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# TOOLS AND STRATEGIES FOR REDUCING CHANNEL EROSION IN MINNESOTA

# Background and approach

- Channel loading major source of sediment in much of MN River basin and around Midwest
- Need approach to prioritize restoration and management sites with limited funds
- Science transfer: need usable tools for TMDLs

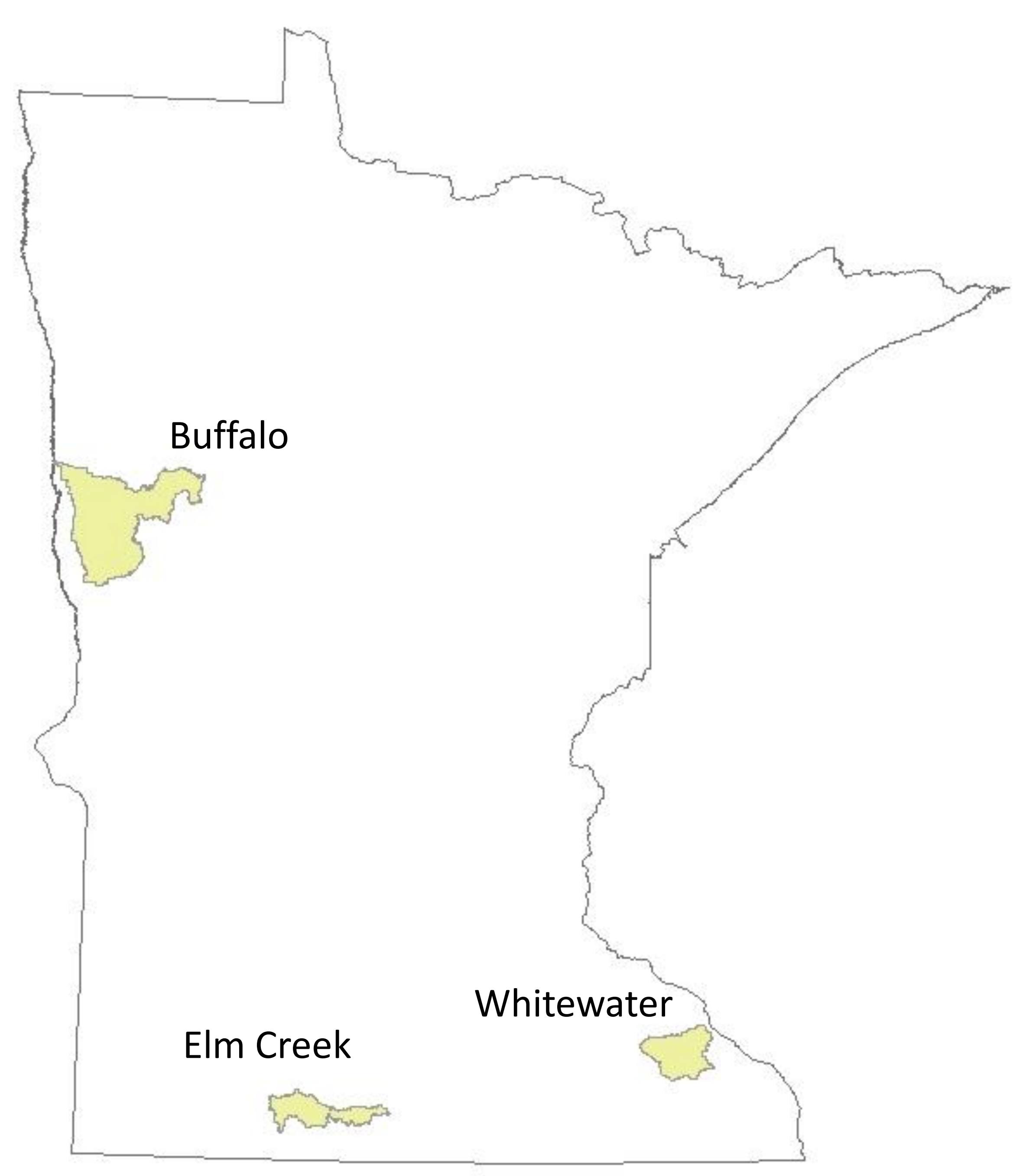
# Two prioritization projects

**MN Dept. of Agriculture**

- Prioritization of restoration actions in sentinel watersheds
  - Development of tools for use in TMDLs
  - Research into hydrologic drivers of erosion to help target flow-reduction BMPs

**McKnight Foundation**

- Developing a comprehensive approach for reducing channel erosion in the MN River Basin
  - GIS
  - Landowner meetings
  - Cost-benefit analysis
  - Development of cost-effective riparian corridor BMPs




Three regions

- Red River Basin
- Cornbelt- Des Moines Lobe till plain
- Driftless Area

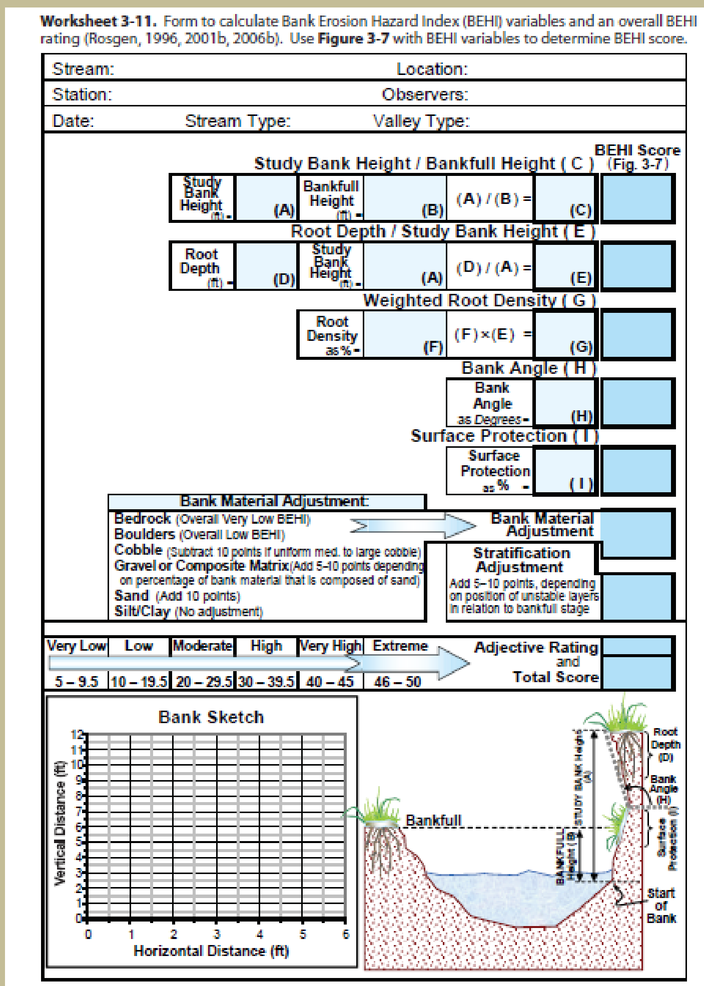
# Prioritization tools: a MN-specific bank erosion index

- Installation of long-term research in 3 ecoregions
  - Driftless region (Whitewater)
  - South Central MN (Elm Creek)
  - Red River Basin (Buffalo)

Comparison to USLE

# BEHI parameters

**Bank resistance vs. erosion forces**


**Worksheet 3-11.** Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating (Rosgen, 1996, 2001b, 2006b). Use **Figure 3-7** with BEHI variables to determine BEHI score.

Stream: Location:

Station: Observers:

Date: Stream Type: Valley Type:

BEHI Score (Fig. 3-7)

Study Bank Height / Bankfull Height ( C )

Study Bank Height (ft) = (A) Bankfull Height (ft) = (B) (A) / (B) = (C)

Root Depth / Study Bank Height ( E )

Root Depth (ft) = (D) Study Bank Height (ft) = (A) (D) / (A) = (E)

Weighted Root Density ( G )

Root Density as % = (F) (F) × (E) = (G)

Bank Angle ( H )

Bank Angle as Degrees = (H)

Surface Protection ( I )

Surface Protection as % = ( I )

Bank Material Adjustment:
Bedrock (Overall Very Low BEHI)
Boulders (Overall Low BEHI)
Cobble (Subtract 10 points if uniform med. to large cobble)
Gravel or Composite Matrix (Add 5–10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (No adjustment)

Bank Material Adjustment

Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage

| Very Low | Low | Moderate | High | Very High | Extreme |
|---|---|---|---|---|---|
| 5 – 9.5 | 10 – 19.5 | 20 – 29.5 | 30 – 39.5 | 40 – 45 | 46 – 50 |

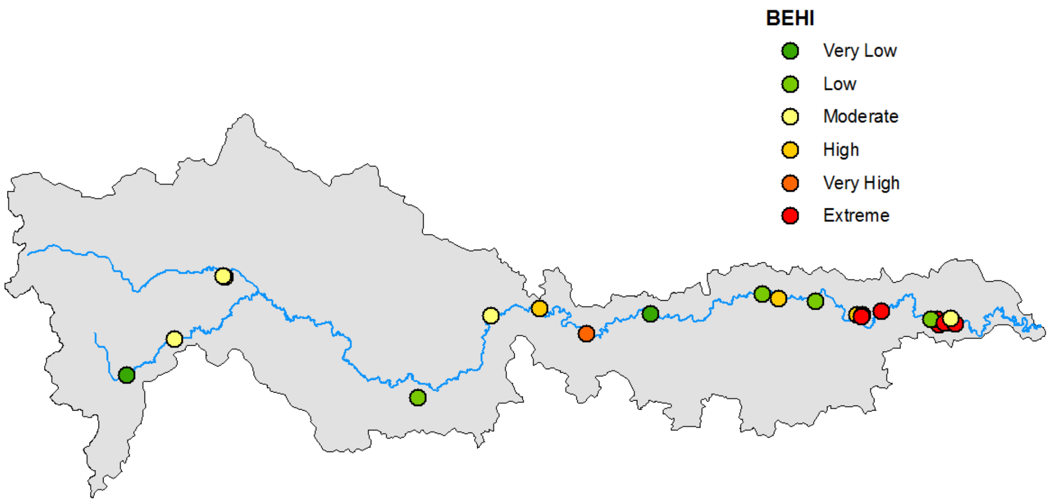
Adjective Rating and Total Score



General findings

- Bank ht: bankfull ht
- Rooting depth/density
  - Grass
  - trees
- Soil properties
  - Alluvial (lower Whitewater, Elm)
  - Lake plain clay (Buffalo)
  - Glacial till (Buffalo, Elm)

# Elm Cr. BEHI prioritization




Erosion rates (ft/yr)
Very low: .02- .10
Low: .1-.2,
Mod:  .25-.6,
High/v. high: .6-2.0,
extreme: 2-8

Loading (mass)=
2 to 1600 tons/yr
per segment;
mean ~ 100 t/yr

Lower Elm Creek producing most of sediment

# Pros & cons of index

- Useful for prioritization and TMDL load estimates
- Builds on DNR, MPCA work in Whitewater & Buffalo watersheds
- Problems - net transport?
- Biota vs. turbidity TMDLs?

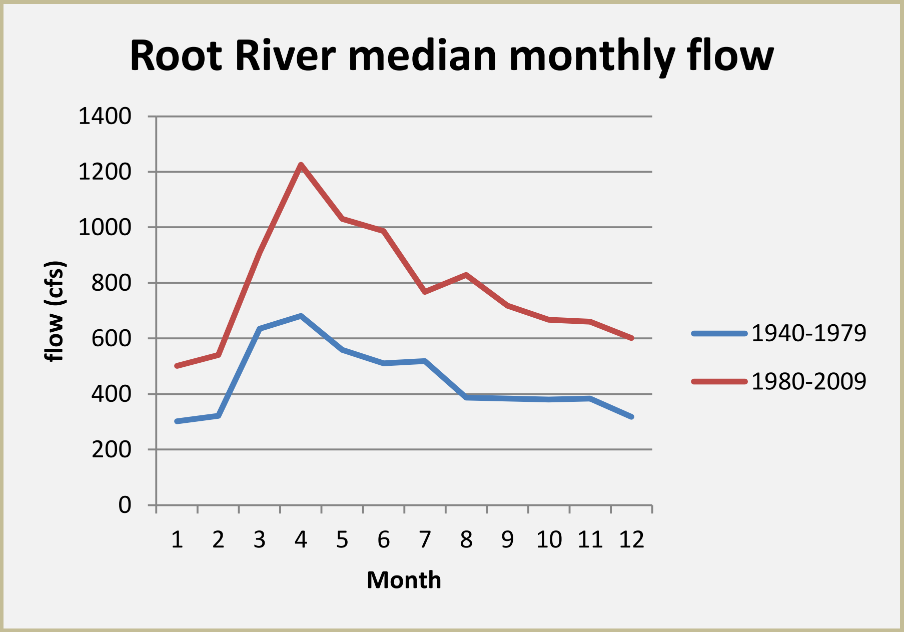
# Measurement of net sediment rate

- Field measures of deposit volume with tree core dating in forest
- Scale up to whole river using model in GIS to get tons/year deposited

# Hydrologic drivers of erosion: streamflow change statistics

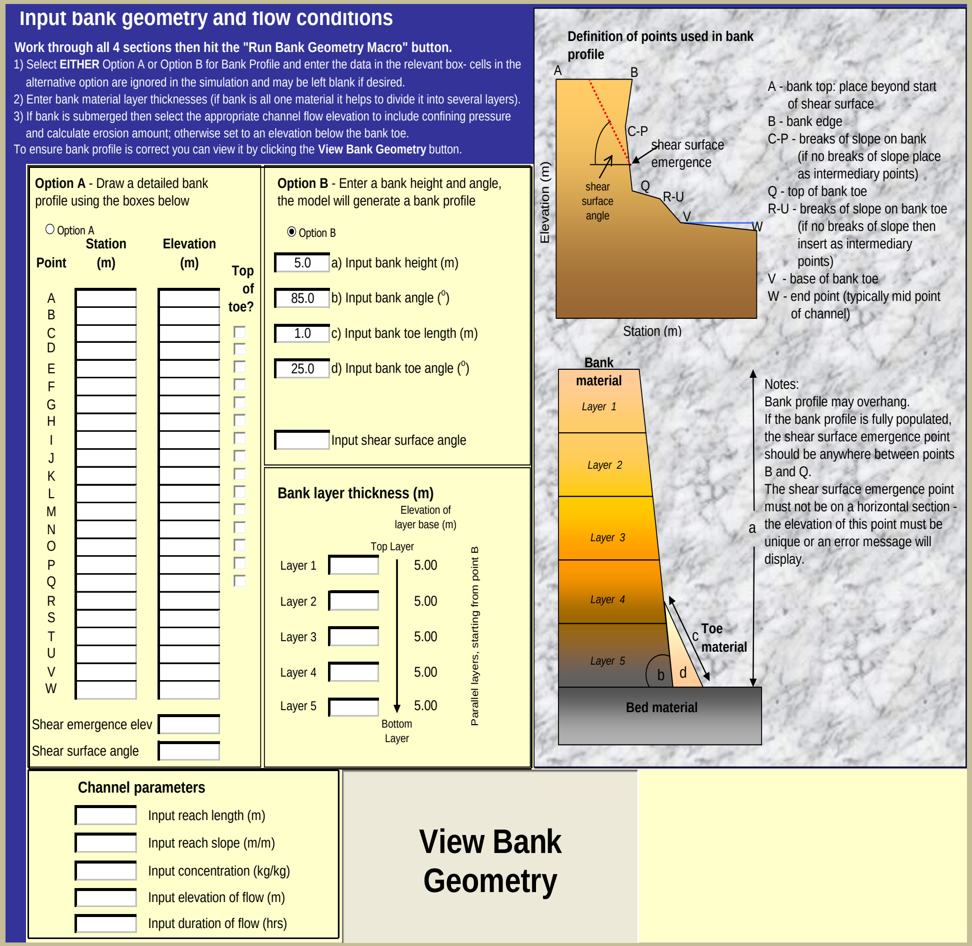
- Hydrologic regime change: Indicators of Hydrologic Alteration (IHA)
- Streamflow-Precipitation (Q:P)
- Land cover & climate change
- Impacts on channel erosion and evolution?

*Driftless area example*



# Hydrologic drivers of erosion: BSTEM modeling

- Mechanics of bank collapse – data on soil erodibility, other
- Input to BSTEM
- Calculates mass of sediment eroded



# Field studies of bank erosion mechanisms

- Benchmarked sites for resurvey-to calibrate BEHI and BSTEM
- Well transect to document water level
- Bank collapse monitored with time-lapse cameras; resurvey
- Water sources: specific conductivity & isotopes



# Comparison of priorities

**Elm Creek (south central)**

SEDIMENT Sources

- streambanks, fields

PRIORITIES

- Sediment loading to MN River, wetlands & waterfowl

SOLUTIONS:

- Wetland storage
- Targeted bluff and channels

**Whitewater (Driftless Area)**

SEDIMENT Sources

- Fields, banks

PRIORITIES

- Trout fishing

SOLUTIONS:

- Reduce field erosion; hydrologic storage; streambanks?

# Issues: Time lag for WQ response

**CAST Report:**

***Assessing The Health of Streams in Agricultural Landscapes: How Land Management Change Impacts Water Quality . 2012.*** *(Special* Publication: Project Manager - Rick Cruse, Iowa Water Center)

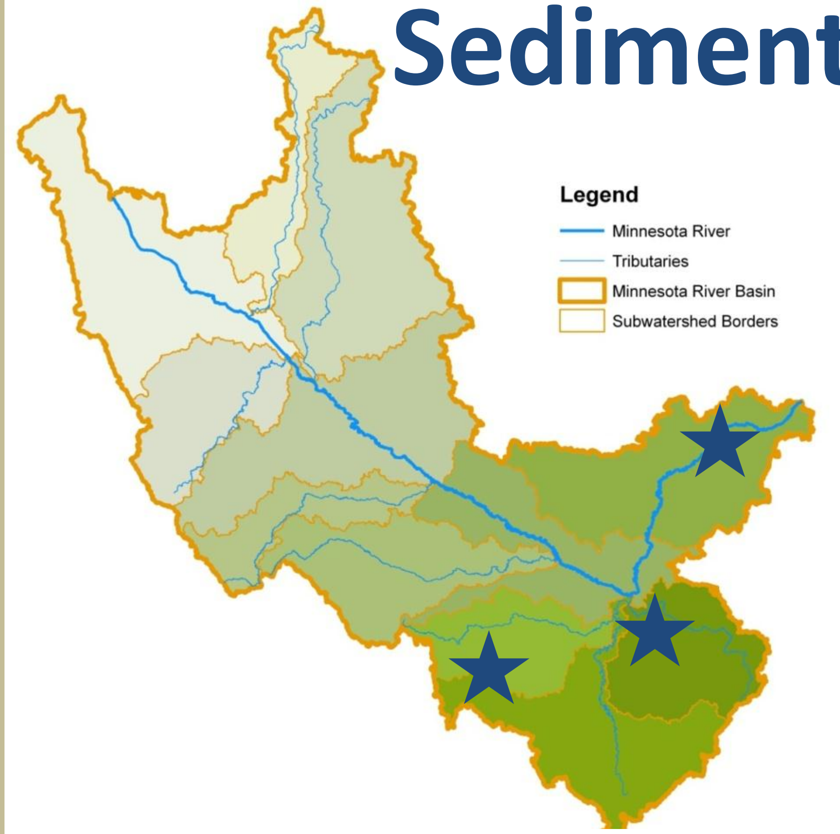
The Science Source for Food, Agricultural, and Environmental Issues

- MN River basin may take decades for noticeable gains
- Smaller basins may respond more quickly --

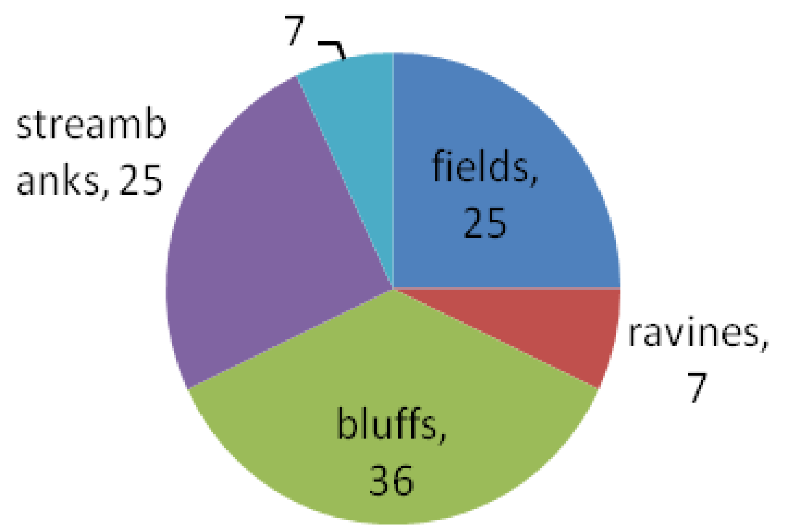
# McKnight Study on MN River Basin

- Collection of existing data
- Cost benefit data
- Case studies
- Development of cost-effective riparian BMPs

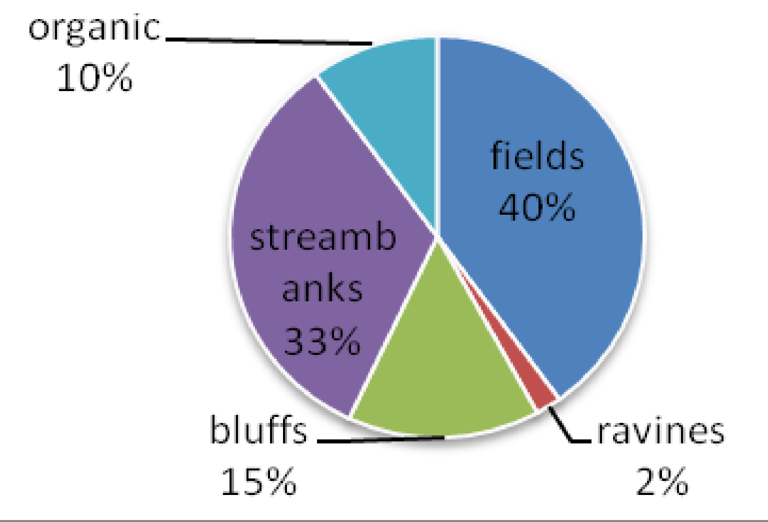
# Sediment sources



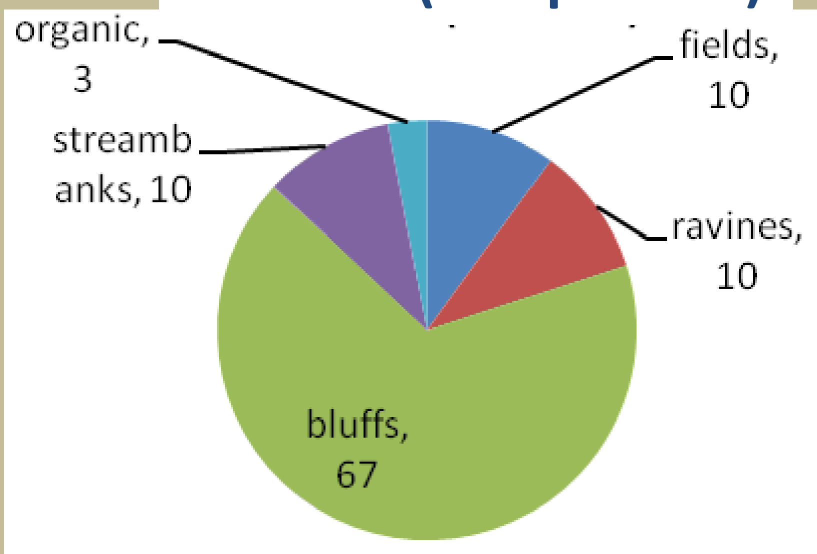

## Minnesota main channel




## Elm Creek (headwaters)




## LeSueur (steep bluffs)



# BMPs targeting

**By geomorphic region**

- Western till plains / prairie potholes
- Bluff country
- Lower MN river

**Cost/benefits**

- Cost of ravines, bluffs, streambanks
- landowner preferences
- Fit with ag systems
- Total ecological services

# Cost of channel stabilization

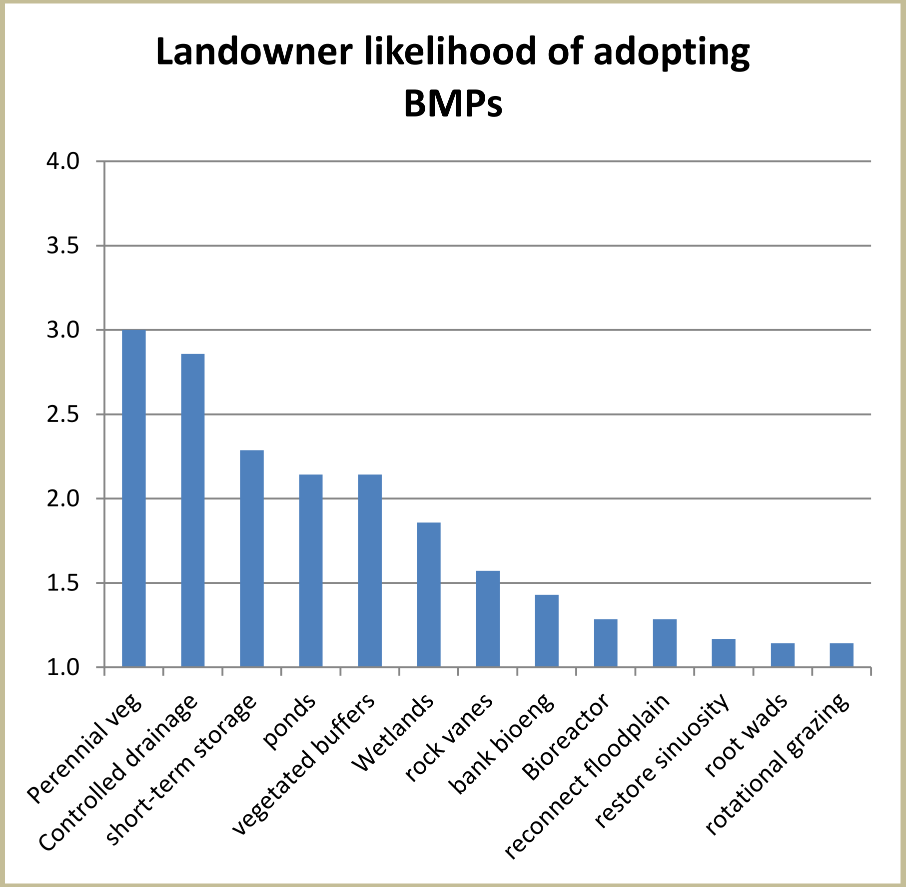
- 57 projects, avg. $100 per linear foot (range $20-$750)
- Hidden costs mobilization, consulting

(data collected by L. Lahti)

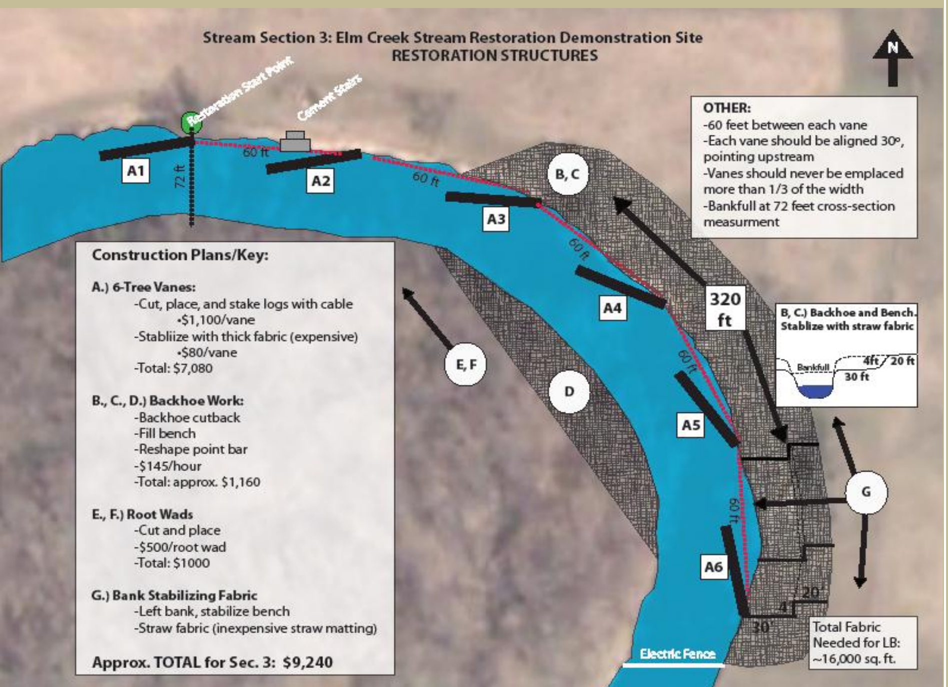
- Preliminary findings
  - Rural/urban difference
  - Rock vs. wood
  - Haves (Twin Cities, trout streams, Red River flooding) vs. have nots – western MN River basin
  - Need cost-effective riparian zone BMPs

# Landowner meeting @ Elm Cr

- Survey from 12/14
- Familiar practices favored
- Stream restoration – unfamiliar
- Technology and training gap exists
- **Opportunity is in riparian corridor, less in fields**

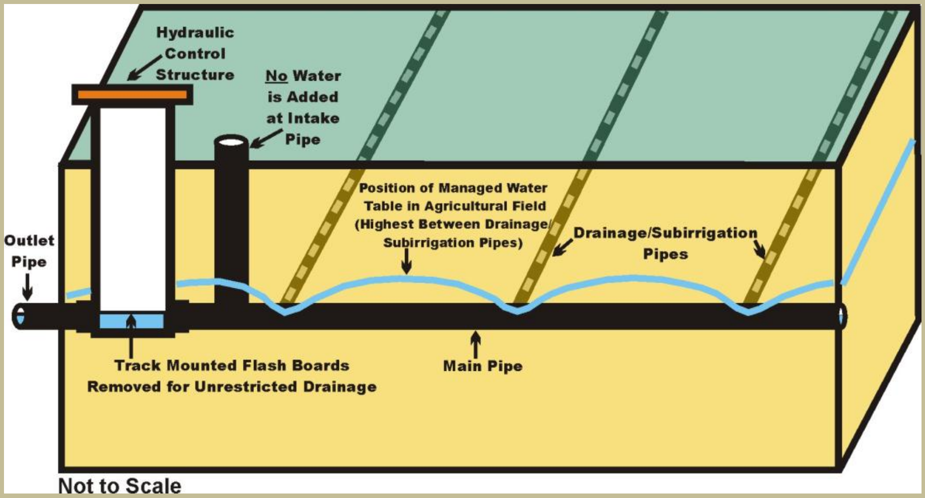


# Use of low-cost, local materials



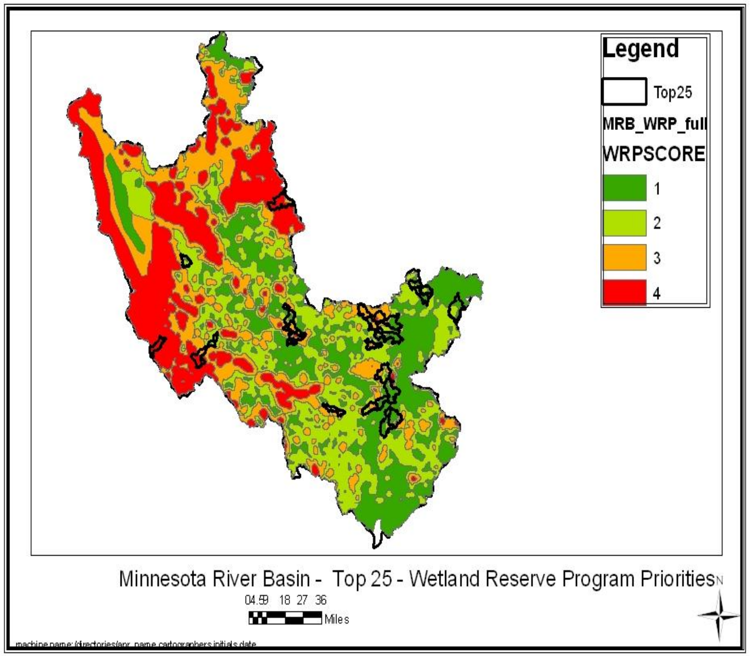

# Tile flow interception

- Controlled drainage
- Saturated buffers
- Treatment wetlands



# Watershed practices : water storage in restored wetlands

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




# 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)
- MN Basin hydrologic change will require economic & policy shift to reduce flow
  - Change Farm Bill
  - Economic incentives

# Future work

- MDA study to 2014
- Develop strategies for different geomorphic regions in MN River basin by 2013

Other

- Channel evolution research
- Riparian vegetation management guidelines update?

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Data, Meeting Assistance: Linse Lahti, Linda Meschke, Mary Presnail

# Role of veg in bank erosion

Bluff – 25 ft

Stream bank 7 ft

*Riparian veg BMP update is needed*