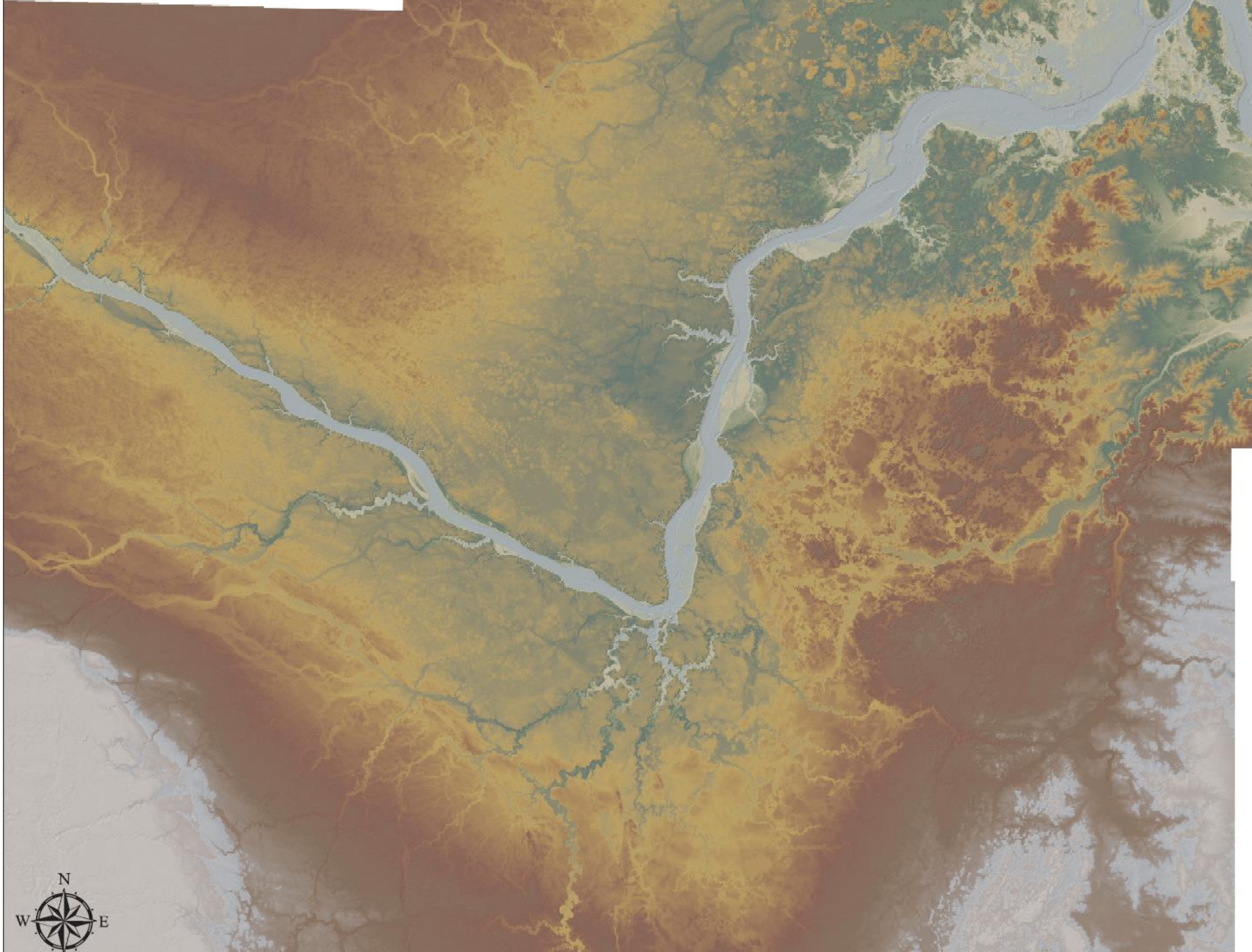
Minnesota River Valley History and Opportunities for Water Retention

Carrie Jennings

Freshwater Research and Policy Director

November 20, 2024



N
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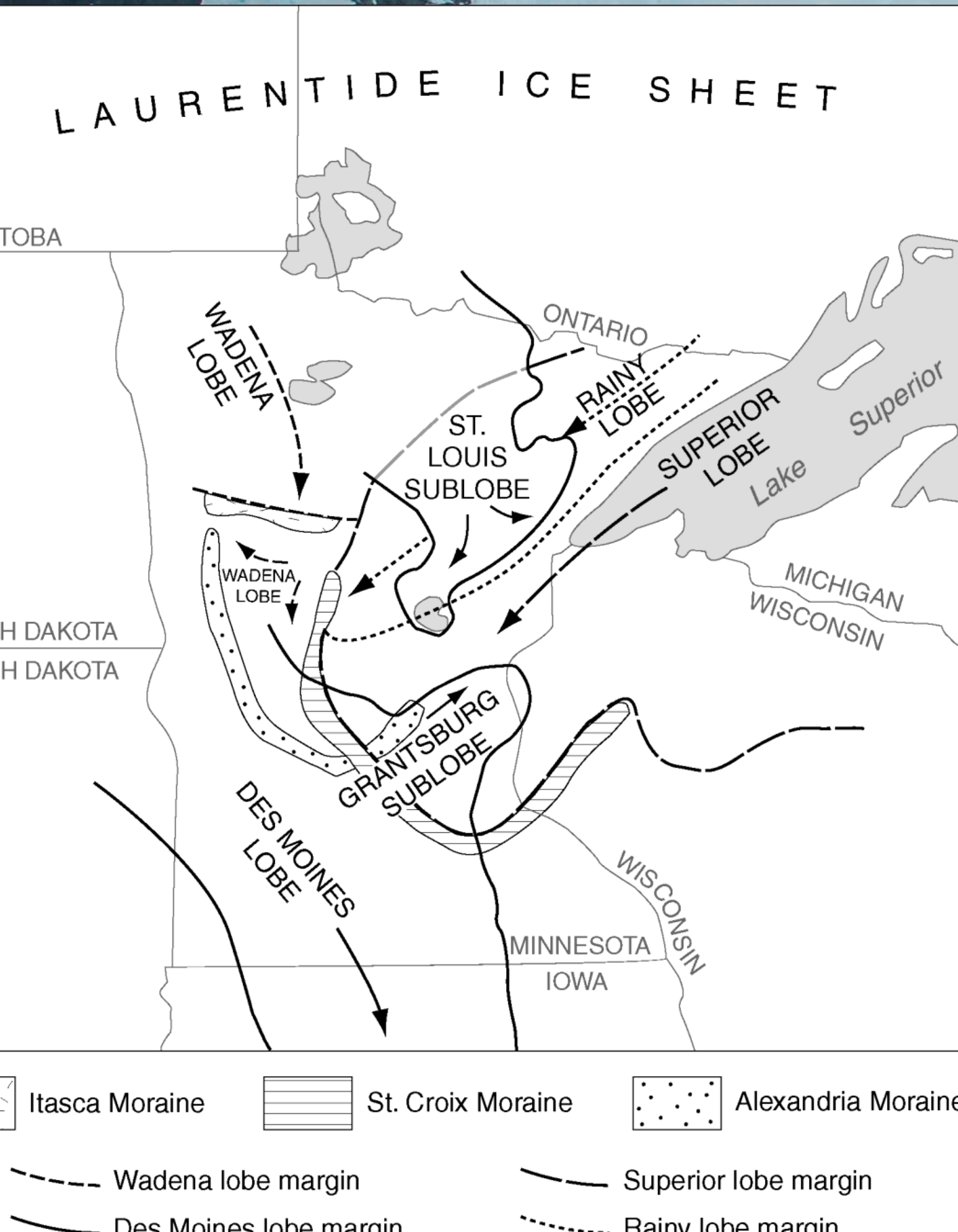
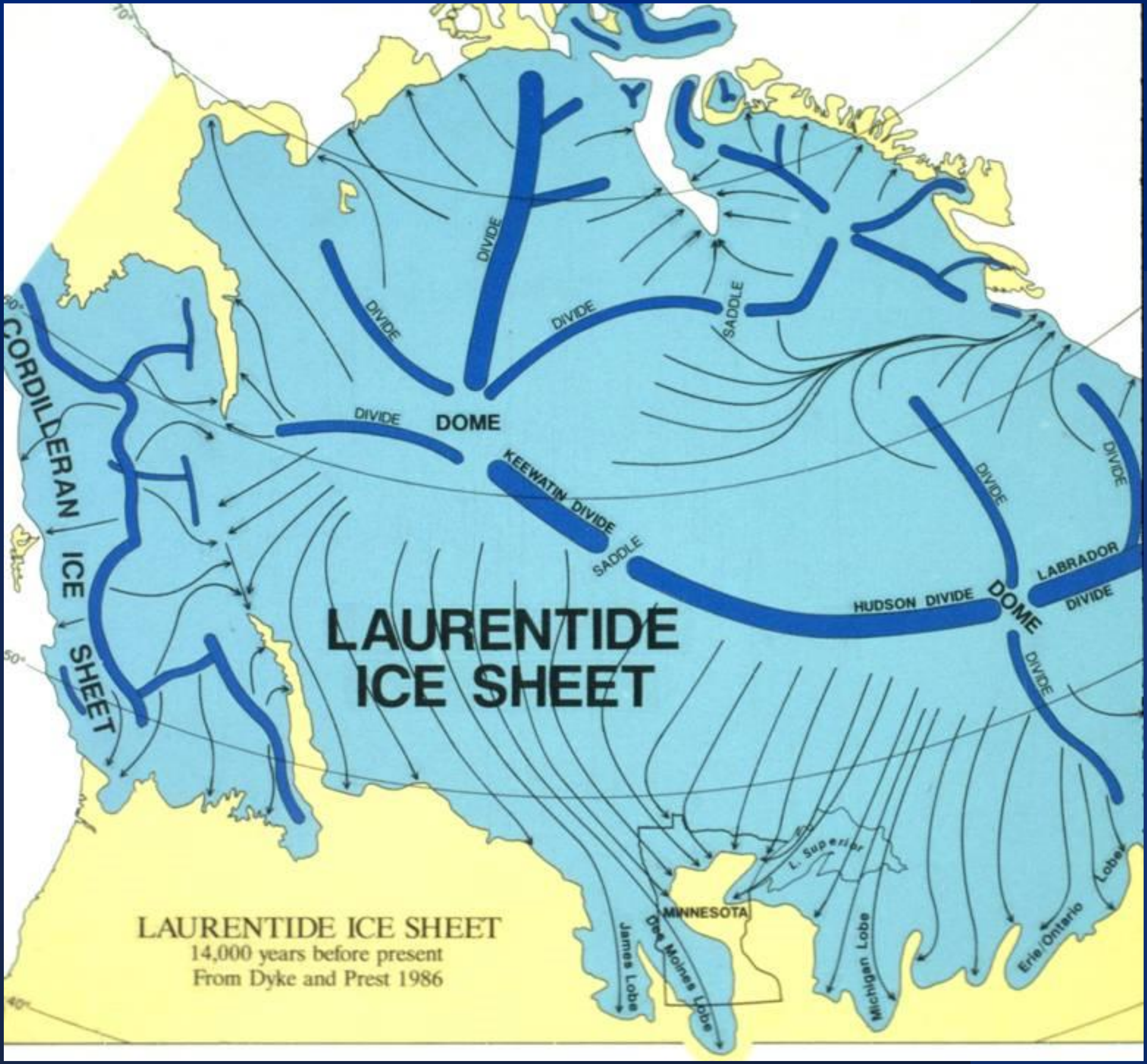
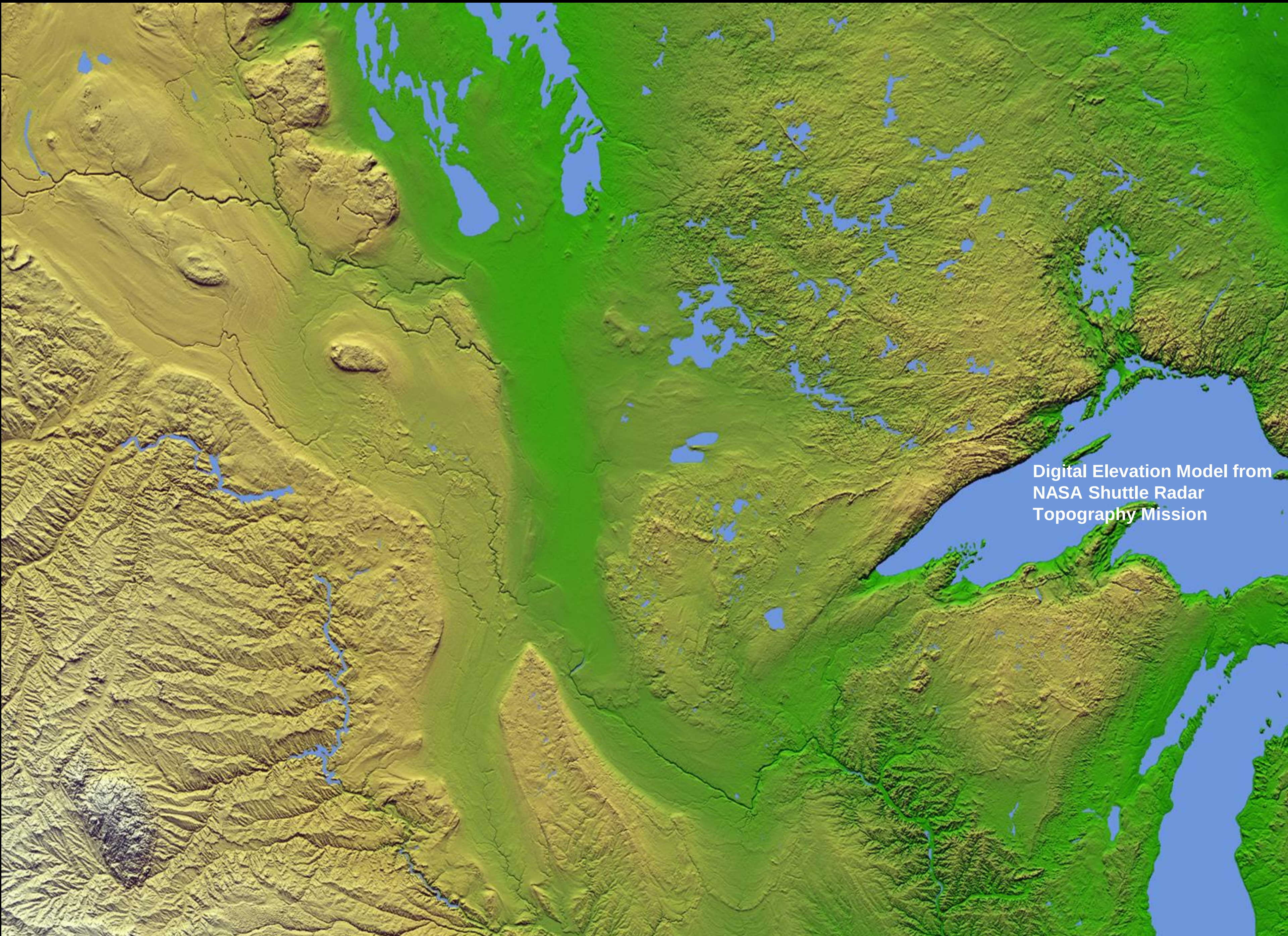
Ice advances ice created the Minnesota River watershed



Patterson and Wright, 1999


CORDILLERAN ICE SHEET
DIVIDE
DOME
KEEWATIN DIVIDE
SADDLE
HUDSON DIVIDE
LABRADOR DIVIDE
LAURENTIDE ICE SHEET
L. Superior
MINNESOTA
James Lobe
Des Moines Lobe
Michigan Lobe
Erie/Ontario Lobe
LAURENTIDE ICE SHEET
14,000 years before present
From Dyke and Prest 1986

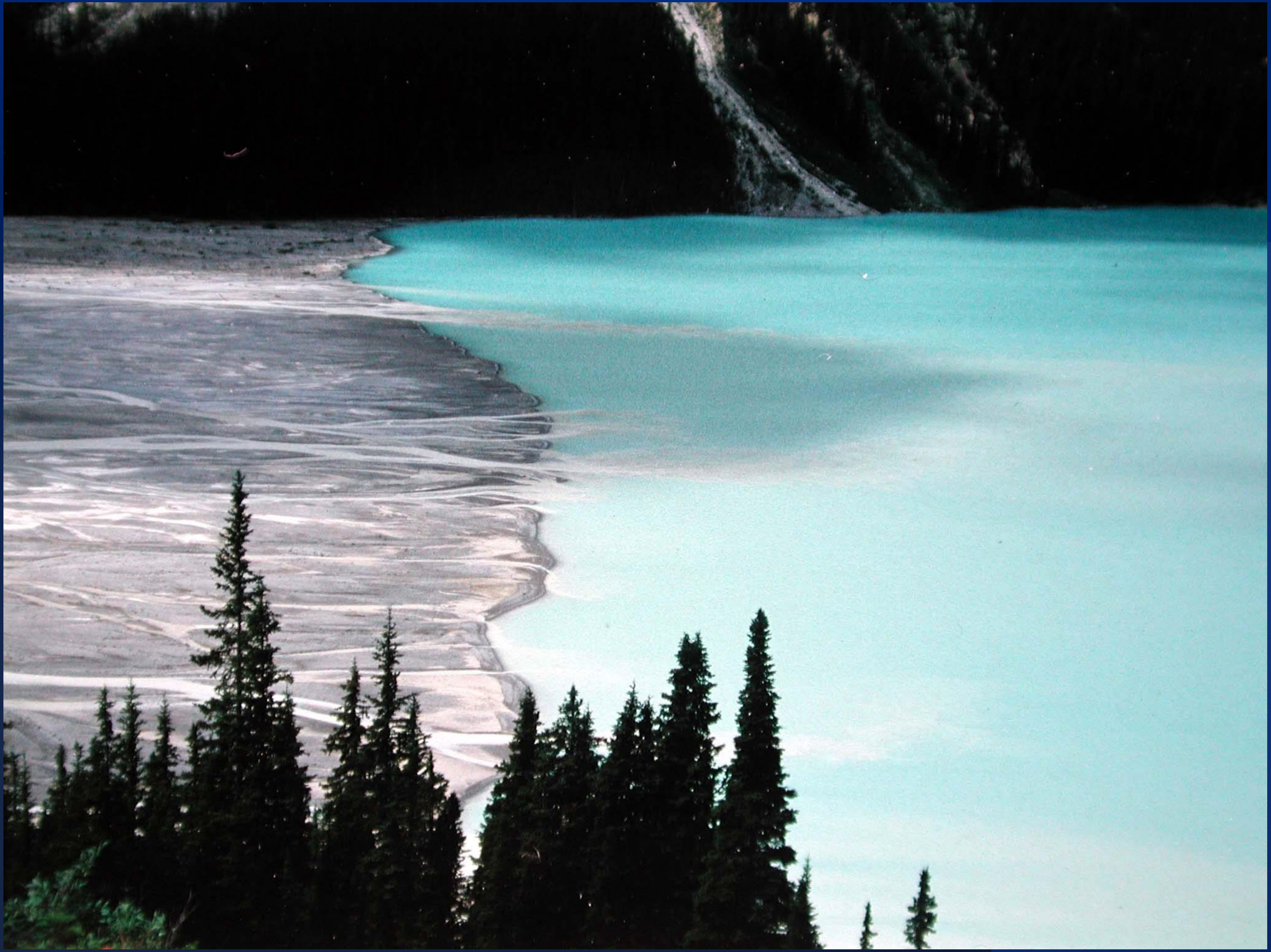

Digital Elevation Model from
NASA Shuttle Radar
Topography Mission

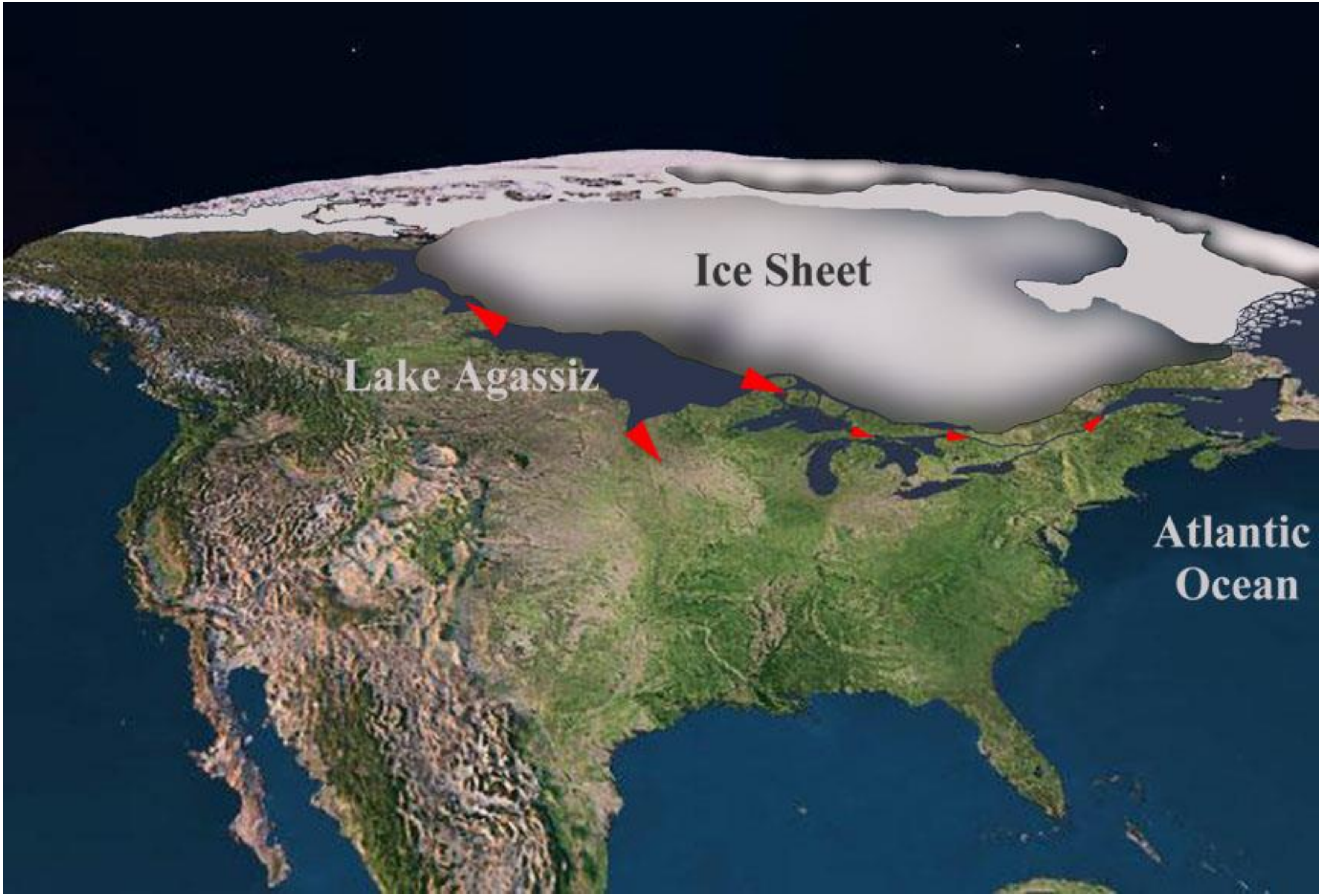

Crystalline Rocks
Sandstone
Carbonate
Rocks

Subglacial Till

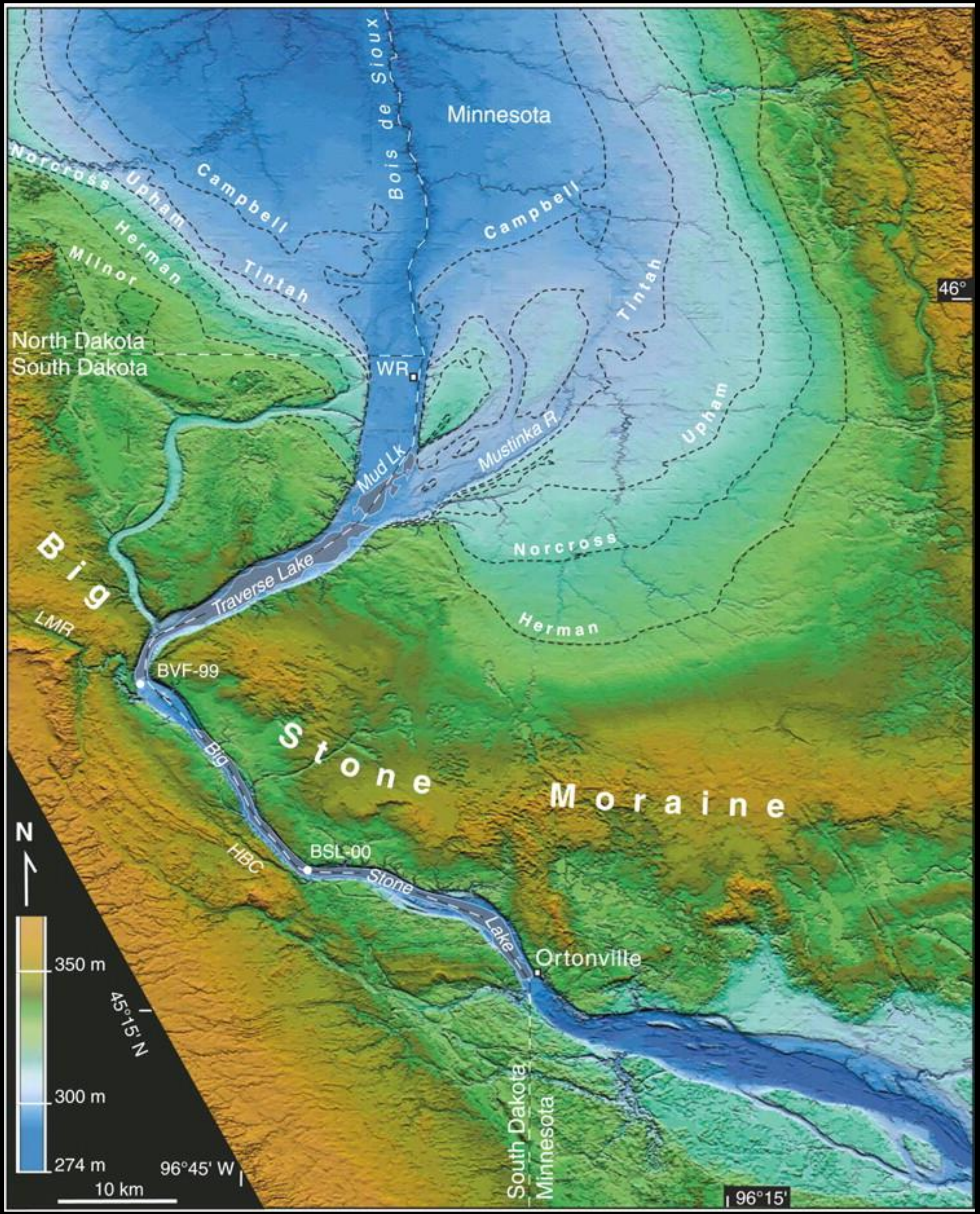
Photo by Peter Knight

Glacial Lakes Formed as the Ice Retreated




Ice Sheet
Lake Agassiz
Atlantic
Ocean

Hillshade digital elevation model of the southern outlet of Lake Agassiz.



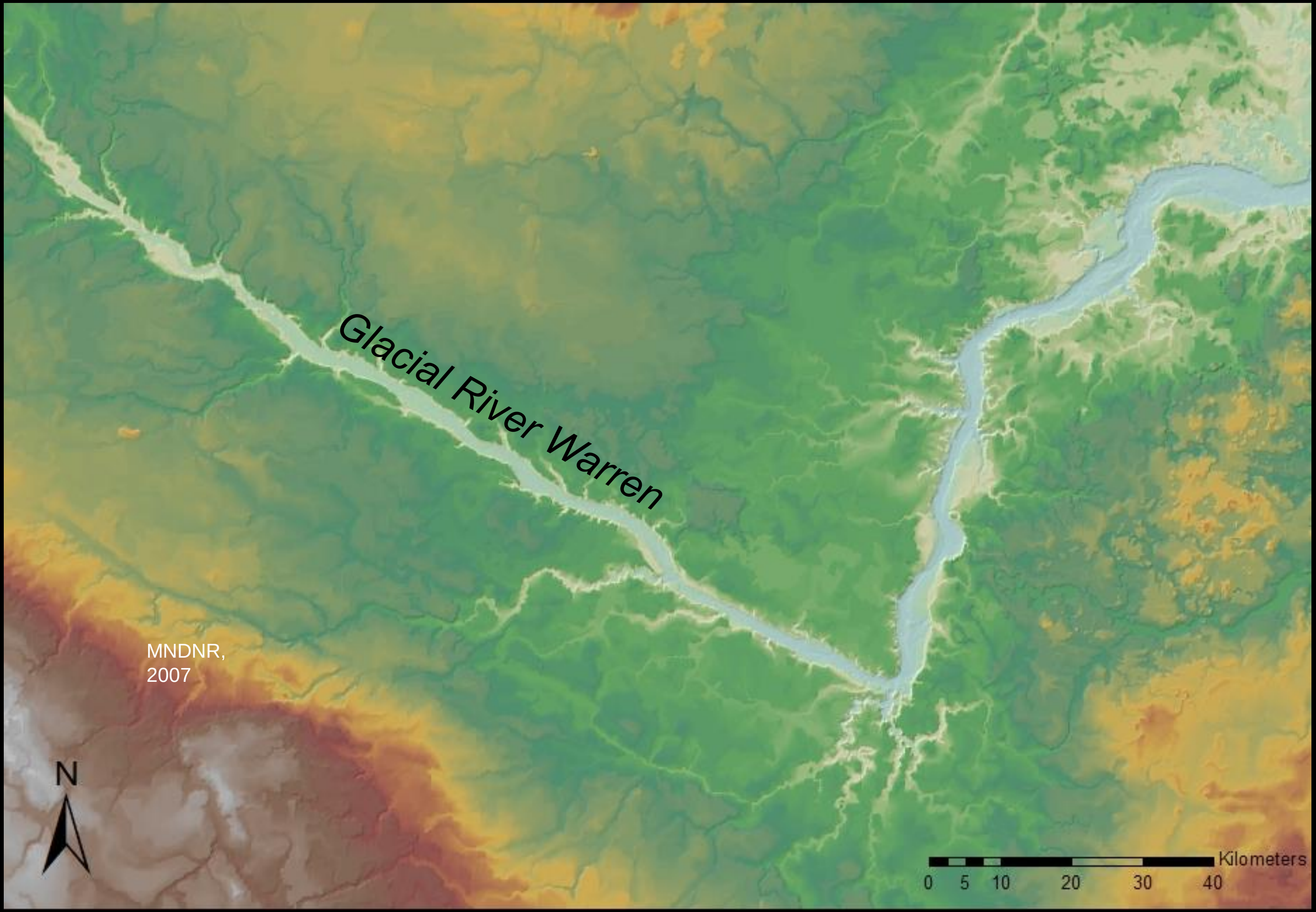
©2005 by Geological Society of America

Timothy G. Fisher Geological Society of America Bulletin 2005;117:1481-1496

Big Stone Lake

(southern outlet)

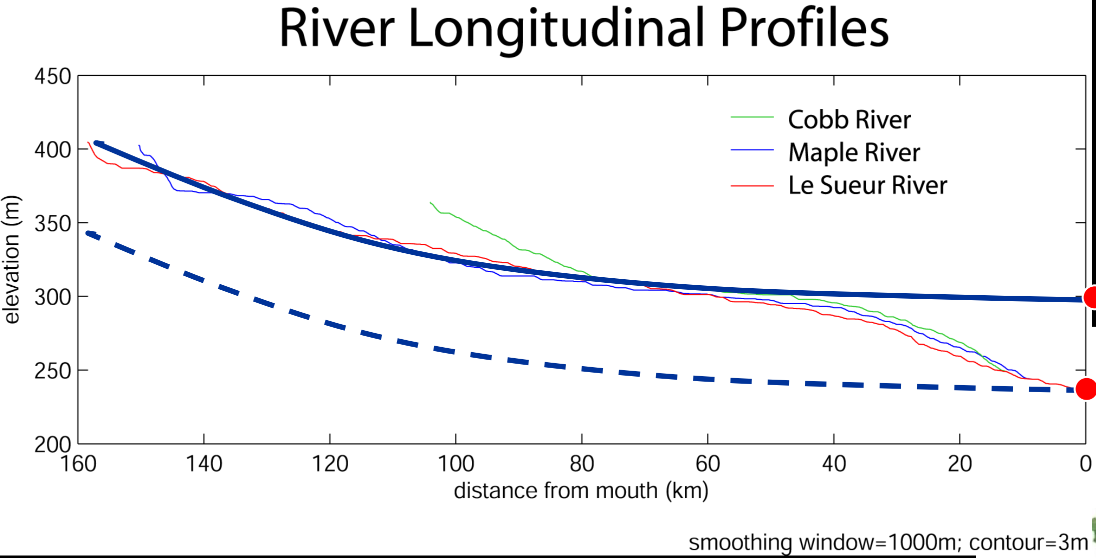
Spillway Formation



Started 13,000 years ago and still affecting the tributaries.

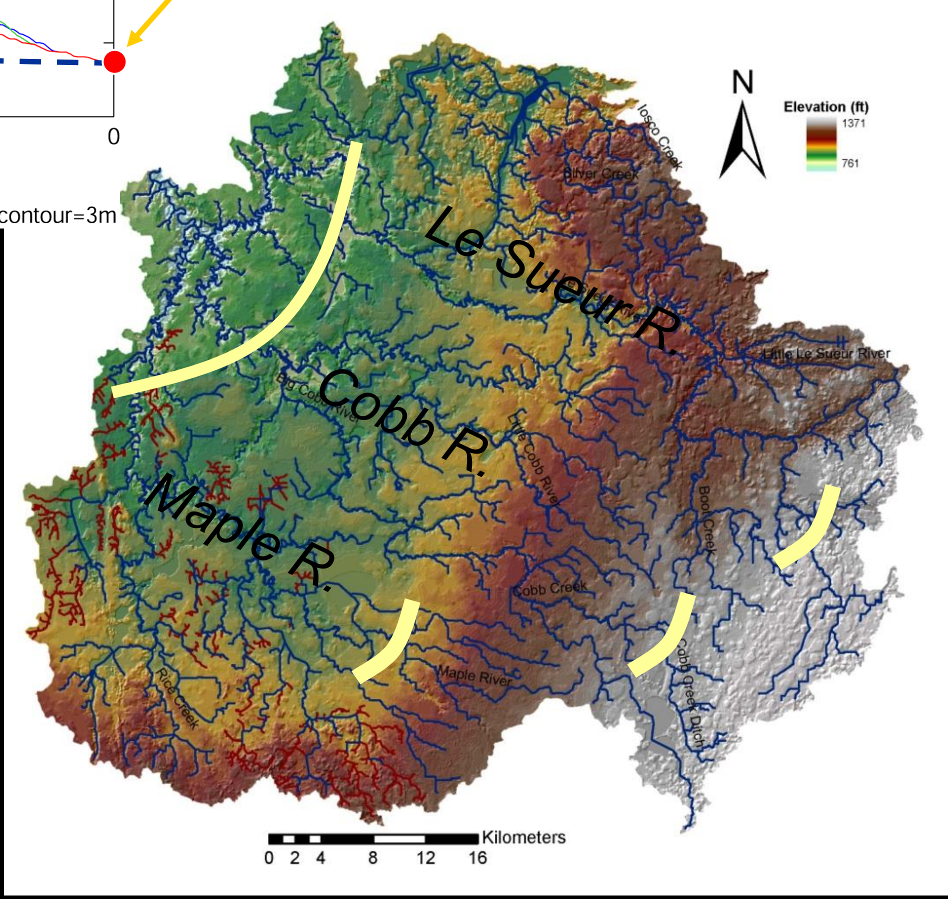

Present
Minnesota
River
900
800
700
600
500
400
300
Feet (Elevation above sea level)
0
200
400
600
800 feet

Nick point propagates into uplands

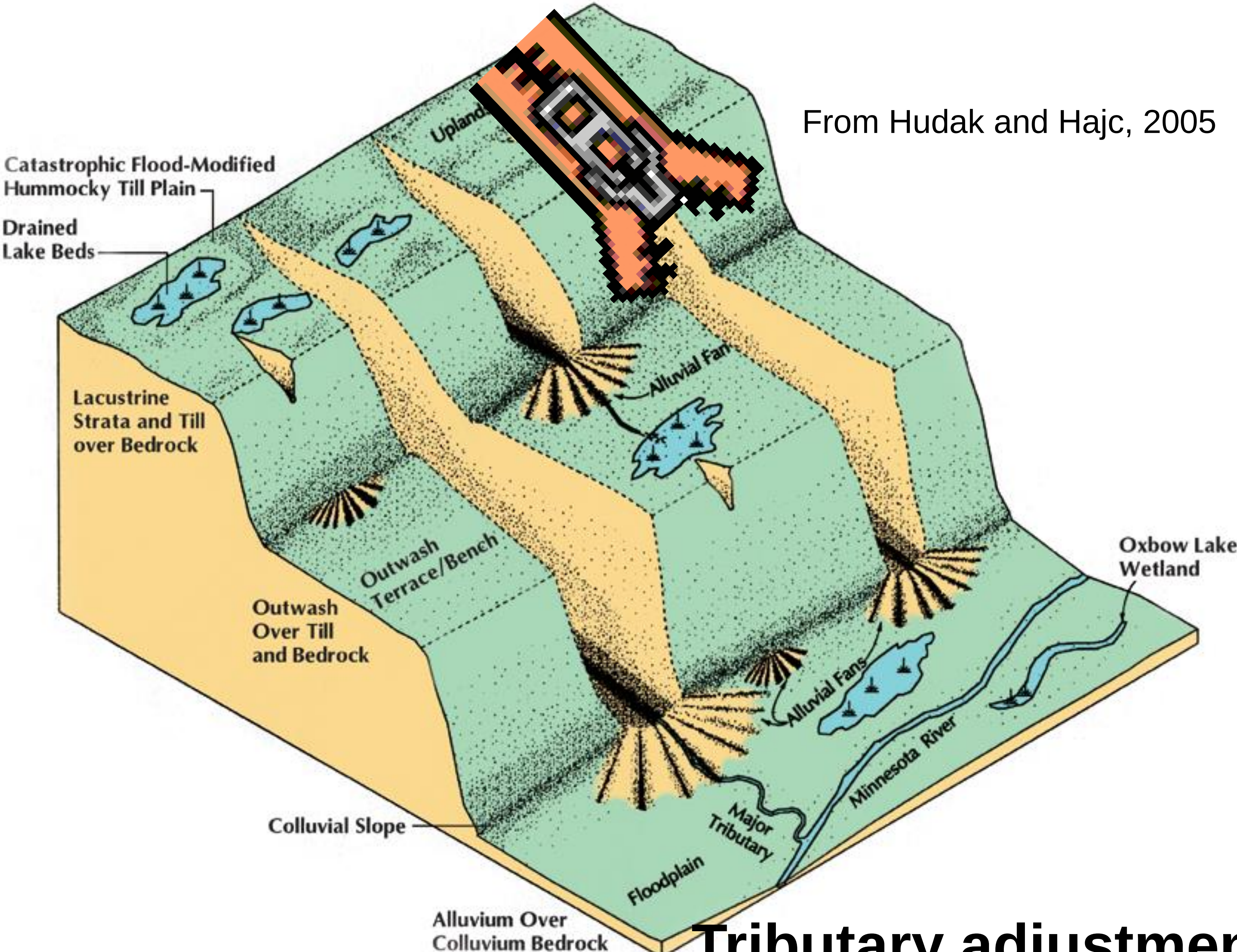


Pre-incision baselevel

Post-incision baselevel



Long-term knick migration rates
Lower — 3 m/yr
Upper — 10 m/yr



From Hudak and Hajc, 2005

Tributary adjustment

All Minnesota River tributaries are still adjusting to the change

Long profiles of tributaries

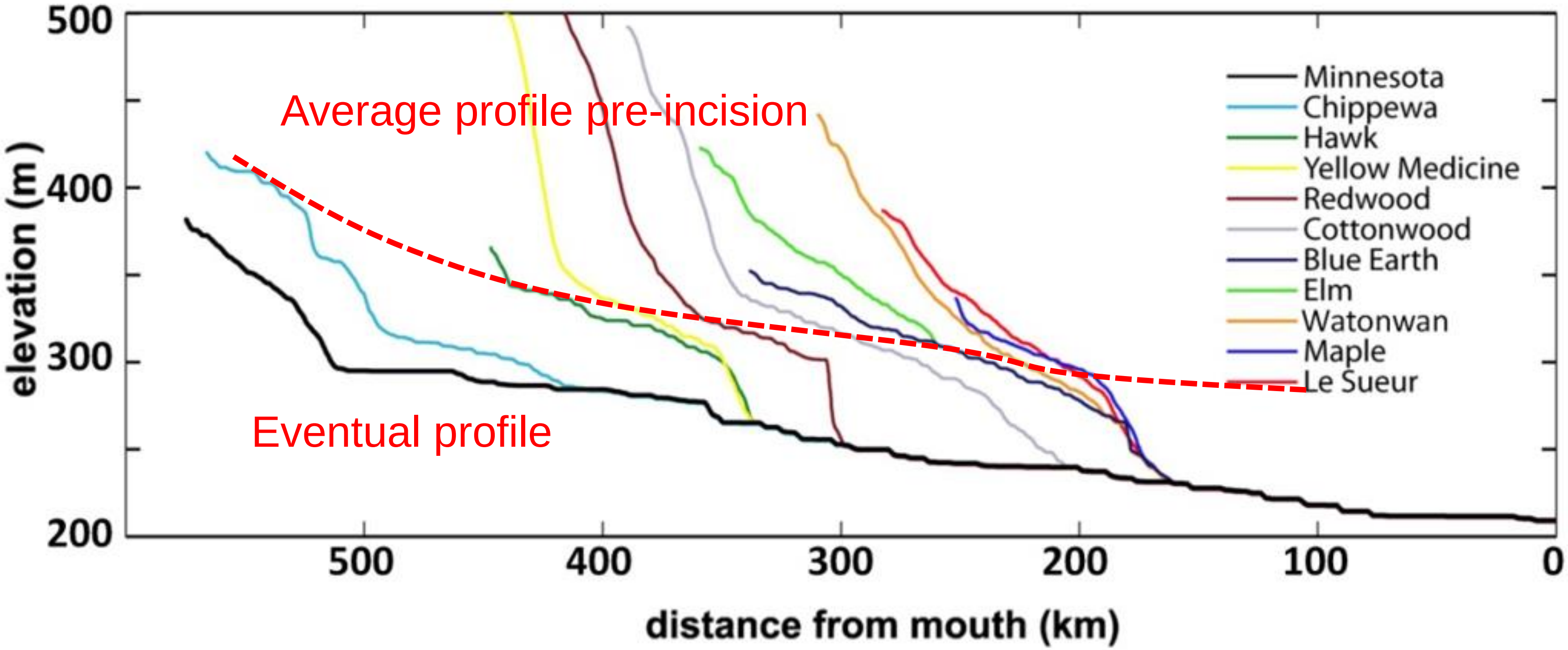



Photo by C. Jennings


Photo by C. Jennings

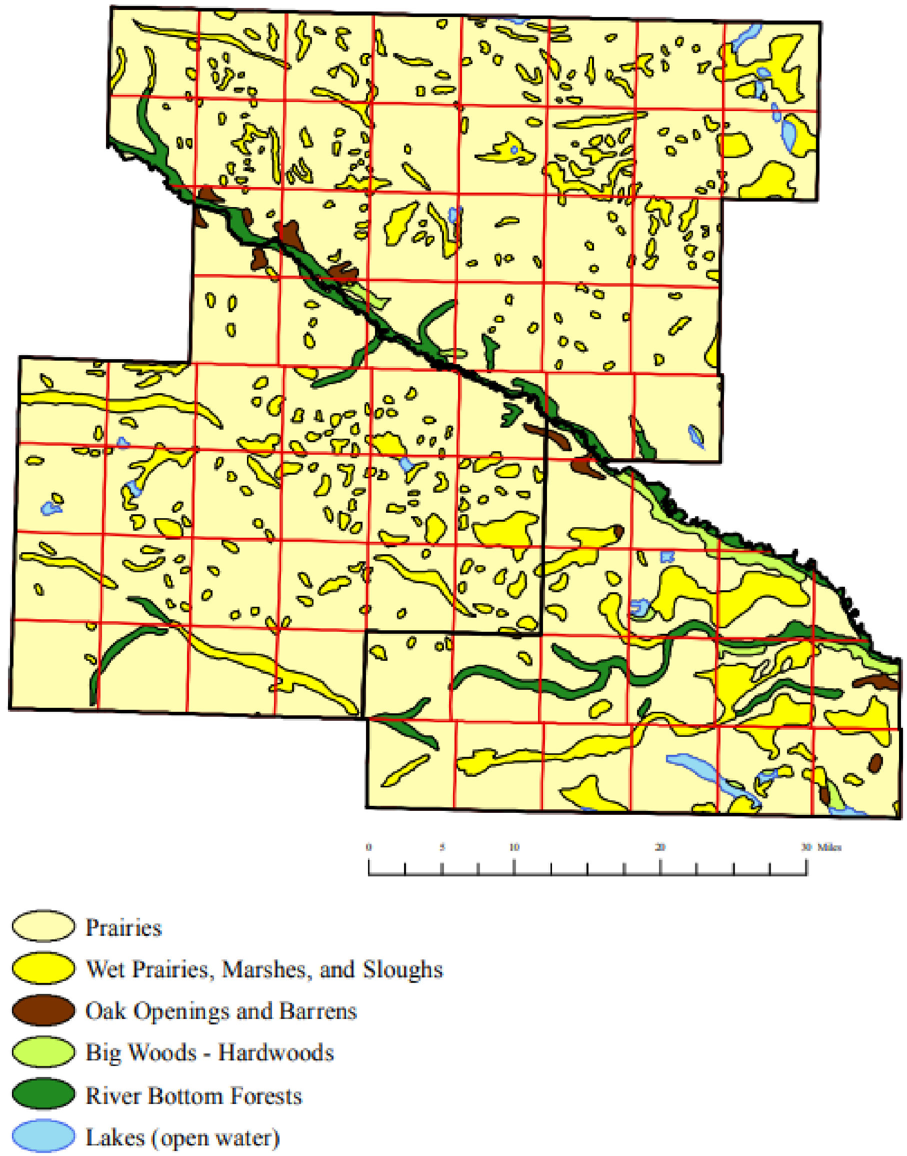
Tributaries cut into landscape to match spillway depth

Yellow Medicine River at Upper Sioux Community

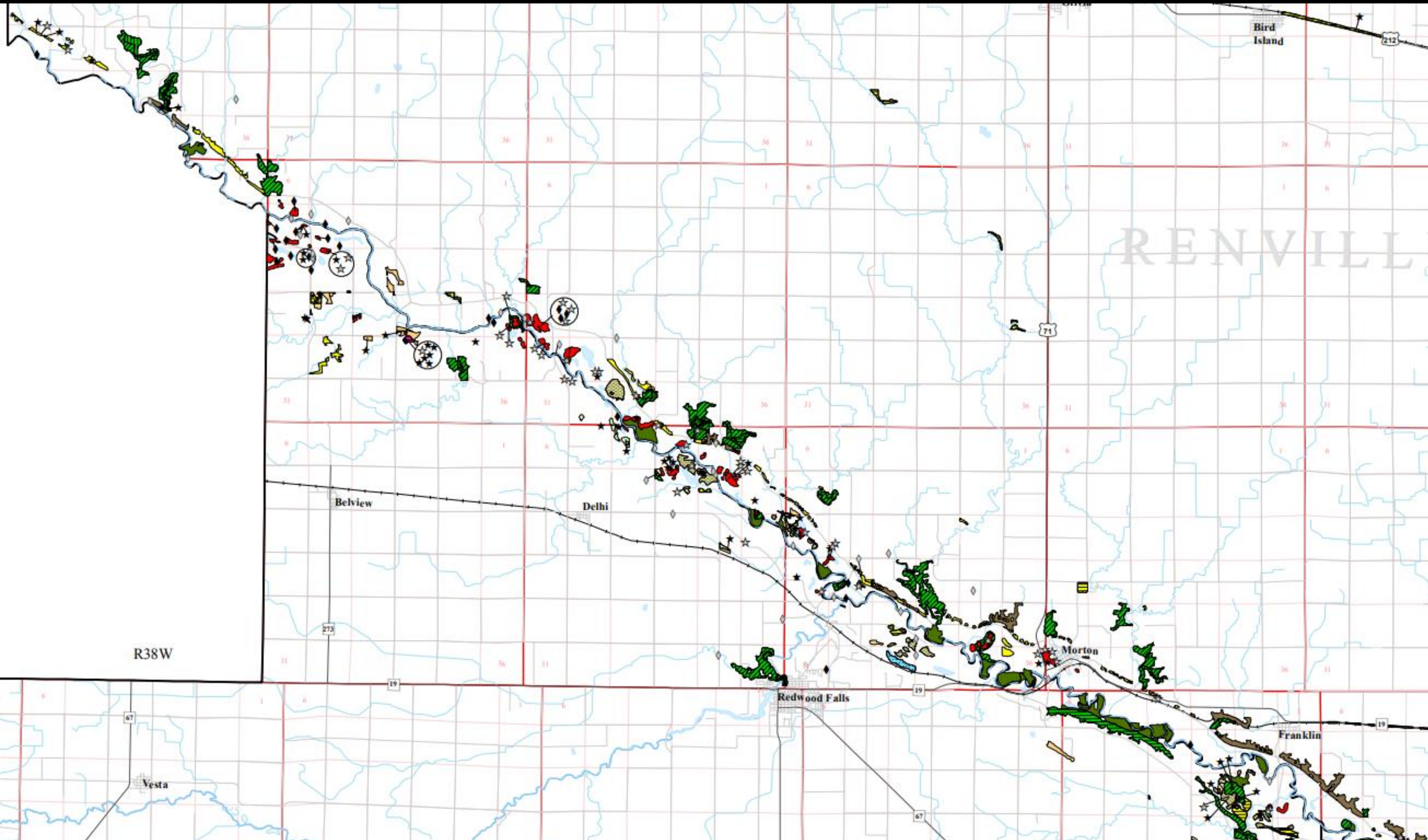
Photo by Patrick Moore

THE VEGETATION OF BROWN, REDWOOD, AND RENVILLE COUNTIES AT THE TIME OF THE PUBLIC LAND SURVEY

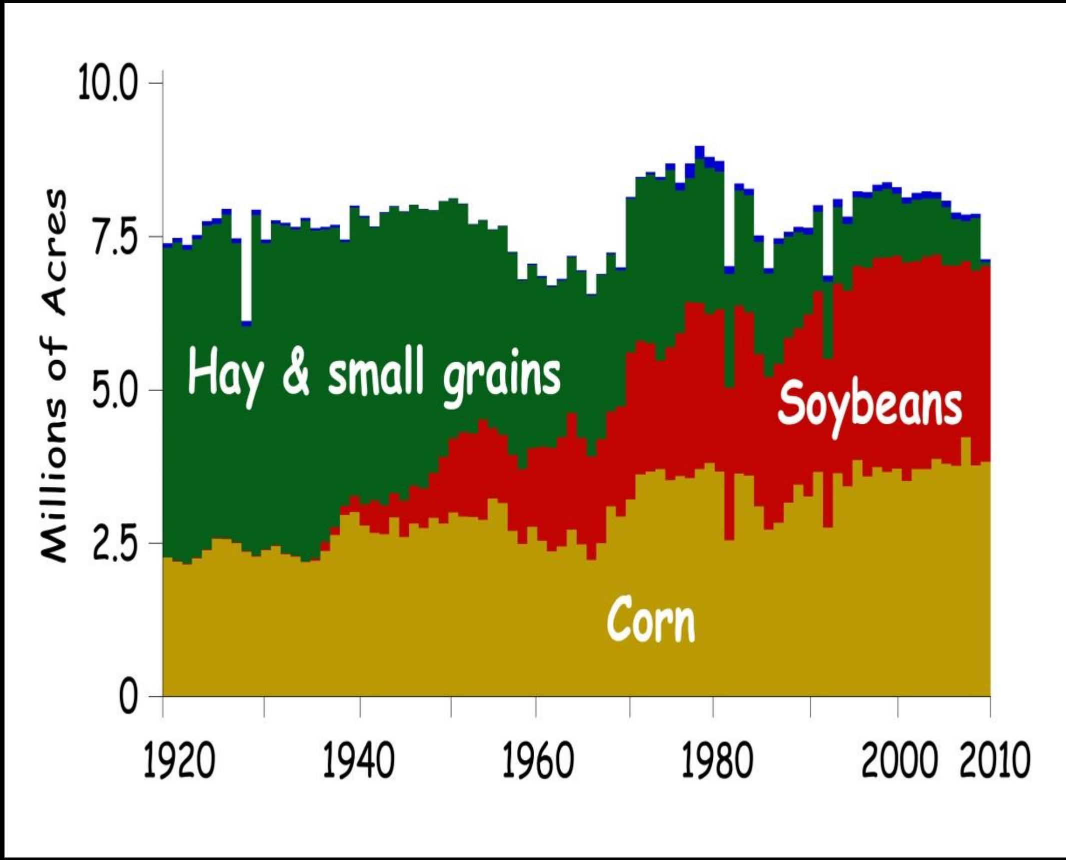
This map shows the vegetation of Brown, Redwood, and Renville counties as interpreted by Francis J. Marschner using Public Land Survey records from 1854-1867. The categories shown are from Marschner's original descriptions.



Remaining original vegetation



Changes in Crops



Loss of alfalfa, small grains & hay

Increased need for N application

Increased potential for losses of sed, N and P from fields

Photo from Dave Craigmile

Historically wet

Prime agricultural soils

Wetlands drained

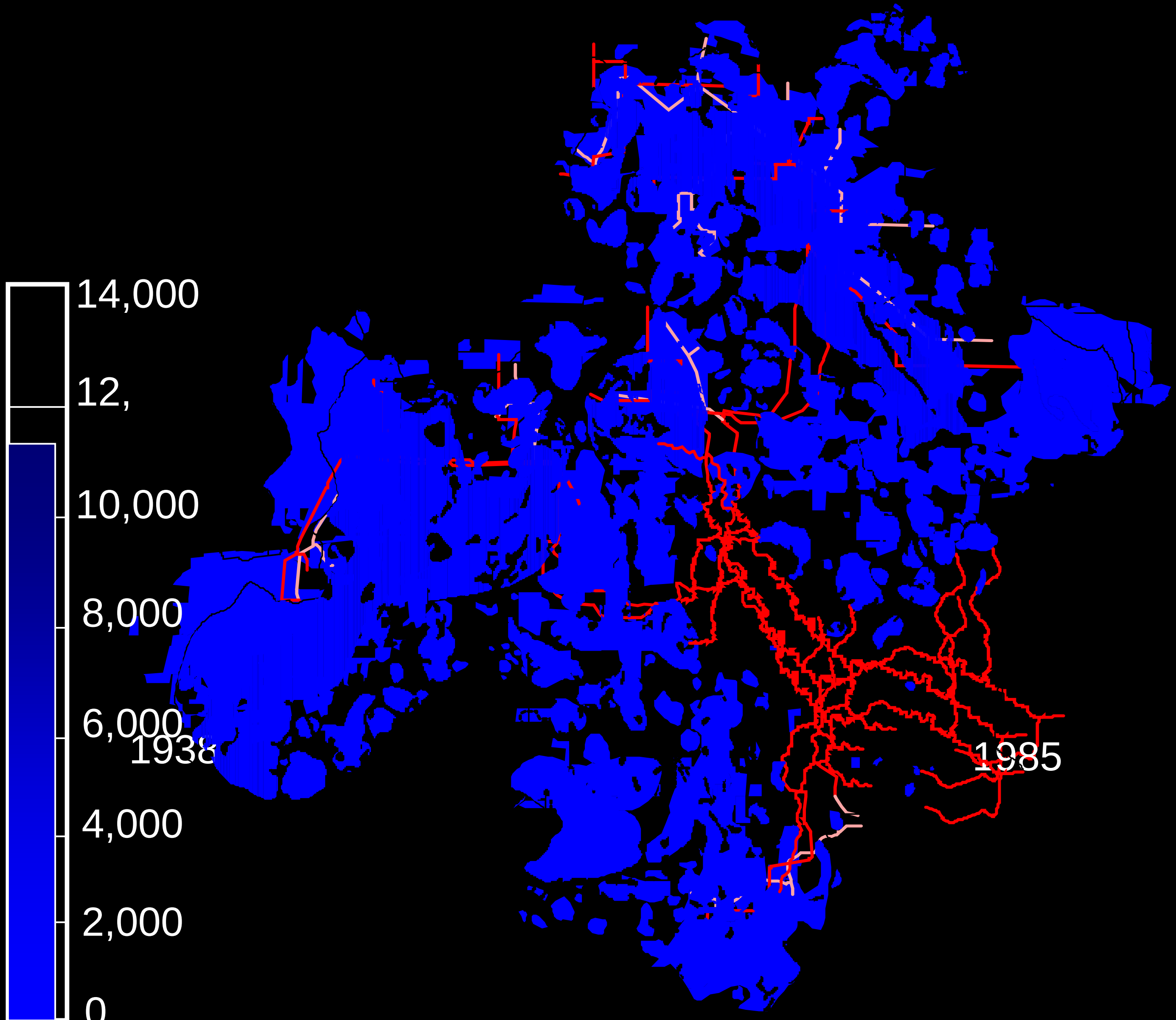
Ditching in Albert Lea

Blue Earth County

Extensive alteration of subsurface hydrology too


Blue Earth County,
slide from MPCA

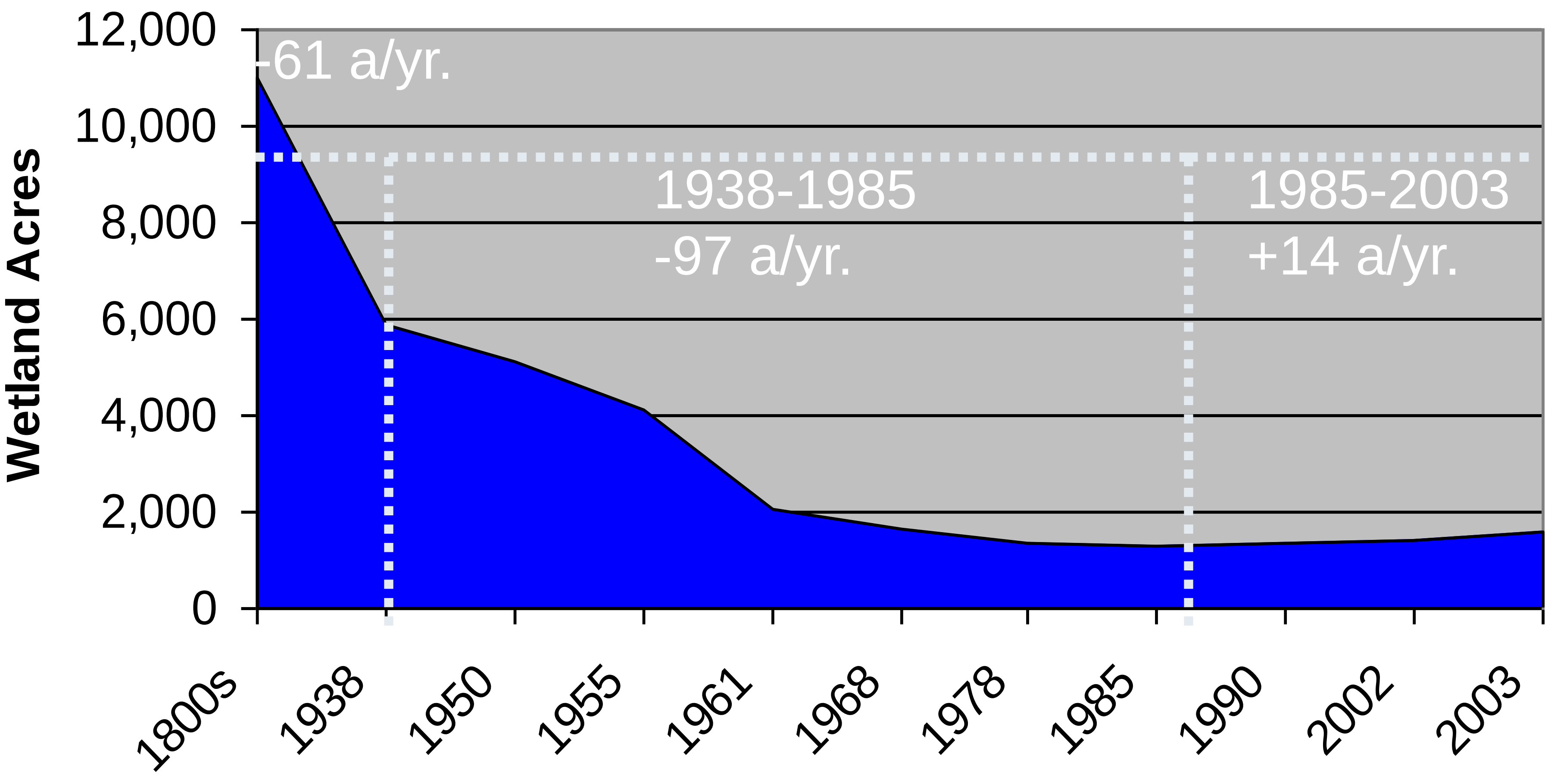

522
Lynch & Sons
Super-Gigant
HOES



Slide from Kevin Kuehner

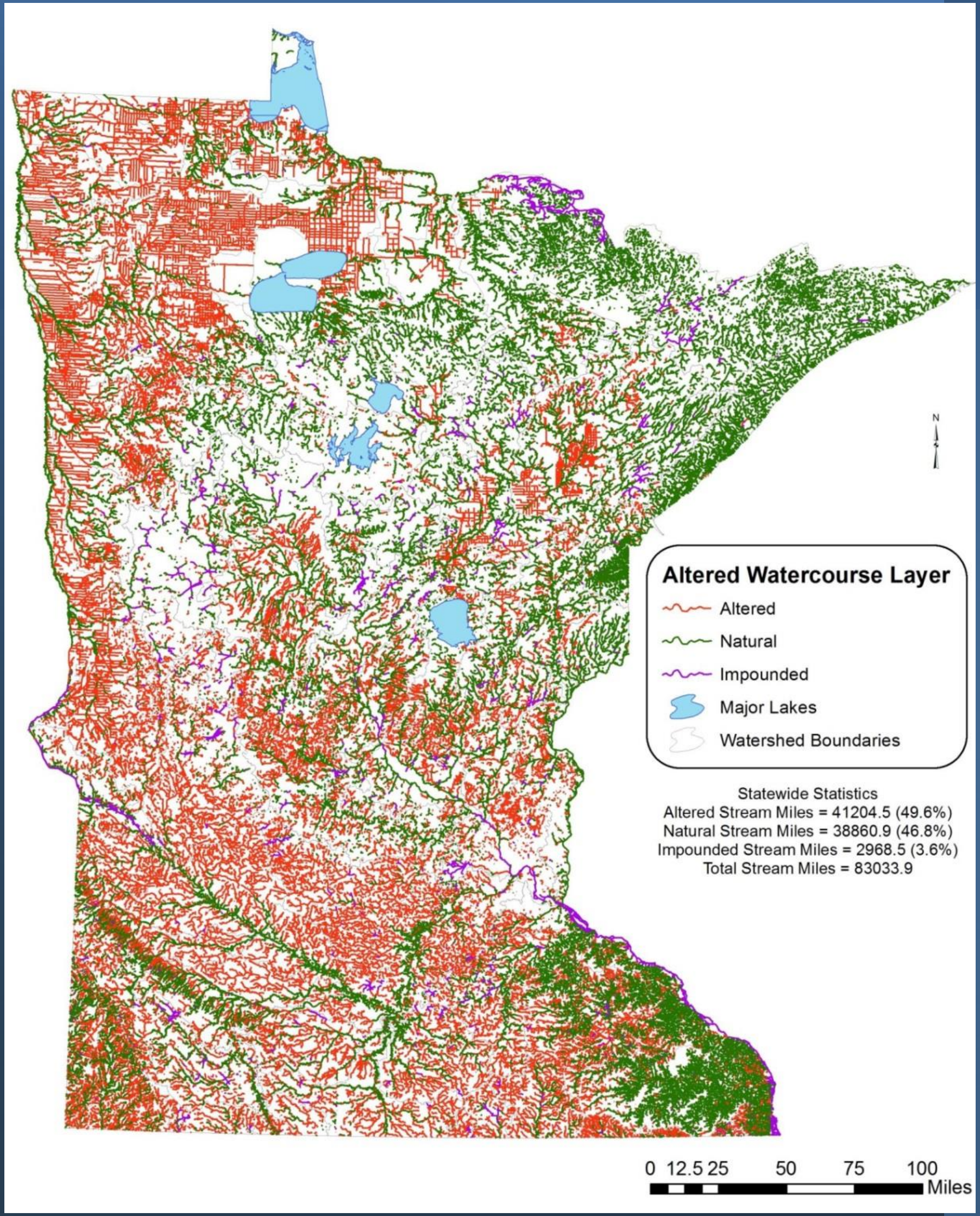
Extent of Wetlands by Year

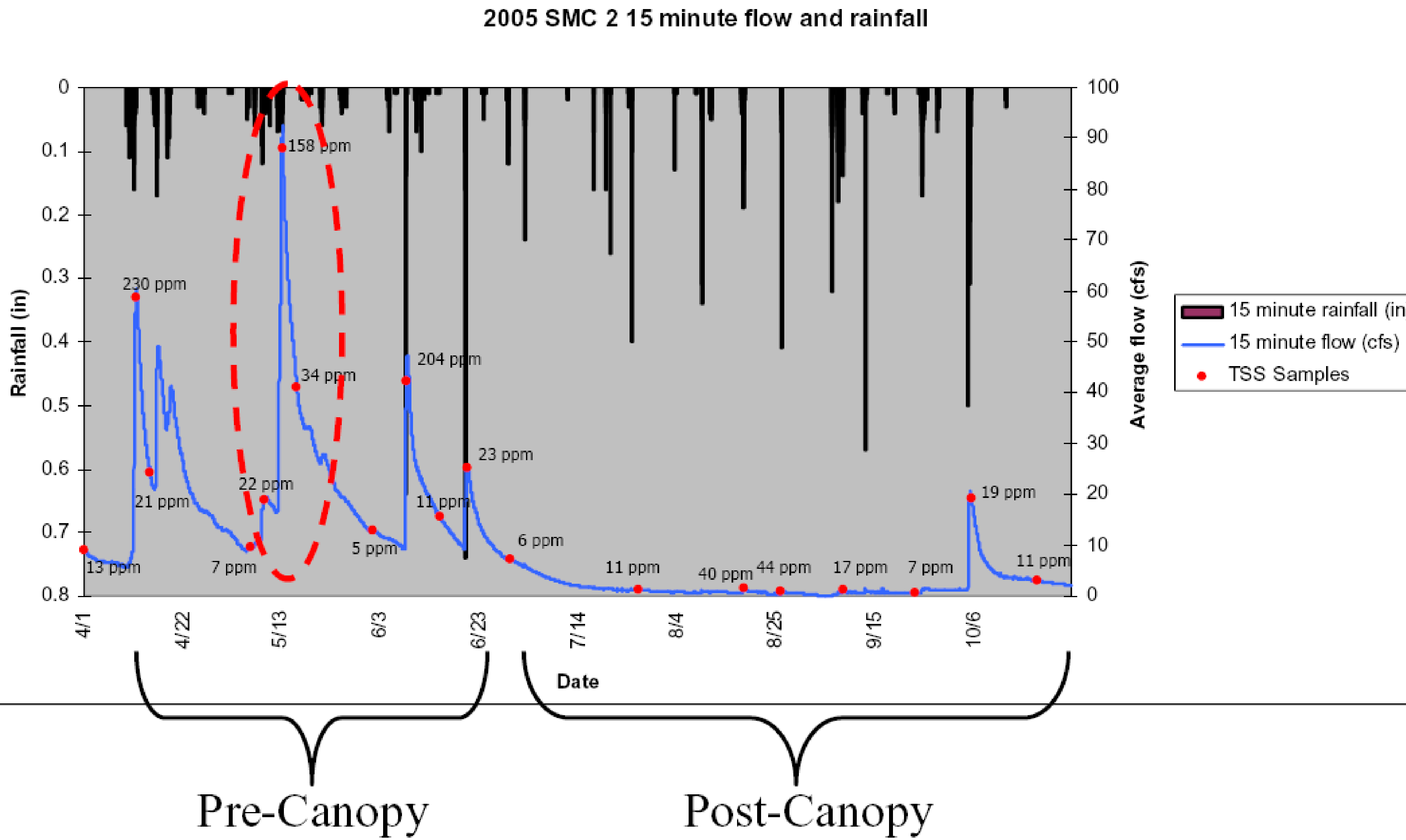
Seven Mile Creek Watershed



Slide from Kevin Kuehner

Altered Hydrology



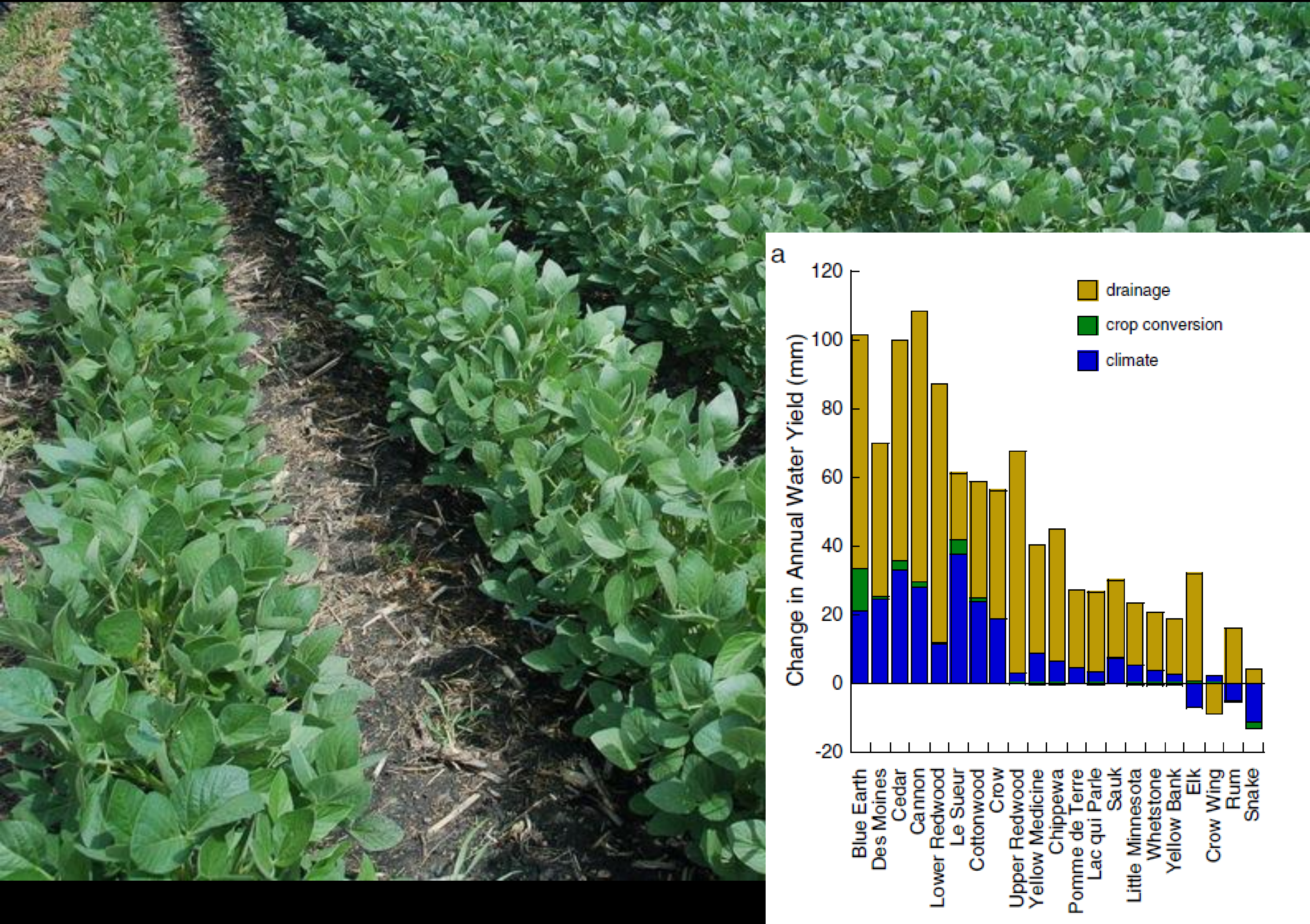


*May 9, 2005 storm event accounted for 44% of the monitored sediment load but only 19% of the total seasonal flow volume.

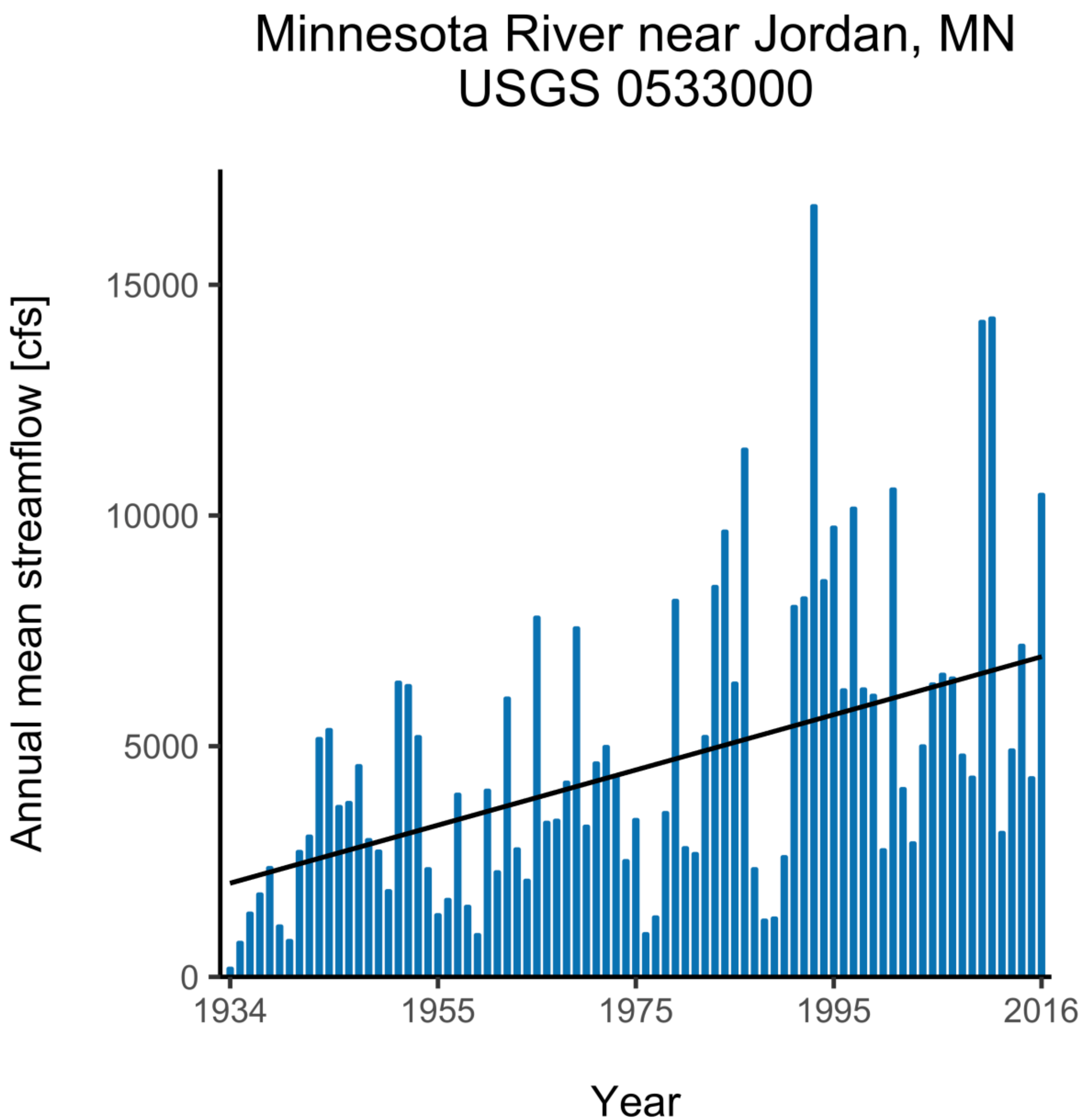
Evapotranspiration limited to growing season

Photo by C. Jennings

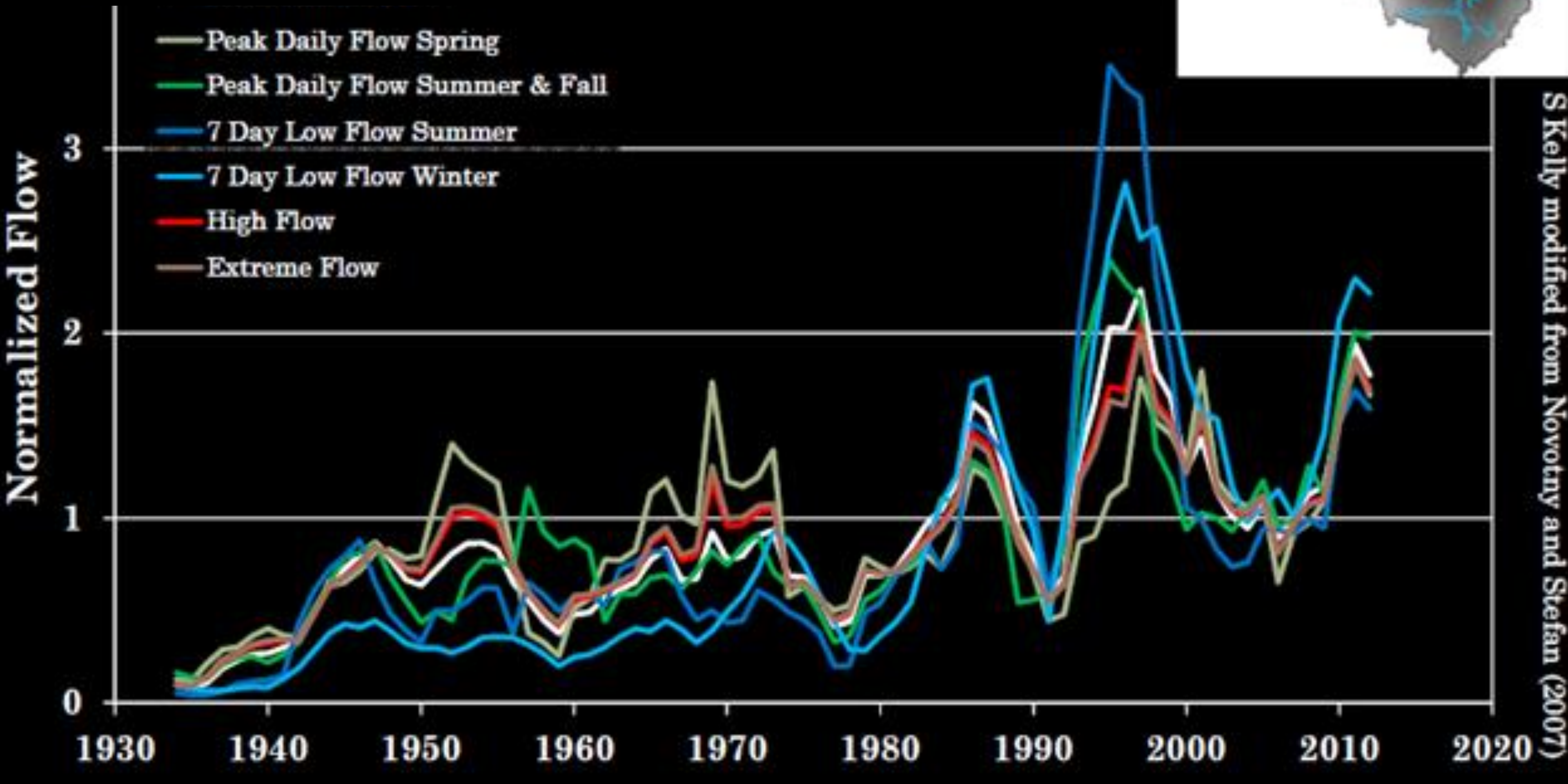
Reduced duration of standing water



a
Change in Annual Water Yield (mm)
120
100
80
60
40
20
0
-20
drainage
crop conversion
climate
Blue Earth
Des Moines
Cedar
Cannon
Lower Redwood
Le Sueur
Cottonwood
Crow
Upper Redwood
Yellow Medicine
Chippewa
Pomme de Terre
Lac qui Parle
Sauk
Little Minnesota
Whetstone
Yellow Bank
Elk
Crow Wing
Rum
Snake

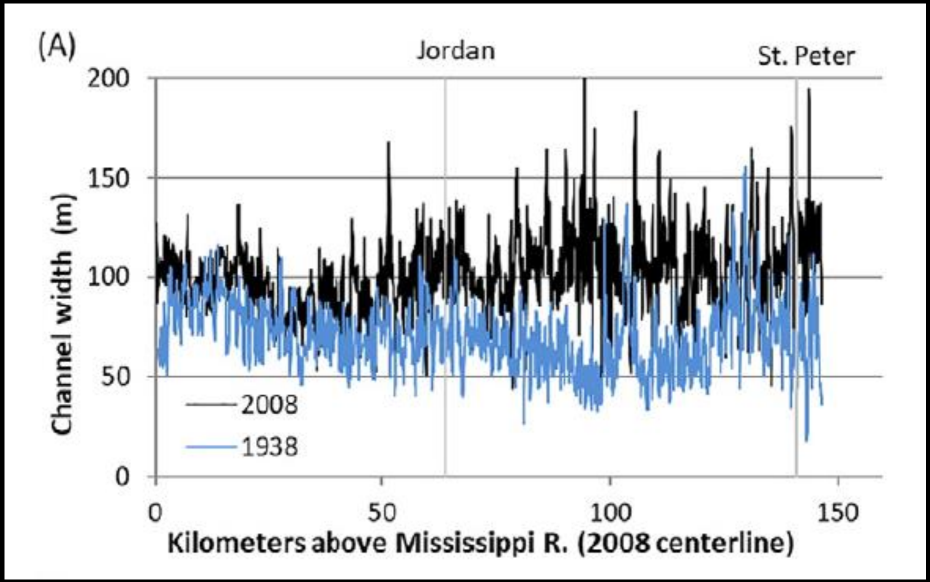

Minnesota River near Jordan, MN
USGS 0533000
Annual mean streamflow [cfs]
15000
10000
5000
0
1934
1955
1975
1995
2016
Year

No matter how you look at it, flows have increased

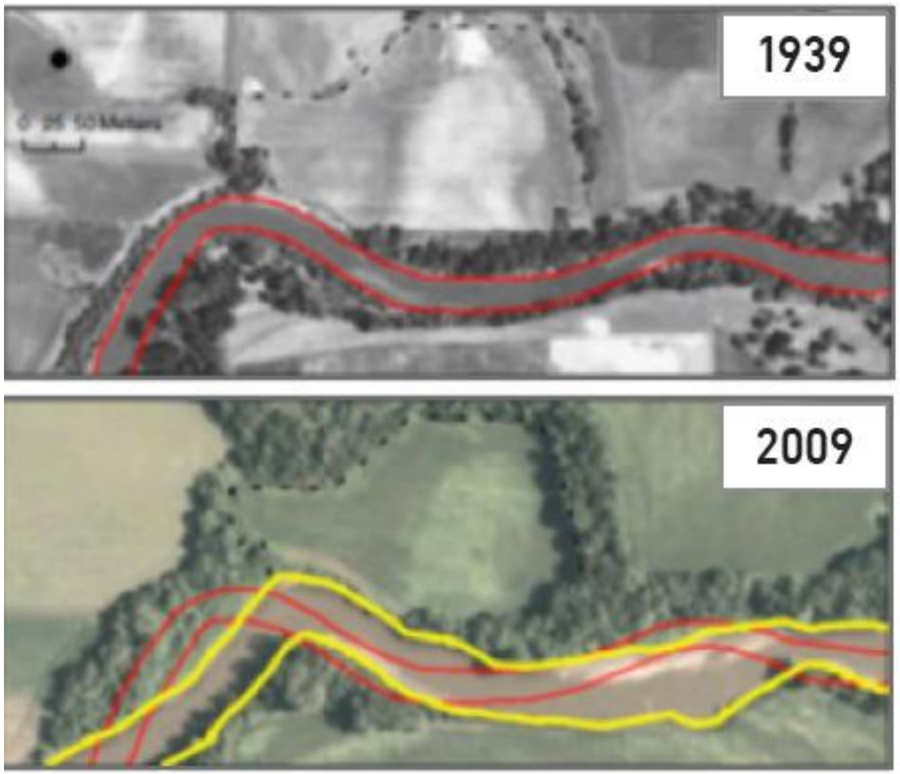


River Widening

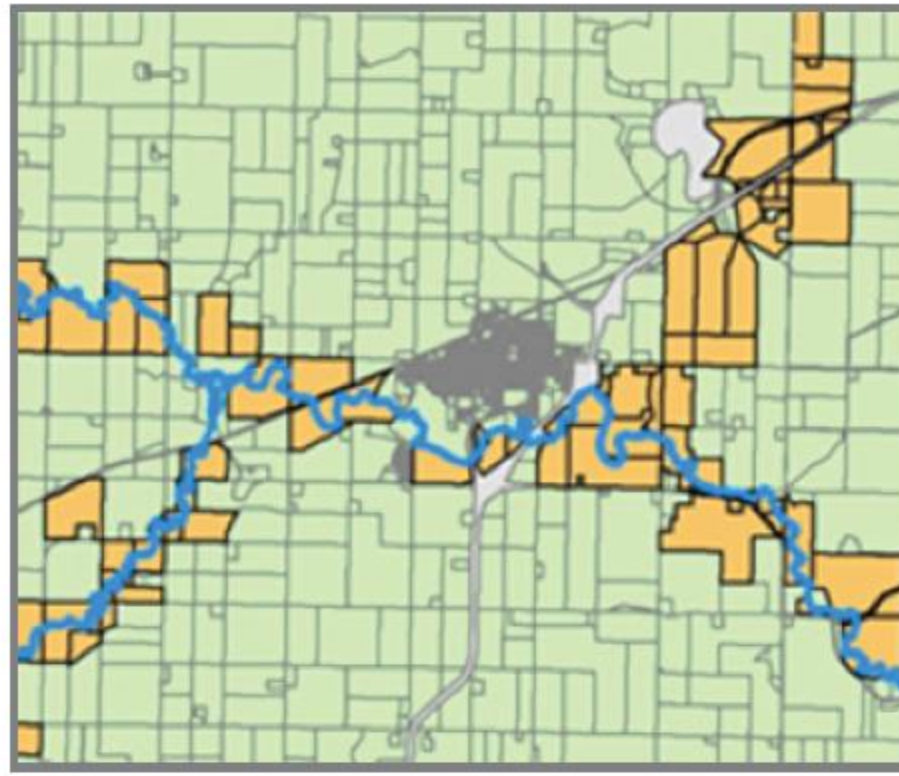
Reach name	Rate of increase (m/y)
Blue Earth R. downstream	0.05
Blue Earth R. upstream	0.23
Chippewa R.	0.06
Cottonwood R.	0.05
Elk R.	0.03
Le Sueur R.	0.18
Little Cobb R. upstream	0.02
Little Cobb R. downstream	−0.07
Maple R.	0.05
Minnesota R. at Chaska	0.34
Minnesota R. at Jordan	0.47
Minnesota R. at Judson	0.71
Sauk R.	0.02
Watonwan R. downstream	0.15
Watonwan R. middle	−0.03
Watonwan R. upstream	0.00



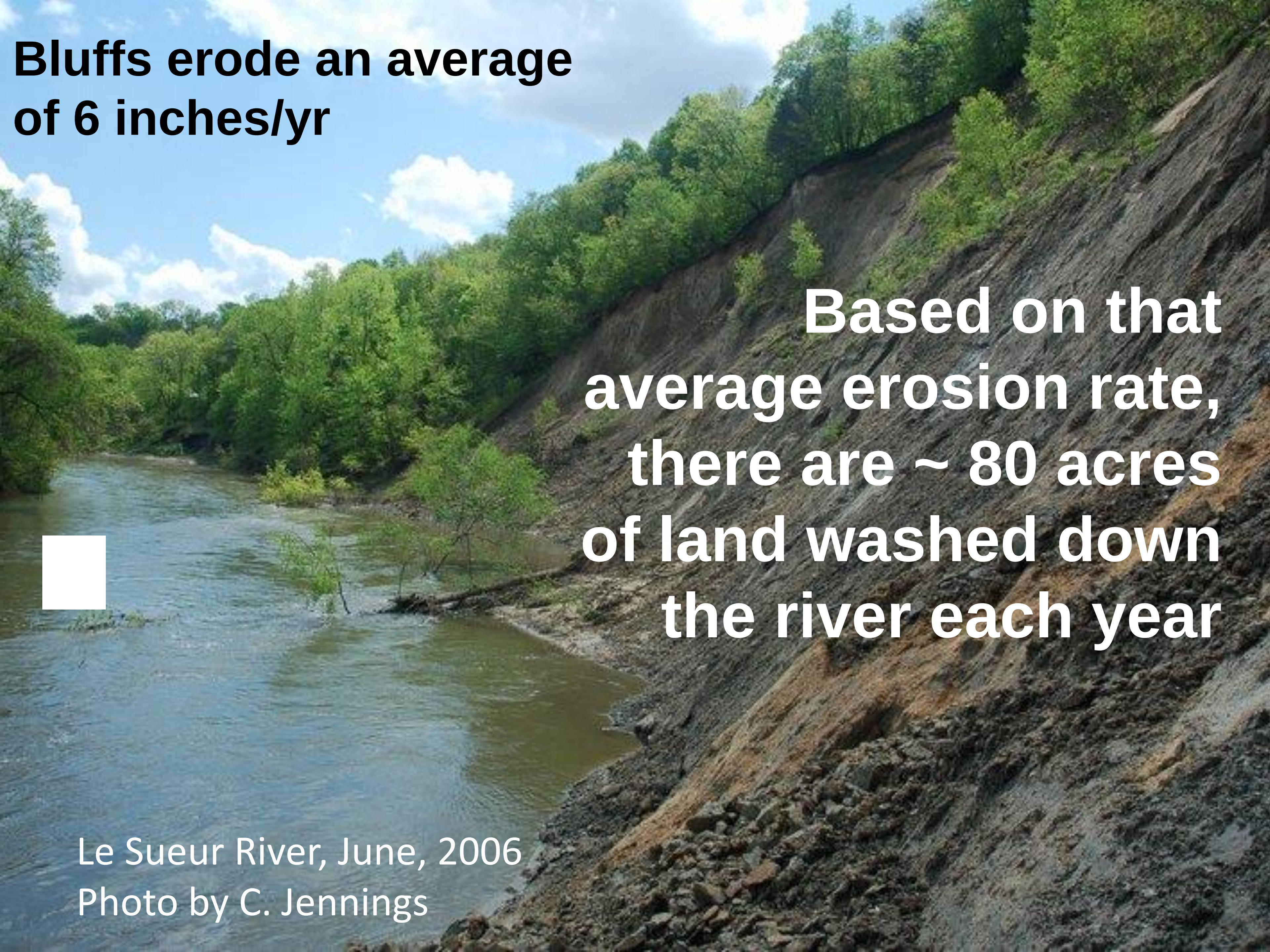
Most have experienced significant widening



Rivers have widened significantly due to increased flows.
Schottler et al. (2014)



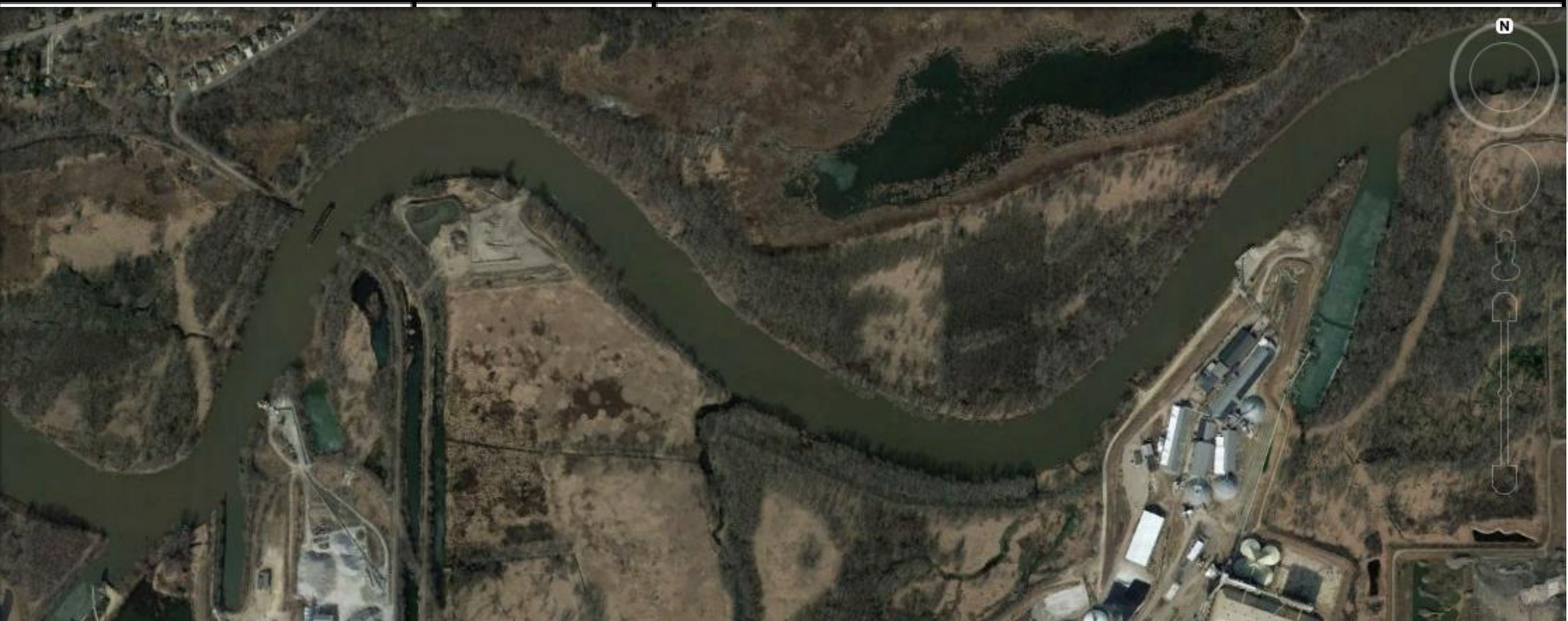
Eroding parcels that line the rivers in an area centered on Madelia lose an average of 6" per year.


Bluffs erode an average of 6 inches/yr
Based on that average erosion rate, there are ~ 80 acres of land washed down the river each year
Le Sueur River, June, 2006
Photo by C. Jennings

Leads to excess sediment in mainstem

Table 1-1 Terminals on the Minnesota River

Name	River Mile	Purpose
Cargill Co.	14.7 (R)	Ship grain; receive salt, fertilizer
Harvest States Coop	14.6 (R)	Ship grain
Bunge Corp.	14.5 (R)	Ship grain
Richards / Shiely Dock	14.4 (R)	Receive asphalt (Richards), sand, gravel, limestone (Shiely)
Port Cargill		
Molasses Dock	13.3 (R)	Receive molasses
Fertilizer Dock	13.1 (R)	Receive dry fertilizer, salt, limestone, etc.
General Dock	13.0 (R)	Receive general cargo (metal products and lumber)
Elevator C Dock	12.9 (R)	Ship grain
U.S. Salt	11.1 (R)	Receipt and transfer of salt, coal, stone, etc.



DredgingToday.com

And tomorrow, and the next day…

GLEN STUBBE • GSTUBBE@STARTRIBUNE.COM

Workers prepared to remove a section of sand transport pipe as the dredge closed in on the edge of the channel, where a 200-foot swath was created so as to ensure a 12-foot deep channel for safe shipping after the river reopens to barge and towboat traffic.

Table 1: Minnesota River Freight Traffic – 2007 to 2010 (Tons x 1,000)

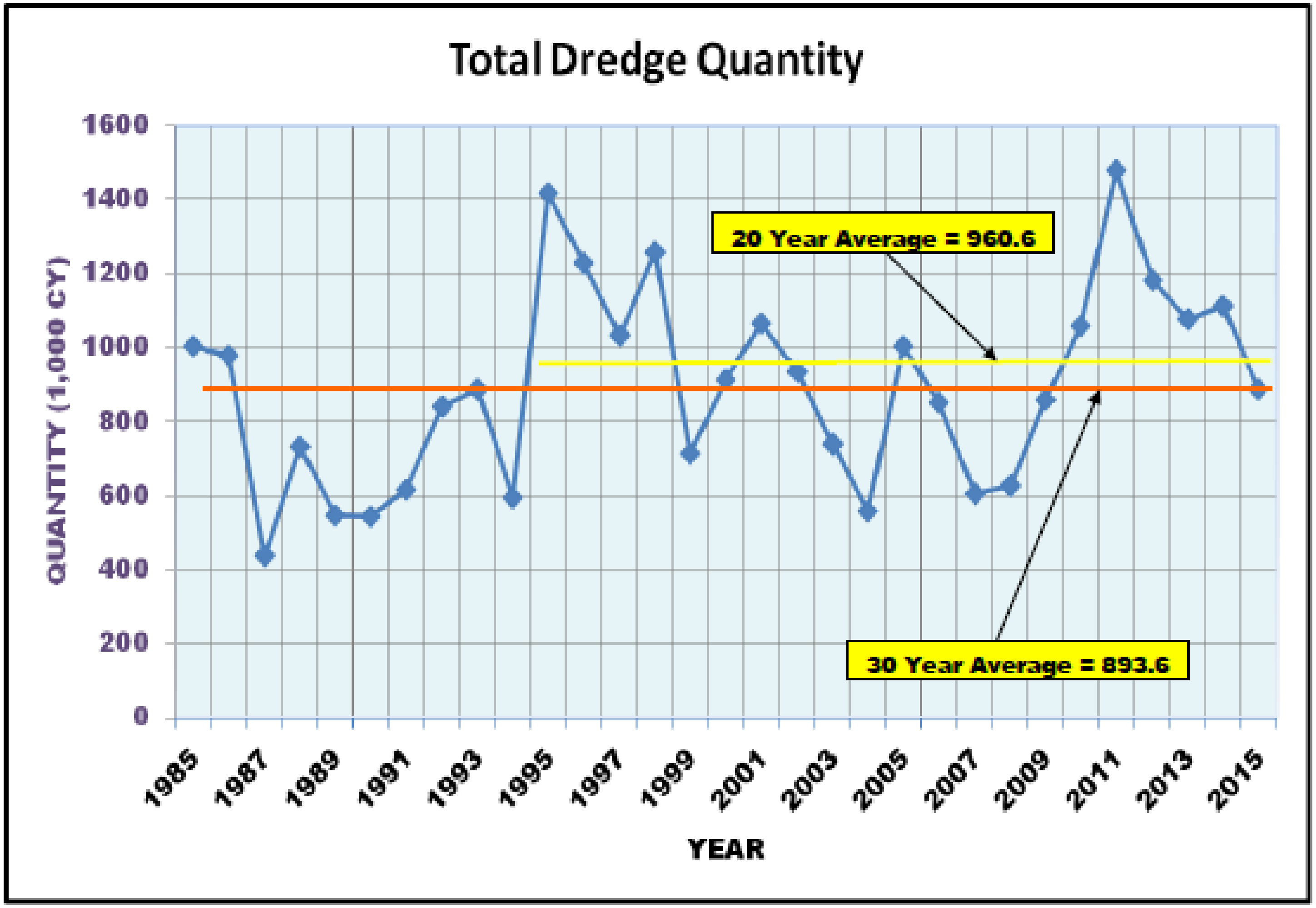
Commodity	2007	2008	2009	2010	Average	Percent Total
Food and Farm Products						
Grain (Wheat, corn, oats)	1,084	1,258	216	1,532	1,023	48.1%
Soybeans	308	516	273	223	330	15.5%
Other	23	5	2	3	8	0.4%
Fertilizers	42	32	86	150	78	3.6%
Crude Materials	626	711	781	628	687	32.3%
Total Tons (times 1,000)	2,083	2,522	1,358	2,536	2,125	100.00%

Source: Waterborne Commerce Statistics

Dredge Quantity History

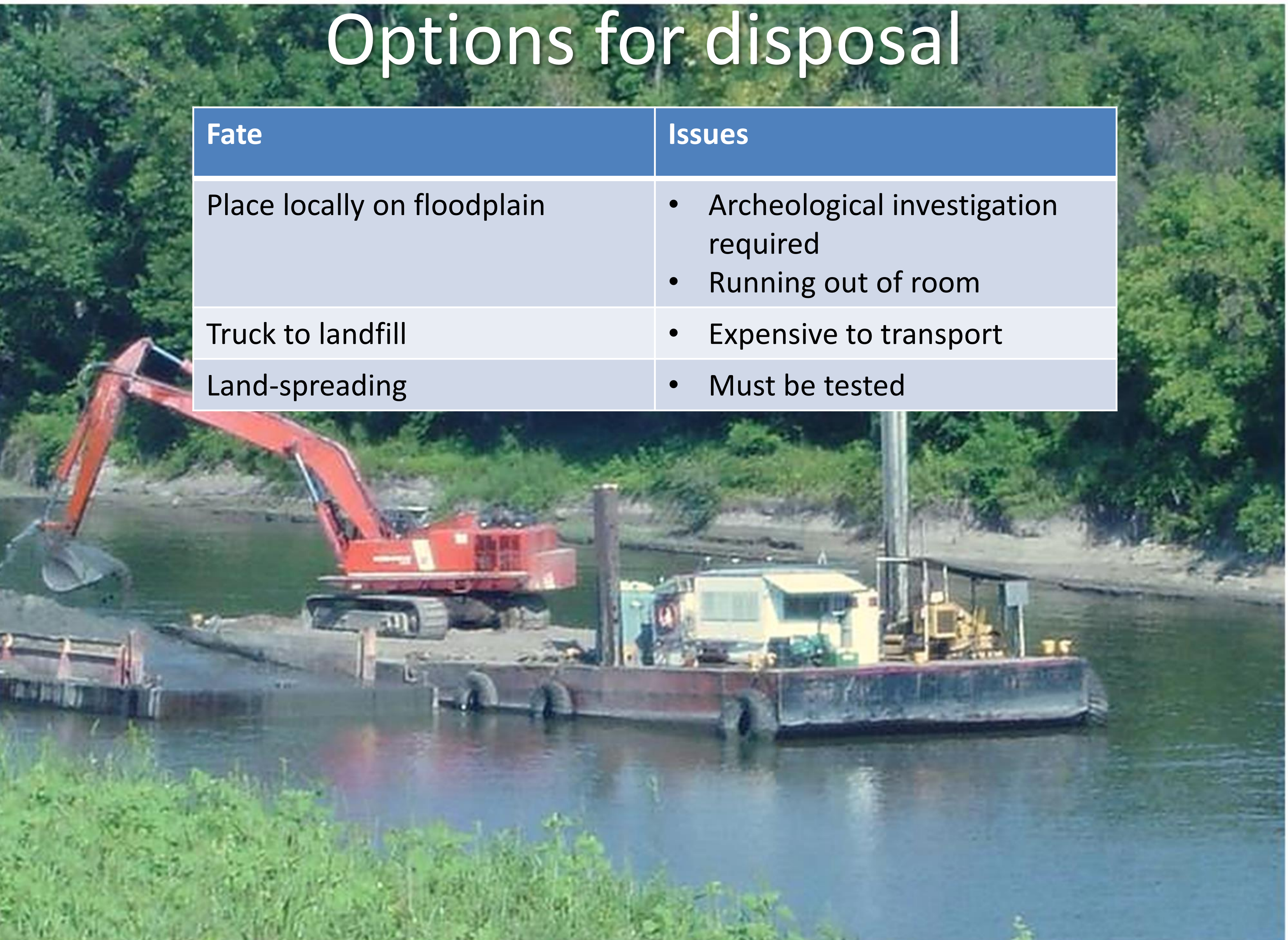
Year	Quantity (1,000 CY)
1985	1,003.0
1986	979.7
1987	437.8
1988	731.0
1989	548.6
1990	542.0
1991	618.1
1992	841.5
1993	888.0
1994	593.2
1995	1,417.4
1996	1,230.0
1997	1,033.9
1998	1,258.9
1999	715.3
2000	911.9
2001	1,066.5
2002	936.3
2003	740.2
2004	577.0
2005	1,003.2
2006	851.1
2007	604.1
2008	625.7
2009	860.9
2010	1,058.8
2011	1,479.0
2012	1,182.1
2013	1,075.2
2014	1,112.3
2015	889.4

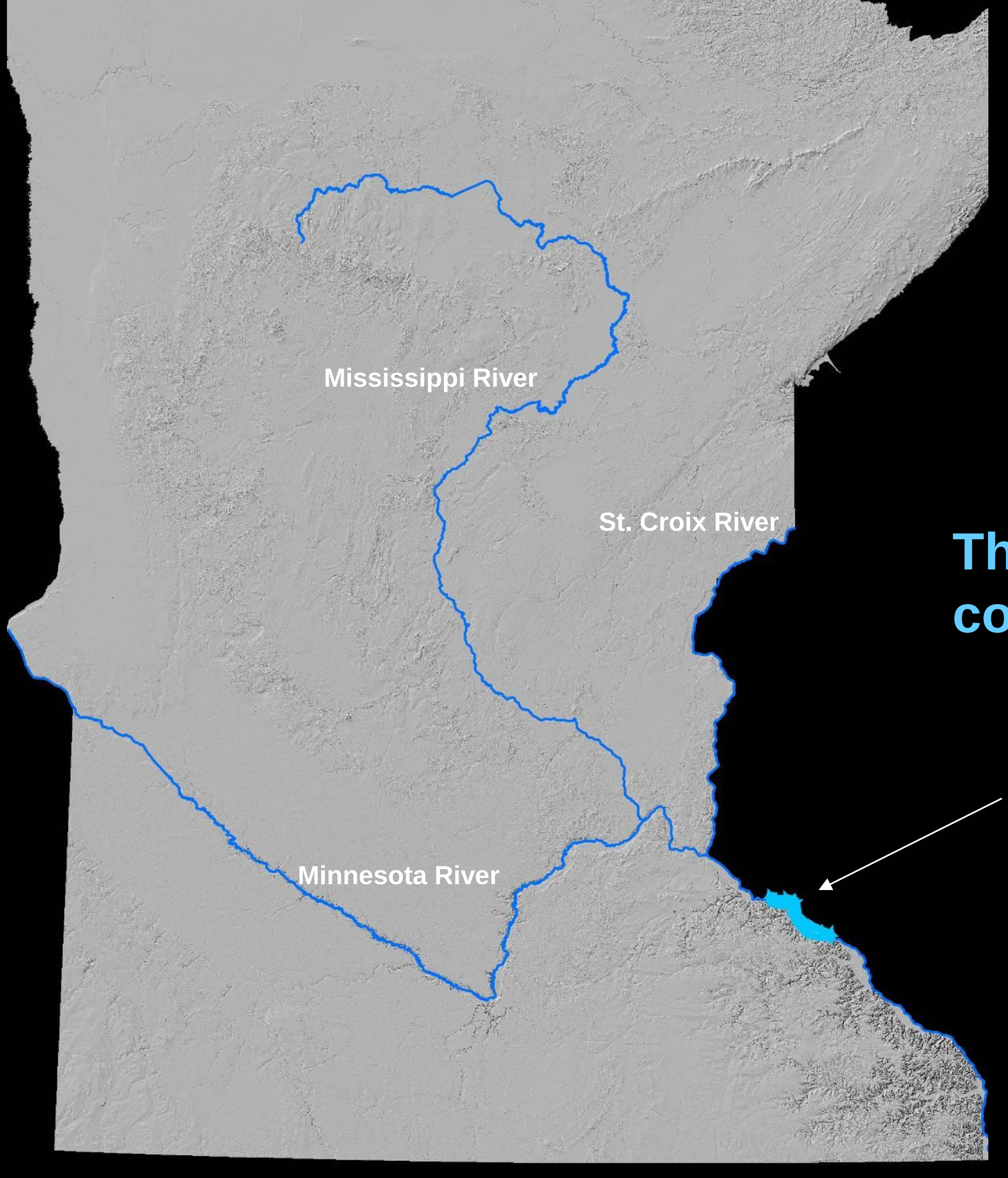
Average	897.2
20 Year Average	960.6



Options for disposal

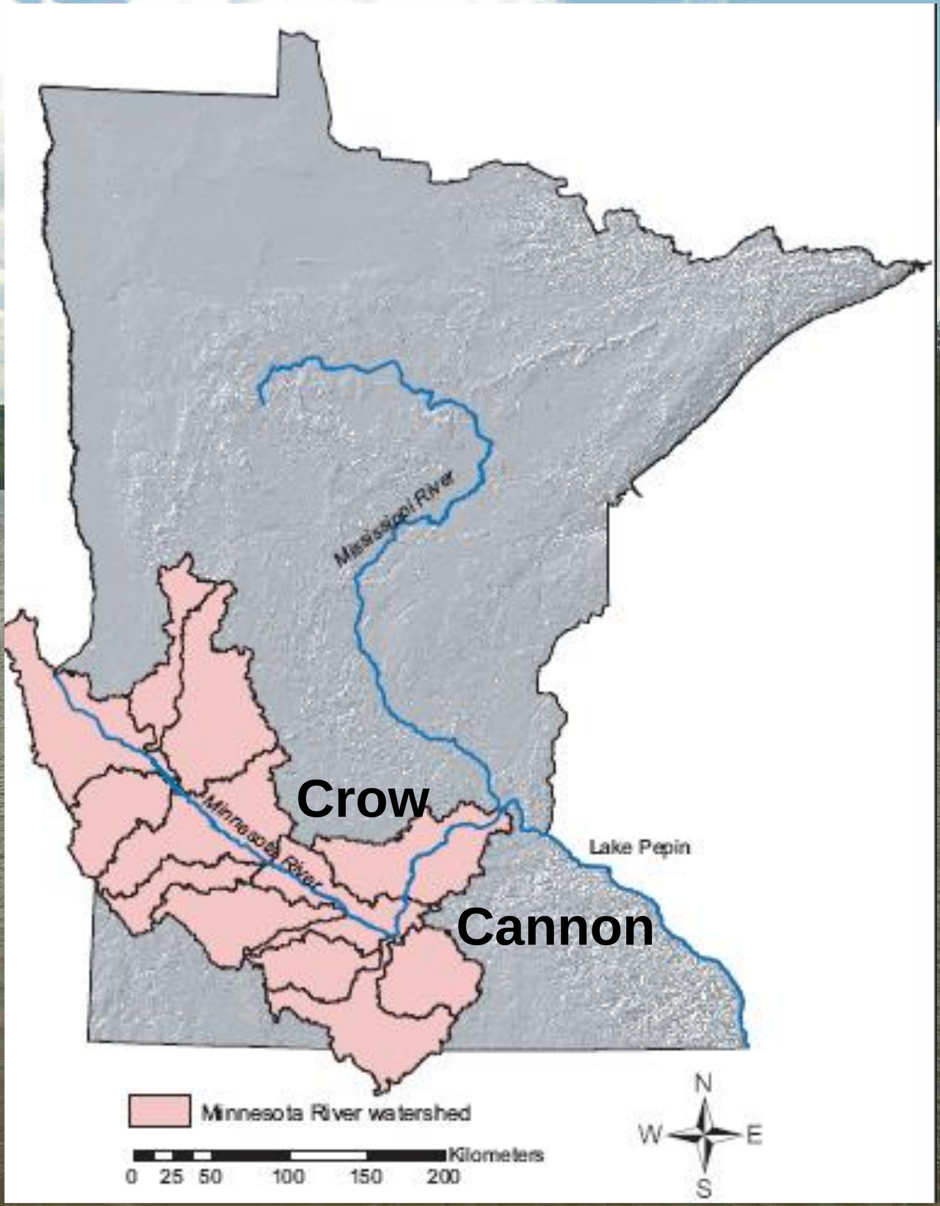
Fate	Issues
Place locally on floodplain	• Archeological investigation required • Running out of room
Truck to landfill	• Expensive to transport
Land-spreading	• Must be tested



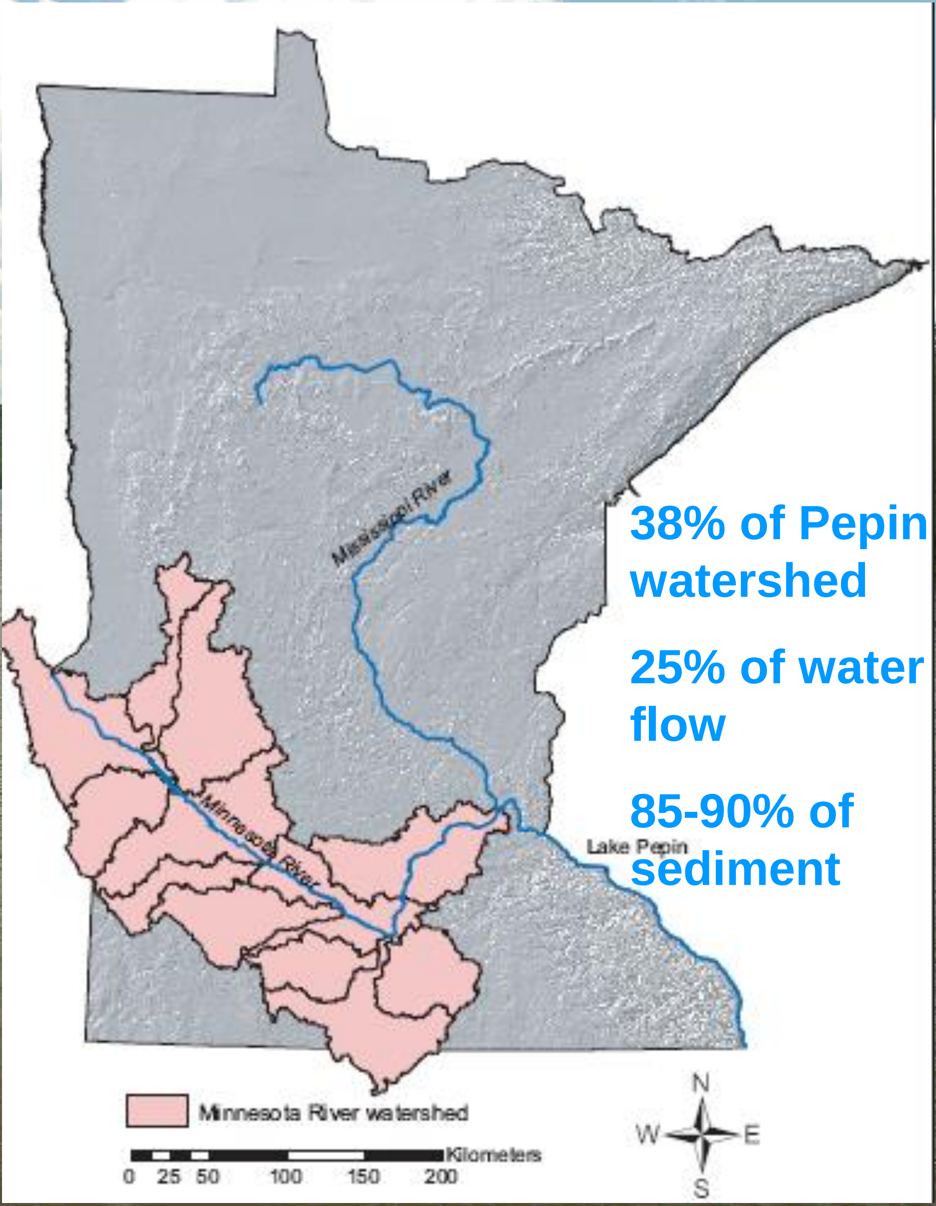


The great collector

Watersheds of the Minnesota River



Watersheds of the Minnesota River

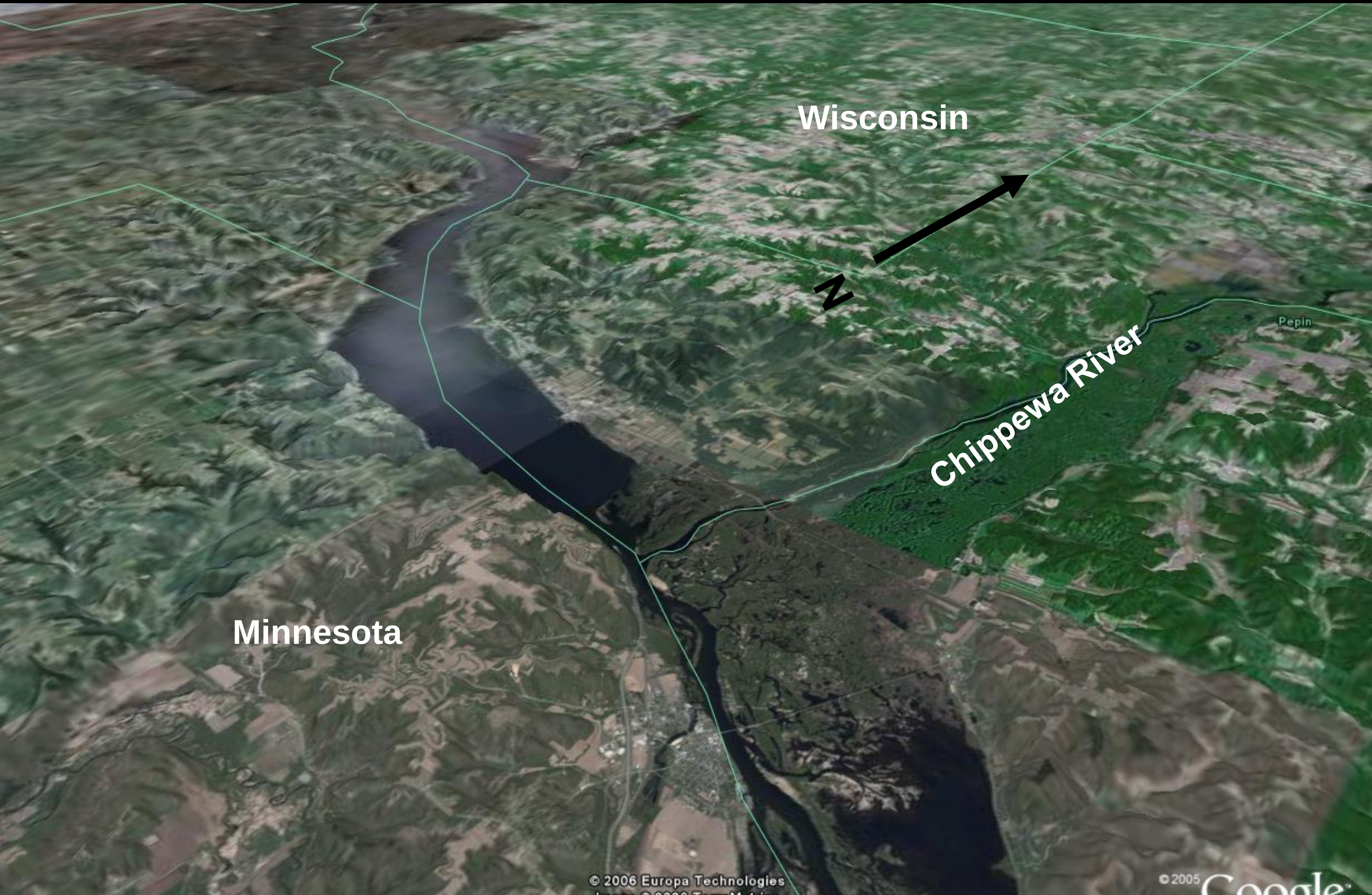


38% of Pepin watershed

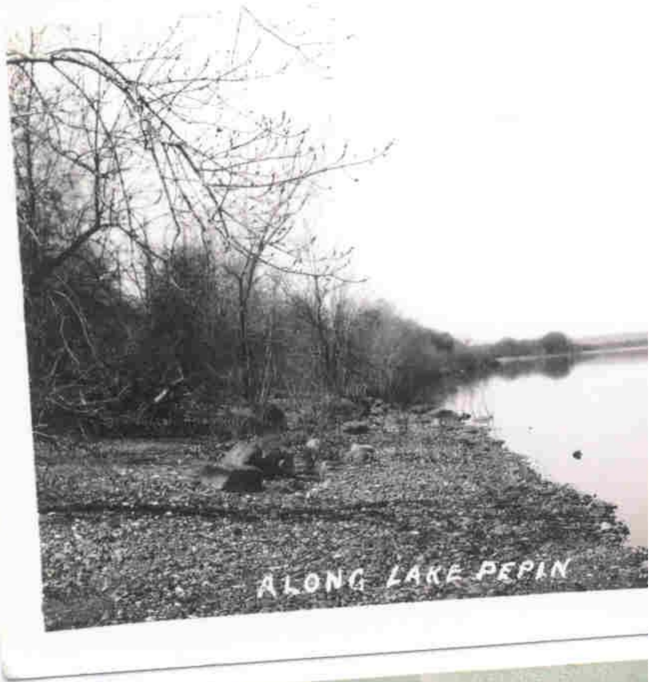
25% of water flow

85-90% of sediment

Chippewa Delta made Lake Pepin



Kelley and Nater, 2000



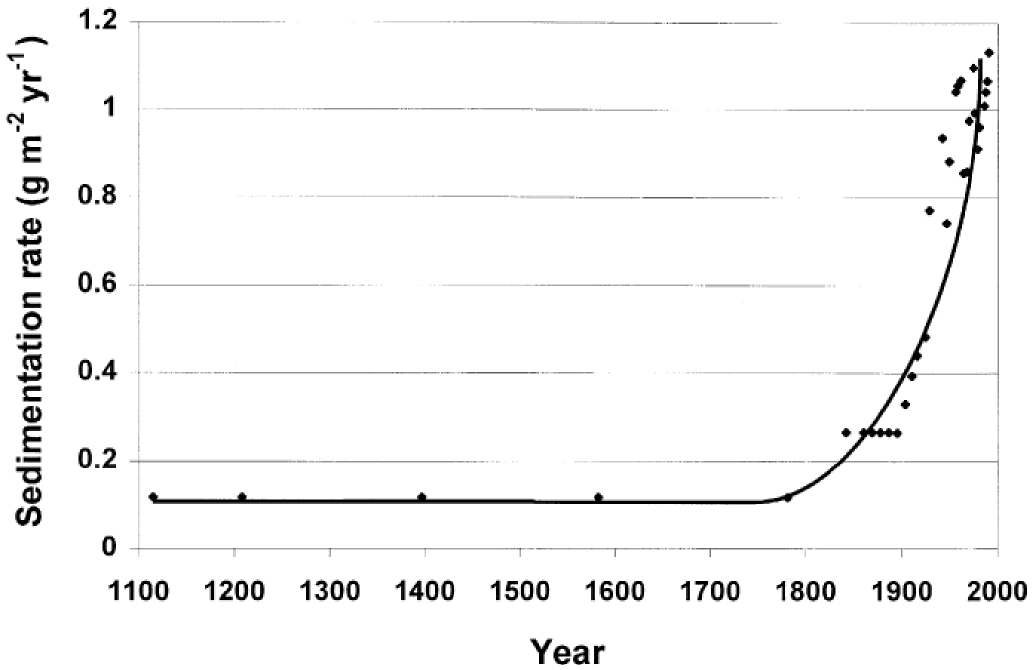


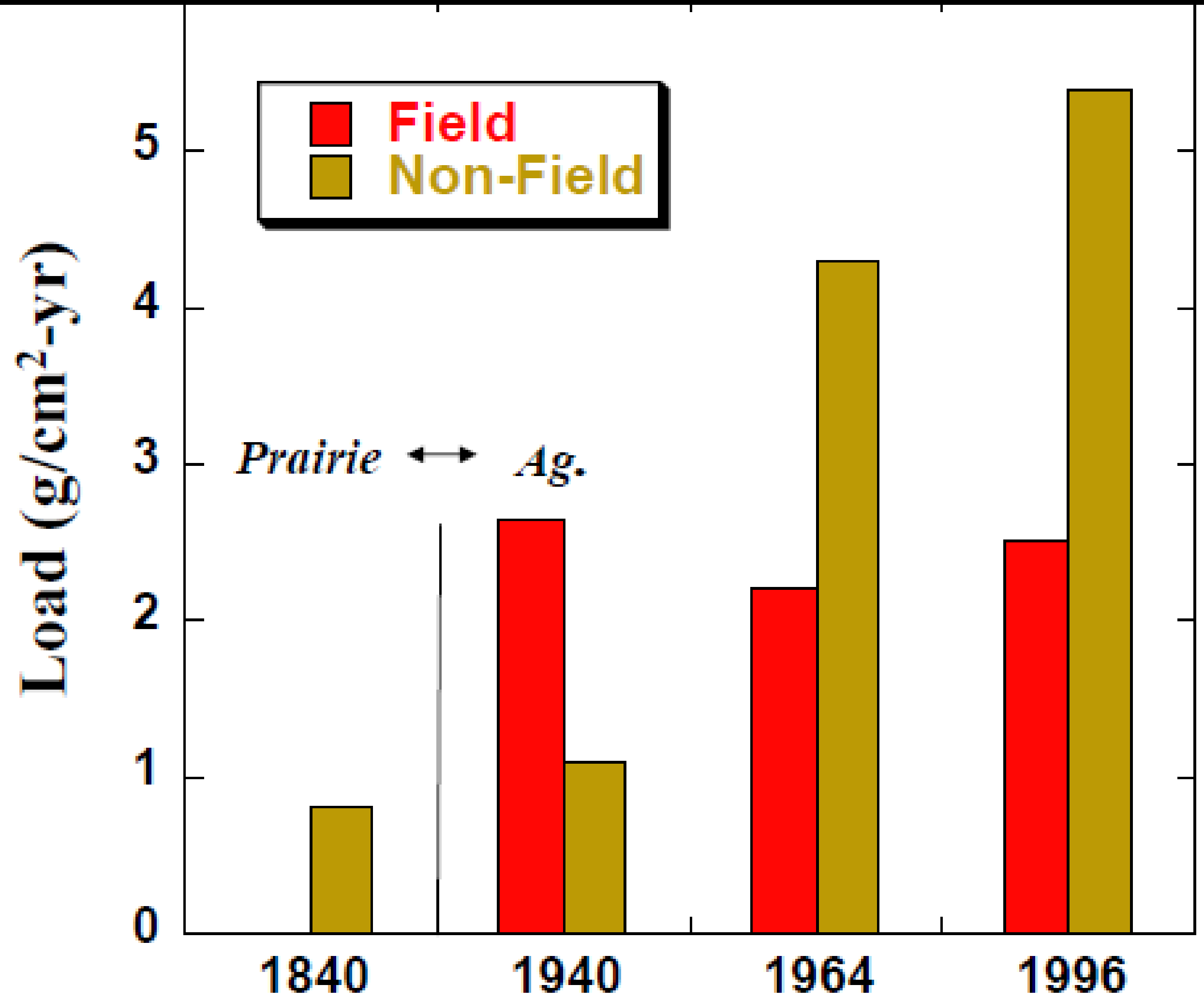
Fig. 2. Changes in sediment accumulation rates in Lake Pepin from pre-1830 to post-European s

Sediment accumulation rates in Lake Pepin

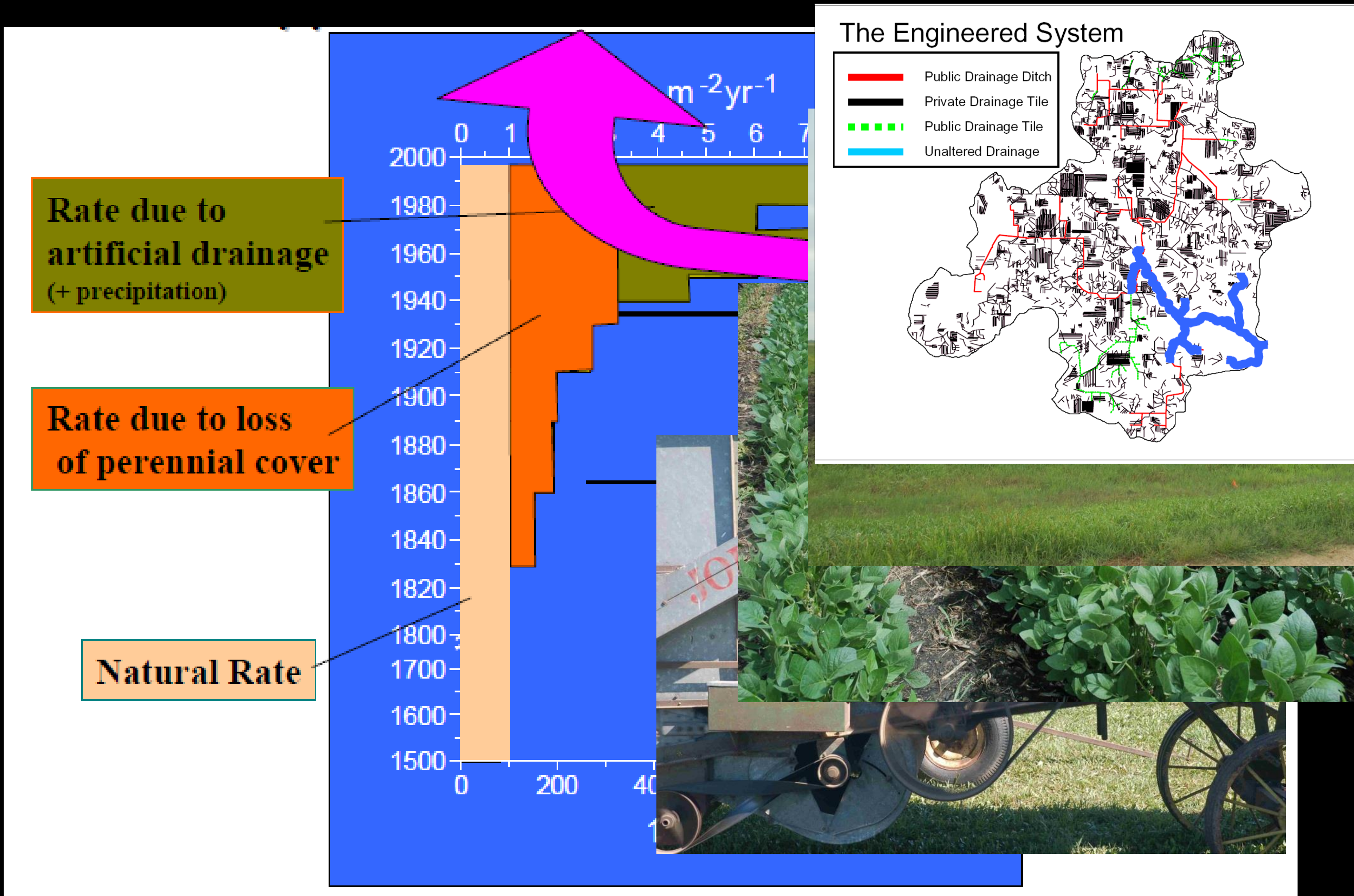
Lake Pepin coring trips, July 2008 and Sep. 2019

Field load ~ constant

Non-field accelerating & is now 6X "natural" rate



From Shawn Schottler



Adapted from Shawn Schottler


A story of unintended consequences.

How can we improve water quality *and* rural economies

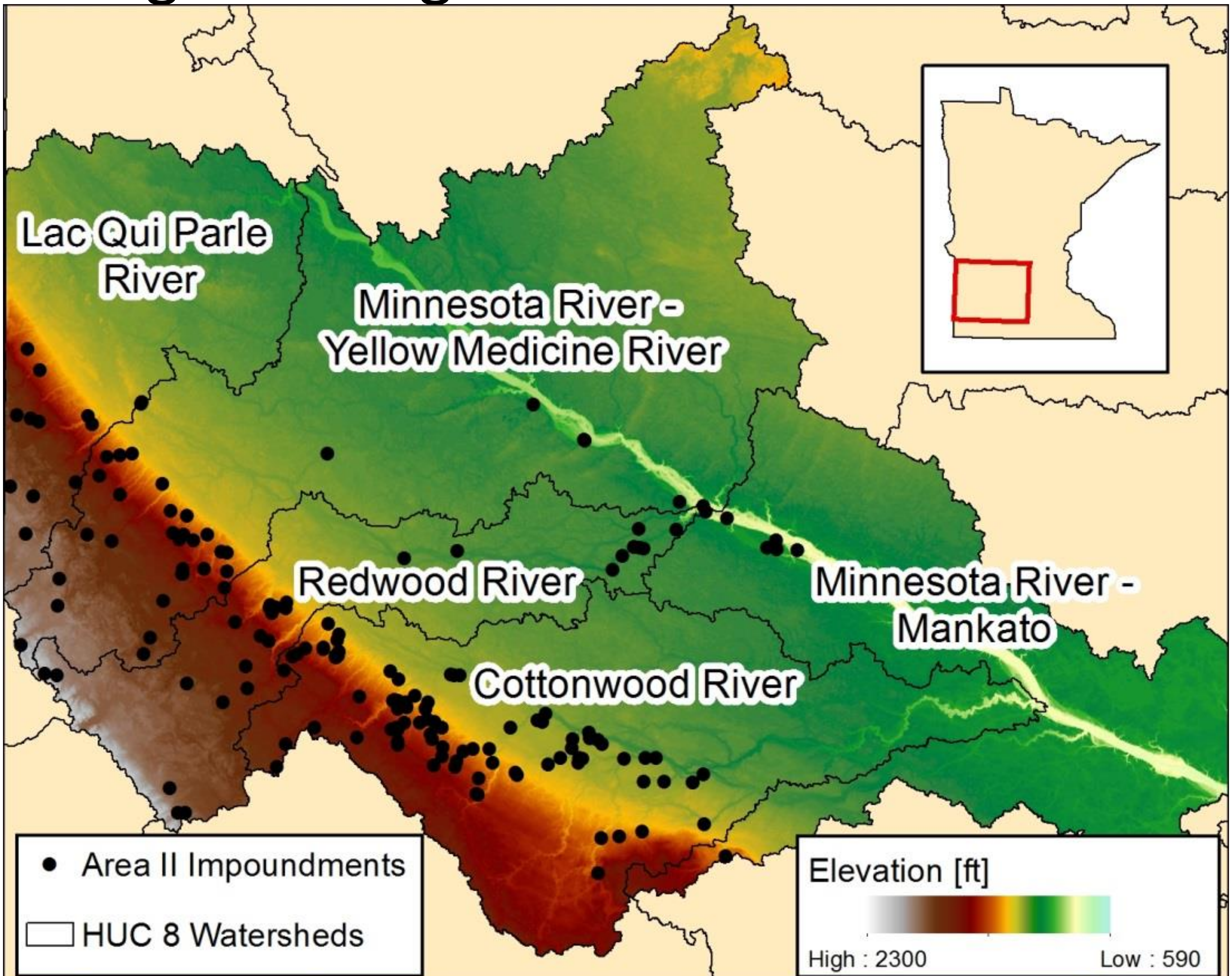
Water Storage Options

		Above ground		On ground		Below ground	
		Cover crops	Perennial crops	Restored wetlands	Detention basins	Reduced tillage	Controlled drainage
Increased	Spring transpiration	x	x				
	Surface water evaporation			x			
	Infiltration	x	x	x	x	x	
	Soil water retention	x	x			x	
Reduced	Total water delivery	x	x	x	x		x
	P and sediment delivery	x	x	x	x	x	
	Peak flows	x	x	x	x		x

Options for Organizing at the Local Level

ORGANIZATIONAL STRUCTURE	PRO	CON
Area II Inc. model	Voluntary, coordinates LGUs, attracts statewide funds	No funds for general management, all structural measures thus far
Watershed districts	Full authority to fund, local control, attracts state funds	Hard to establish unless counties support
Watershed management organizations via joint powers agreements	Right scale, promotes coordination	Can easily collapse when stressed
Minnesota River Basin Joint Powers Board-like	Controlled by LGUs	Hard to have single vision, no authority or money, failed once
County – 103B authority	Existing authority	Water is a secondary issue

Storage and organizational model—Area II



Incentives

8495
McLEOD CO. 911 SERVICES
A RIVER-FRIENDLY FARMER LIVES HERE
Leader

BWSR Soil Health Incentives

PRACTICES SUCH AS REDUCED TILLAGE AND COVER CROPS CAN IMPROVE AGRICULTURAL PROFITABILITY BY REDUCING INPUT COSTS AND INCREASING PRODUCTIVITY.

AT THE SAME TIME, THEY PROTECT WATER BY INCREASING THE WATER HOLDING CAPACITY OF SOIL AND REDUCING THE TRANSPORT OF POLLUTANTS TO STREAMS AND LAKES.

Differences in soil structure are key.

Affects how water, nutrients, and gases move.

Improved when microorganisms are undisturbed (no tillage).

Conventional

30+ years of no-till with grass

Aggregate stability

Minn. Laws 2021, 1st Special Session, Chap. 6, art. 2, sec. 80
(Minn. Stats. §103F.05)

“…provide financial assistance to local units of government to control water volume and rates to protect infrastructure, improve water quality and related public benefits, and mitigate climate change impacts."

The legislation defines the practices as those that sustain or improve water quality via surface water rate and volume and ecological management, including but not limited to:

retention structures and basins;

acquisition of flowage rights;

soil and substrate infiltration;

wetland restoration, creation, or enhancement;

channel restoration or enhancement; and

floodplain restoration or enhancement.

BWSR News Release

BWSR Awarded $21 Million in Federal Funds to Prioritize Water Storage

In addition to traditional (water) storage practices, the funding will allow BWSR and its partners to construct more edge-of-field practices to reduce the amount of nitrogen and other pollutants entering Minnesota waterways

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