Prioritization of strategies to reduce channel-derived sediment in the Minnesota River Basin

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UNIVERSITY OF MINNESOTA

Twin Cities • Duluth • Morris • Crookston • Rochester • Other Locations

The Problem

Minnesota River basin carries largest load of sediment & nutrients to Mississippi R

- Majority of sediment exported from basin is channel /near channel sources (about 2/3)
- Streamflow increases
- But how can we practically reduce channel erosion?
  - Watershed vs. in-stream
- Where to prioritize
  - by load, sediment delivery rate
- Cost issues

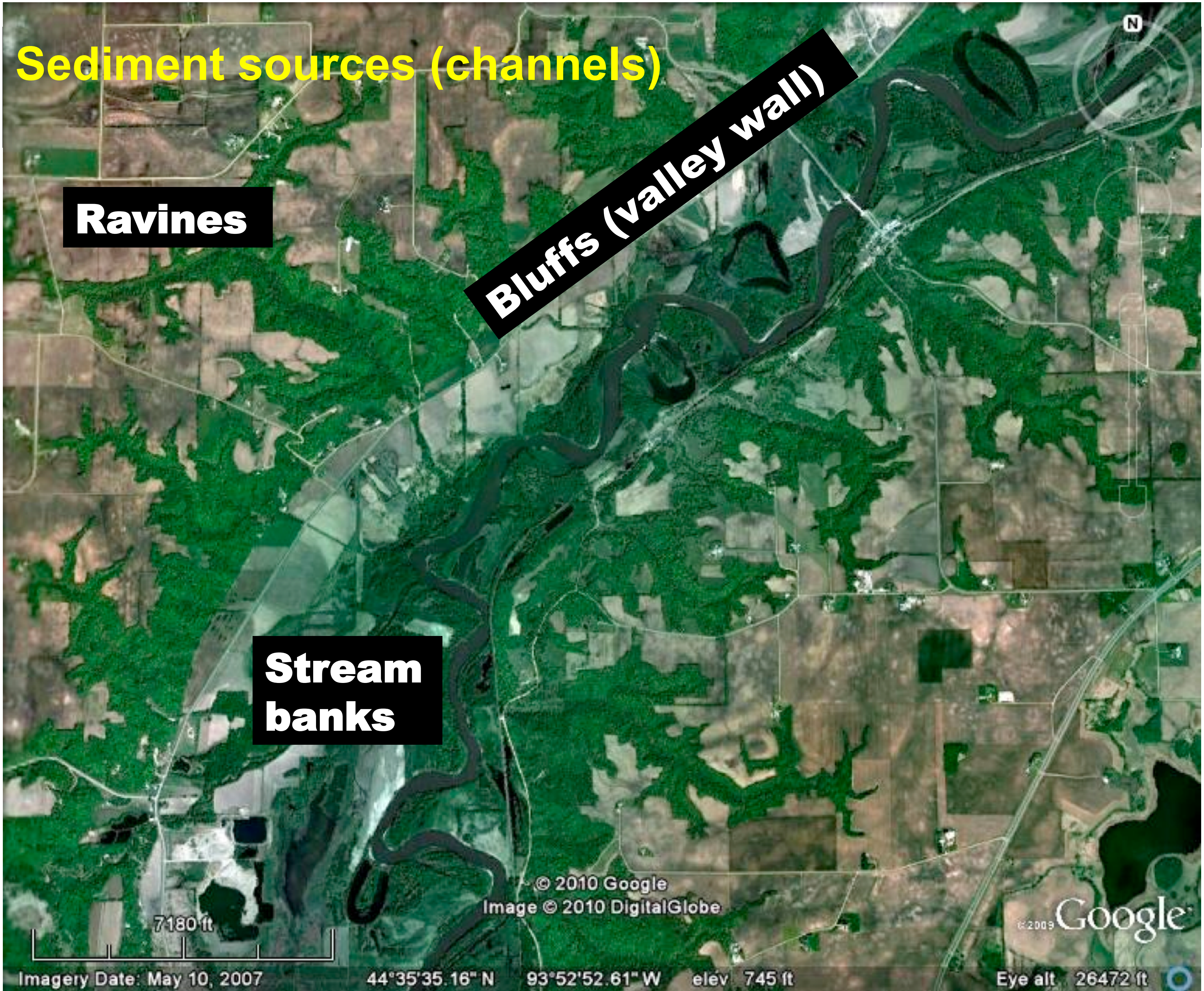
MN River near its mouth

McKnight Foundation Study on MN River Basin

Project Components

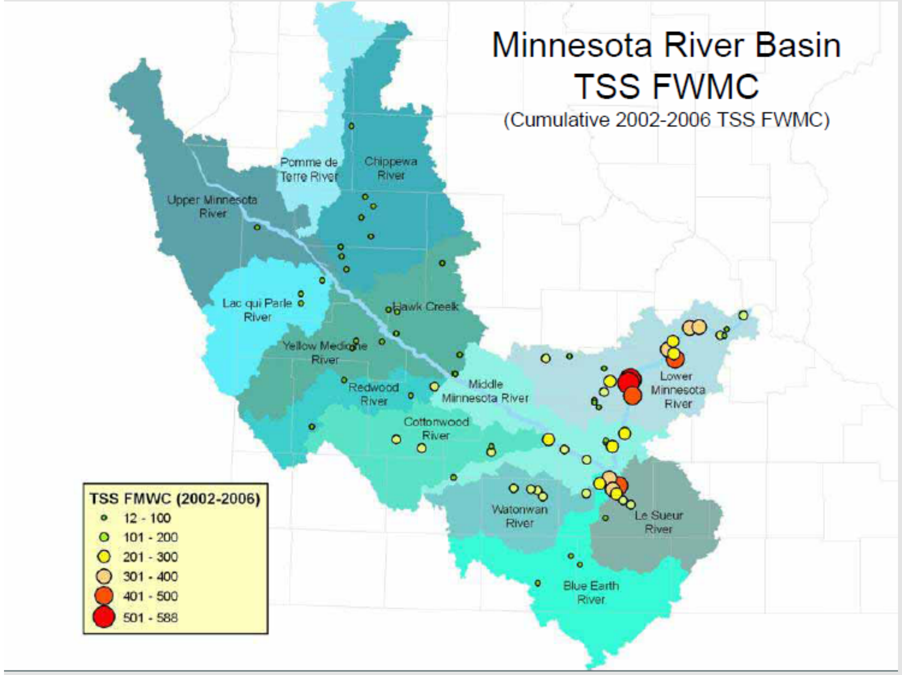
- Synthesis of existing data (MPCA RBS study, Corn Growers Lower MN River Study)
- Cost-benefit data
- Landowner meetings
- Case studies
- Identification of cost-effective riparian BMPs

Sediment sources (channels)



Sediment loading – bluffs and deposition

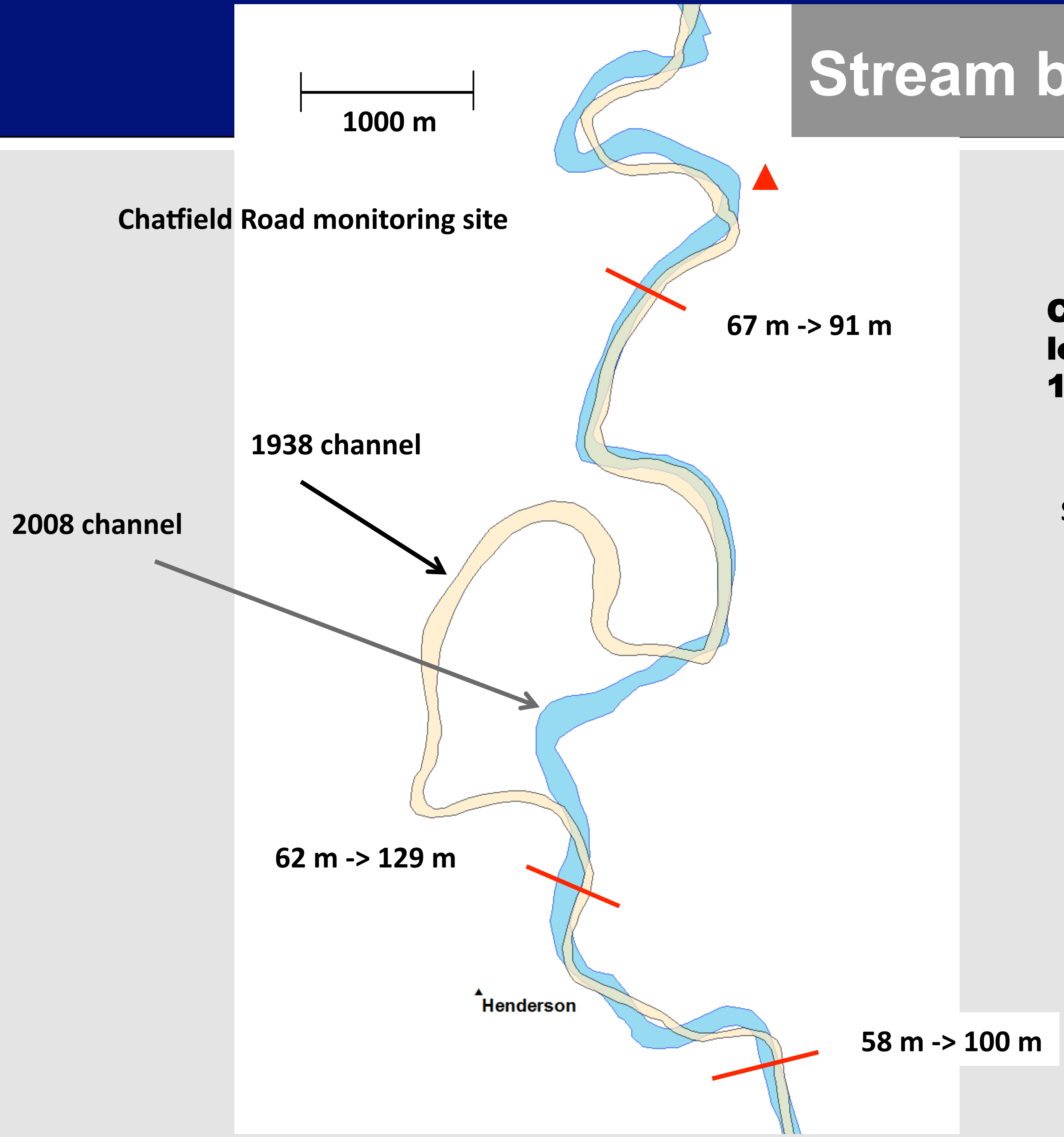
Bluff loading



Sediment deposited in lower MN valley

MPCA-Scott Matteson

Stream bank erosion

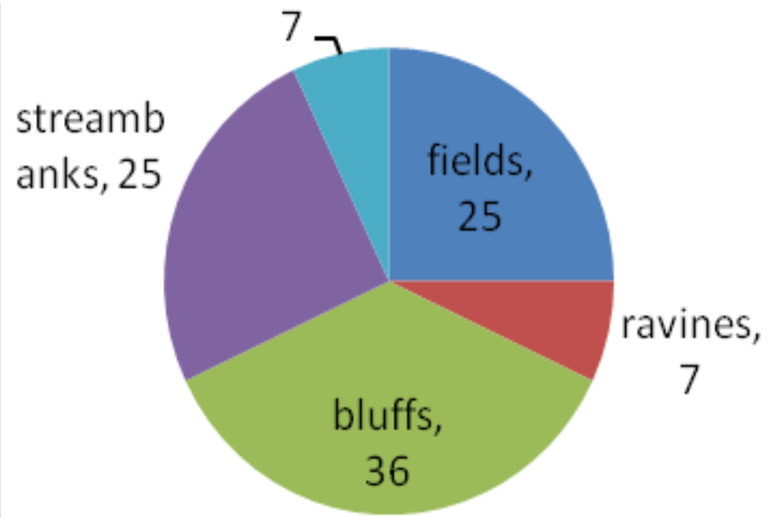


Channel Widening- lower MN River 1938-2009

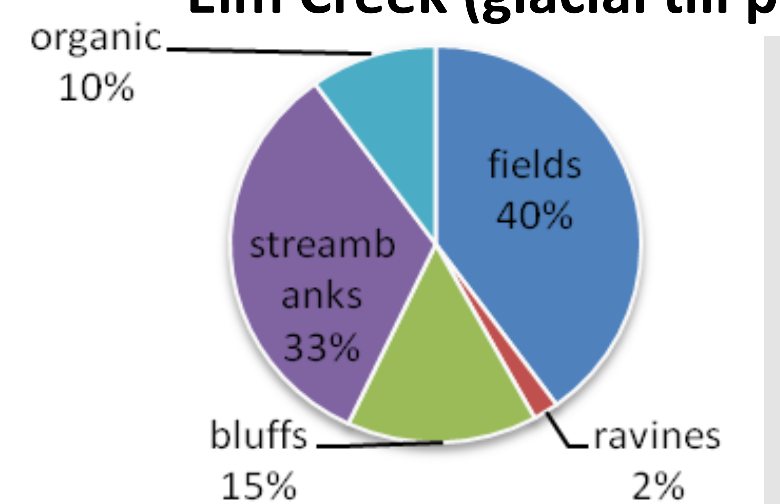
Supplies 100'000s of tons/ year

Sediment sources by region

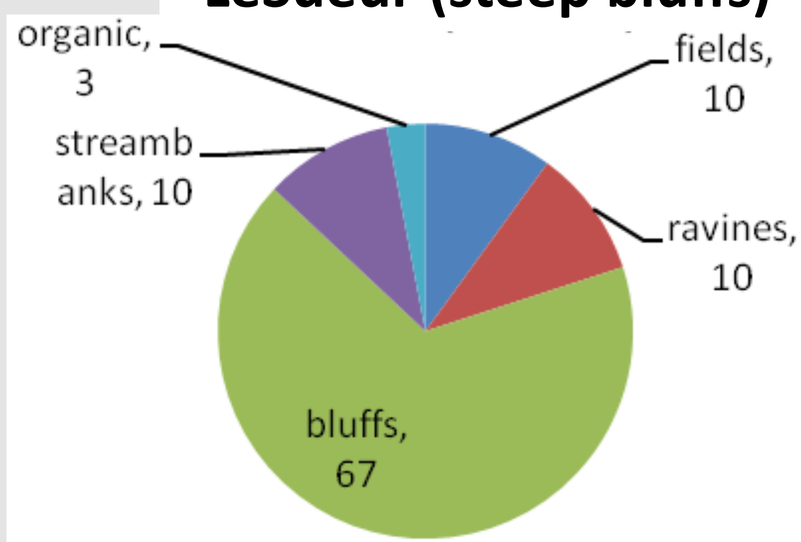
Minnesota main channel



Elm Creek (glacial till plain)



LeSueur (steep bluffs)



Where to start? Pros and cons of watershed vs. channel actions:

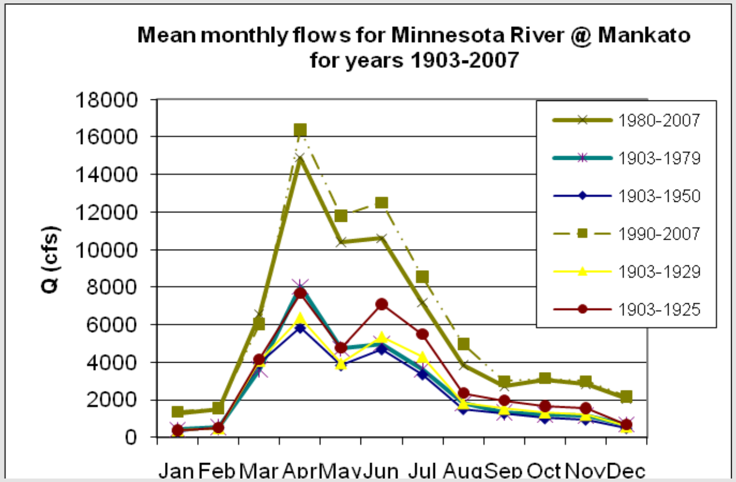
Watershed

+Addresses causes

+Ag. sustainability

-Hydrologic storage difficult to find

-Lag time



Channels

+High sed. delivery ratio

+Reduce loss of farmland

+Ecological restoration potential

+Aesthetics/recreation

-Expensive

-May only address symptoms

Watershed management issues

- 85% row crops
- High crop prices & land values
- Few storage opps in uplands

LANDCOVER	ACRES	PERCENT
Corn	934,781.23	45.63%
Soybean	783,218.02	38.23%
Spring Wheat	672.63	0.03%
Winter Wheat	22.47	0.00%
Rye	72.84	0.00%
Oats	184.43	0.01%
Alfalfa	5,562.39	0.27%
Beets	304.54	0.01%
Potatoes	18.60	0.00%
Peas	3,607.26	0.18%
Grassland	41,056.94	2.00%
Woodland	57,978.92	2.83%
Shrubland	6.20	0.00%
Baren	264.25	0.01%
Developed	152,958.85	7.47%
Water	35,805.29	1.75%
Wetland	32,153.86	1.57%
Total	2,048,668.75	100.00%

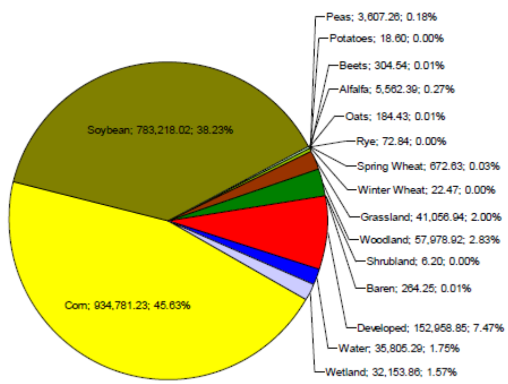
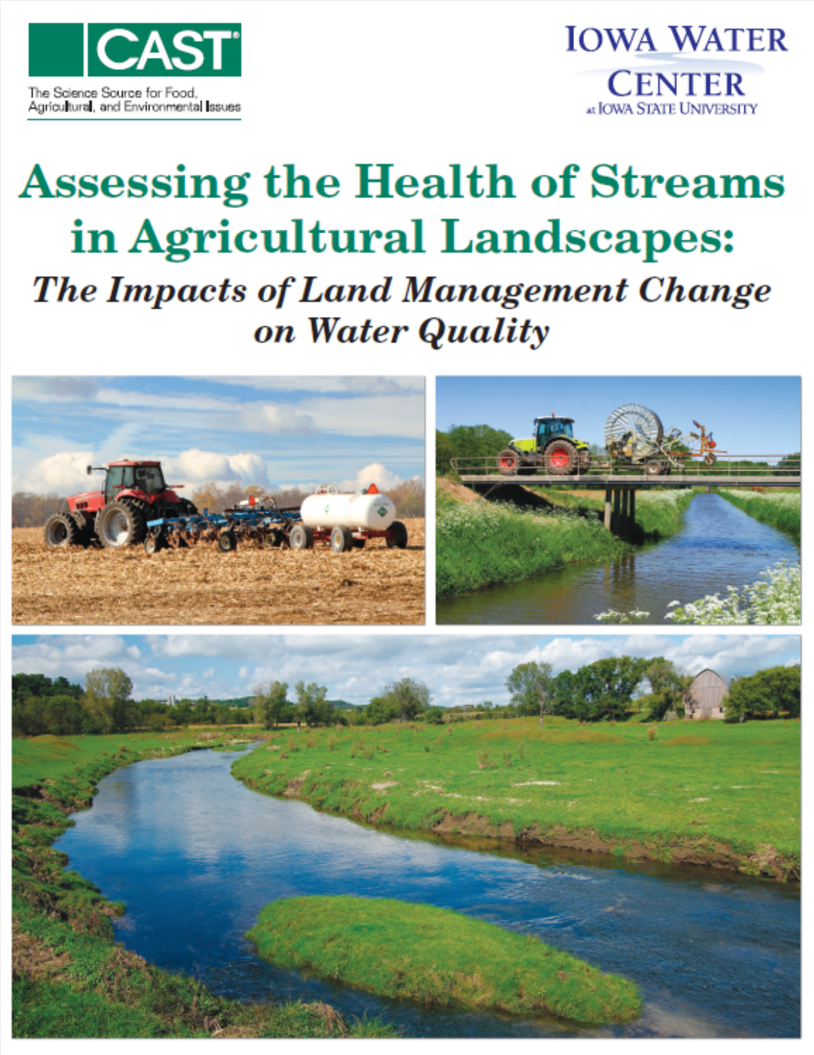


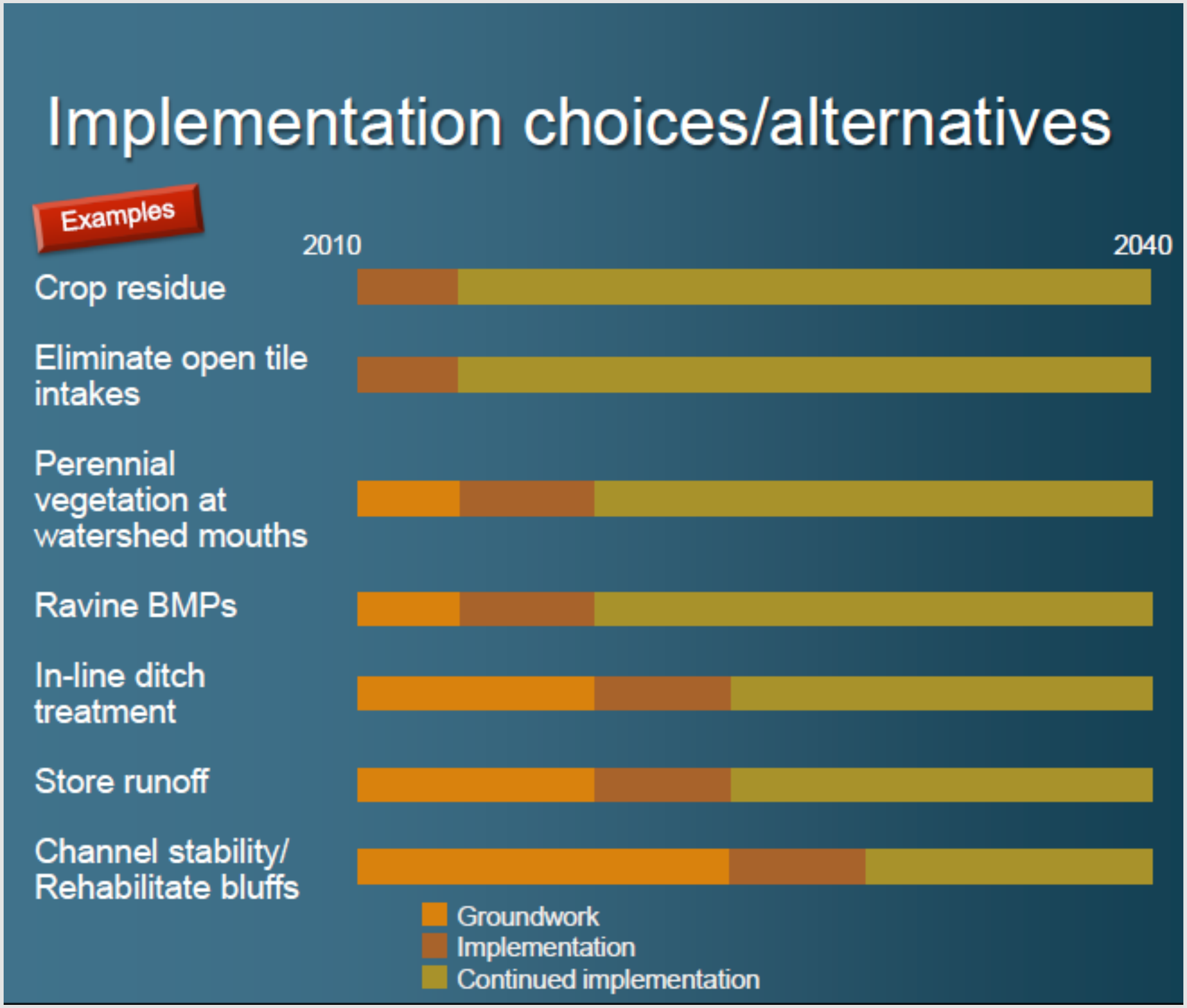
Figure 5.28: 2006 Land Use Statistics for the Blue Earth River; LeSueur R to Minnesota R.

Time lag for WQ response in large watersheds

- **MN River basin may take decades**
- **Other large muddy, Midwestern Rivers – Illinois and Maumee, Ohio**
- **Smaller basins respond more quickly**



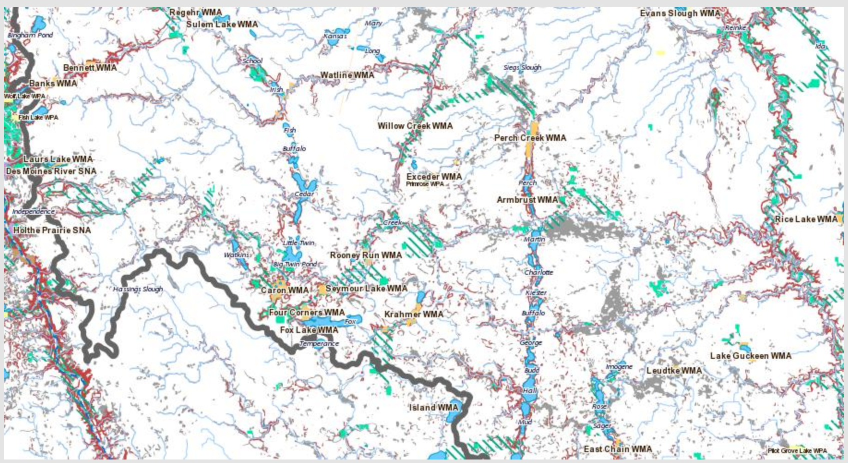
MPCA prioritization – fields first, then targeted channel sites



Larry Gunderson, MPCA

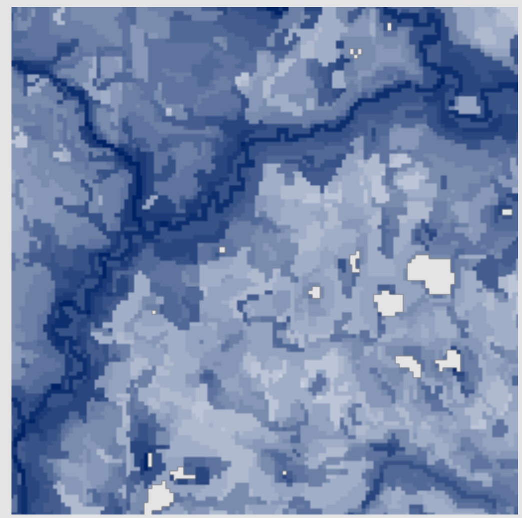
Other strategies

Riparian corridors and “marginal lands” in Blue Earth Basin



Lansing Shepard and Paula Westmoreland *This Perennial Land*

Environmental Benefit Index- BWSR (Mulla)



“Water quality risk” on Mn river

Alternative MN River strategy

Short term

- Focus on riparian corridor where implementation is possible
- Focus on smaller watersheds where WQ improvements can be seen (esp. sentinel watersheds)

Long-term

- MN Basin hydrologic change requires policy shift
  - Change Farm Bill
  - Change economic incentives

Prioritization strategy

Strategy

1. Identify largest sources of channel sediment and Location of sediment sources,
2. Characterize types of sediment (particle size, structure, etc) and delivery ratio
3. Identify major sediment impacts on in-stream biota
4. Weight priorities: biota, sediment, infrastructure, etc. for management
5. **Characterize restorability based on logistical, social, economic and technical criteria (Norton et al.)**

Issues

Net vs. local sediment impacts

IBI vs. turbidity TMDLs

Restorability issues: Cost /benefit of channel stabilization

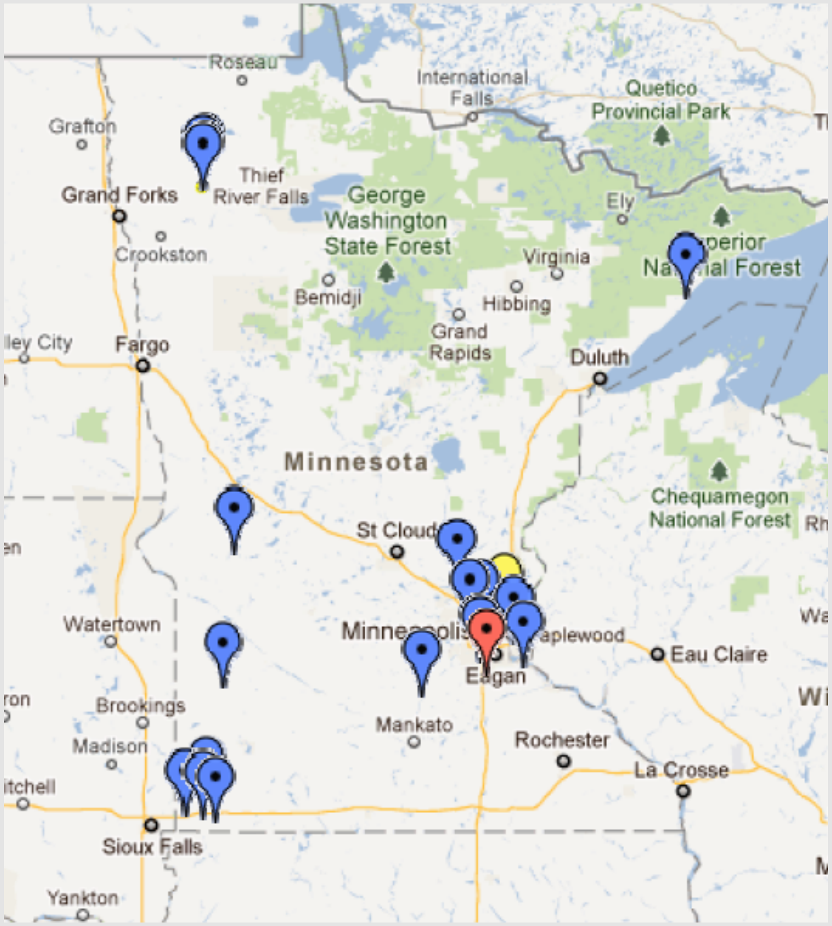
Cost Data

57 projects (34 projects full data)

- $125/linear foot
- $10,000 fixed cost
- Median project cost $25,000 (Avg. $76,000)

- Some Twin Cities projects >$1 million
- Cost-prohibitive for large-scale use

Locations



Examples from BWSR Fact Sheets

Fact sheet benefits

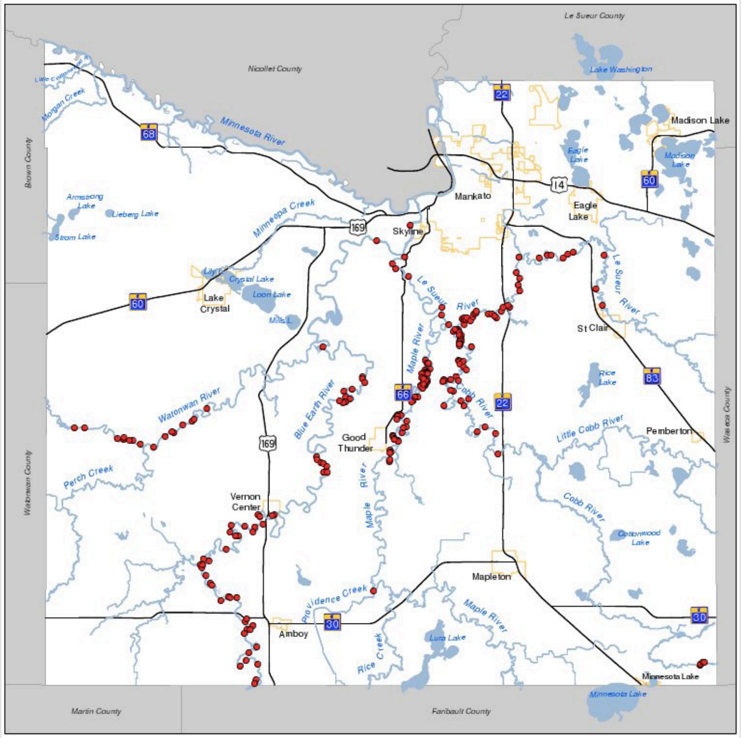
- Estimated 5.5 tons/year sediment reduction
- Removal of invasives
- Correction of broken stormwater outlet

Yelllow Medicine, Lyon County. $73,000; 2400 ft.

Blue Earth County Bluffs

Part of "Hazard Mitigation Plan"

Potential Stream Channel Stabilization Design Projects



Improving the cost/benefit ratio

What brings costs down?

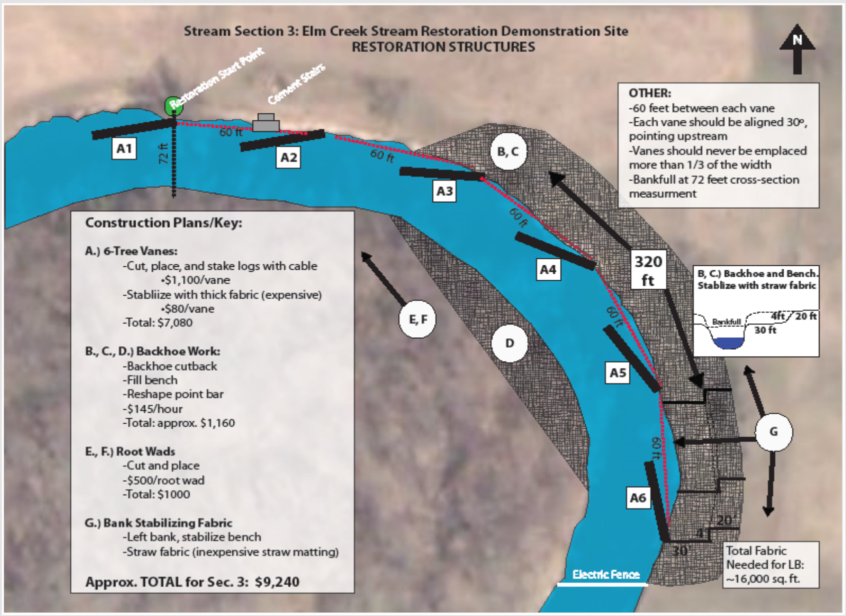
- Use of local materials
- Wood over rock
- Proximity to roads for access
- Leveraging $$$
- Planning ahead

What drives costs up?

- Urban, infrastructure
- Rock (rip rap and vanes)
- Relocating channel
- Consulting fees or lack of local training
- Historic structures

Use of low-cost, local wood instead of rock

Wood in place of rock



Wood harvested on-site

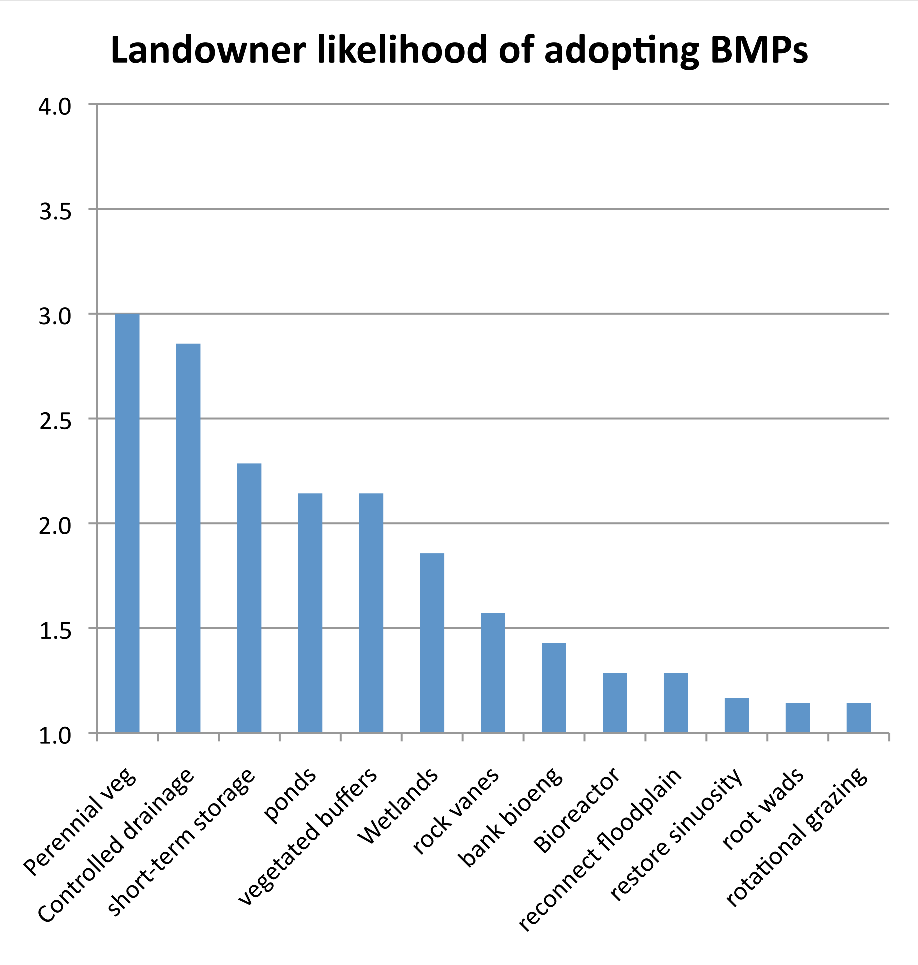
Cost benefit research – need for quantification of ecological services

- Reduced farmland loss
- Sediment, nutrient loss reduction (TMDLs)
- Aesthetics
- Recreation/access to river on reduced slopes

Restorability issues: landowner perspectives

Questions

- Landowners' definition of problem
- Criteria for solutions
- A list of the most acceptable solutions
- A matrix evaluating the solutions
- Individual answers to questionnaire.



General strategies by by region

Geomorphic region	Actions
• Western till plains / prairie potholes	• Wetlands, flow reduction; Streambanks
• Bluff country – LeSueur and Blue Earth	• Targeted bluffs, > x tons/year and/or threatening roads, etc.
• Lower Minnesota River	• Targeted streambanks, >y tons/year and/or threatening roads, etc.

General strategies/policies

Bluffs

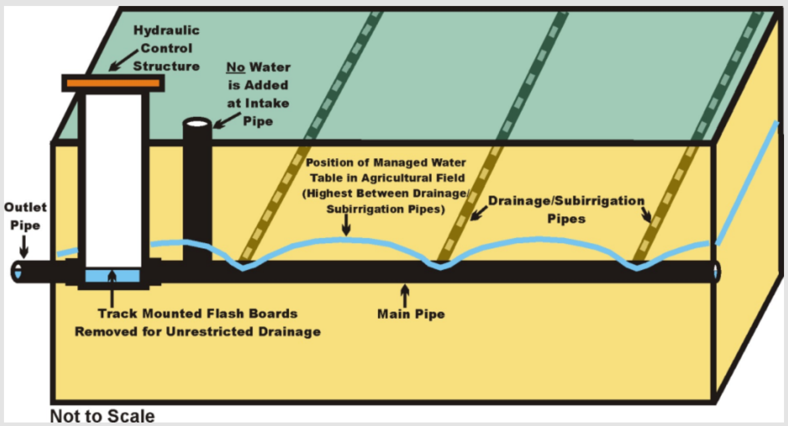
- **Manage the valley, not just streams**
- **Plan ahead; don't wait for disaster –---- Brown County example**

Streambanks

- **Plan ahead**
- Lower Minnesota:
- **Divert before reaching valley wall**
- **>1 to 5,000 tons/yr (depending)**
- **Restore sinuosity**
- **Veg management**

Specific BMPs—drainage treatment

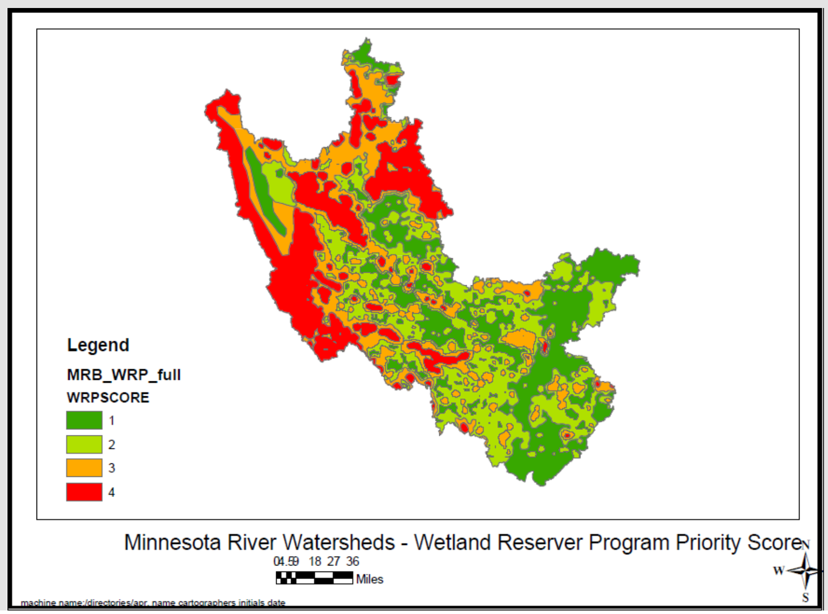
Controlled drainage & reduced tile density



Treatment wetlands

Water storage: wetlands for water storage, nutrient removal & waterfowl habitat

- Hydrologic storage
- Flood peak reduction
- Excellent N removal
- Some P removal
- Waterfowl habitat



Conclusions and Future Work

Largest sediment sources ≠ most "restorable"

- Long term– try to reduce flow with land-use policy change
- Short-term – small watershed goals; targeted channels/ bluffs

Remaining needs / questions

- Assessment of benefits of stream projects
- IBI benefits
- Sediment delivery rate?
- Need to quantify eco benefits better
- Farm economics may change in future