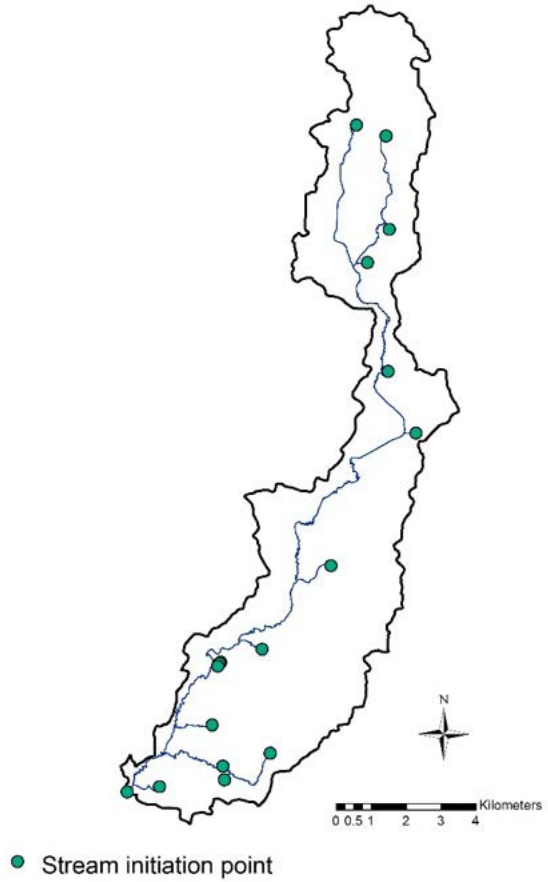
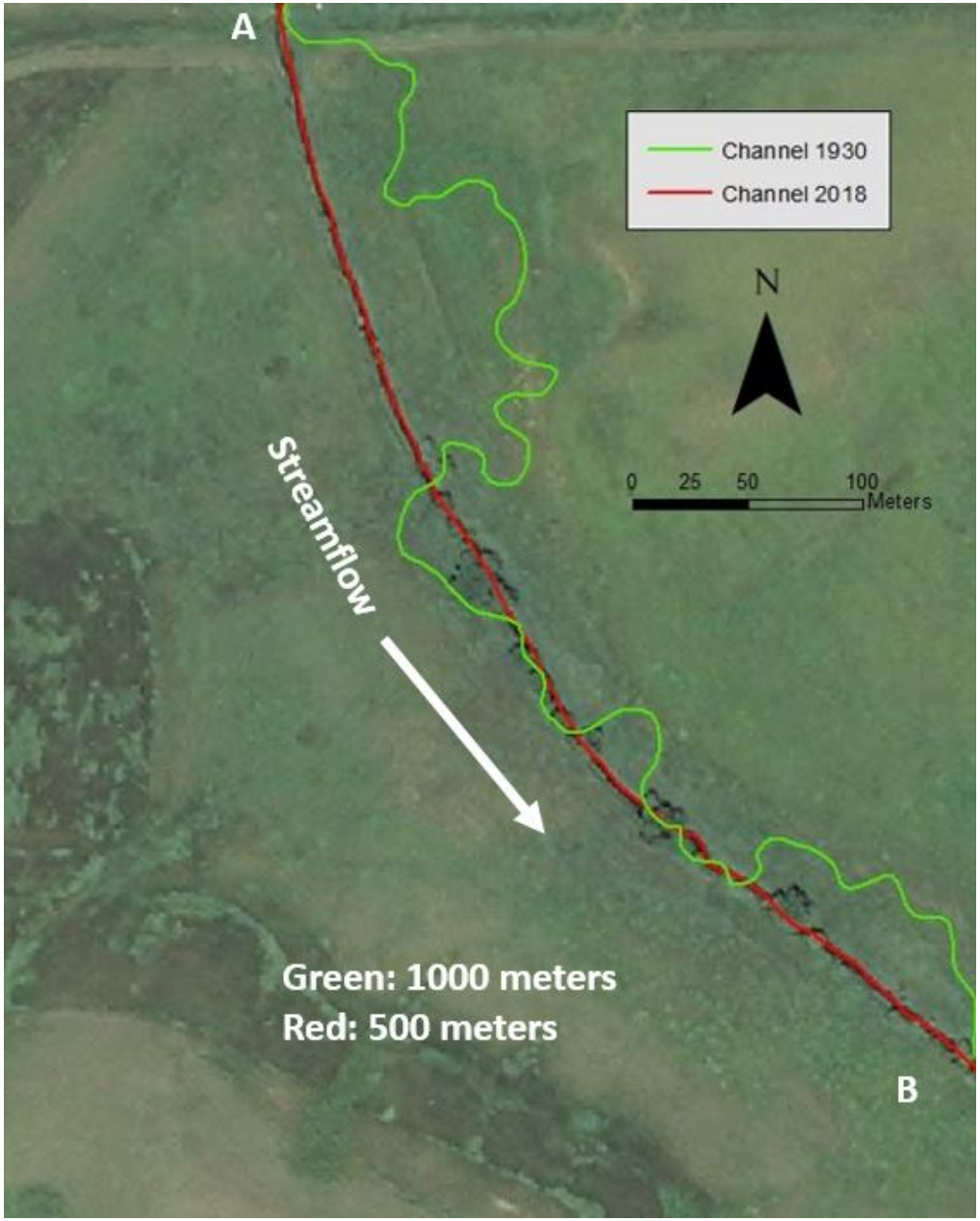
Where do streams begin?

Tile outfalls!

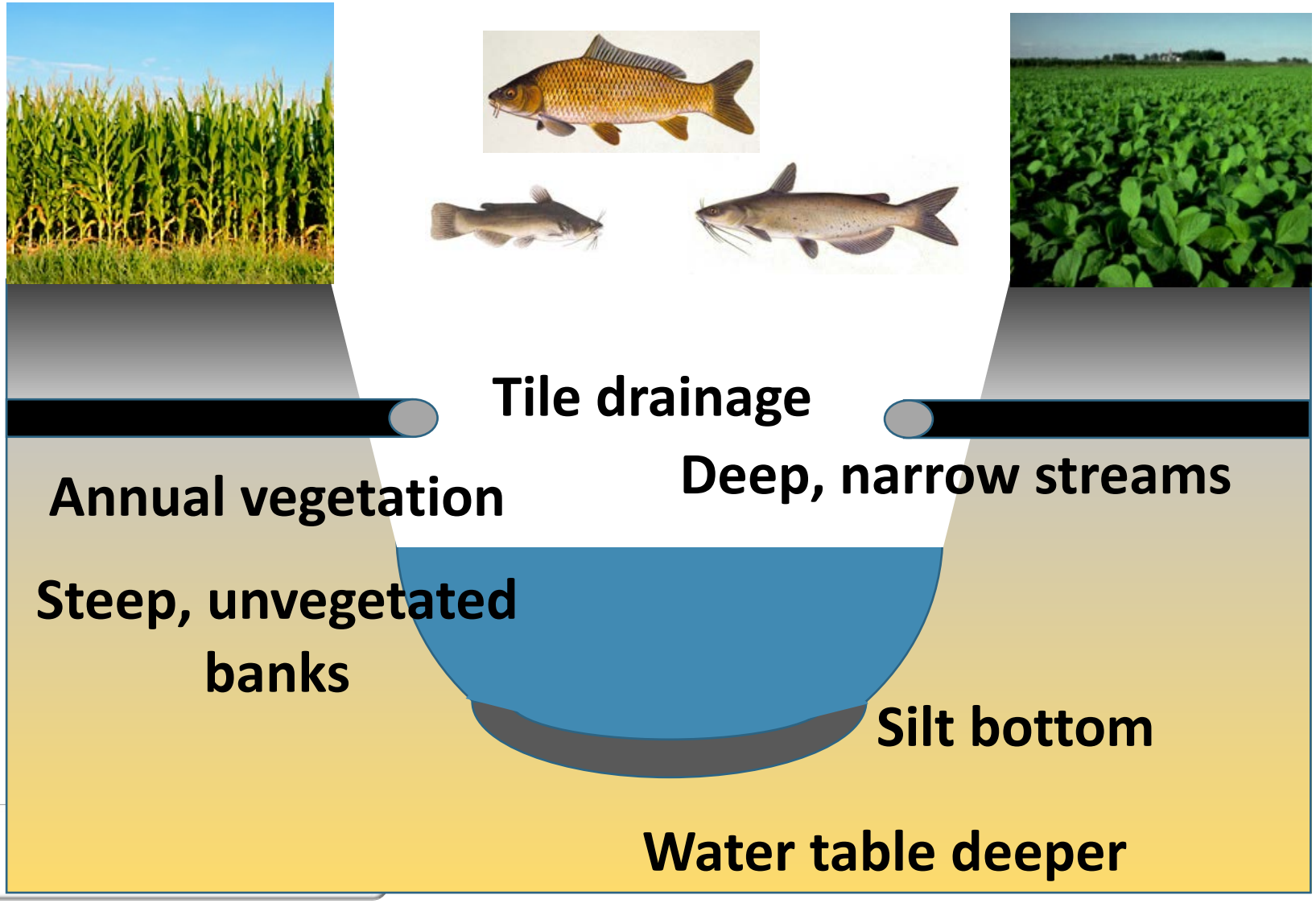


Slide courtesy of K. Schilling, Iowa Geological Survey

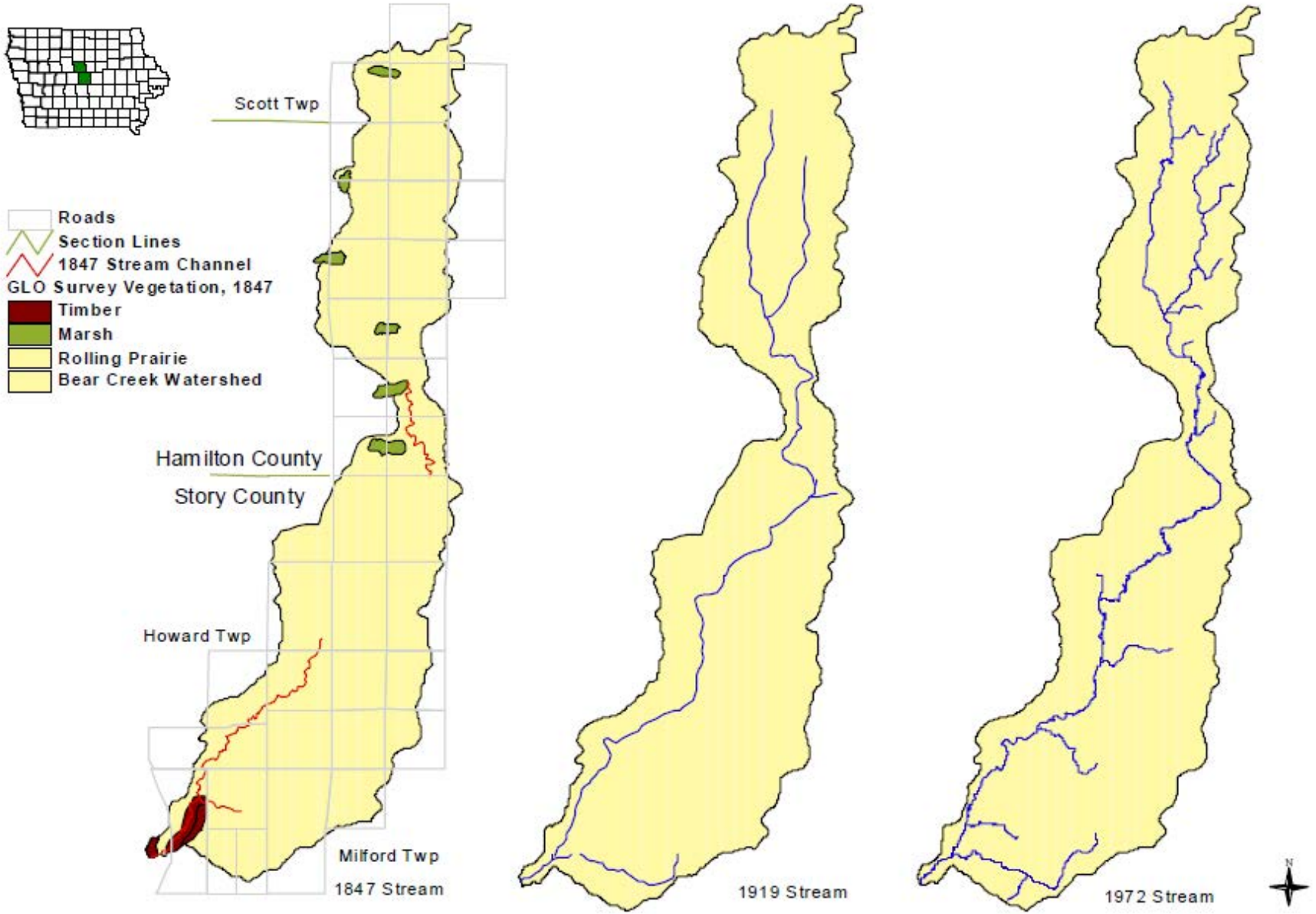


Stream incision

Now

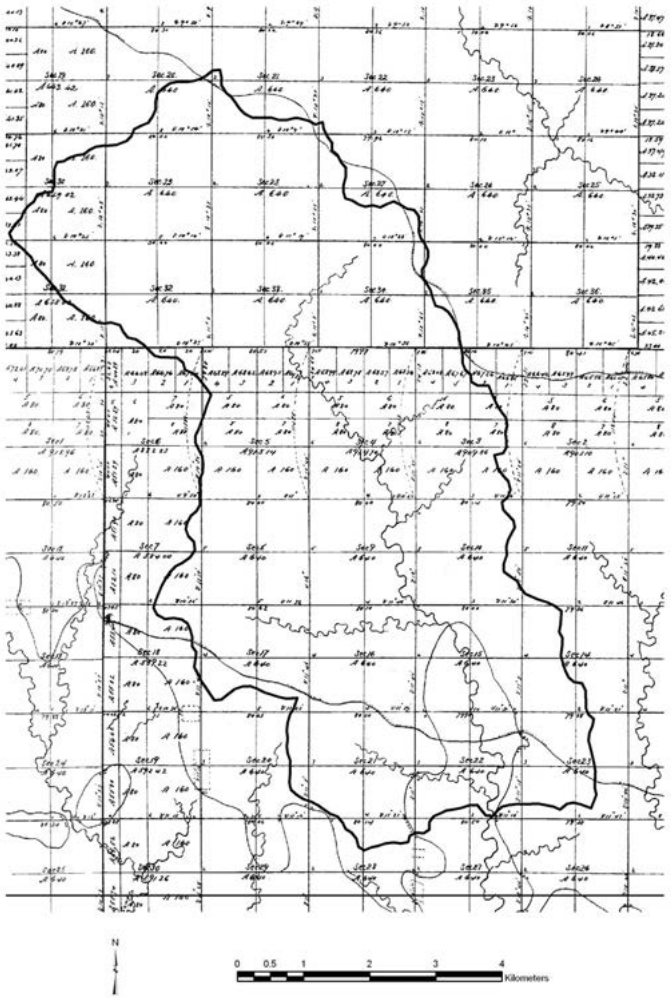

Tile drainage
Annual vegetation
Deep, narrow streams
Steep, unvegetated banks
Silt bottom
Water table deeper

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)

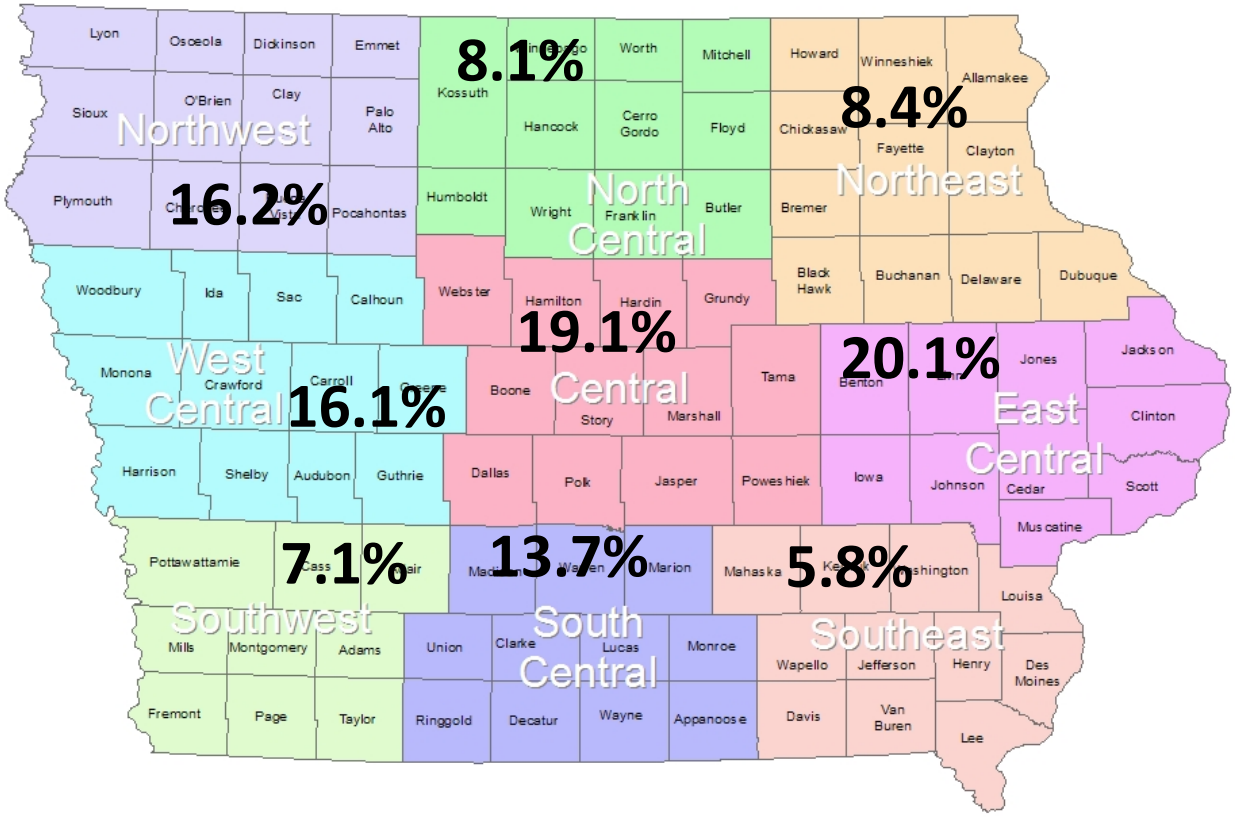
Property	GLO Survey (1847)	1972 USGS Streams
Stream length (m)	37,185	60,286
Drainage density[1]	0.9	1.52
Channel frequency[2]	0.32	1.20

[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



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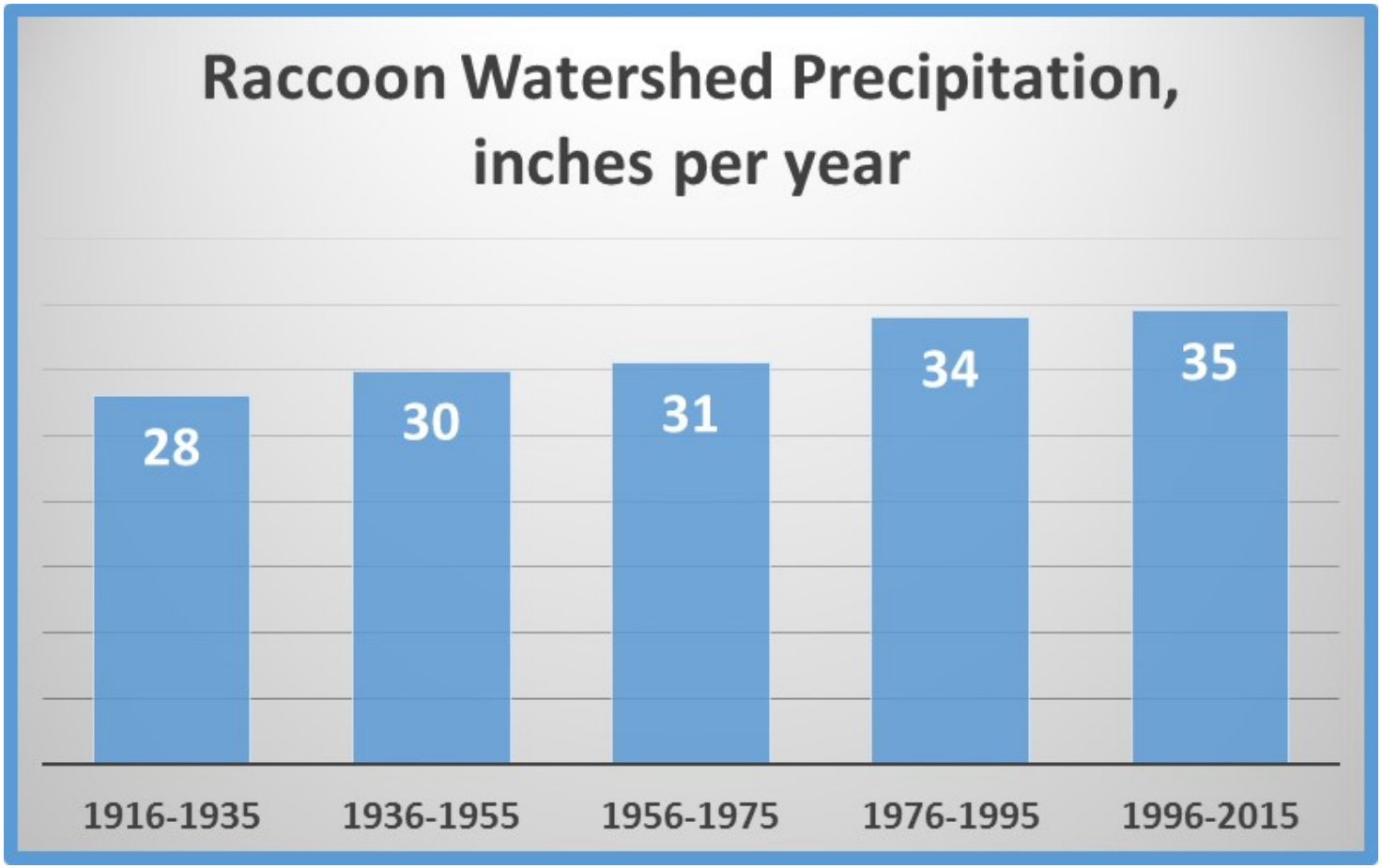
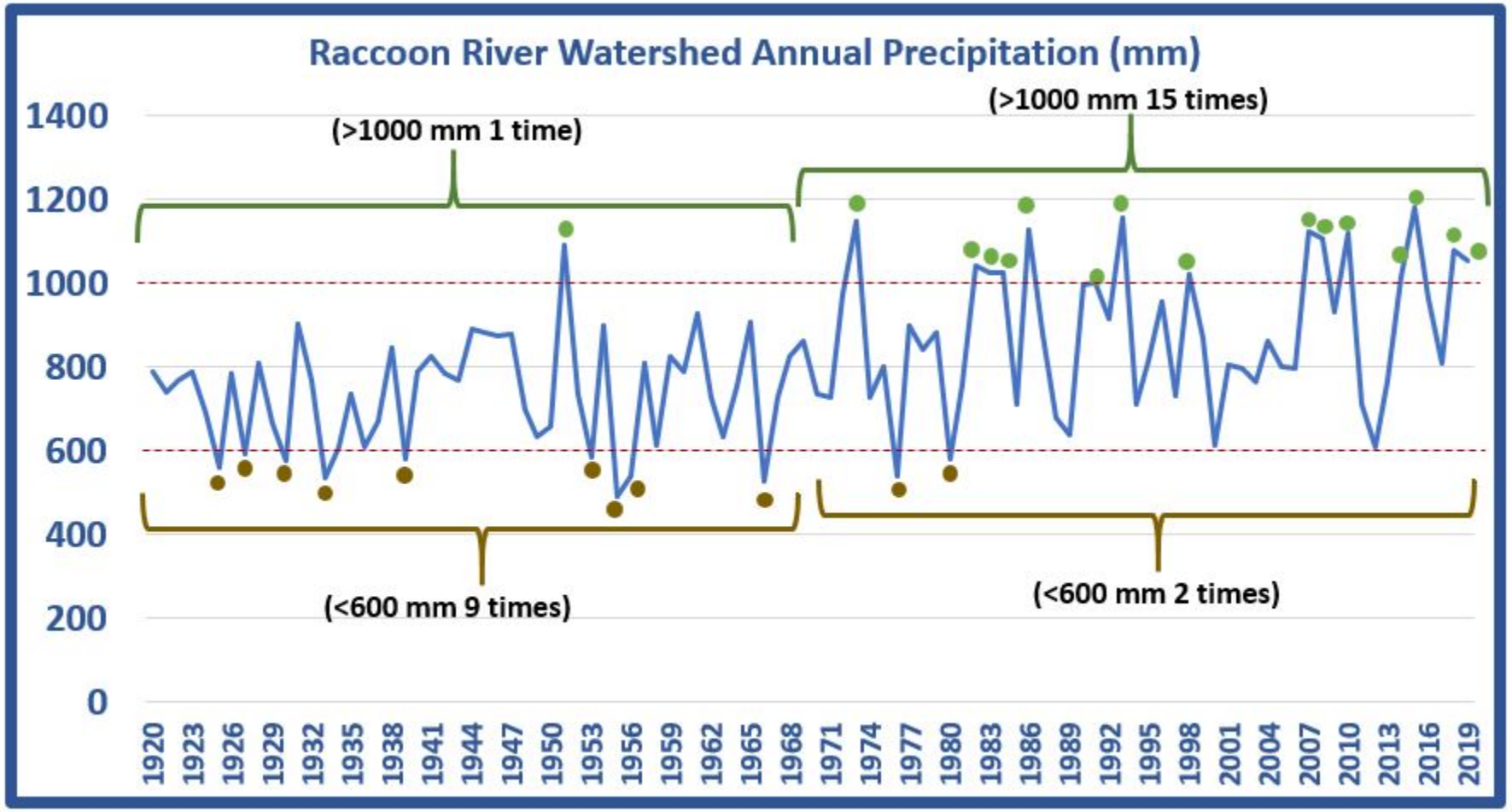
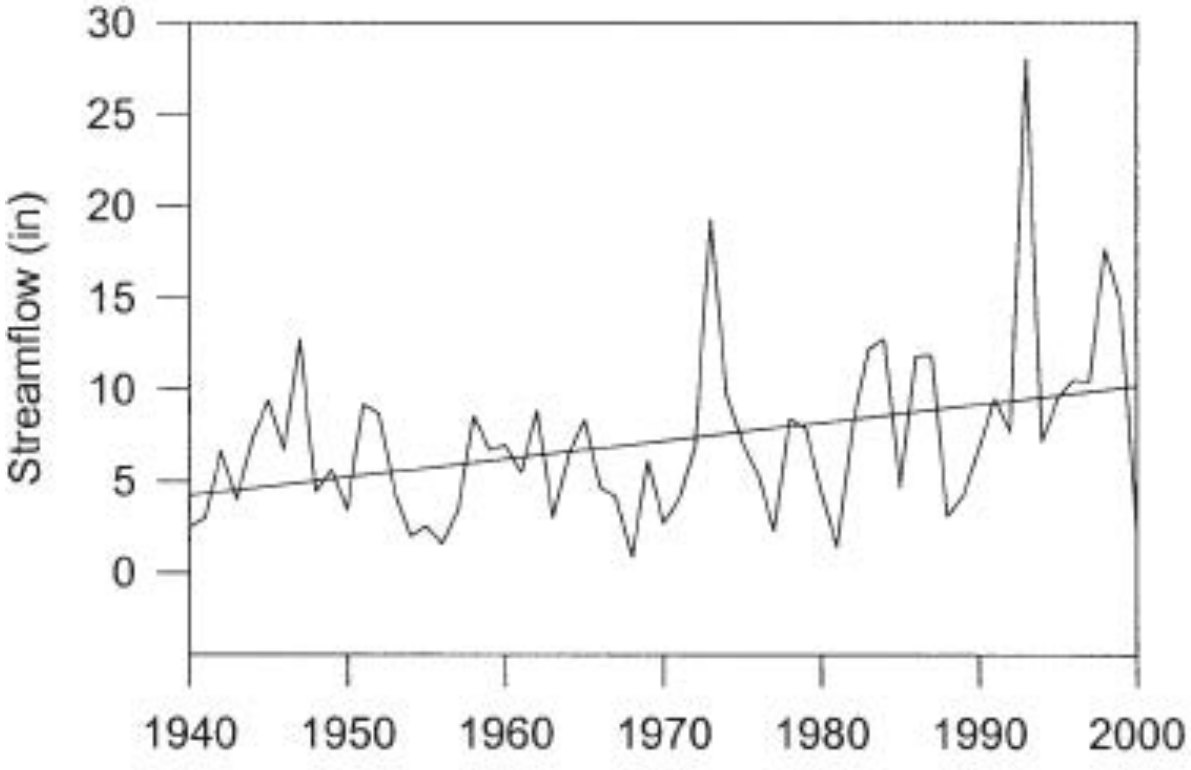
It's Wetter


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

Last Century: Raccoon Watershed

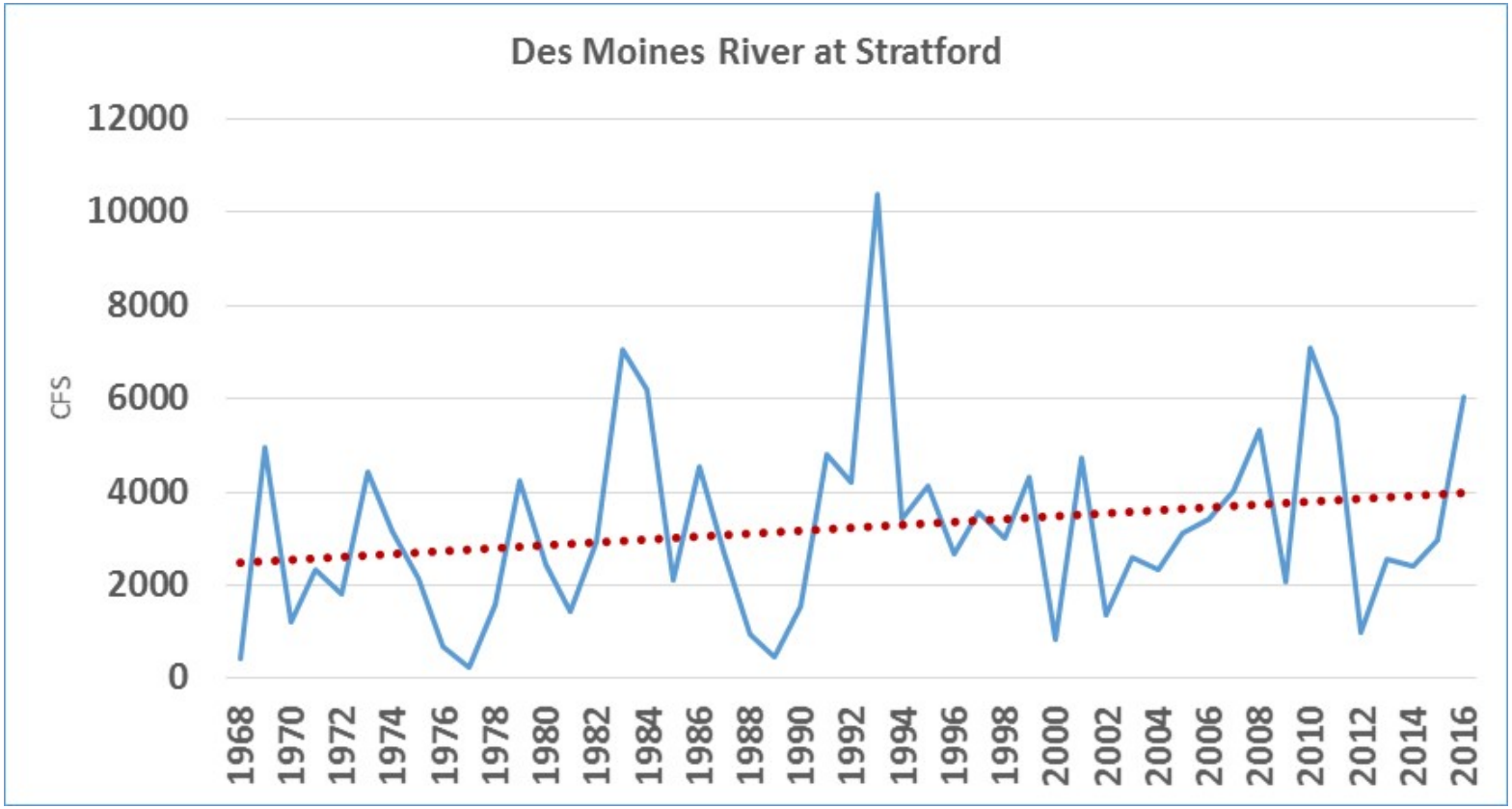


E. Nishnabotna

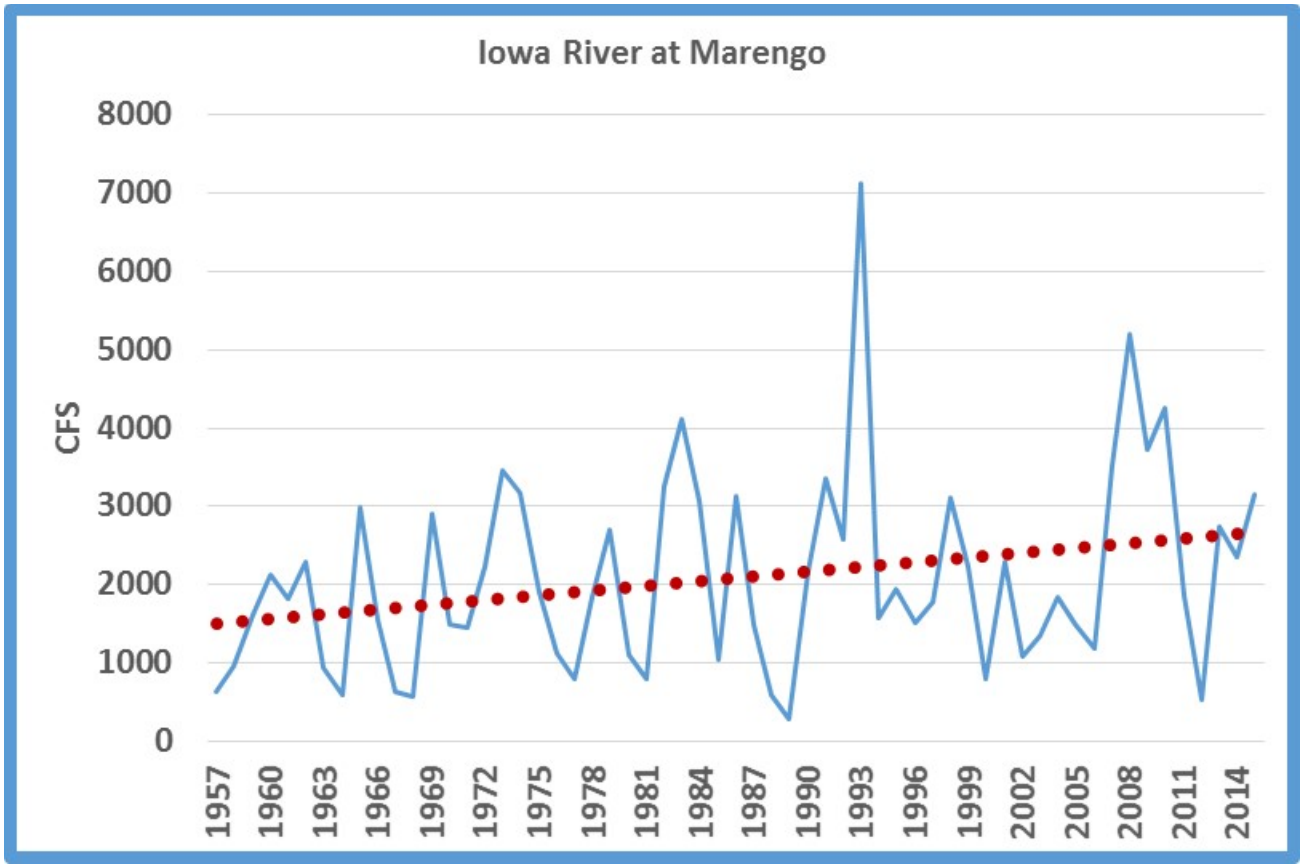


Schilling, K. E. and Libra, R. D. (2003), INCREASED BASEFLOW IN IOWA OVER THE SECOND HALF OF THE 20TH CENTURY[1]. JAWRA Journal of the American Water Resources Association, 39: 851–860. doi:10.1111/j.1752-1688.2003.tb04410.x

Des Moines R. at Stratford



Iowa R. at Marengo



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]

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Perry, Iowa

- **24-32% increase in annual precipitation**
- **2.3-2.7°C increase in temperature**
- **Increase tile drainage flows**
- **Change distribution of flows within the calendar year**