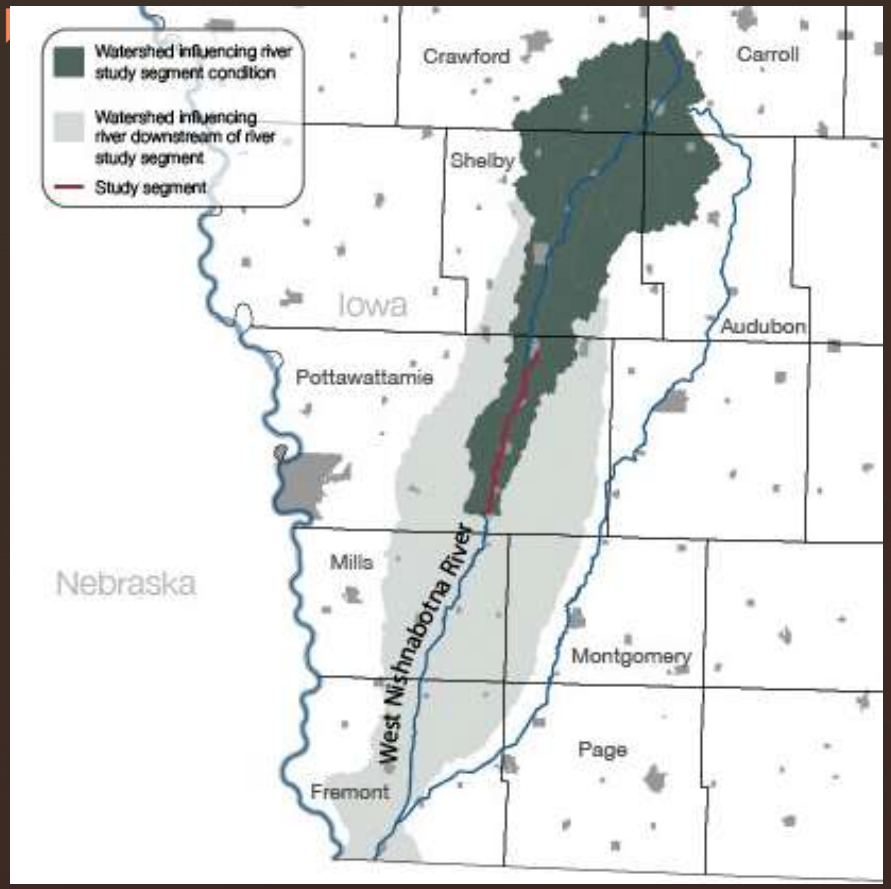
The costs and benefits of post-channelization re-meandering rivers

Something For Nothing

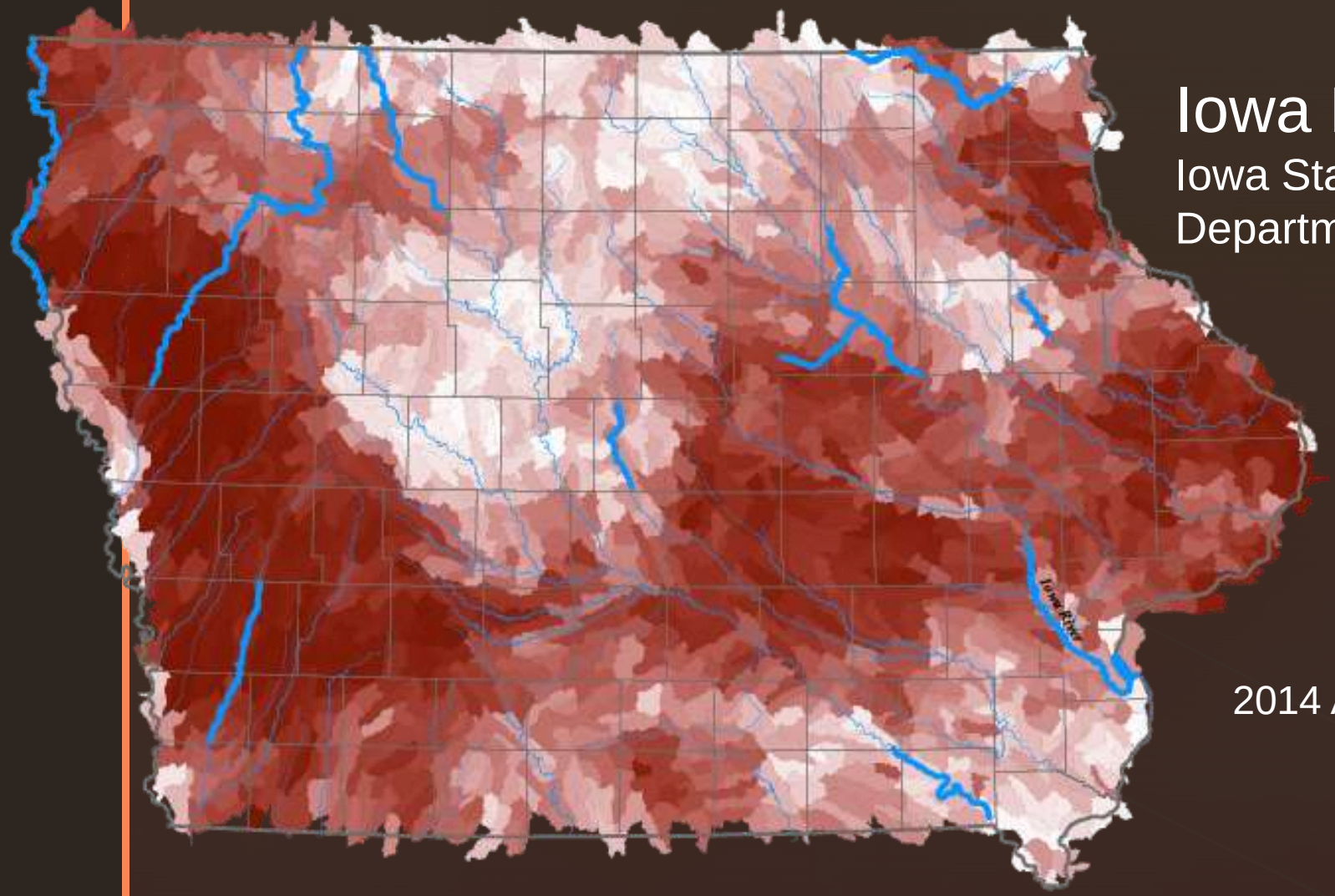
Mimi Wagner
Associate Professor of Landscape Architecture
Director, Design for Sustainable Environments Graduate Program

West Nishnabotna River

Pottawattamie County
Western Iowa



- Channelized in 1910 through use of a drainage district
- Watershed Land Cover (USDA ARS CDL 2013)
  - 80% Cropland
  - 11% Grass, Alfalfa
  - 1% Forest, Woodland
- 27-mile channel length today



Iowa Daily Erosion Project

Iowa State University Agronomy Department

2014 Annual Soil Loss Data

West Nishnabotna State Water Trail Planning
2014

Simple early indicators discovered

- Riparian perennial vegetation cover
- % Annually cultivated land in watershed

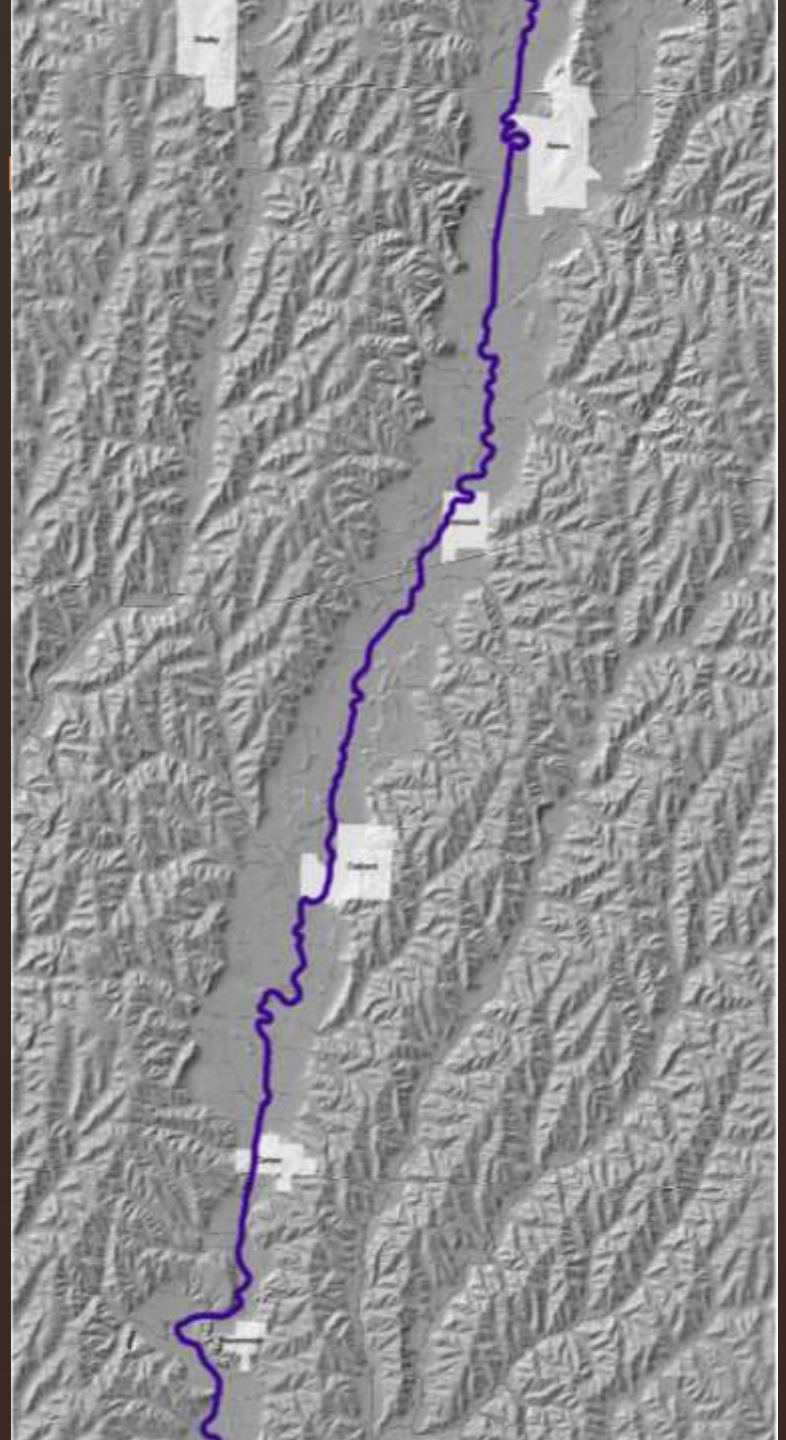
River	% Cropped first 100'	Cropland % watershed
Black Hawk Creek	4%	89%
Cedar	0%	81%
Iowa	3%	74%
Little Sioux	12%	79%
Lower Des Moines	14%	67%
Maqouketa	1%	72%
South Skunk	8%	85%
West Fork Des Moines	6%	80%
West Nishnabotna	24%	80%

West Nishnabotna State Water Trail Planning
2014

Simple early indicators discovered:

- % River Edge Permanently protected
- % Channel length change 1980-2010
- Bird SGCB (BBA II)

River	% River edge in permanent protection	% Channel length change 1980-2010	Bird SGCN
Black Hawk Creek	15%	3.7	11
Cedar	19%	1.2	24
Iowa	14%	1.0	43
Little Sioux	12%	8.20%	32
Lower Des Moines	6%	-0.20%	30
Maqouketa	30%	0.03%	28
South Skunk	15%	-0.03%	26
West Fork Des Moines	13%	-0.80%	21
West Nishnabotna	3%	6%	13

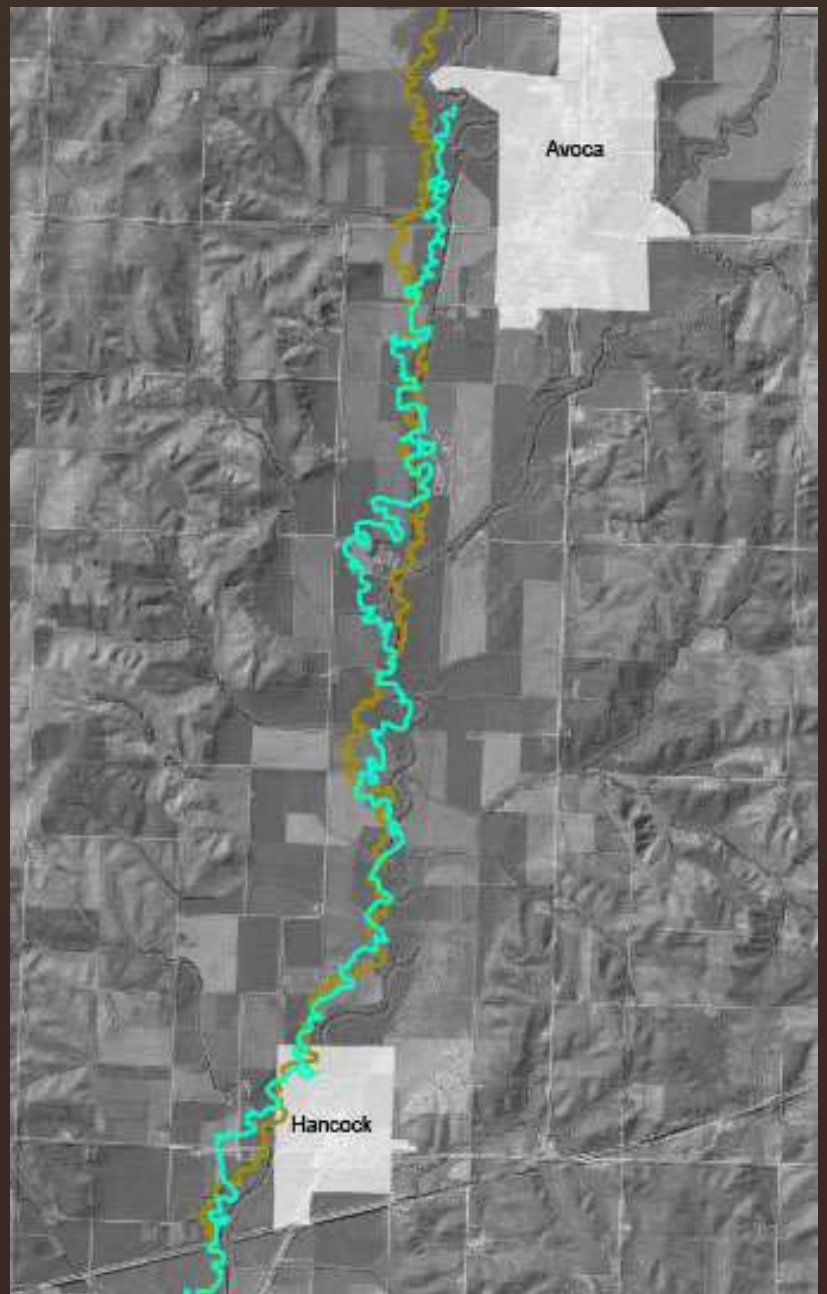


Study Reach
2015 Channel Alignment

489,509-acre drainage area

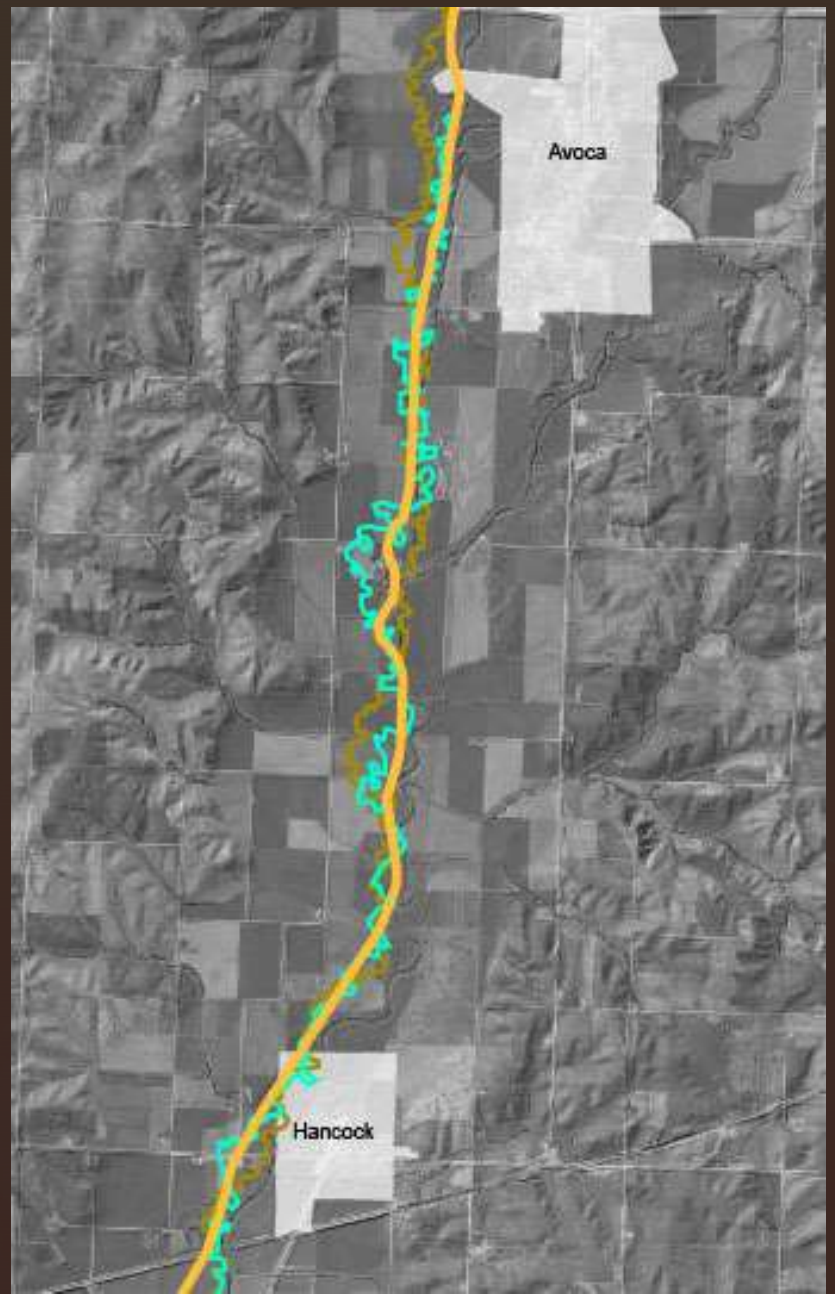
Study Reach
1851 General Land Office Channel Alignment

- 1846 Mormons established Macedonia on the W Nish River in 1846; church remaining there until 1852 when final Mormon Trail Movement left Iowa
- The last of the Sioux were officially forced to abandon land in Western Iowa in 1853
- First Transcontinental Railroad, completed in 1869



Study Reach
1909 Pre-Dredge Survey
Channel Alignment

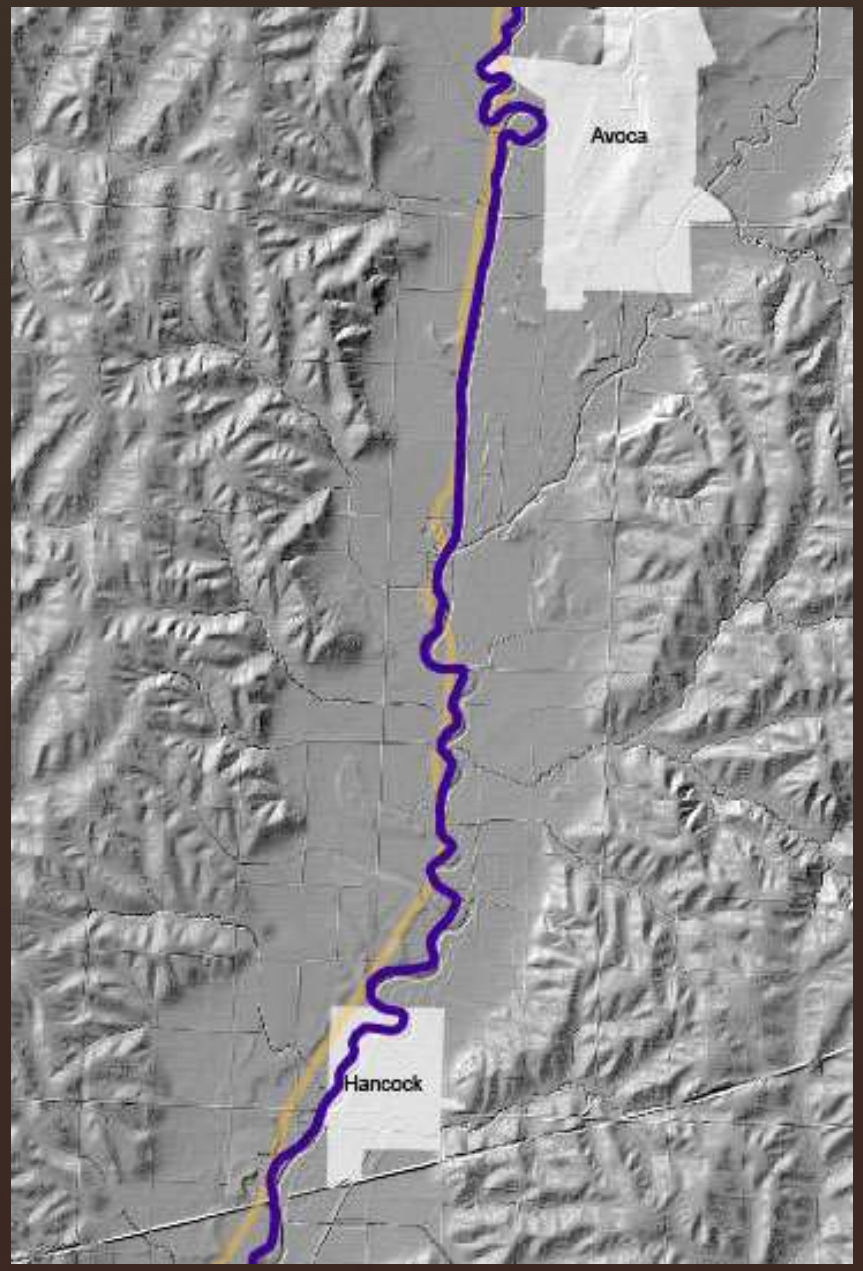
- As of 1906, Iowa had claimed 4,572,816 acres of swamp land (Swamp & Overflowed Lands Acts 1849, 1850)



Study Reach
1911 Drainage Ditch Completed

- States came to view drainage of swamp and overflowed lands, when it extends beyond the individual land owner, as a public function.

- "…in the swampy portions of Iowa, public drainage districts have been formed and hundreds of miles of large open ditches … thereby increasing the value of the land many fold and making healthful what were at the time malarious and and sickly districts." (Wright, 1907)



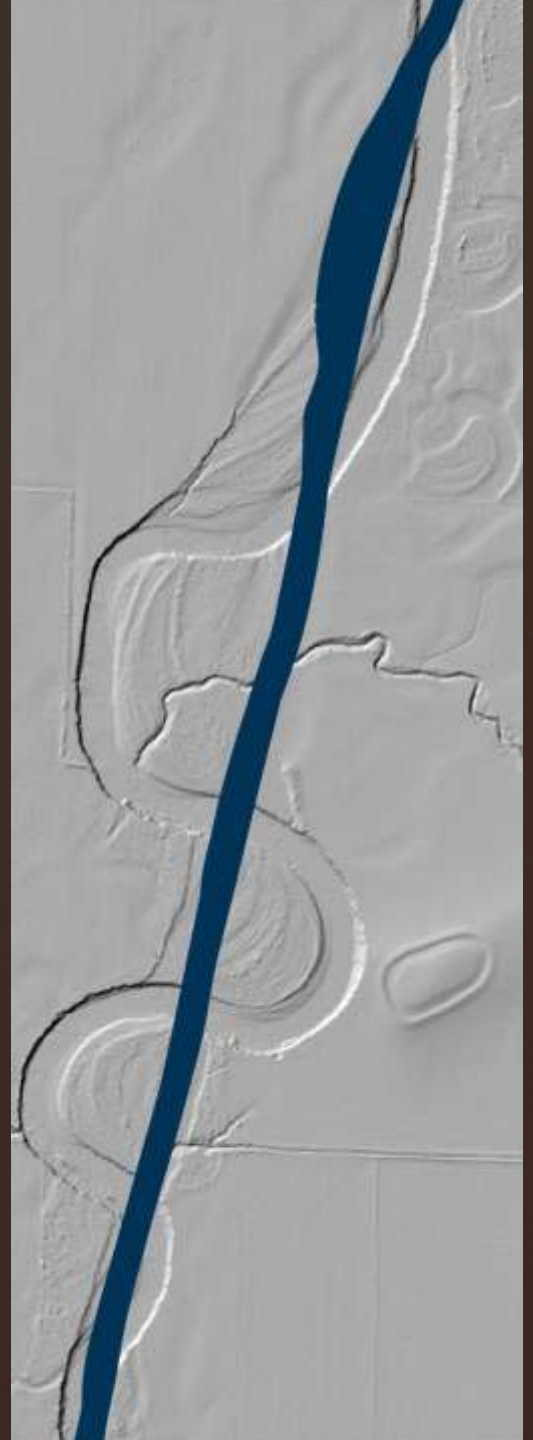
1939-2015 Study Reach Channel Alignment

- Streambank heights of 15-20’ are not uncommon today
- 150 years post-channelization, floodplains and near-river landscapes have been radically drained and transformed by agriculture
- Today’s channel length is nearly nearly eight miles longer compared to its initial channelized length and 7.5 miles shorter than the 1909 surveyed length

Methods & Calculations

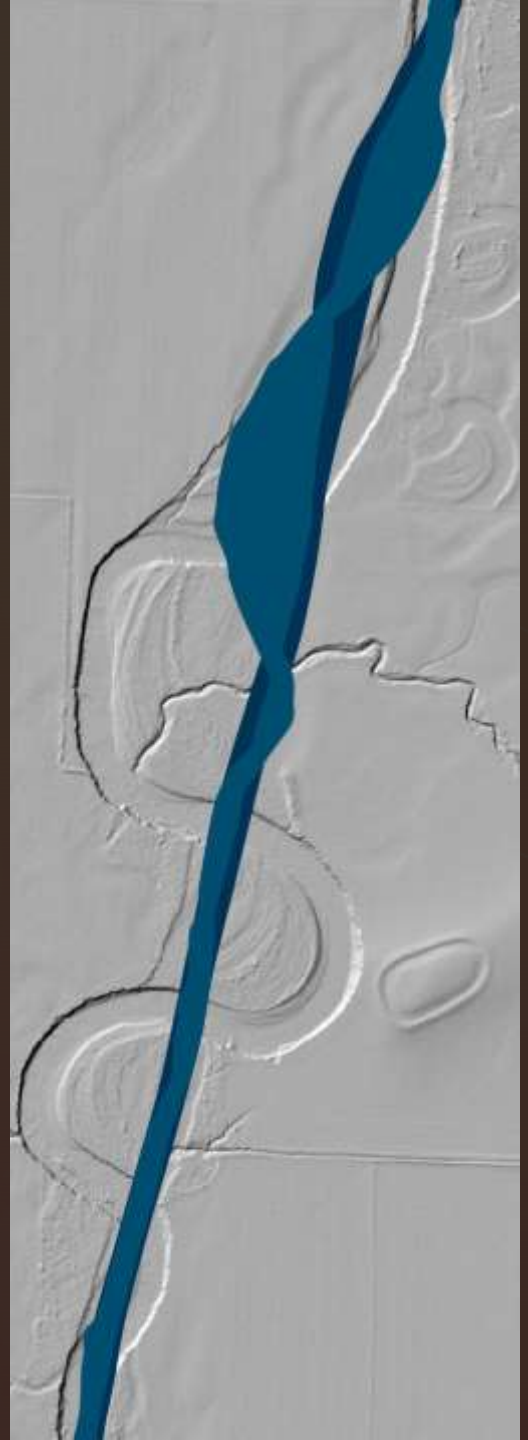
- General Land Office Survey Map & Notes. 1851
- Pottawattamie County Engineers Office & Drainage District Records
- Digitized channel centerlines and 7 landcover classes based on rectified historic and current aerial imagery in GIS
- Sampson, M. Stream Response to Channelization: West Nishnabotna, Pottawattamie County Iowa. U.S. Military Academy. 1991
- Quantified channel migration zone (Channel Migration Toolbox, 2014, Washington State Department of Ecology)
- Applied Iowa Flood Center Flood Inundation Risk Gradients (LiDAR data was used to create computer models of river flow Stream centerlines and topographic data are then used to calculate drainage areas, estimate stream flows, create computer models, and predict flood inundation)

1911-1938
Meander Zone



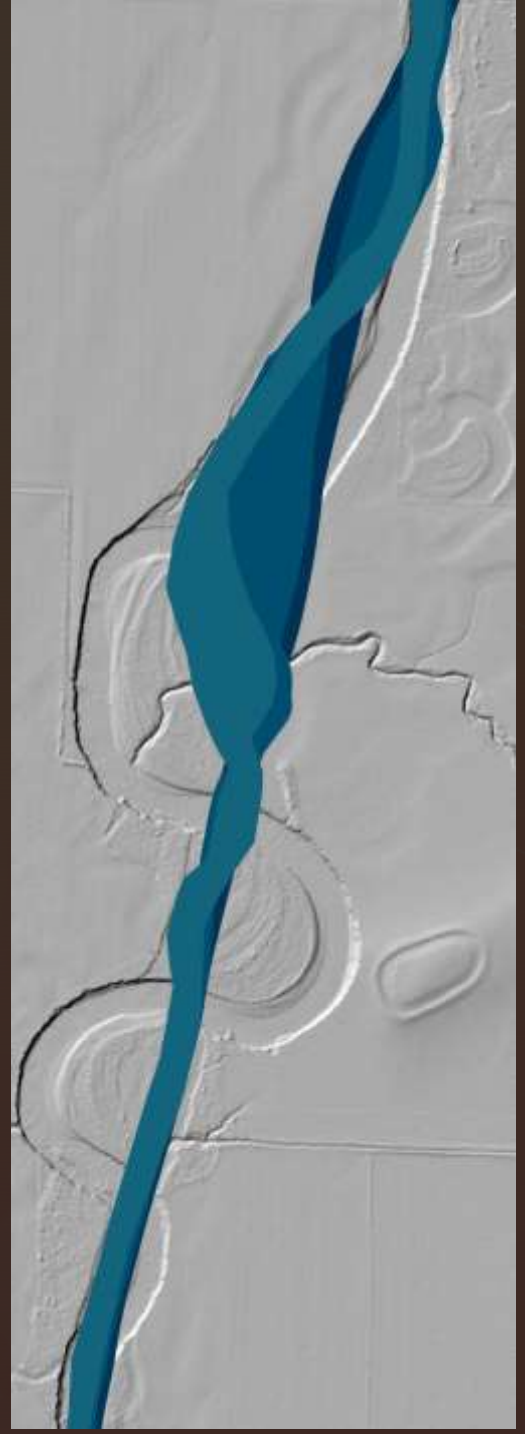
1911-1938
Meander Zone

- Channel length increase of 0.05 miles
- Meander zone = 285.3 acres



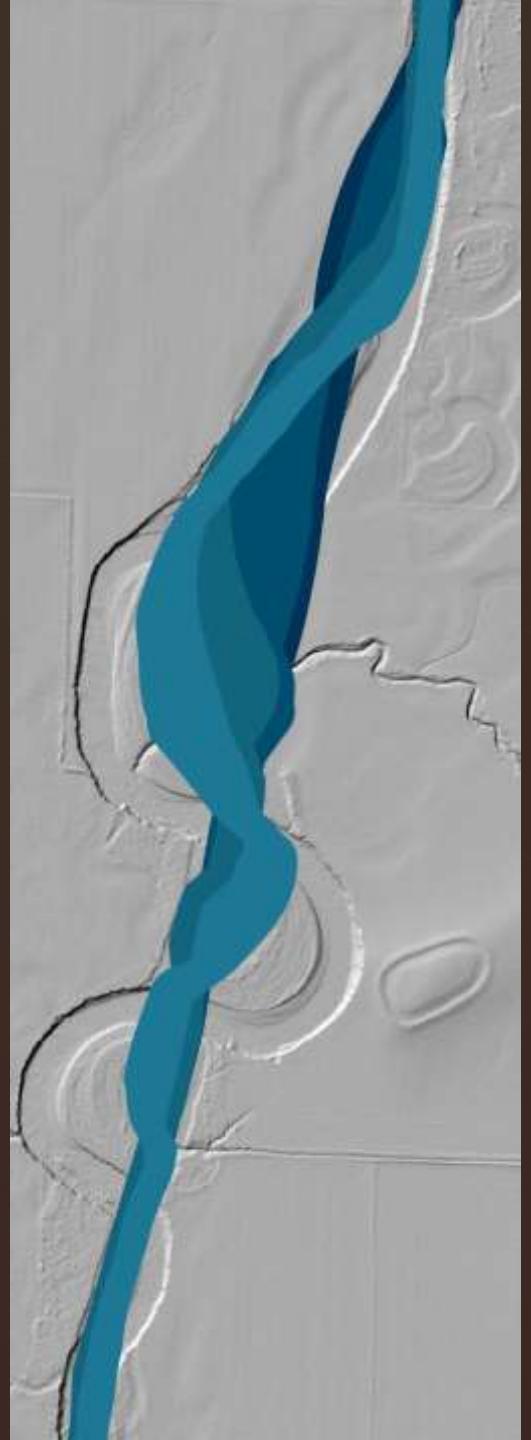
1938-1950
Meander Zone

- Channel length increase of 1.63 miles
- Meander zone = 509.5 acres



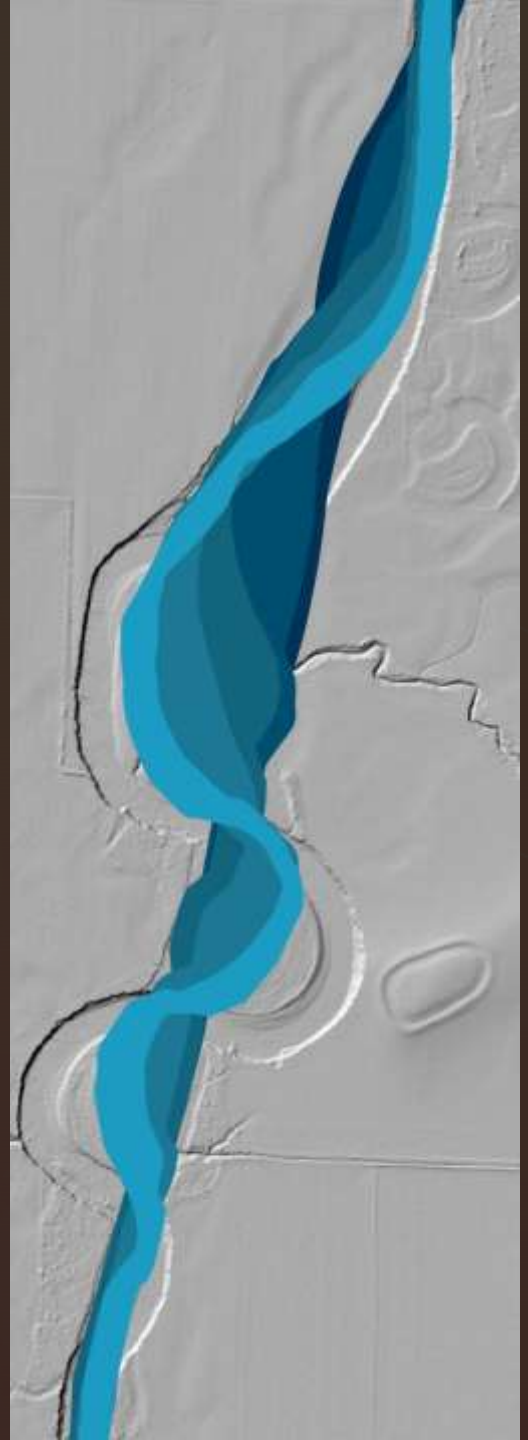
1950-1960
Meander Zone

- Channel length increase of 0.76 miles
- Meander zone = 349.3 acres



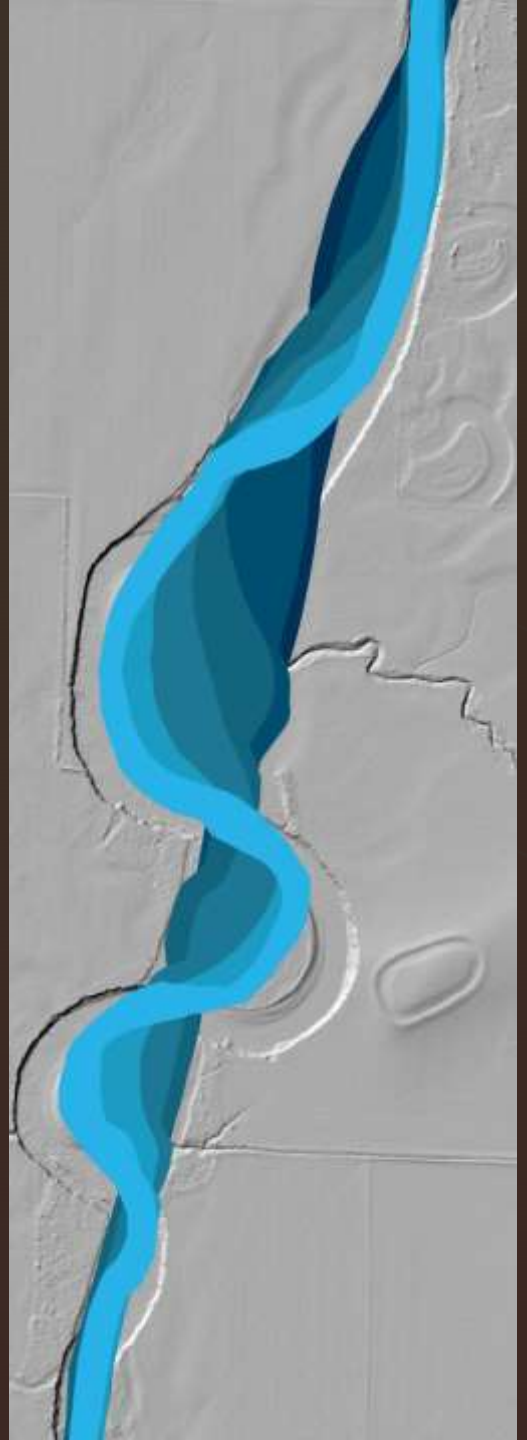
1960-1973
Meander Zone

- Channel length increase of 1.68 miles
- Meander zone = 463.1 acres



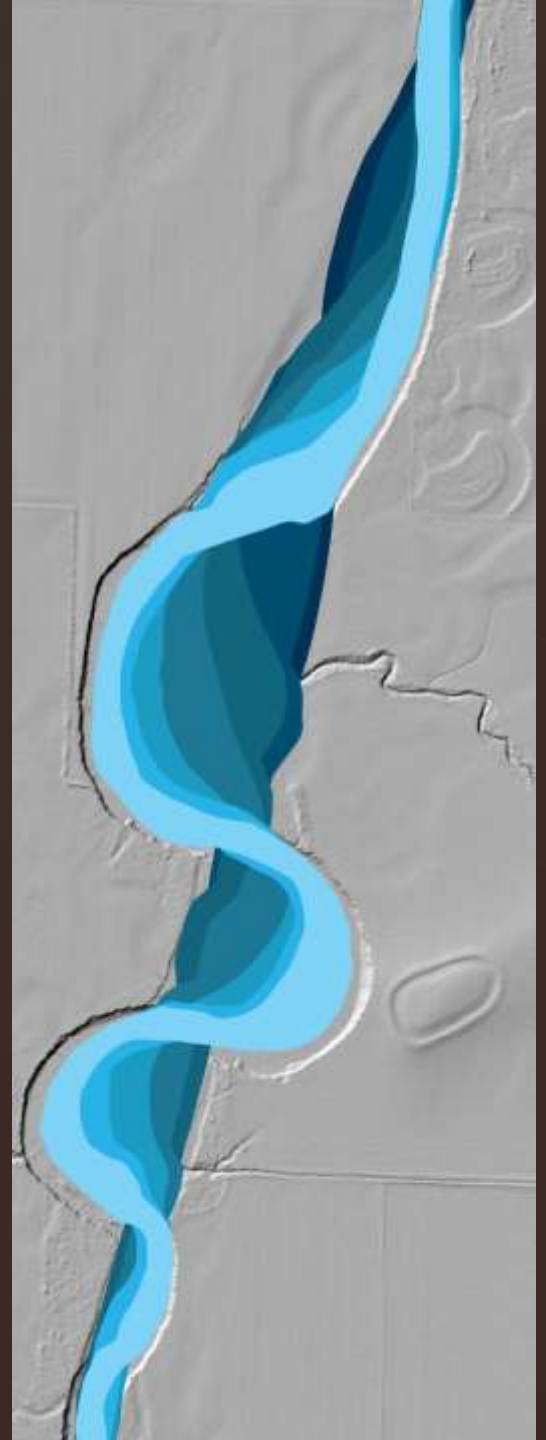
1973-1982
Meander Zone

- Channel length increase of 1.1 miles
- Meander zone = 280.8 acres



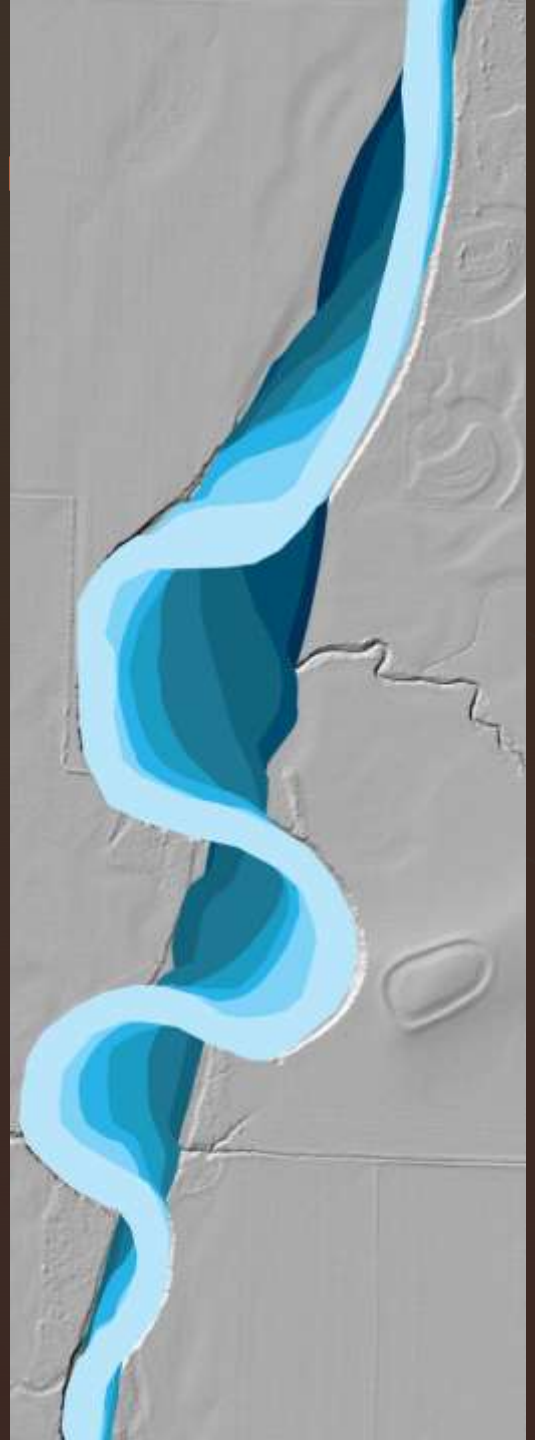
1982-1990
Meander Zone

- Channel length increase of 0.72 miles
- Meander zone = 334.1 acres



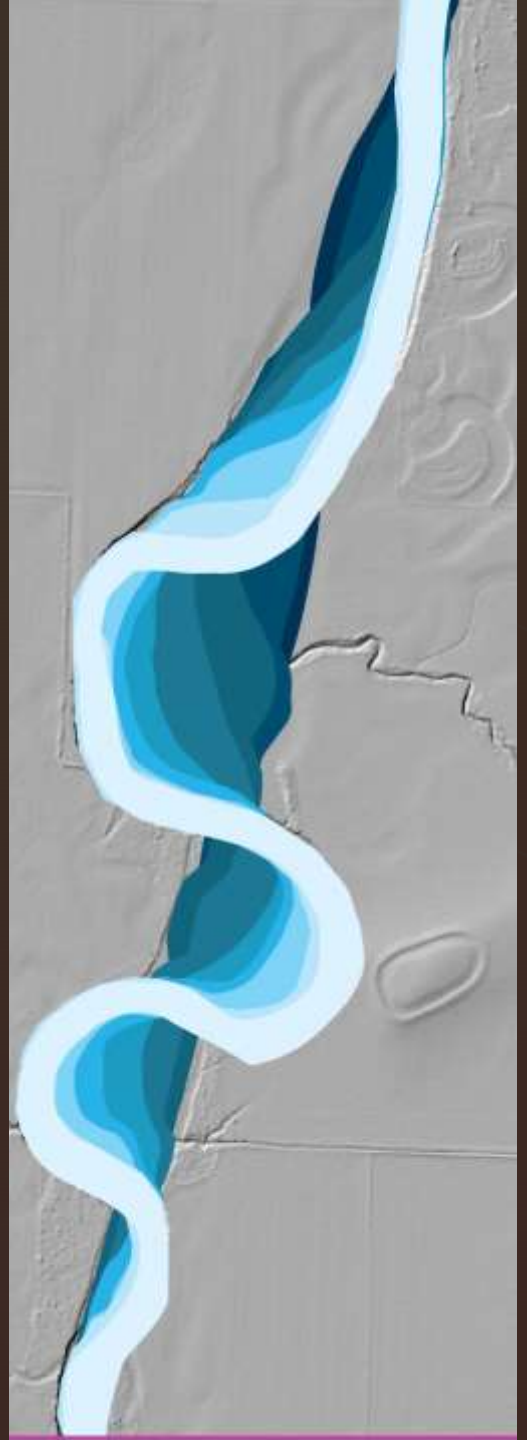
1990-2002
Meander Zone

- Channel length increase of 1.2 miles
- Meander zone = 389.6 acres



2002-2010
Meander Zone

- Channel length increase of 0.28 miles
- Meander zone = 433.7 acres



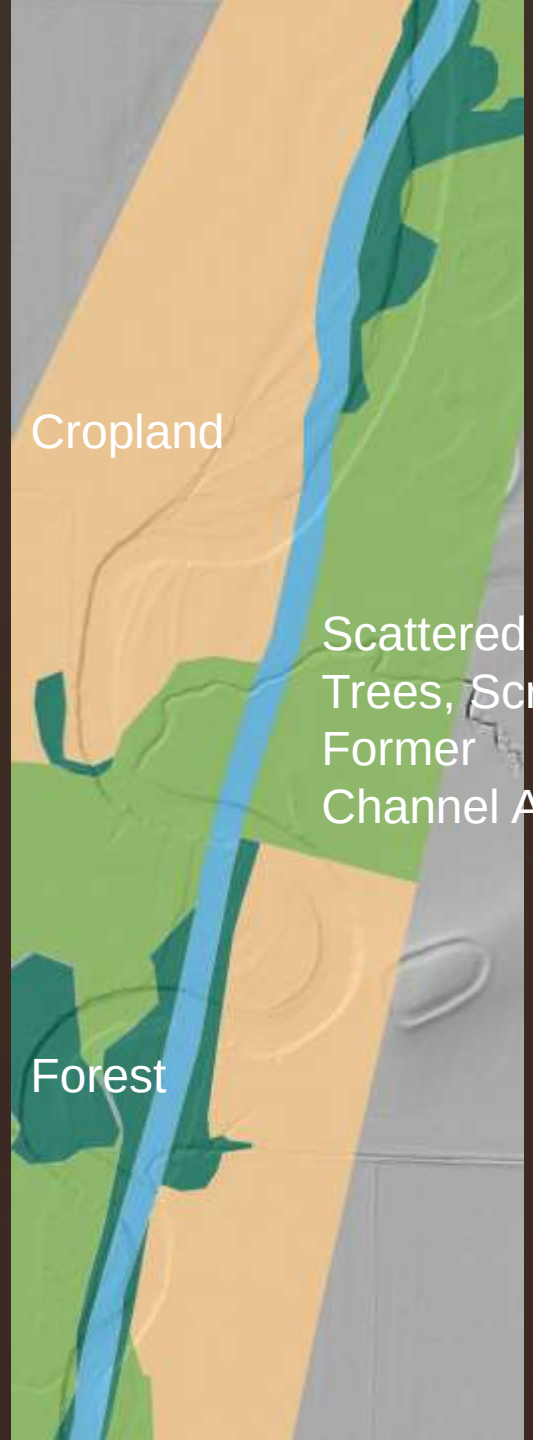
2010-2015 Meander Zone

- Channel length increase of 0.26 miles
- Meander zone = 427.7 acres

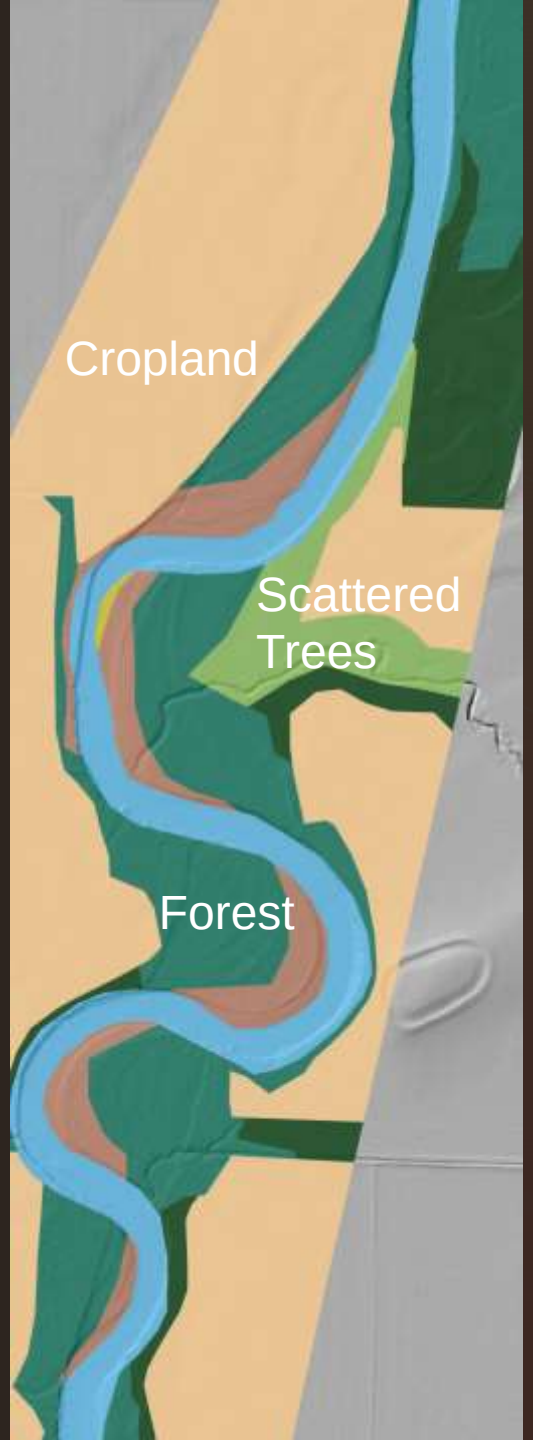
1911-2015 Meander Zone

- Total channel length increase of 7.7 miles
- Total meander zone = 1358.8 acres

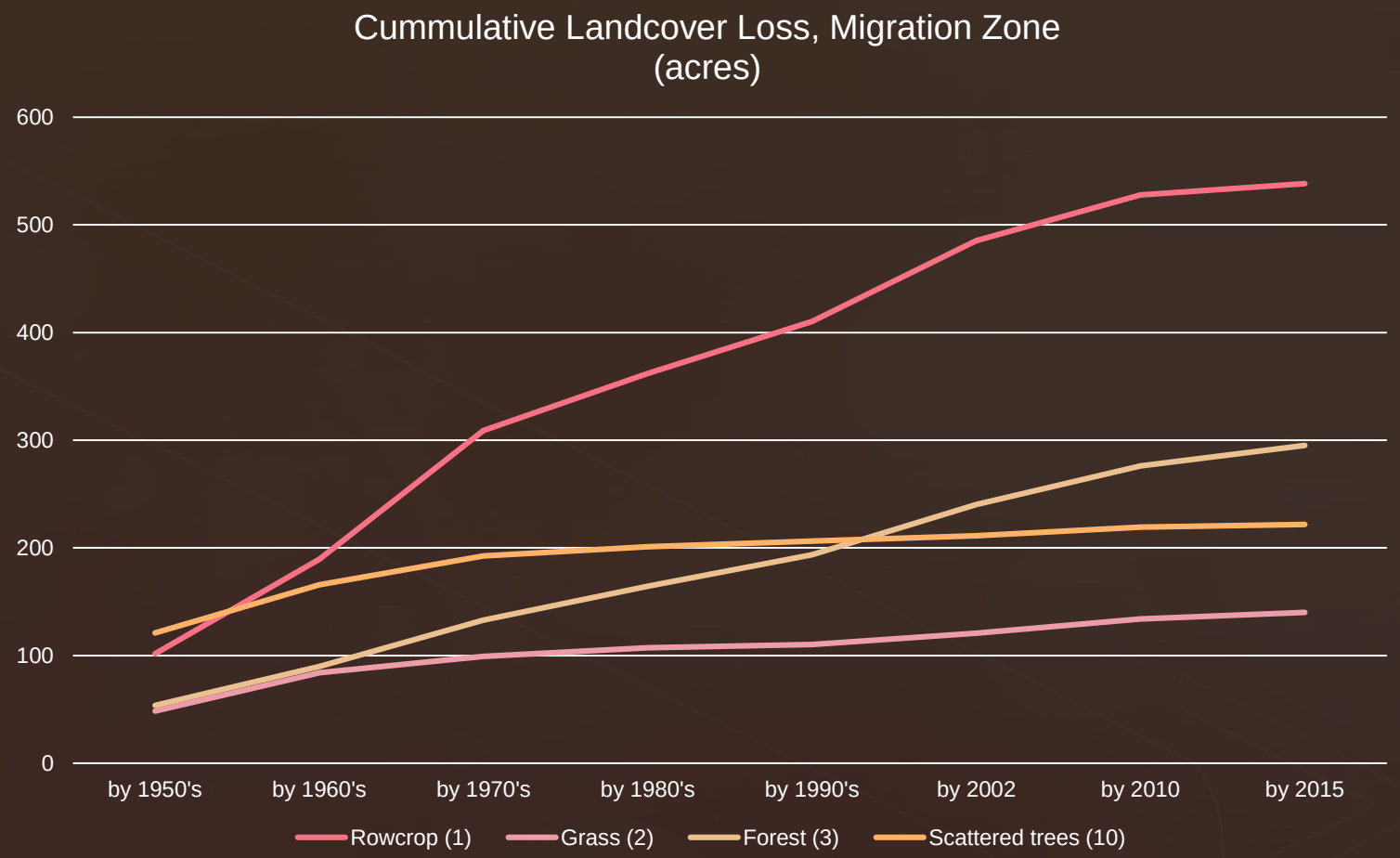
1938
Landcover Inside Meander Zone



1980
Landcover Inside Meander Zone

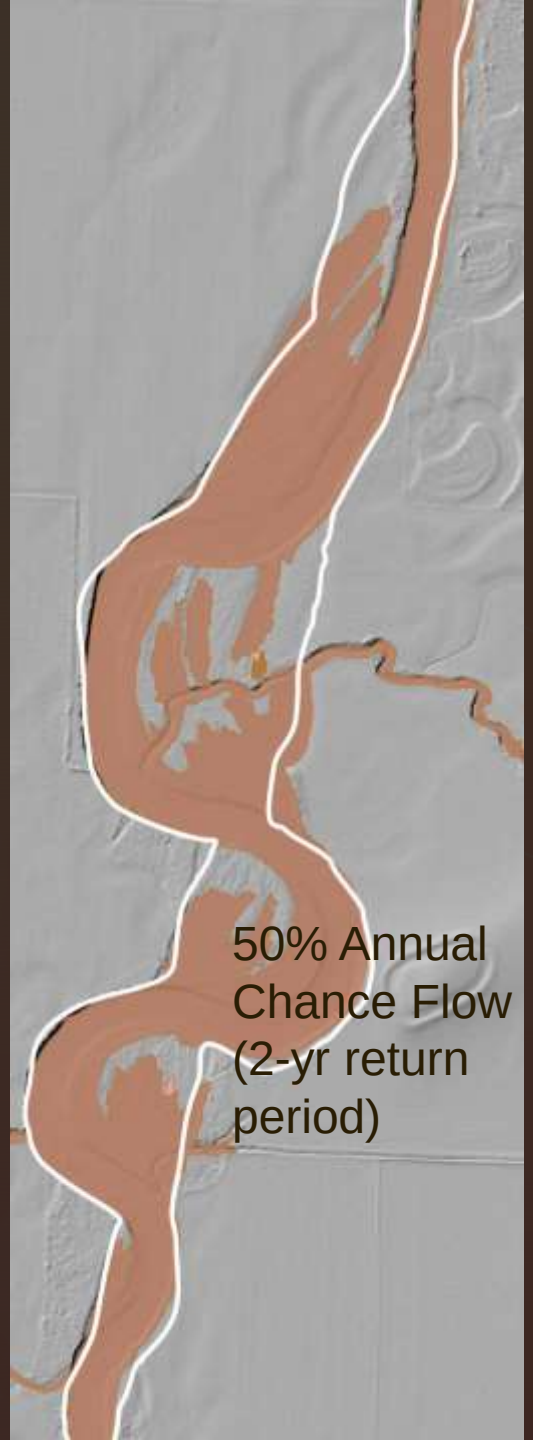


2015 Landcover Loss Inside Meander Zone



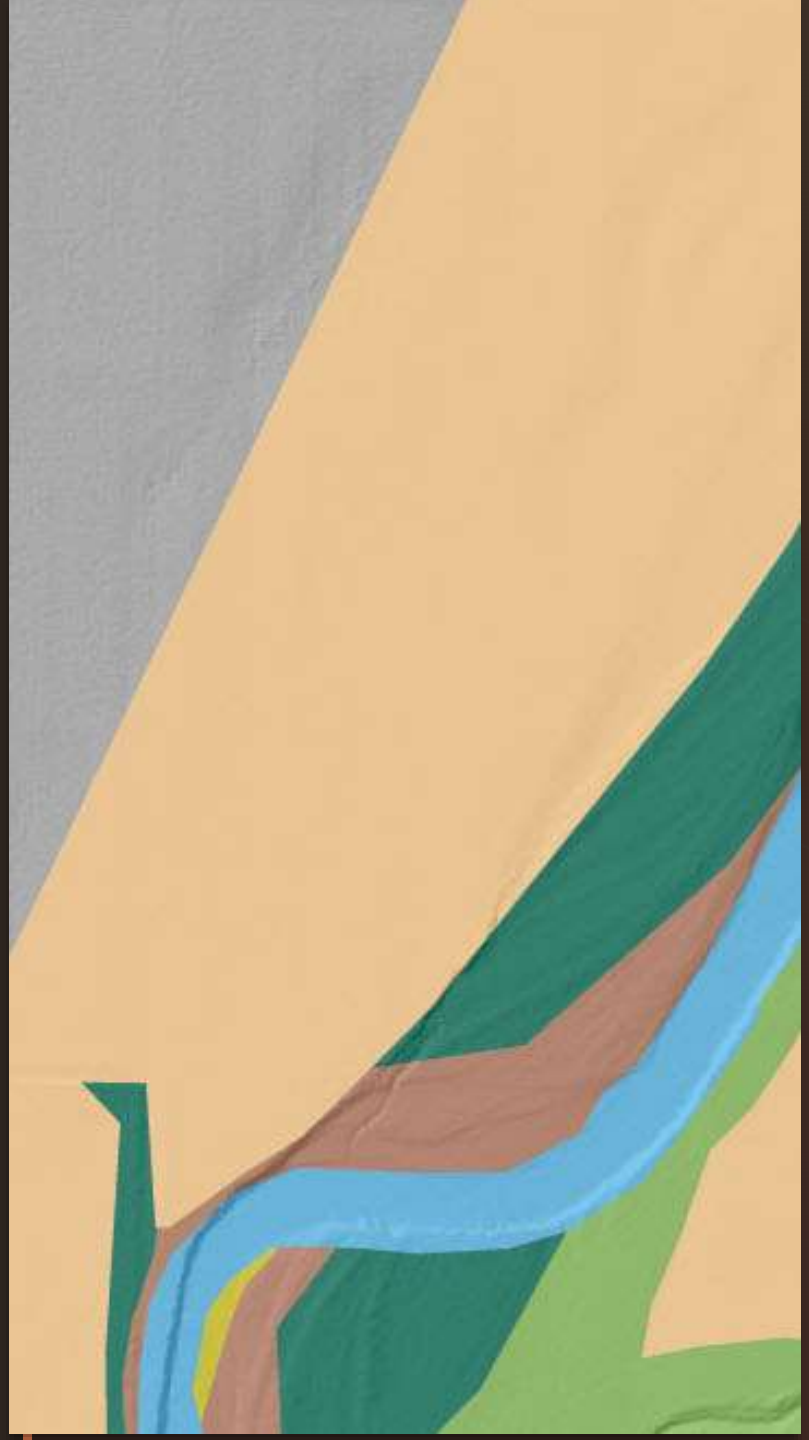
Meander Zone

- 538.4 acres of cropland lost to the meander zone between 1938 and 2015
- Only 10.4 acres have been returned to cultivation

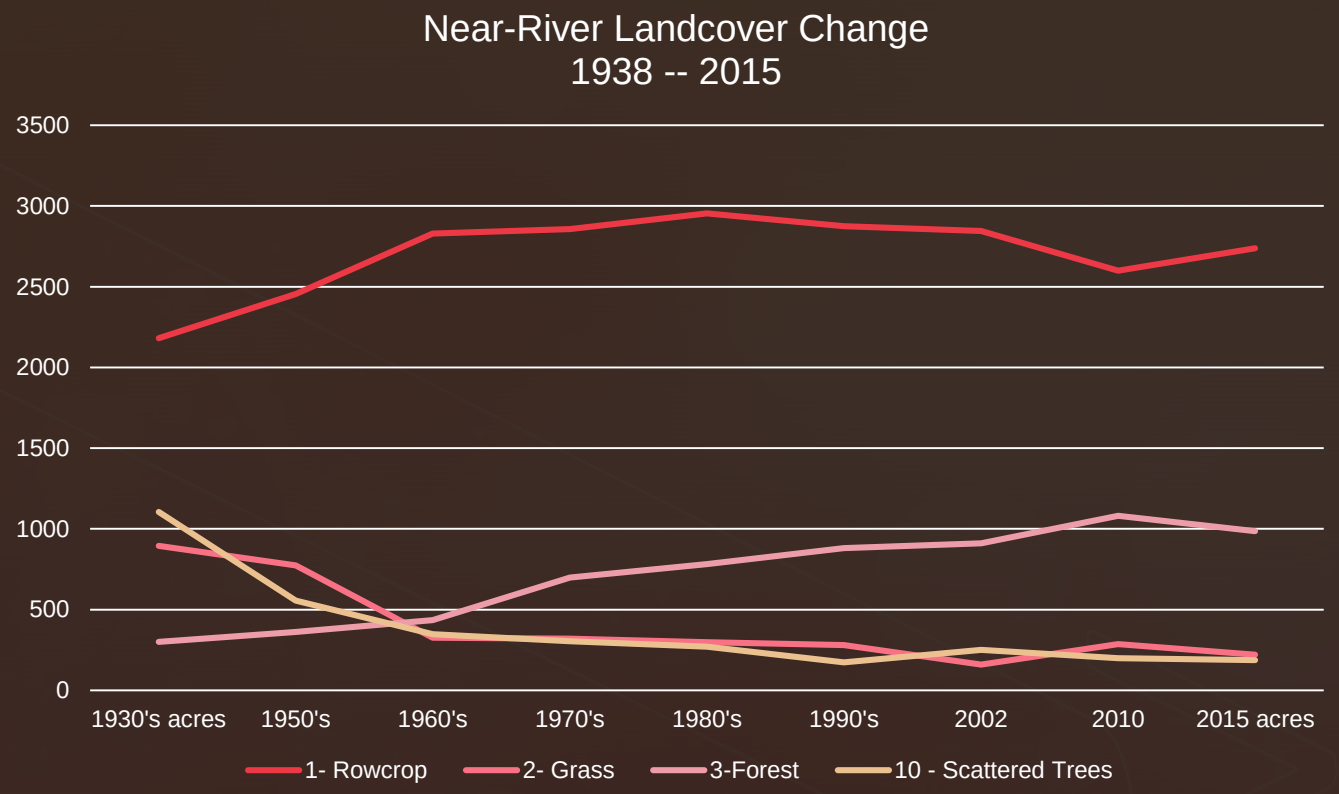


Meander Zone

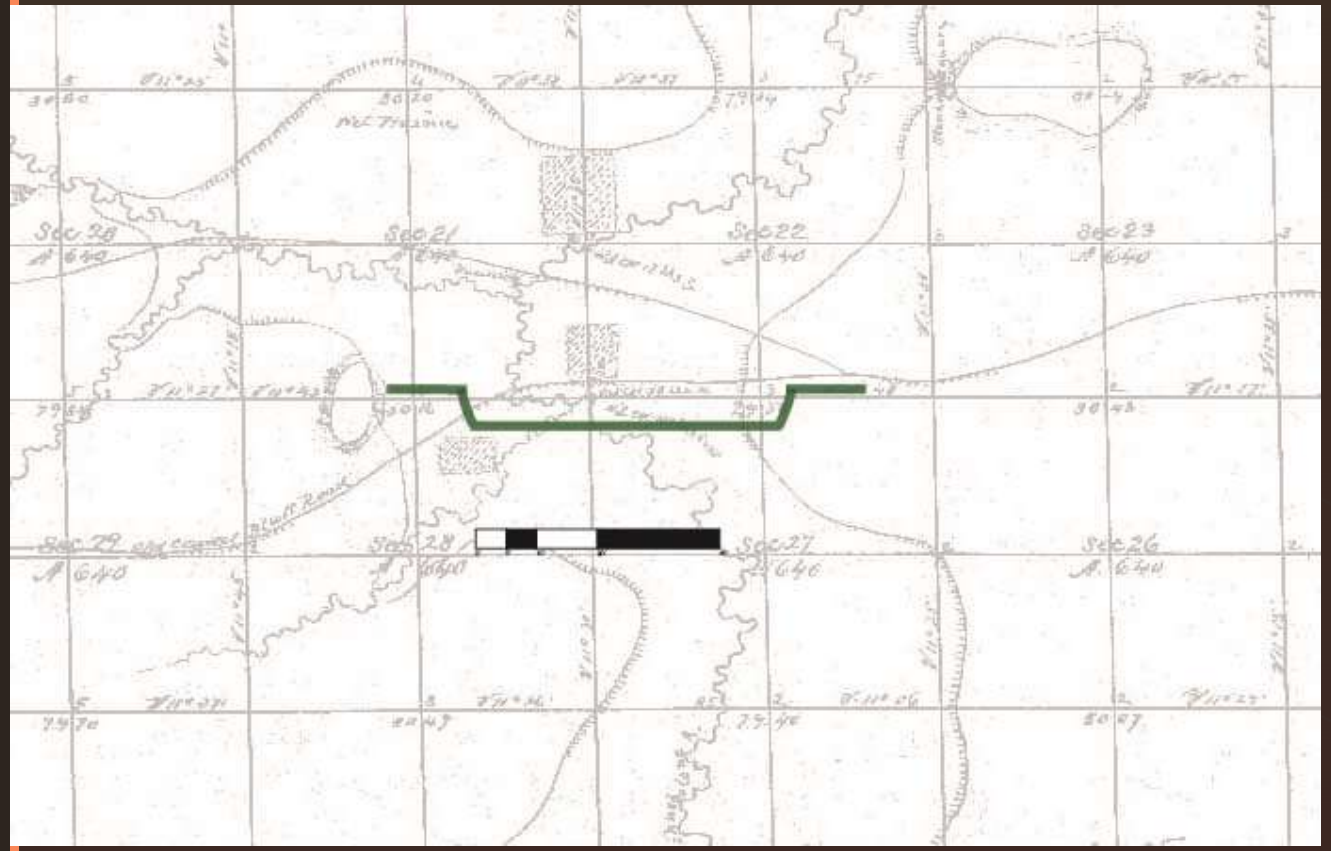
- Iowa Flood Center Flood Inundation Risk Gradients



1938-2015
Near-Channel Landcover

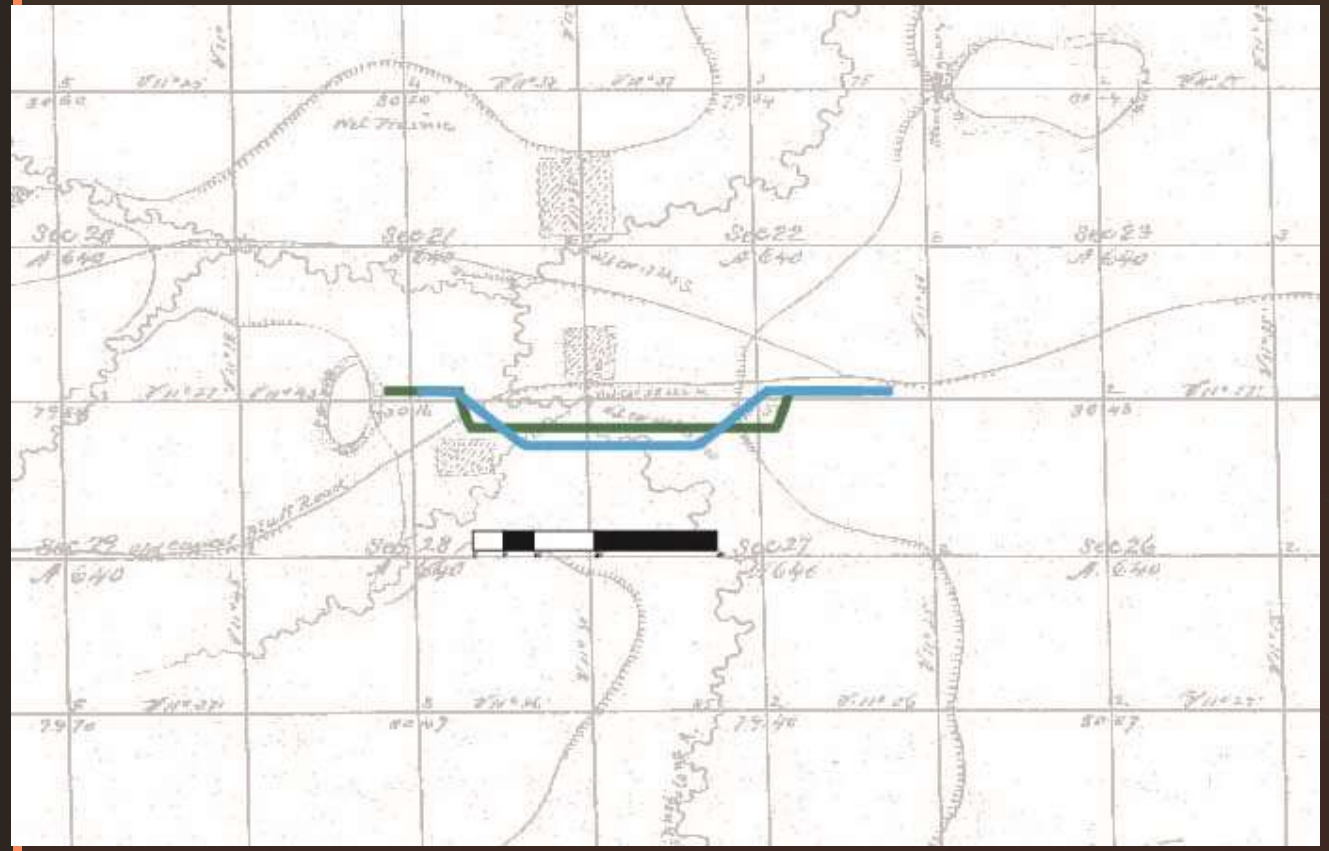


Channel Dimensions
1851 GLO Survey Notes



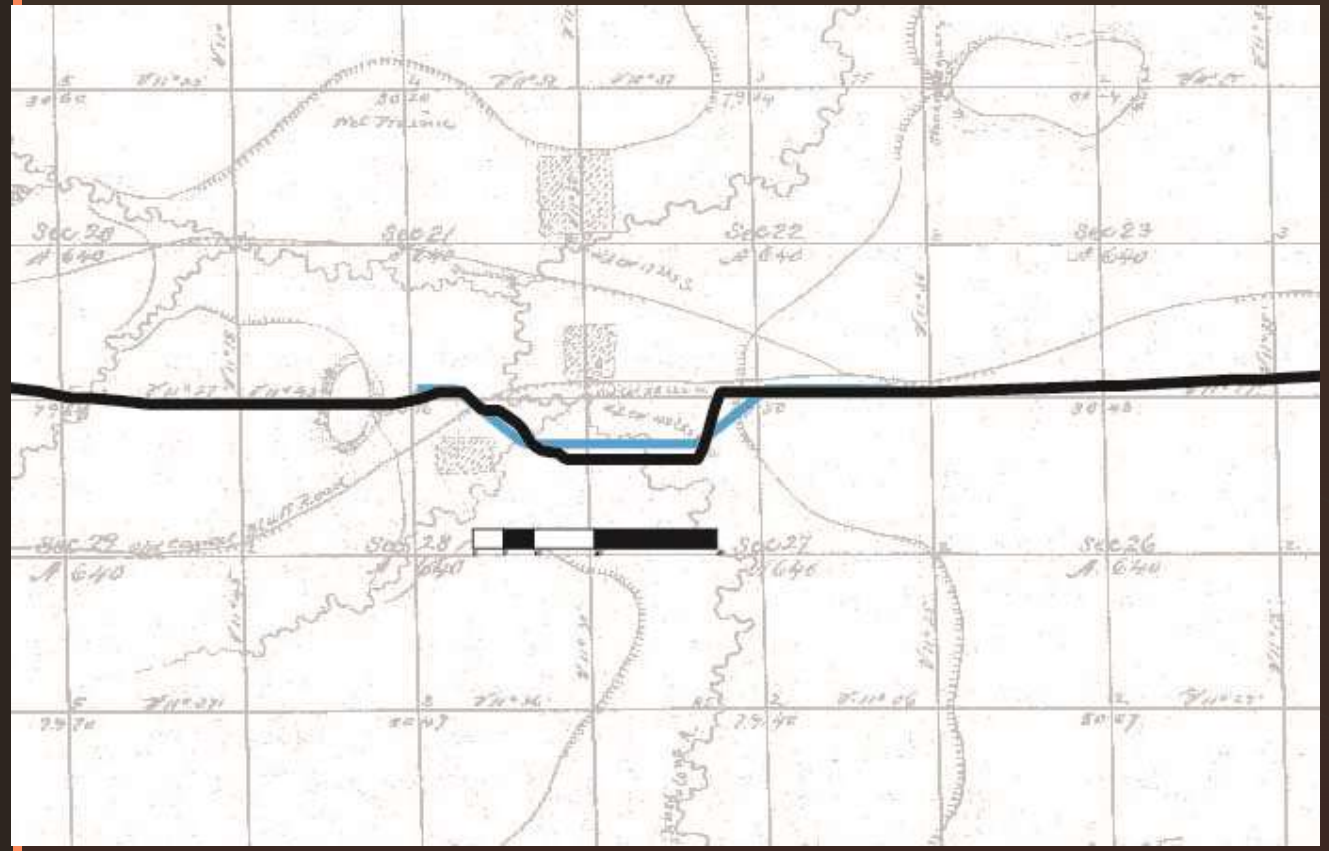
“Nishnabotna is the only stream of any size being from 60 to 90 links in width at an ordinary stage of water – with a sluggish current with few exceptions and flows its bottoms from 3 to 6 feet”

Channel Dimensions Engineered Ditch Section



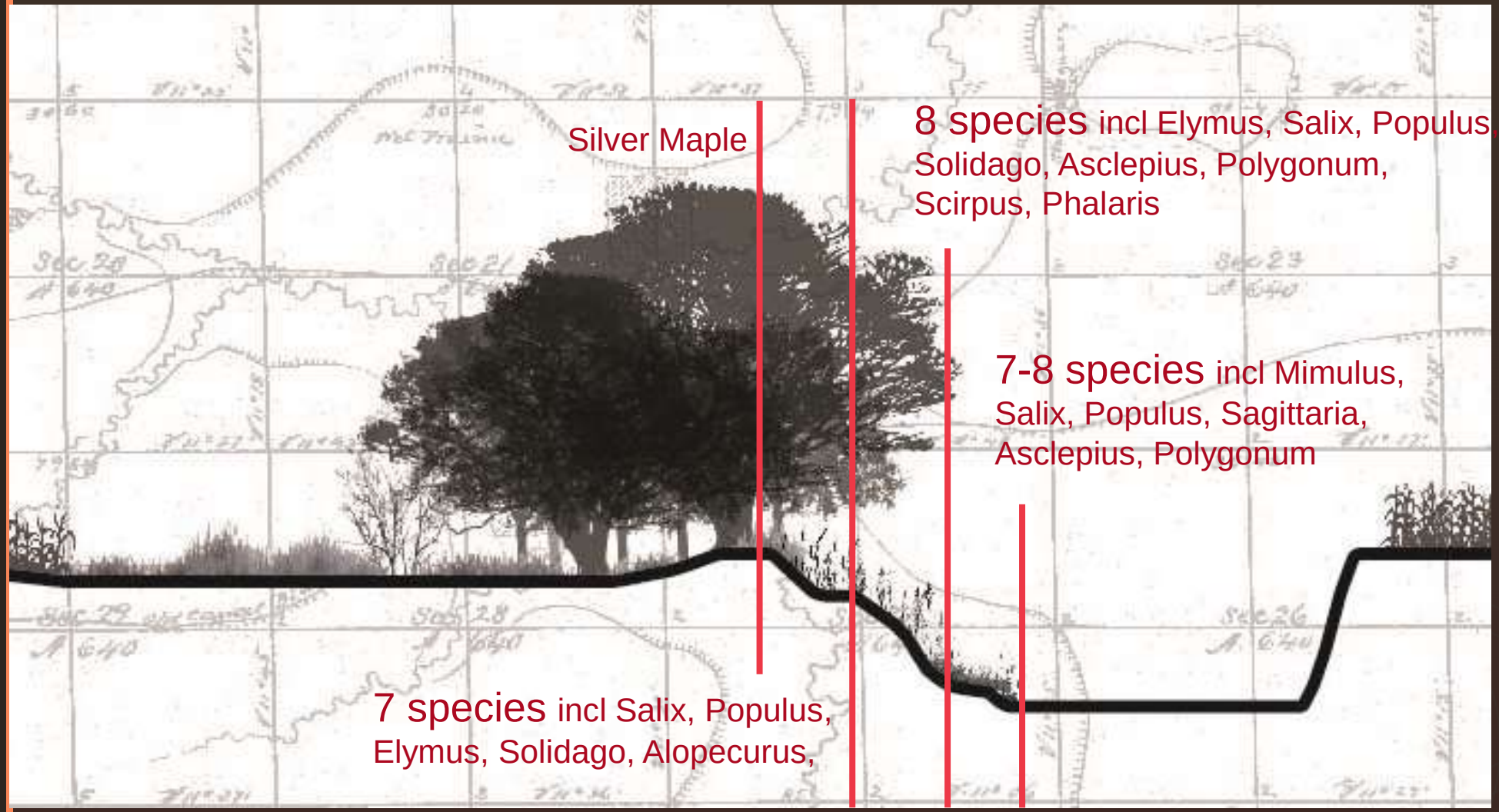
Channel designed as 20’ wide at its bottom and 9’ deep

Channel Dimensions 2010 Iowa LiDAR



- 60’ wide from top of bank to top of bank and 12’ deep

2017
Vegetation Transect



- Costs and to whom from lateral migration between 1911 and today
  - Nutrient and sediment load impacts downstream
  - Negative impact to downstream aquatic habitat impact
  - Loss of farmland to the current owner at time of erosion
  - Loss of tax revenue to county and state

- Public benefits of lateral migration compared to channelized condition:
  - Relatively recovered channel
  - Enormous gains in bankfull floodplain wetlands
  - Increased flood storage inside the channel area
  - Aquatic & terrestrial habitat diversity

Conclusions

- Unregulated soil loss in agricultural land uses
- Strong need for additional flood storage and wetland habitat
- Tax implications of eroding farmland (maybe?)
- Land value implications due to lost acres (is this significant due to ownership patterns?)
- With changing precipitation patterns, other vulnerable channelized rivers could also be impacted in the future (>additional 150 miles in Western 1/3 of Iowa)