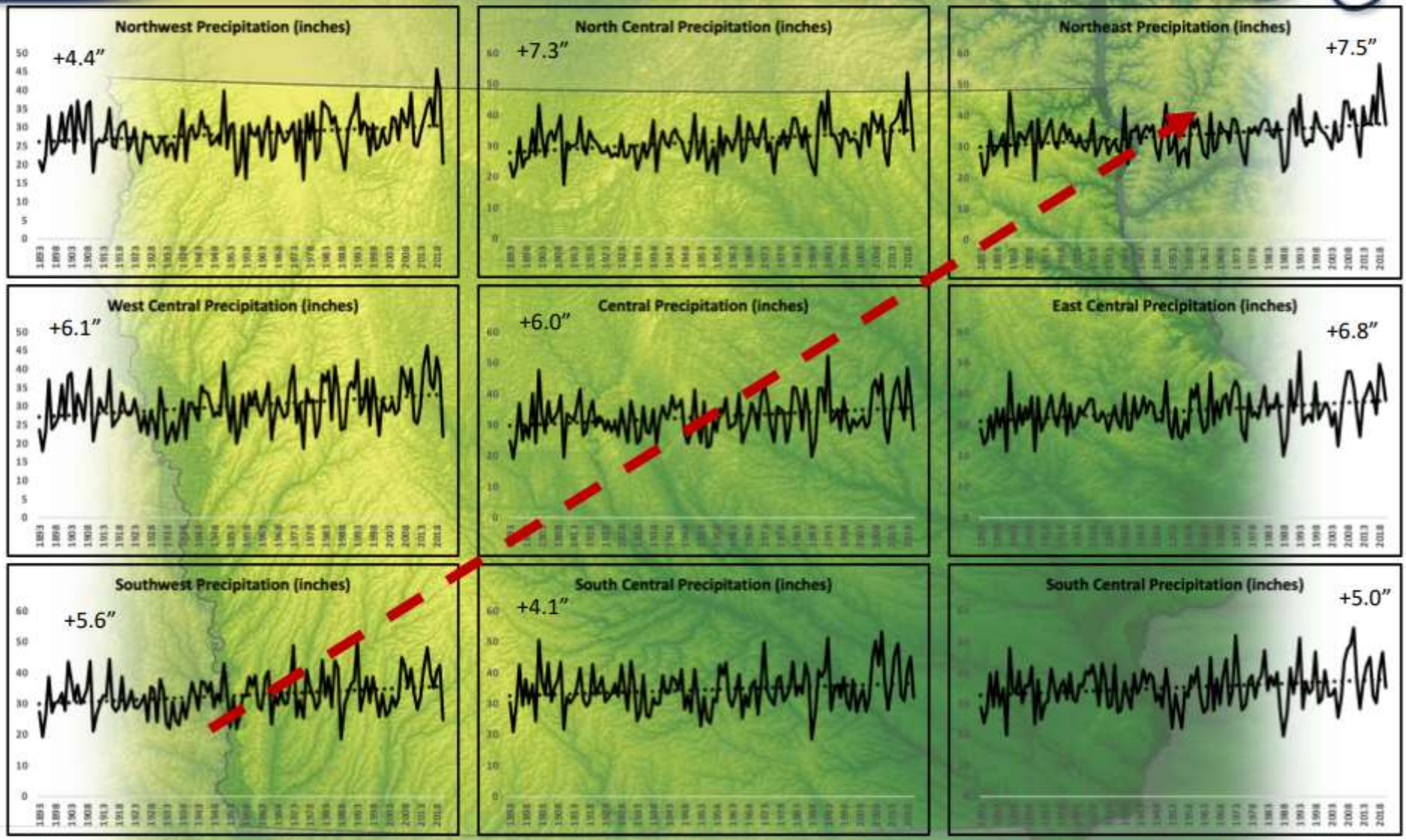
Iowa Temperature since 1893



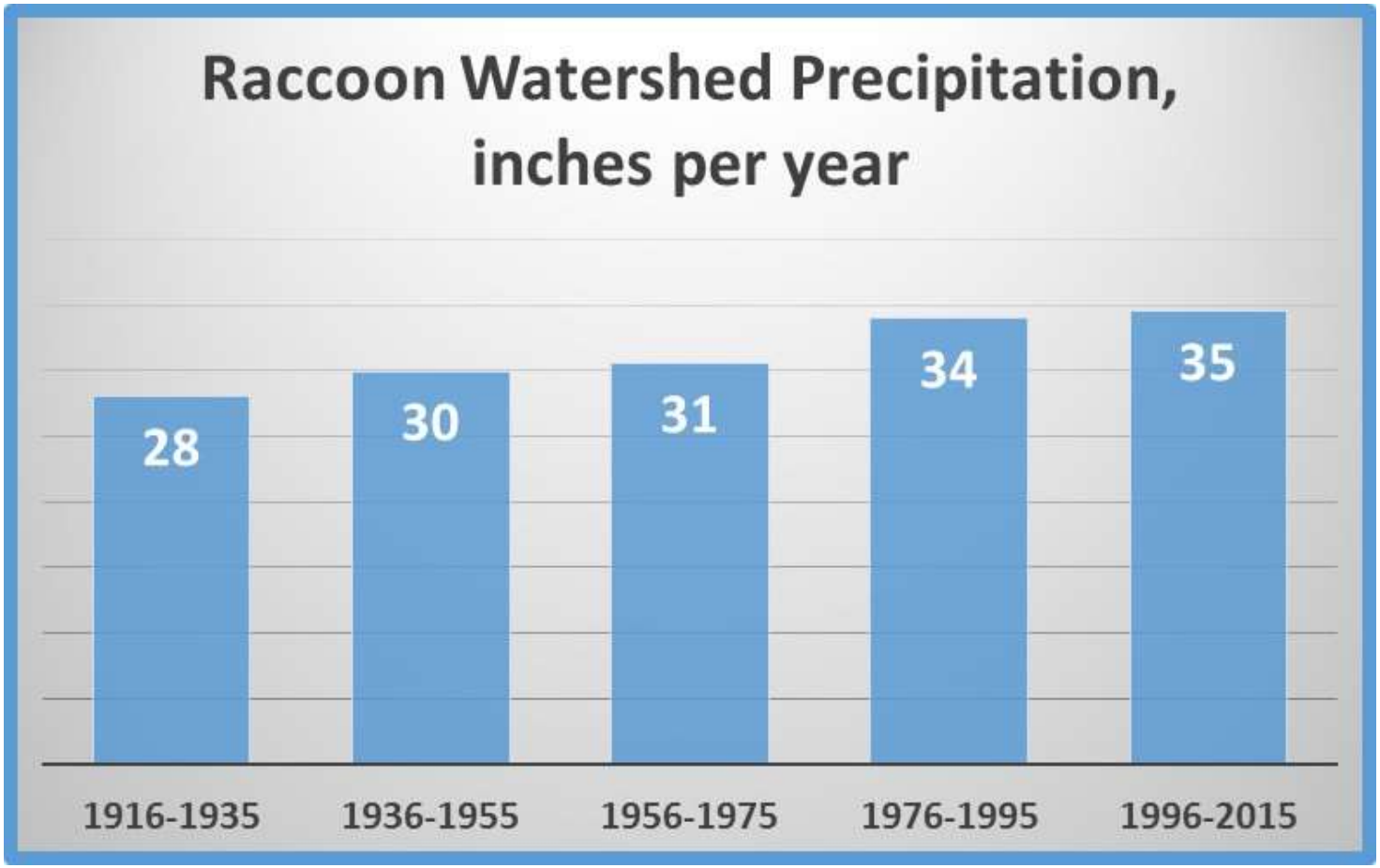

Iowa versus Minnesota Statewide Temperature (F)
55
53
51
49
47
45
43
41
39
37
35
1893
1896
1899
1902
1905
1908
1911
1914
1917
1920
1923
1926
1929
1932
1935
1938
1941
1944
1947
1950
1953
1956
1959
1962
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019
Minnesota
Iowa
Linear (Minnesota)
Linear (Iowa)

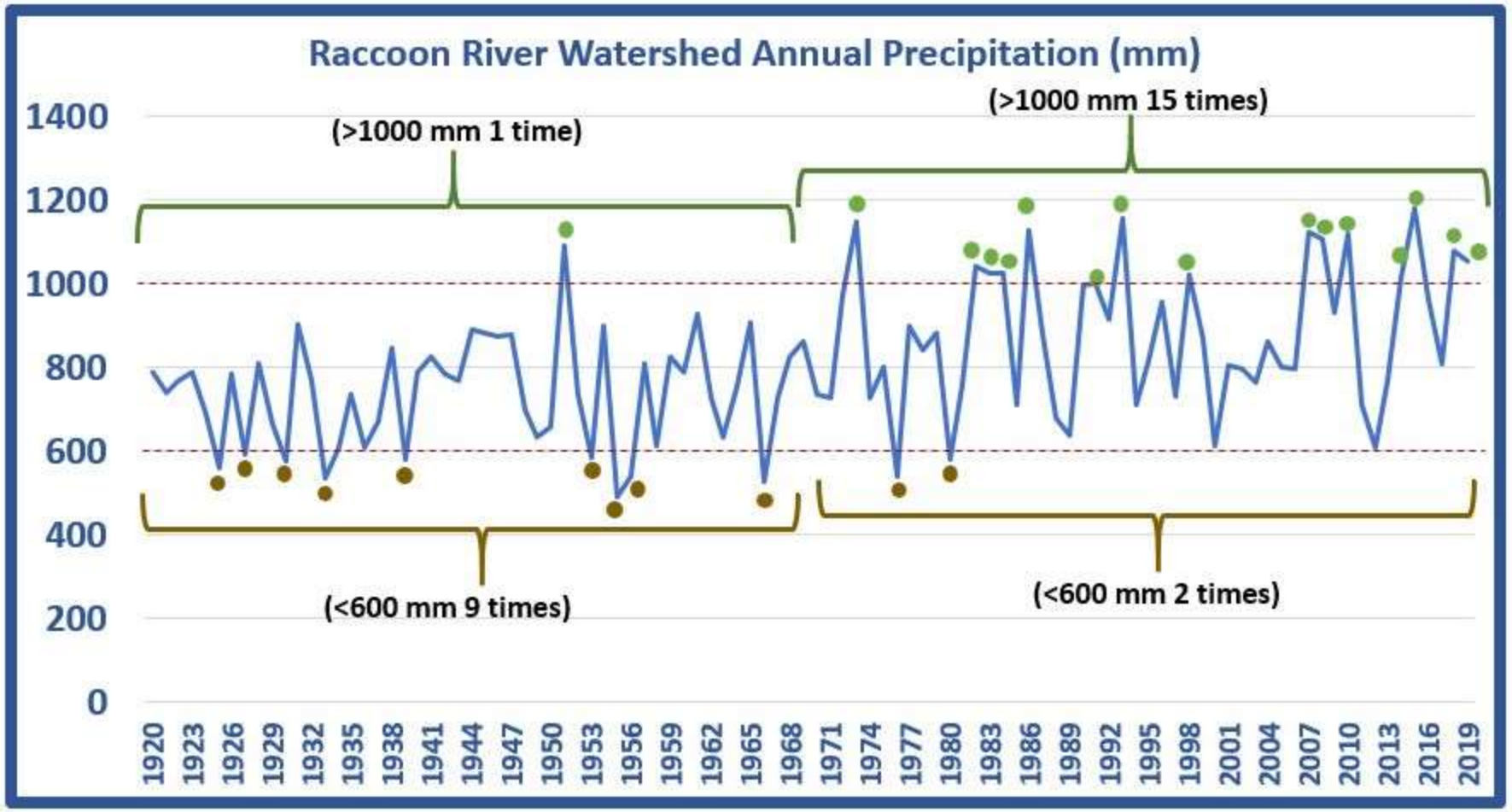

Iowa Statewide Precipitation (inches)
50
45
40
35
30
25
20
15
10
1893
1896
1899
1902
1905
1908
1911
1914
1917
1920
1923
1926
1929
1932
1935
1938
1941
1944
1947
1950
1953
1956
1959
1962
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019

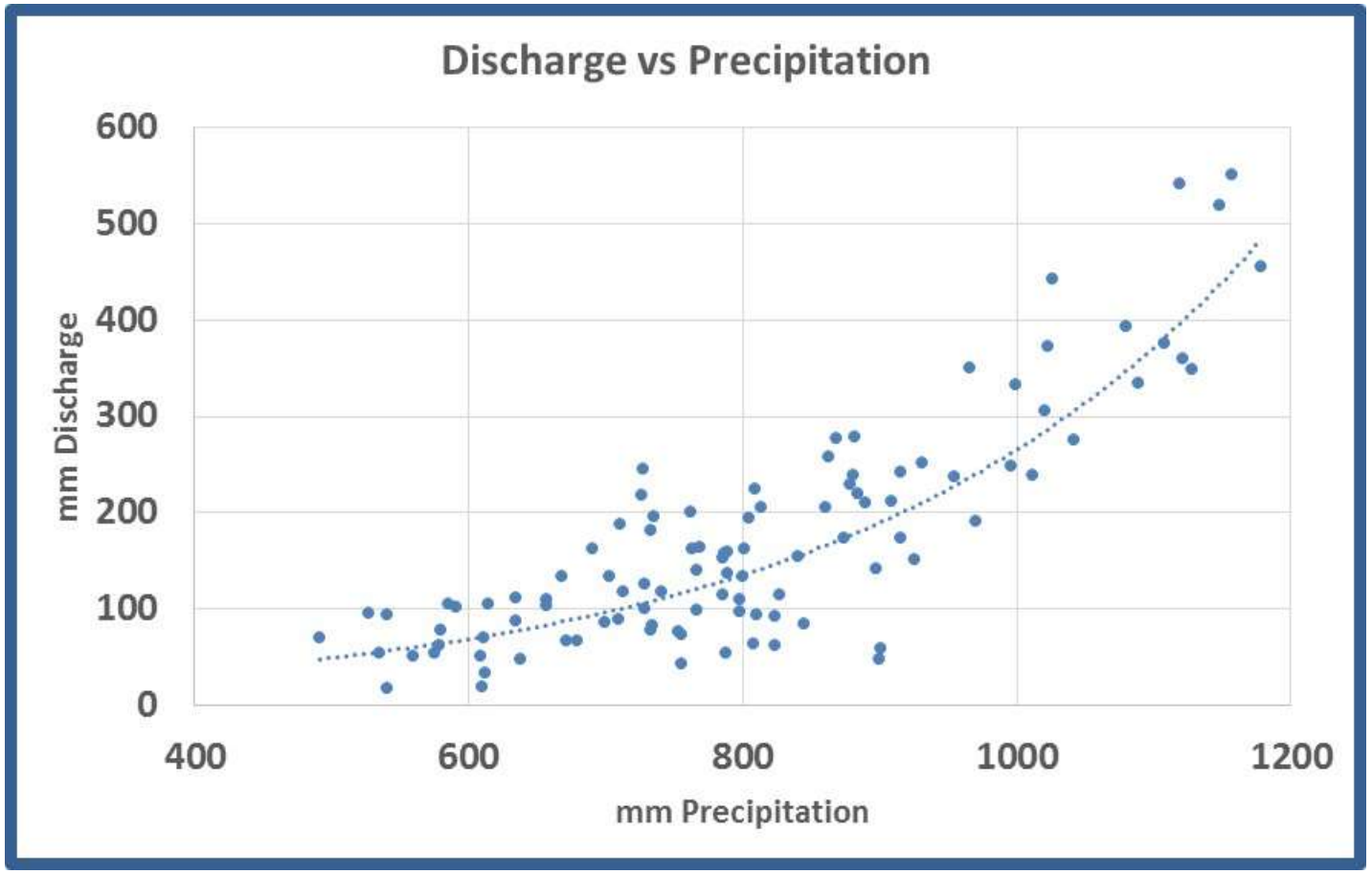

Iowa statewide annual precipitation
30
25
20
15
10
5
0
winter
spring
summer
fall
Linear (winter)
Linear (spring)
Linear (summer)
Linear (fall)

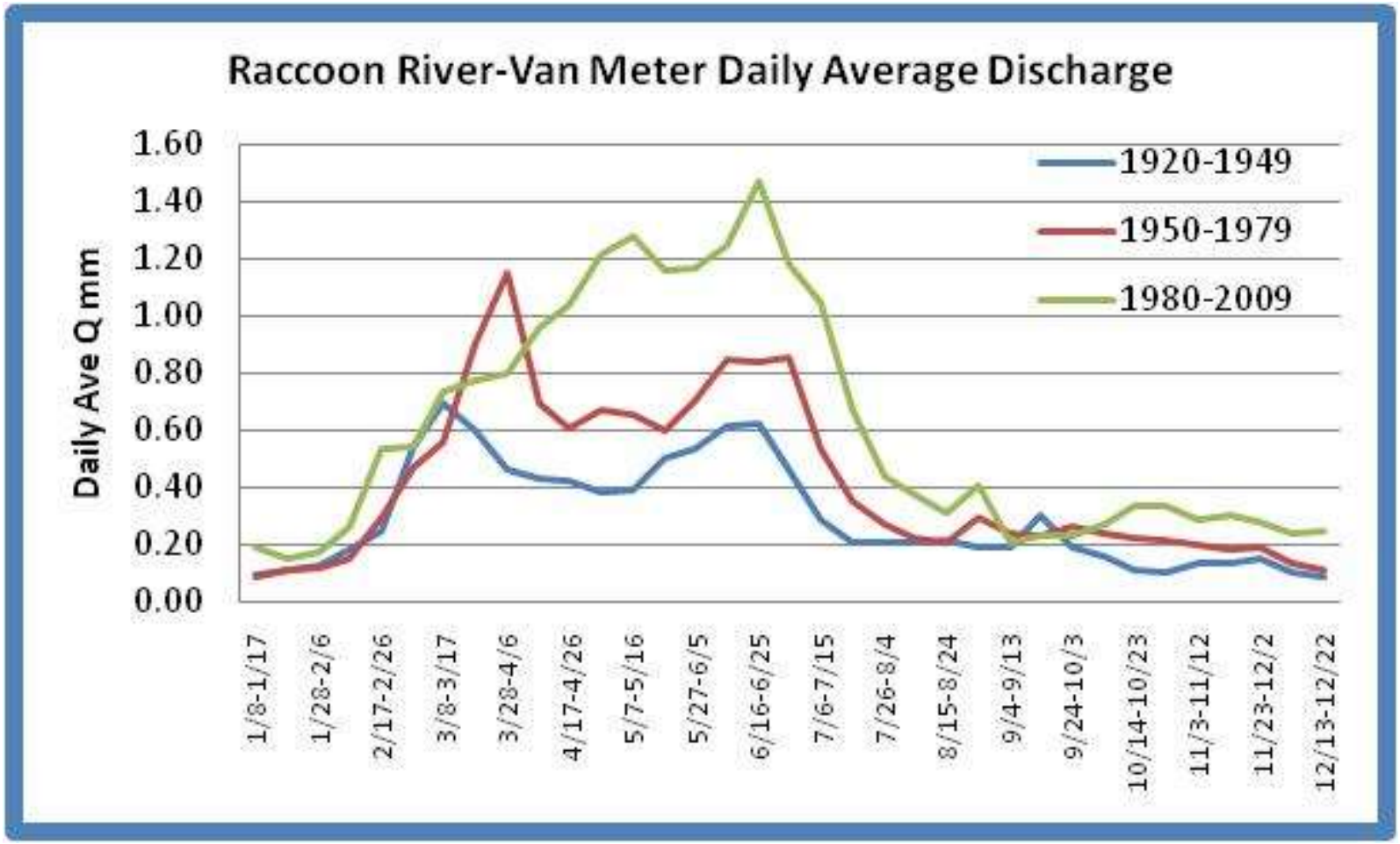


Raccoon Watershed



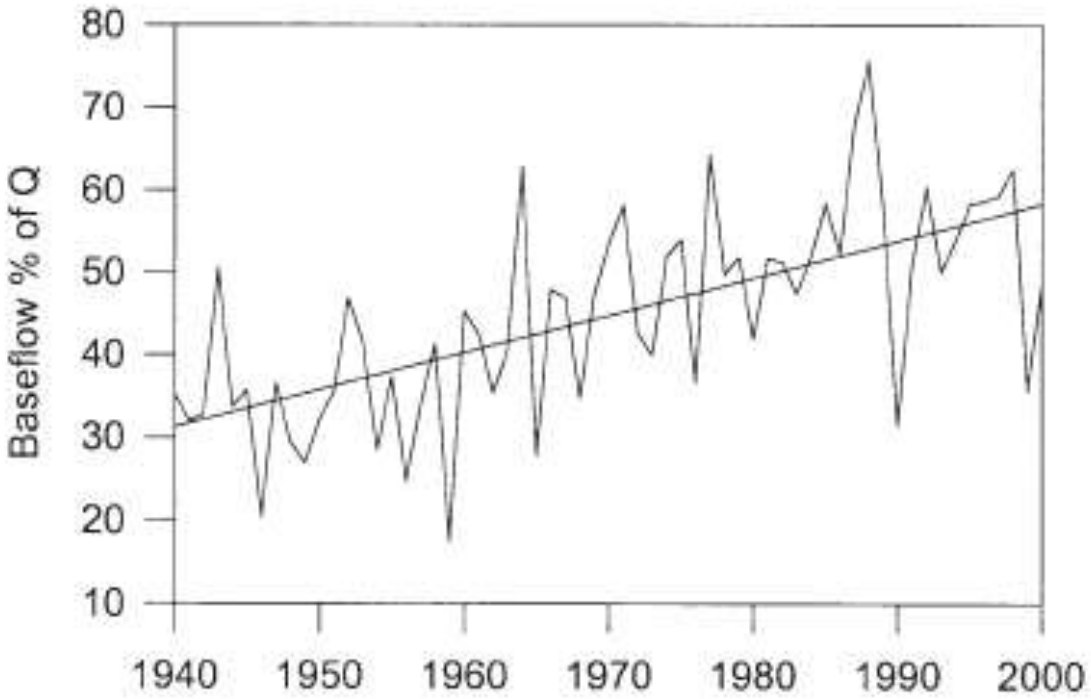

Raccoon River Watershed Annual Precipitation (mm)
(>1000 mm 1 time)
(>1000 mm 15 times)
(<600 mm 9 times)
(<600 mm 2 times)
1400
1200
1000
800
600
400
200
0
1920
1923
1926
1929
1932
1935
1938
1941
1944
1947
1950
1953
1956
1959
1962
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
2004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


Discharge vs Precipitation
600
500
400
300
200
100
0
mm Discharge
400
600
800
1000
1200
mm Precipitation


Raccoon River-Van Meter Daily Average Discharge
Daily Ave Q mm
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
1920-1949
1950-1979
1980-2009
1/8-1/17
1/28-2/6
2/17-2/26
3/8-3/17
3/28-4/6
4/17-4/26
5/7-5/16
5/27-6/5
6/16-6/25
7/6-7/15
7/26-8/4
8/15-8/24
9/4-9/13
9/24-10/3
10/14-10/23
11/3-11/12
11/23-12/2
12/13-12/22

Streams have more water

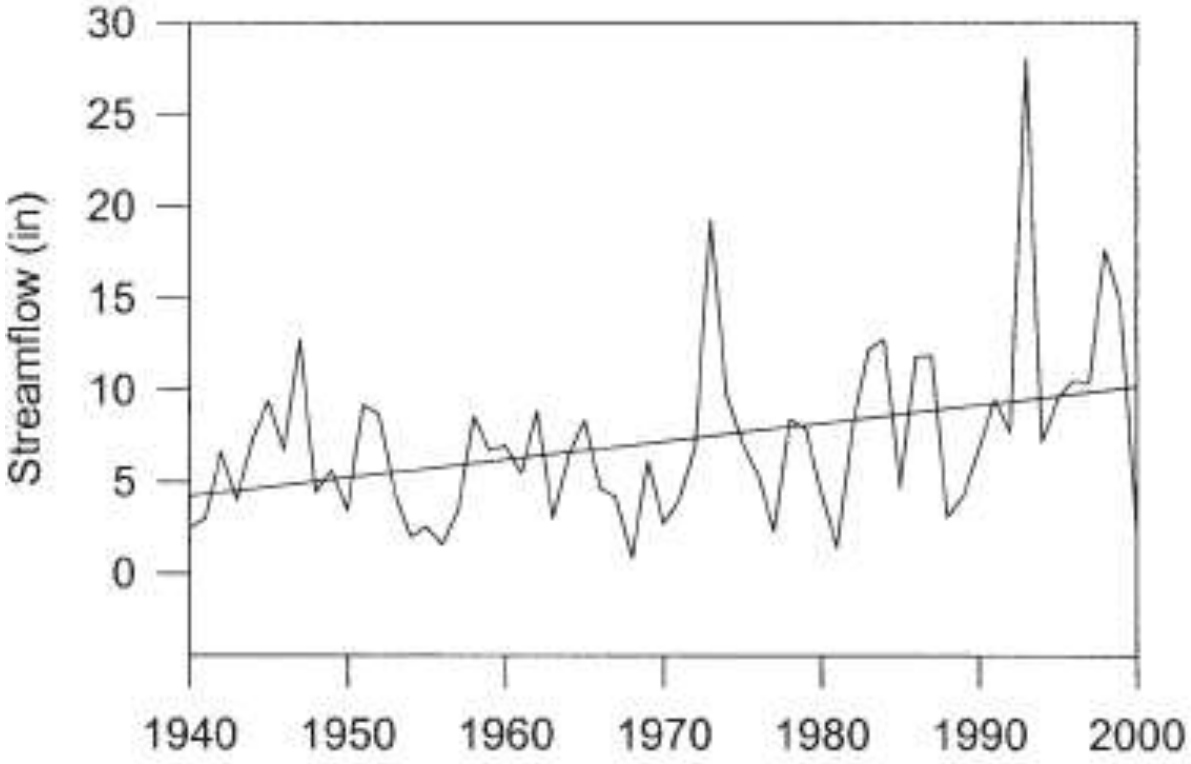
Wapsipinicon



Baseflow=is the portion of streamflow that comes from "the sum of deep subsurface flow and delayed shallow subsurface flow".

Schilling, K. E. and Libra, R. D. (2003), INCREASED BASEFLOW IN IOWA OVER THE SECOND HALF OF THE 20TH CENTURY[1]. JAWRA Journal of the American Water Resources Association, 39: 851–860. doi:10.1111/j.1752-1688.2003.tb04410.x

E. Nishnabotna



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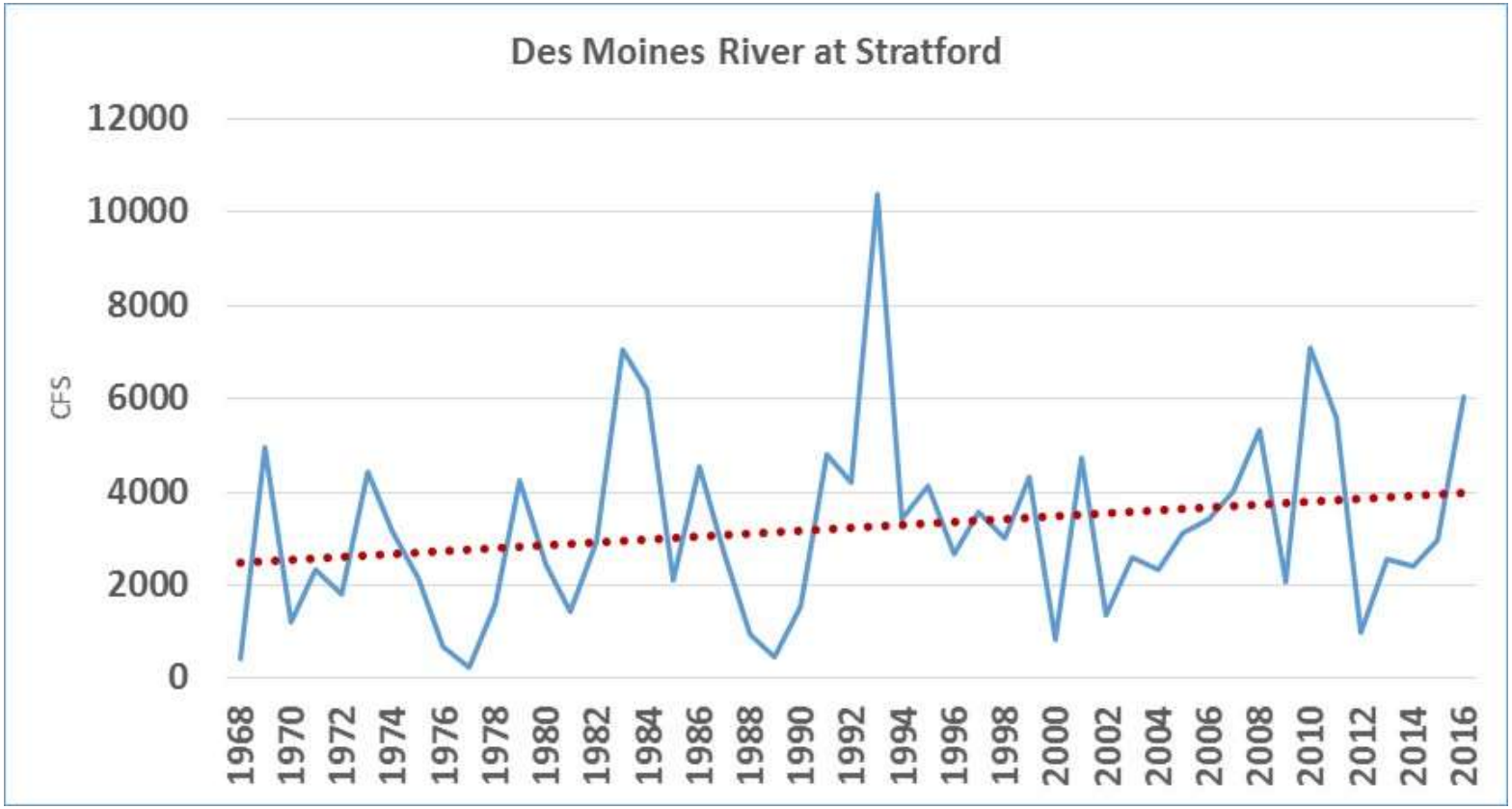
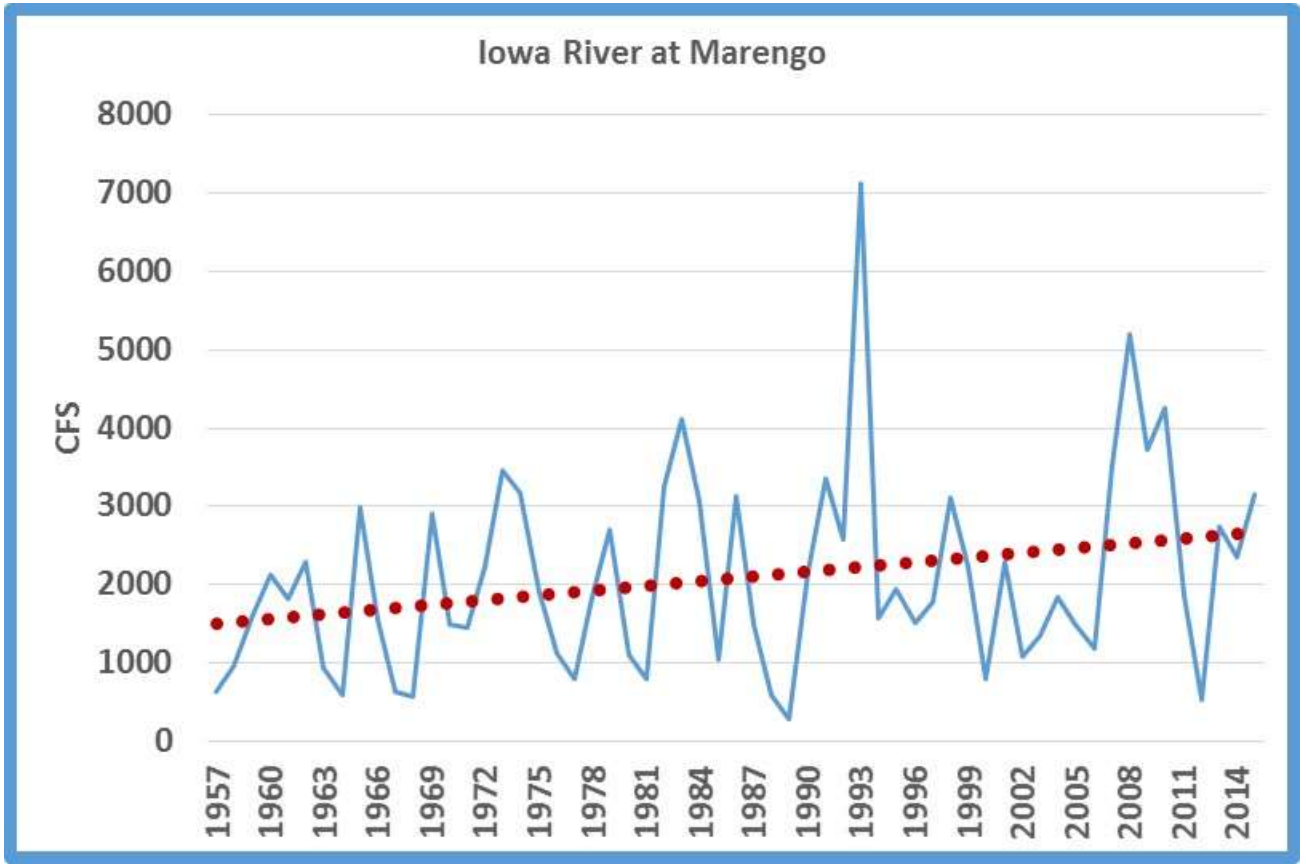
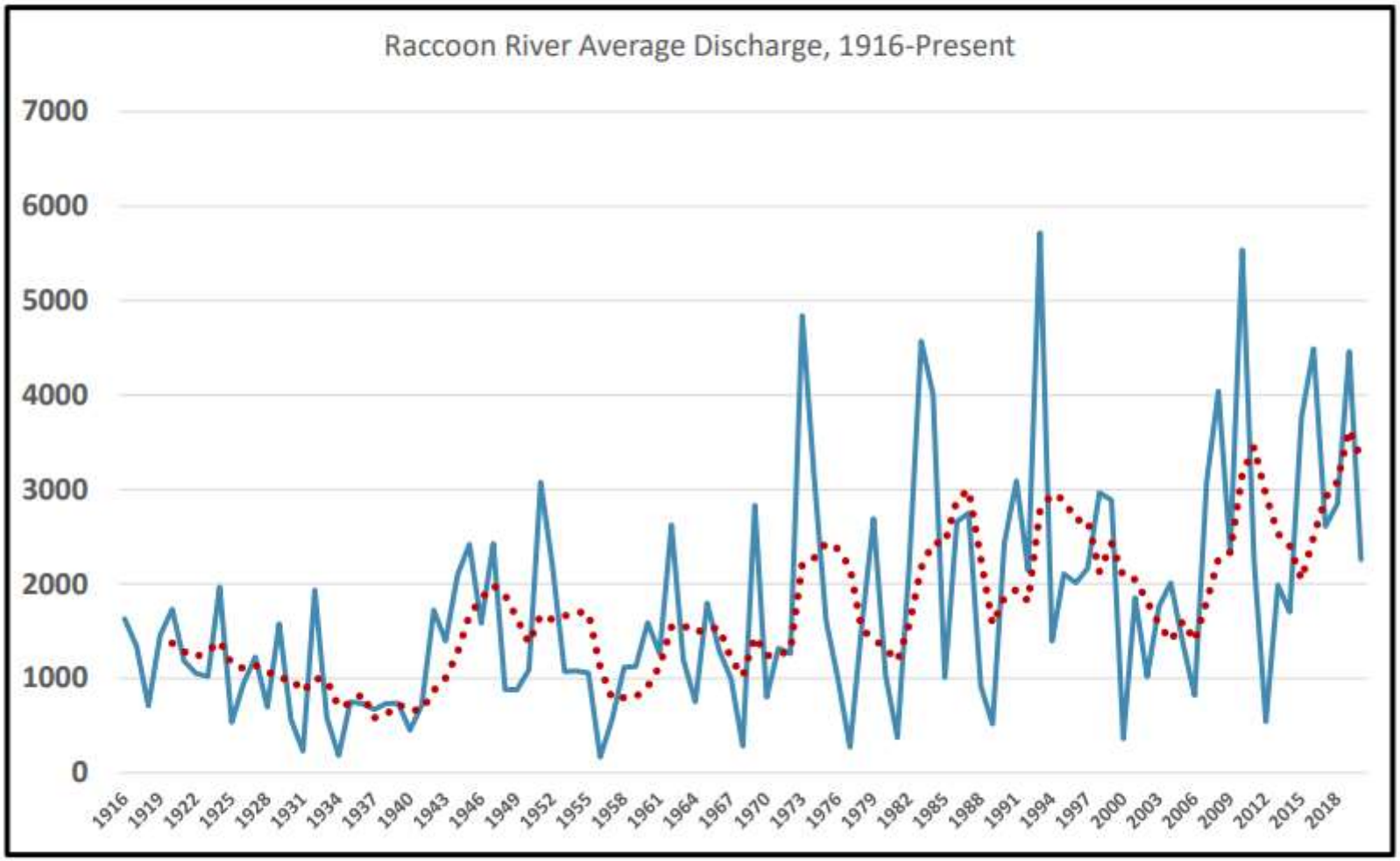
Des Moines R. at Stratford

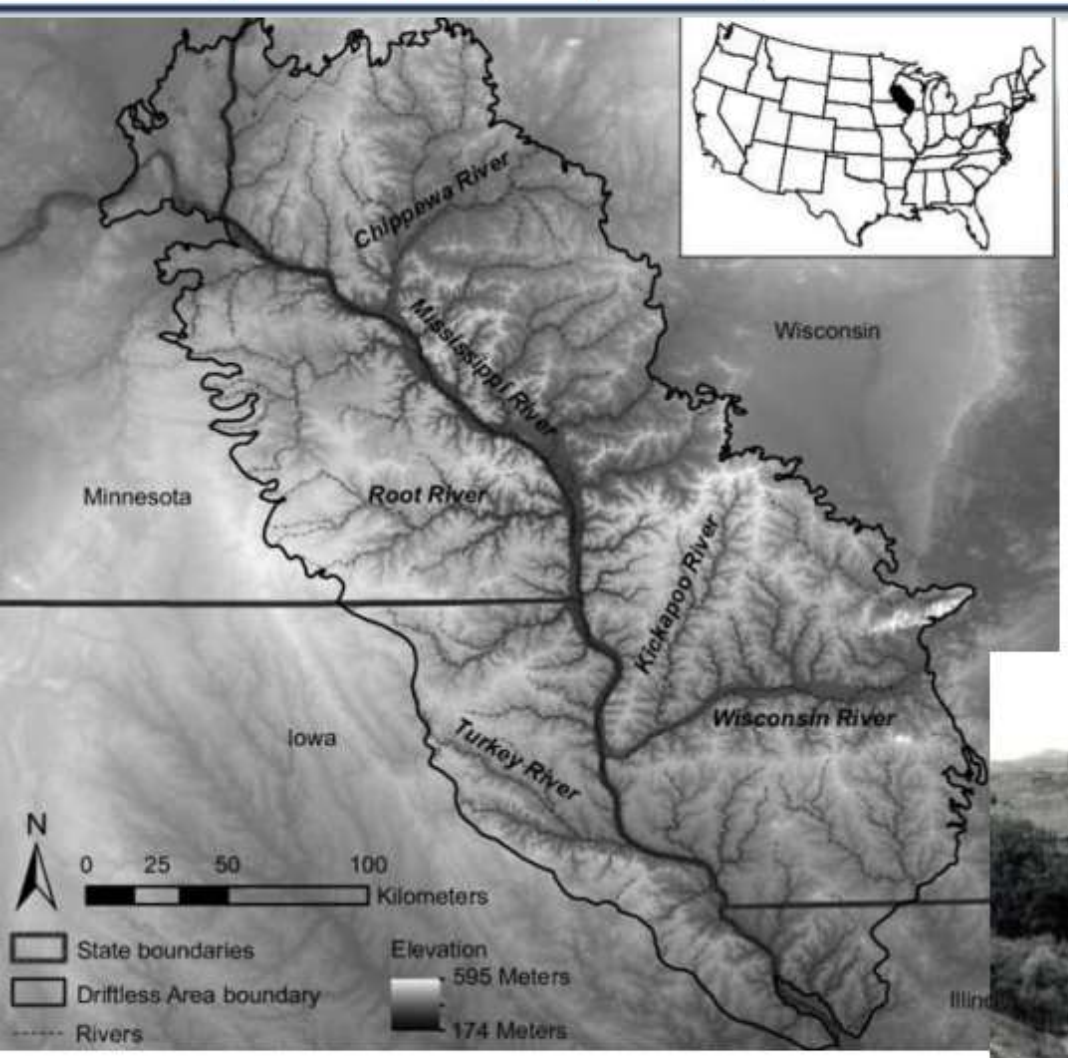


Iowa R. at Marengo




Raccoon River Average Discharge, 1916-Present
7000
6000
5000
4000
3000
2000
1000
0
1916
1919
1922
1925
1928
1931
1934
1937
1940
1943
1946
1949
1952
1955
1958
1961
1964
1967
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018


Skunk River
Flats WMA



Credit: Shea, M.E., Schulte, L.A. and Palik, B.J., 2014. Reconstructing vegetation past: pre-Euro-American vegetation for the midwest driftless area, USA. *Ecological Restoration*, *32*(4), pp.417-433.

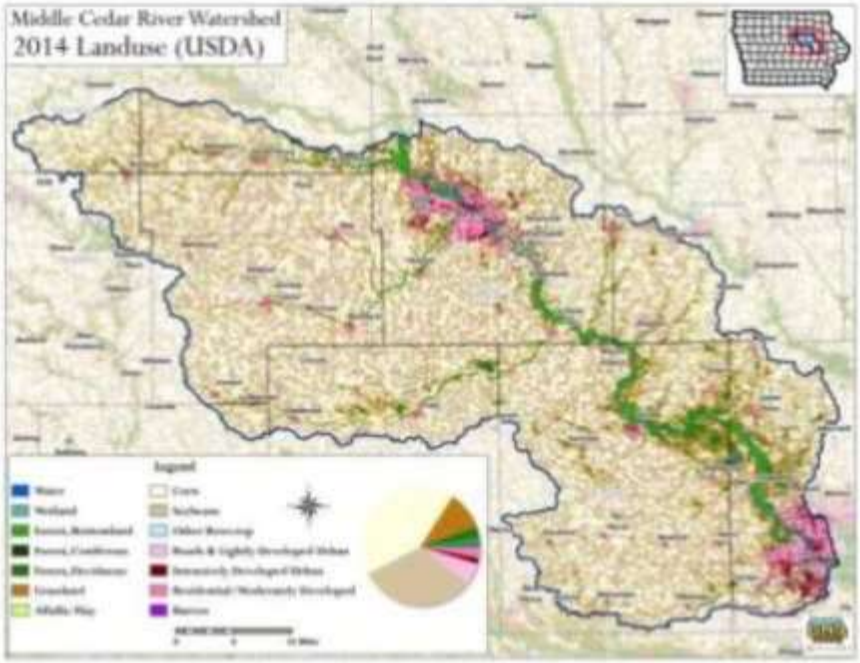
More Erosion/More P loss

Credit: USDA

More tile

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

More N loss: Middle Cedar Example



Iowa's Middle Cedar Watershed (credit: Middle Cedar Watershed Management Authority and Iowa DNR)

1200 miles new tile per year

1 acre of pattern tile = 1452' (0.275 mi)

1200 miles = 4364 acres

2018 N loss = 31.5 lbs/ac

New tile multiply N loss by 1.5 (15.9 lbs)

Increase watershed N load by 69,000 lbs

- 136 woodchip bioreactors (we currently have about 50 statewide), or,
- 3 constructed wetlands (currently we have about 100 statewide), or
- Around 7000 new acres of cover crops (currently we have million ac statewide).

Potential Impact of Climate Change on Subsurface Drainage in Iowa's Subsurface Drained Landscapes

R. Singh[1]; M. J. Helmers[2]; Amy L. Kaleita[3]; and Eugene S. Takle[4]

JOURNAL OF IRRIGATION AND DRAINAGE ENGINEERING © ASCE / JULY/AUGUST 2009 / 459

Perry, Iowa

- **24-32% increase in annual precipitation**
- **Increase tile drainage flows**
- **Change distribution of flows within the calendar year**

IOWA STATE UNIVERSITY

THE UNIVERSITY OF IOWA College of Engineering

IIHR Hydroscience & Engineering


JOHN DEERE

What has happened to Iowa Ag since 1970?

- Loss of Crop Diversity
- Concentration of Livestock
- Decouple Livestock and Crop Production
- Huge increase in Hogs and Chickens
- Loss of Cattle—especially on pasture
- Fewer Farmers farming more land

How do we define "WATER QUALITY"?

- Drinking Water
- Streams
- Lakes
- Estuaries
- Oceans
- Aquifers

Water Quality Index

- Single value index that objectively translates a body of data into one value
- Concept dates to at least 1848

Two types:

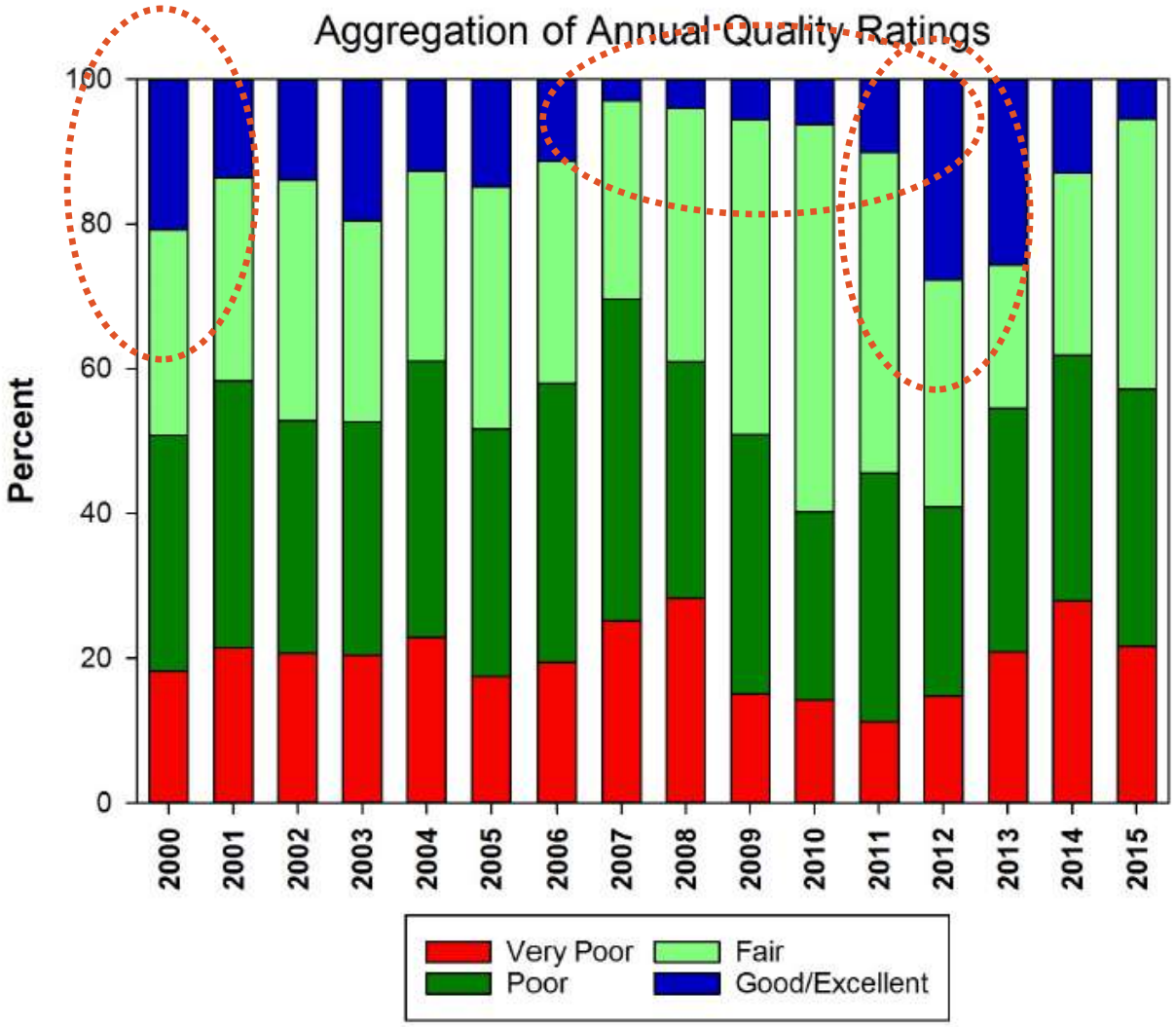
- Water Quality Index (high #'s for good water, low #'s for bad water)
- Water Pollution Index (low #'s for good water, high #'s for bad water)

Iowa

- WQI created by DNR in 2005
- Modification of WQI created by the National Sanitation Foundation

Parameter	IWQI	NSFWQI
Biological Oxygen Demand (BOD)	Yes	Yes
Dissolved Oxygen (DO)	Yes	Yes
E. coli	Yes	No
Fecal coliforms	No	Yes
Nitrate as Nitrogen (NO3-N)	No	Yes
Nitrate + Nitrite as Nitrogen (NOx-N)	Yes	No
Pesticides	Yes	No
Temperature	No	Yes
Total Dissolved Solids (TDS)	Yes	Yes
Total Phosphorous (TP)	Yes	Yes
Total Suspended Solids (TSS)	Yes	No
Turbidity	No	Yes

Figure 1: Aggregate IWQI Ratings for Iowa Streams, 2000-2015



Rating	Index Value
Very Poor	10 to 25
Poor	25 to 50
Fair	50 to 70
Good	70 to 90
Excellent	90 to 100

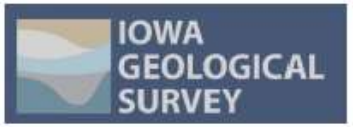
Analysis of Iowa Water Quality Index

and

Proposed Alternative

Christopher S. Jones, Ph.D., Research Engineer
University of Iowa IIHR Hydroscience and Engineering

Richard J. Langel, M.S. Research Specialist
Iowa Geological Survey



IIHR – Hydroscience and Engineering
College of Engineering
The University of Iowa
Iowa City, Iowa 52242-1585

Prepared for: Iowa Department of Natural Resources

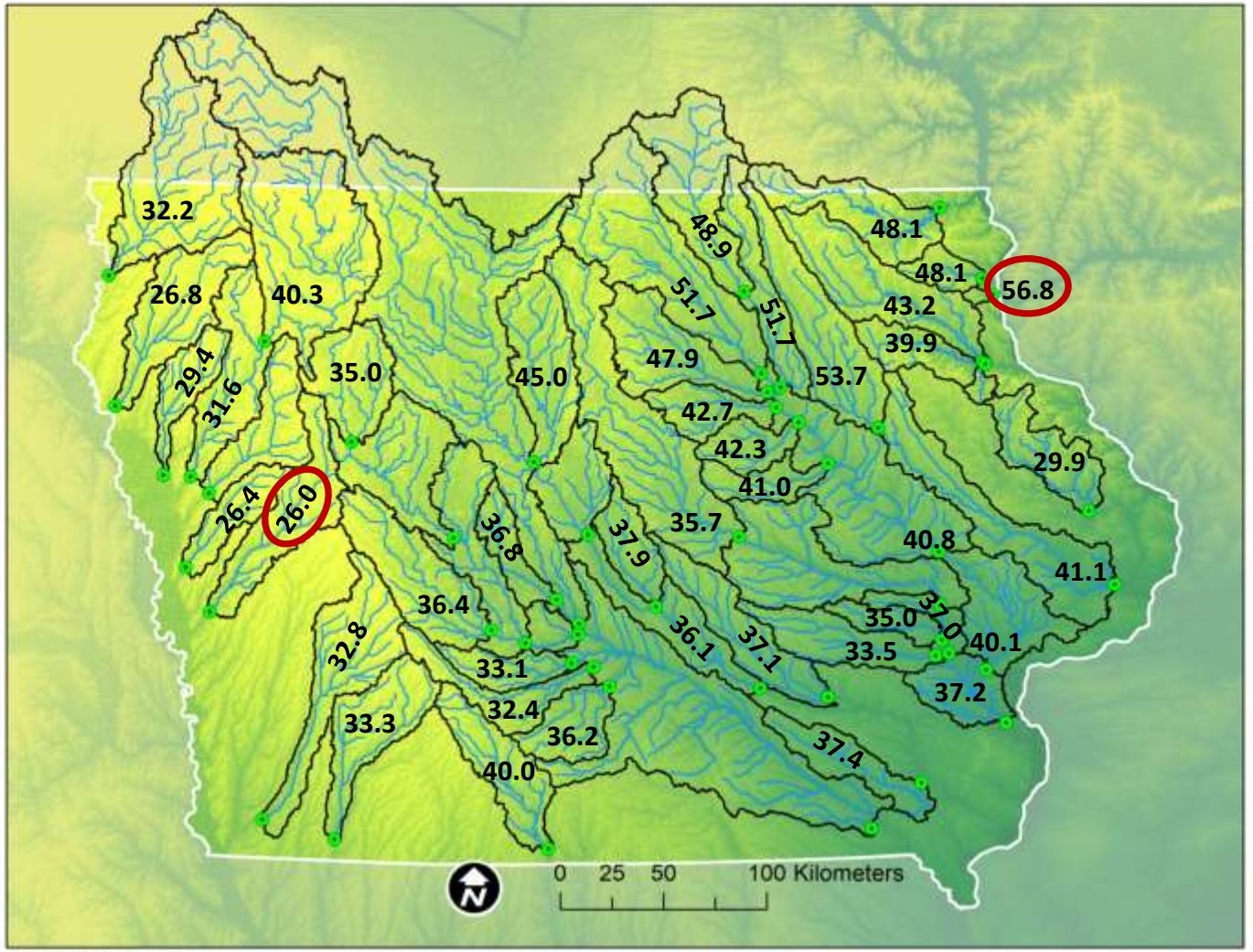
July 15, 2016

What parameters are driving water quality in Iowa Streams?

What parameters can be easily and inexpensively monitored?

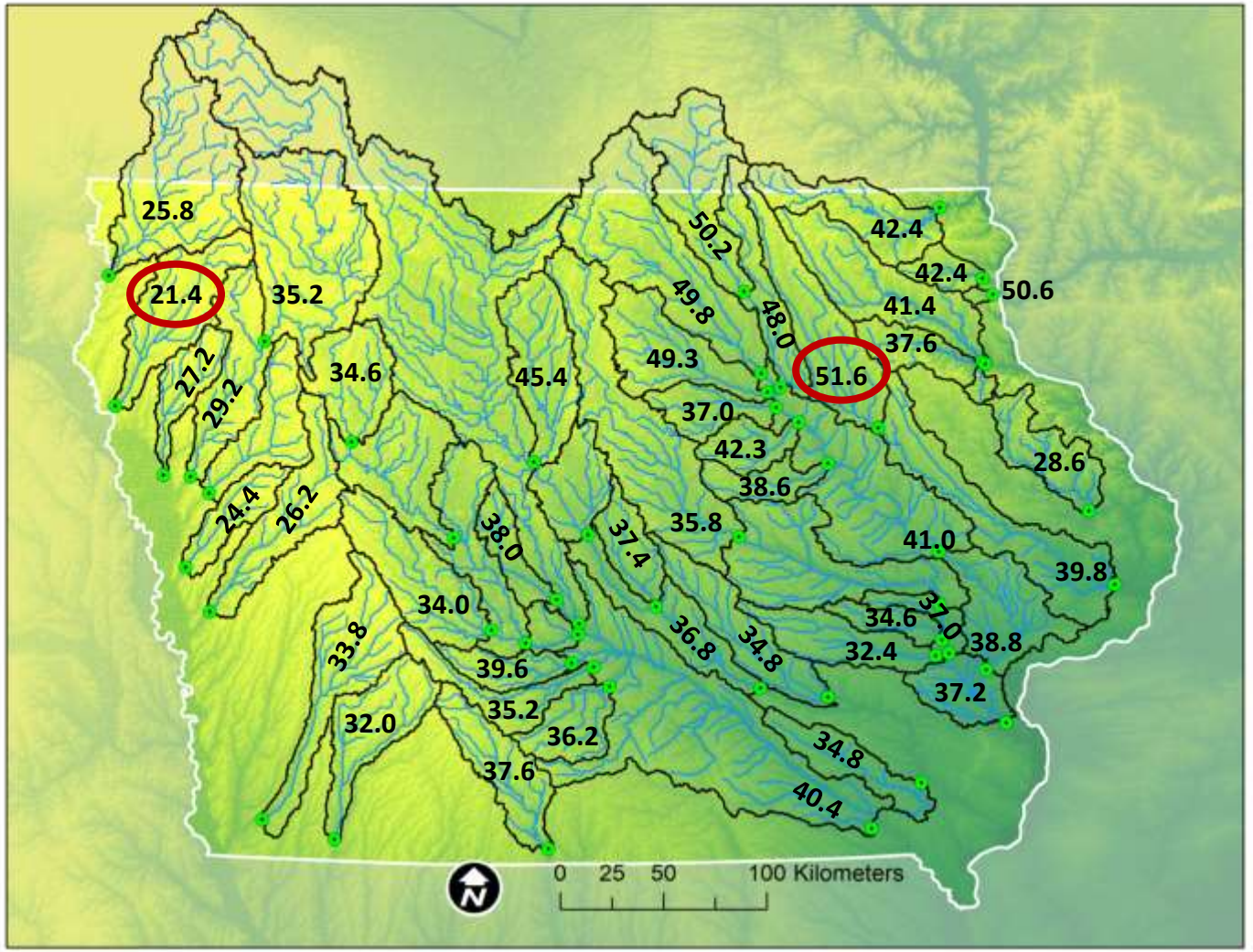
1. Dissolved Oxygen
2. Total Nitrogen (Kjeldahl N, Nitrate, Nitrite)
3. Total Phosphorus
4. *E. coli*
5. Turbidity

2000-2020



>96=Excellent
81-95=Good
66-80=Fair
46-65=Marginal
10-45=Poor
<10=Very Poor

2016-2020



>96=Excellent
81-95=Good
66-80=Fair
46-65=Marginal
10-45=Poor
<10=Very Poor

wqi	water quality index
DO	Dissolved oxygen
EC	E. coli
N	Total nitrogen
P	Total phosphorus
Turb	Turbidity
	less than 5% change
	5 to 10% improvement
	10-20% improvement
	>20% improvement
	5-10% deterioration
	10-20% deterioration
	>20% deterioration

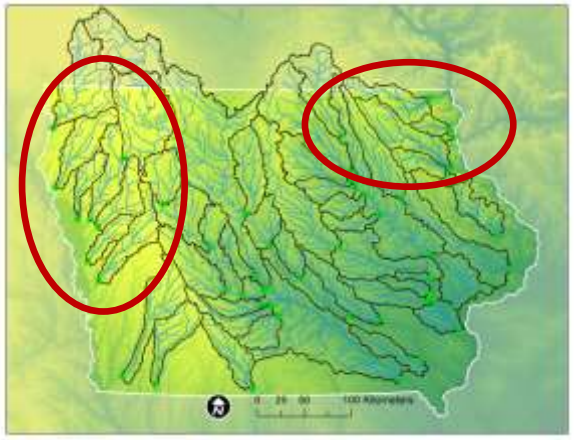
3/44 improving (>5%)

16/44 <5% change

25/44 declining (>5%)

Location	group	WQI 2016-20	Percent Change, 2016-20 versus pre-2016					
			change wqi	change DO	change EC	change N	change P	change turb
Wapsipinicon River at Independence	Iowan Surface	51.6	-5.1	-1.0	31.6	12.0	50.0	18.3
Bloody Run Cr at Marquette	Paleozoic Plateau	50.6	-14.4	-1.7	111.8	18.0	62.5	198.3
Cedar River at Charles City	Iowan Surface	50.2	4.4	-1.8	-38.1	-2.6	-9.5	-0.7
Shellrock River at Shellrock	Iowan Surface	49.8	-4.8	-5.2	30.0	-2.1	11.1	-12.3
W. Fork of the Cedar River at Finchford	Iowan Surface	49.3	2.8	-4.7	55.6	0.1	21.4	0.0
Cedar River at Janesville	Iowan Surface	48.0	-11.1	-9.8	51.5	3.3	11.8	-12.1
Boone River at Stratford	Des Moines Basin Up	45.4	1.3	-4.3	-16.8	-8.0	-16.7	-13.8
Upper Iowa River at Dorchester	Paleozoic Plateau	42.4	-14.7	-8.4	-51.7	20.5	0.0	-9.3
Yellow River at Ion	Paleozoic Plateau	42.4	-17.3	-5.8	-48.7	27.6	21.1	76.5
Blackhawk Creek at Waterloo	Iowan Surface	42.2	-0.2	0.0	-5.8	-2.3	-5.9	20.4
Turkey River at Garber	Paleozoic Plateau	41.4	-5.5	-2.7	-44.3	8.8	-10.3	5.4
Cedar River Downstream of Cedar Rapids	Iowan Surface	41.0	0.7	0.9	17.6	5.9	-13.3	31.0
Des Moines River at Keosauqua	Des Moines Basin Down	40.4	-6.5	-1.8	161.9	7.8	-17.1	53.6
Wapsipinicon River at DeWitt	Iowan Surface	39.8	-5.0	-8.2	6.0	1.1	13.6	0.3
North River at Norwalk	Des Moines Basin Down	39.6	23.0	2.1	-80.6	-19.1	-24.2	-21.1
Cedar River at Conesville	Iowan Surface	38.8	-4.2	-9.4	21.5	-0.7	-5.6	-6.0
Wolf Creek at LaPorte City	Iowan Surface	38.6	-7.4	1.0	58.3	-6.3	12.5	15.4
Beaver Creek at Grimes	Des Moines Basin Up	38.0	4.4	3.8	-11.6	-16.7	43.8	-26.8
Thompson River at Davis City	Missouri River Trib	37.6	-7.8	-4.0	-32.3	0.5	10.7	-5.8
Volga River at Elkport	Paleozoic Plateau	37.6	-7.8	-3.7	-41.3	8.2	-7.4	-2.5
Indian Creek at Colfax	Iowa-Skunk	37.4	-1.8	-1.9	25.7	-20.9	3.6	25.1
Beaver Creek at Cedar Falls	Iowan Surface	37.0	-16.7	-3.6	-39.8	11.6	-7.1	13.3
South Skunk River at Oskaloosa	Iowa-Skunk	36.8	2.5	-2.8	-28.6	-29.1	-11.8	-3.7
South River at Ackworth	Des Moines Basin Down	36.0	-0.8	1.0	-35.9	0.0	3.2	18.8
Iowa River Downstream of Marshalltown	Iowa-Skunk	35.8	0.3	-0.9	-1.3	-3.5	-13.2	67.9
Middle River at Indianola	Des Moines Basin Down	35.2	7.0	-2.8	-68.7	-19.6	-16.7	-6.6
Little Sioux River at Larrabee	Missouri River Trib	35.2	-16.0	-8.0	200.0	9.2	8.0	39.9
Cedar Creek at Oakland Mills	Iowa-Skunk	34.8	-11.2	0.0	12.1	-25.0	-6.9	-13.6
North Skunk River at Sigourney	Iowa-Skunk	34.8	-7.9	0.0	12.1	-7.7	-6.9	-13.6
Iowa River at Lone Tree	Iowa-Skunk	34.8	-8.9	0.9	75.7	0.7	22.2	34.6
North Raccoon at Sac City	Des Moines Basin Up	34.6	-3.6	-2.8	87.6	-26.9	-37.5	12.9
Old Mans Creek at Iowa City	Iowa-Skunk	34.6	-1.4	-3.8	-48.7	-18.8	3.6	45.0
South Raccoon River at Redfield	Des Moines Basin Up	34.0	-8.4	-1.8	19.3	6.8	-14.3	-36.0
South Skunk River at Cambridge	Iowa-Skunk	34.0	7.3	-1.9	-24.1	-23.3	-40.0	80.5
E. Nishnabotna at Shenandoah	Missouri River Trib	33.8	2.4	-2.8	-43.8	-5.4	-19.1	-42.2
English River at Riverside	Iowa-Skunk	32.4	-5.0	1.0	-54.8	-9.4	6.3	38.9
W. Nodaway at Shambaugh	Missouri River Trib	32.0	-5.3	0.9	-15.9	-9.6	10.8	-17.5
Little Sioux River at Smithland	Missouri River Trib	29.2	-15.1	-2.8	-23.5	10.8	9.4	32.5
N. Fork Maquoketa R. at Hurtsville	Iowan Surface	28.6	-6.8	-2.8	7.7	7.7	56.3	85.1
West Fork Ditch at Hornick	Missouri River Trib	27.2	-9.6	-1.9	-22.2	17.6	21.1	8.8
Boyer River at Missouri Valley	Missouri River Trib	26.2	0.8	-6.5	70.9	-2.2	-36.6	-36.5
Rock River at Rock Valley	Missouri River Trib	25.8	-24.8	-3.8	392.8	44.7	38.5	31.4
Soldier River at Pisgah	Missouri River Trib	24.4	-10.0	0.0	-44.5	36.8	-1.9	-20.3
Floyd River at Sioux City	Missouri River Trib	21.4	-26.5	-1.0	235.9	35.2	6.8	88.4
	Iowan Surface	42.9	-4.5	-3.7	16.3	2.3	11.3	12.7
	Paleozoic Plateau	42.9	-11.9	-4.5	-14.8	16.6	13.2	53.7
	Des Moines Basin Up	38.0	-1.6	-1.3	19.6	-11.2	-6.2	-15.9
	Des Moines Basin Down	37.8	5.7	-0.4	-5.9	-7.8	-13.7	11.2
	Missouri River Trib	29.3	-11.2	-3.0	71.7	13.8	4.8	7.9
	Iowa-Skunk	35.0	-2.9	-1.0	-3.5	-15.2	-4.8	29.0

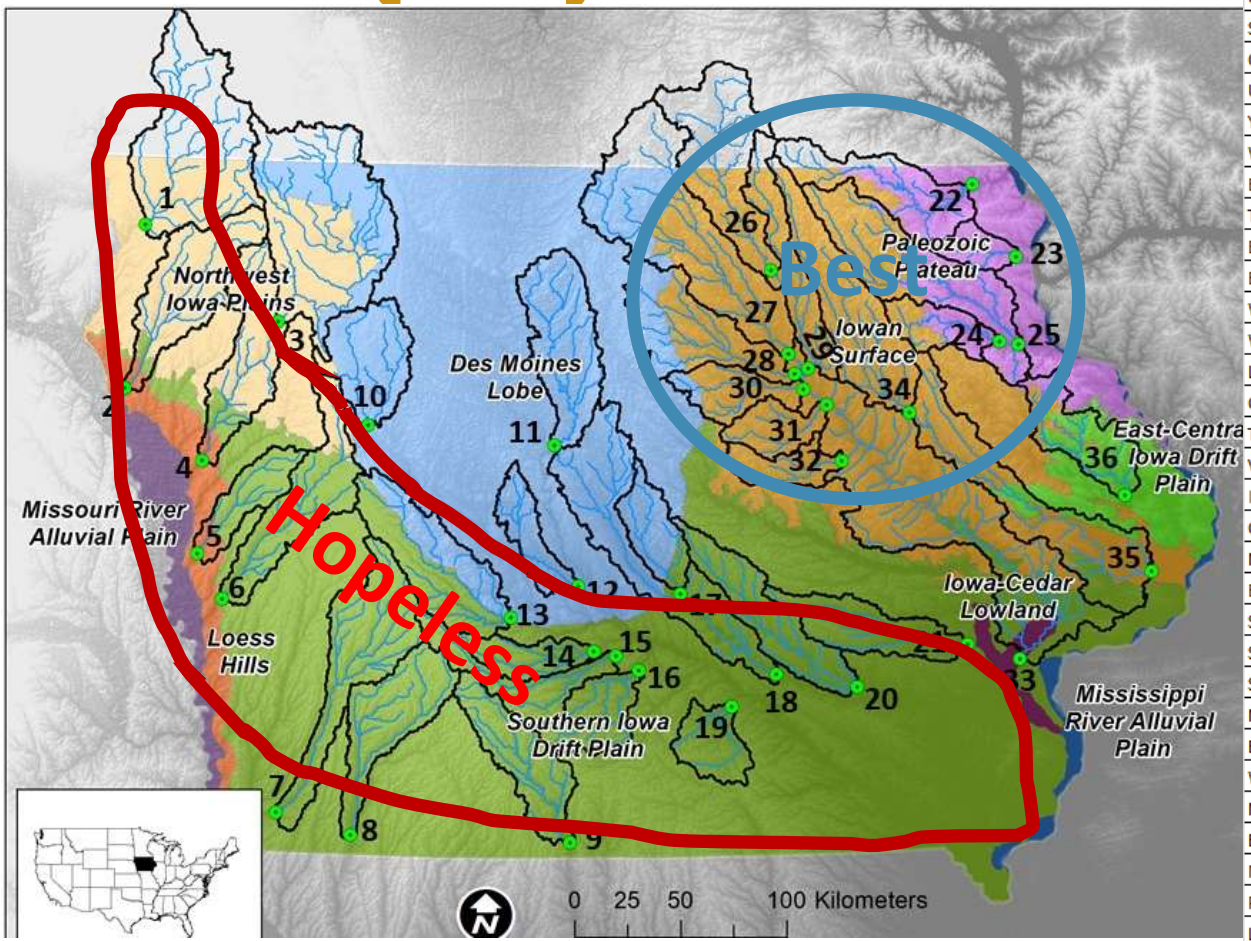
Category	Best ('16-20)	Biggest Improvement (%)	Worst ('16-20)	Biggest Deterioration (%)
WQI	Wapsi (Ind.)	North R.	Floyd R.	Floyd R.
DO	Bloody Run	Beaver Cr. (Grimes)	Thompson R.	Cedar R. (Janesville)
E Coli	Shellrock R.	North R.	Rock R.	Rock R.
TN	South R.	S. Skunk (Osk.)	Floyd R.	Rock R.
TP	Bloody Run	S. Skunk (Camb.)	Floyd R.	Bloody Run
Turb	Wapsi (Ind.)	E. Nishnabotna	South R.	Bloody Run



What has happened to Iowa Ag since 1970?

- Loss of Crop Diversity
- Concentration of Livestock
- Decouple Livestock and Crop Production
- Huge increase in Hogs and Chickens
- Loss of Cattle—especially on pasture
- Fewer Farmers farming more land

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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