Use of Sediment Fingerprinting Technique to Identify Provenance of Stream Bed Sediments

Jasmeet Lamba, Anita M. Thompson, K.G. Karthikeyan

Biological Systems Engineering
UNIVERSITY OF WISCONSIN–MADISON

THE UNIVERSITY of WISCONSIN
MADISON

Introduction

- Sediment: Important non point source pollutant
  - Impacts
    - Off-site
      - Legacy effect
      - Transfer and fate of phosphorus
      - Aesthetics
    - On-site
      - Depletion of nutrient rich soils

Introduction

- Implementation of best management practices (BMPs)
  - Targeted BMP approach
  - Identify sediment sources

Erosion Plots

Erosion Pins

- Additional information on sediment yield and routing to apportion in-stream fine sediment contribution from different sources

Introduction

- Sediment fingerprinting
  - Identification of potential sediment sources through the use of natural tracers (e.g. fallout radionuclides, stable isotopes, and trace elements).
- Tracer properties should be:
  - Conservative
  - Measurable
  - Representative

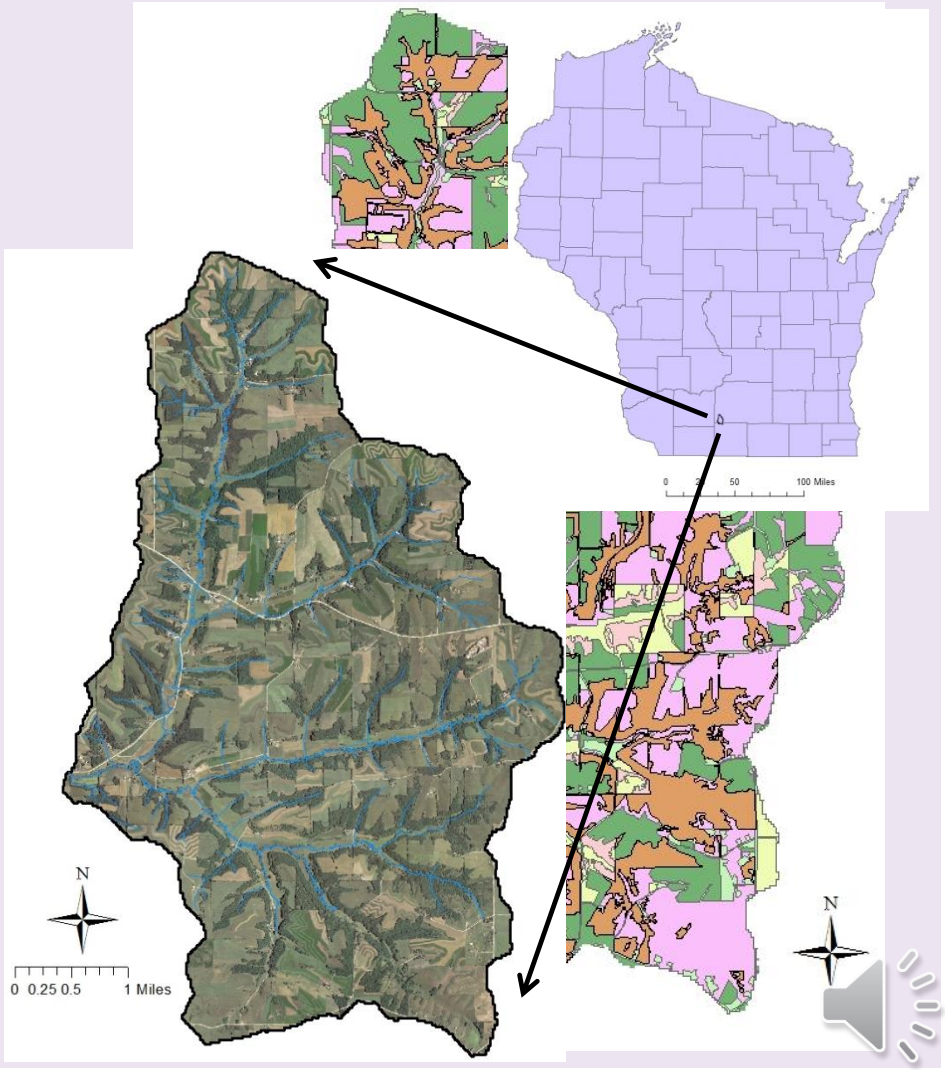
Objectives

- Identify sources of fine sediment deposited on stream bed at a subwatershed scale.

- Determine effect of land use on fine sediment sources.

Project Site

- Pleasant Valley Watershed
- Dominant land uses are:
  - Cropland
  - Pasture
  - Woodland
  - Grassland
- Area ~19 sq miles
- Silt loam soils



Sample Collection

- Potential sources of sediment:

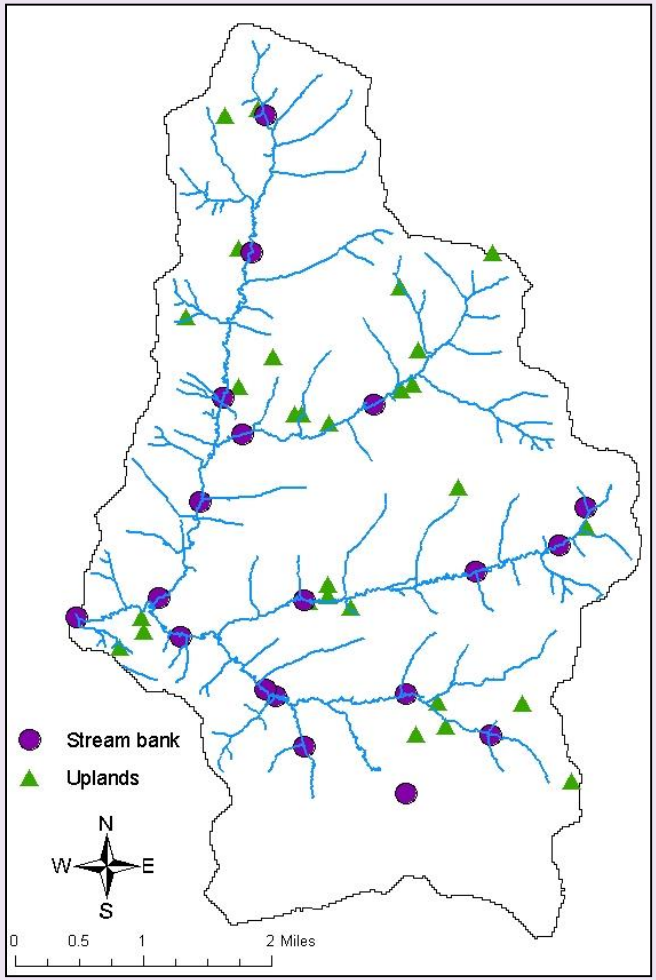
1- Agriculture (Pastures + Croplands)

2- Woodlands

3- Stream banks

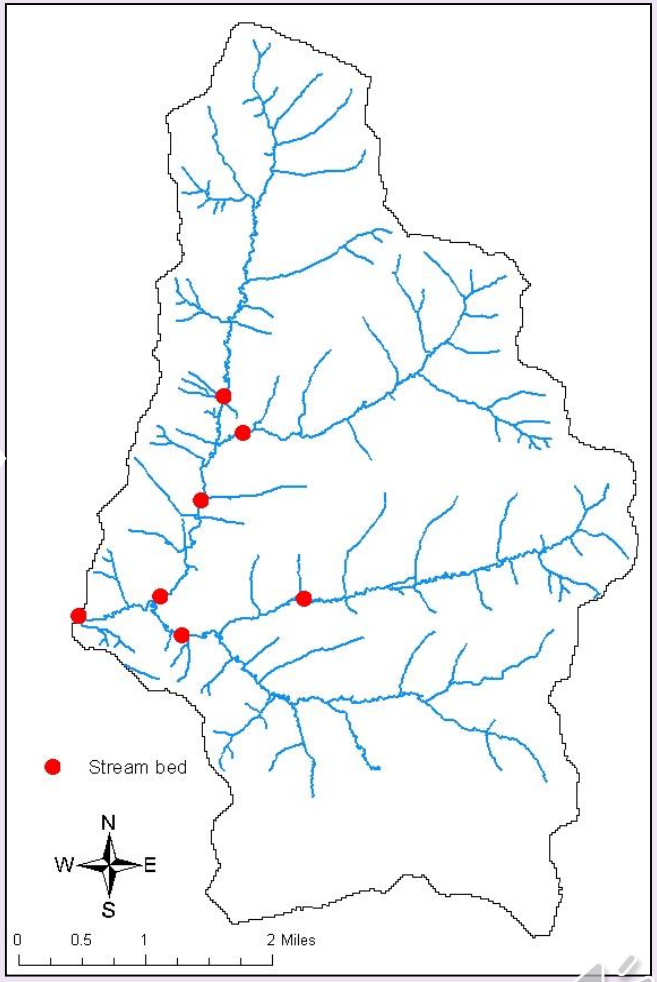
- Bed sediment samples collected as part of a watershed geomorphic assessment
- All sample cores collected were 2.5 cm deep

Sample Collection



Sources

Stream bed



Statistical Analysis

- Li, B n, Ga, As, S Bi, Th, U

1. **Conservation Test**
   To select conservative tracers

2. **Kruskal-Wallis H-Test**
   Select tracers that are able to discriminate between sources

3. **Stepwise Discriminant Function Analysis**
   Smallest combinations of tracers that maximize difference between sources

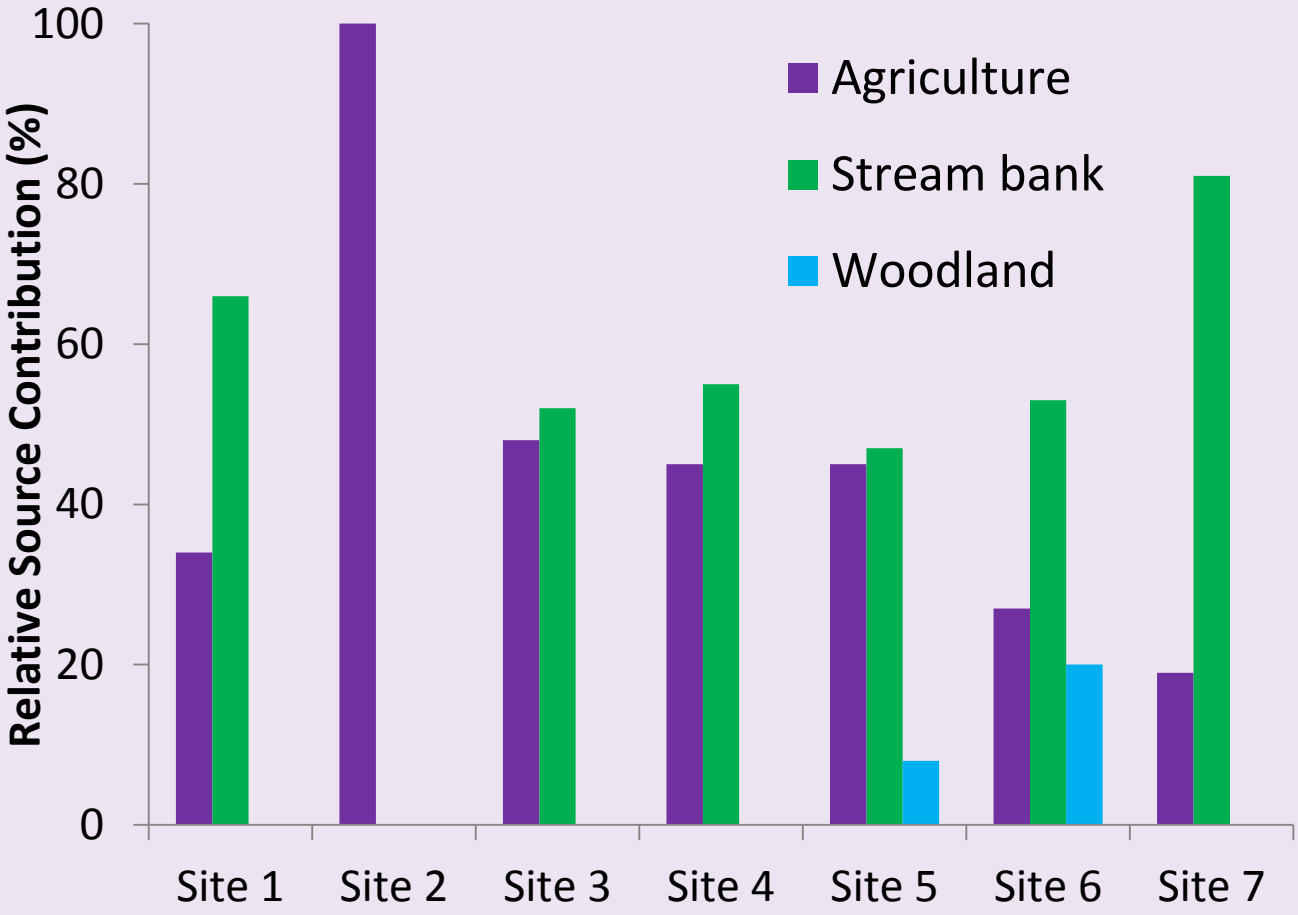
4. **Mixing Model**
   Relative contribution from different sources

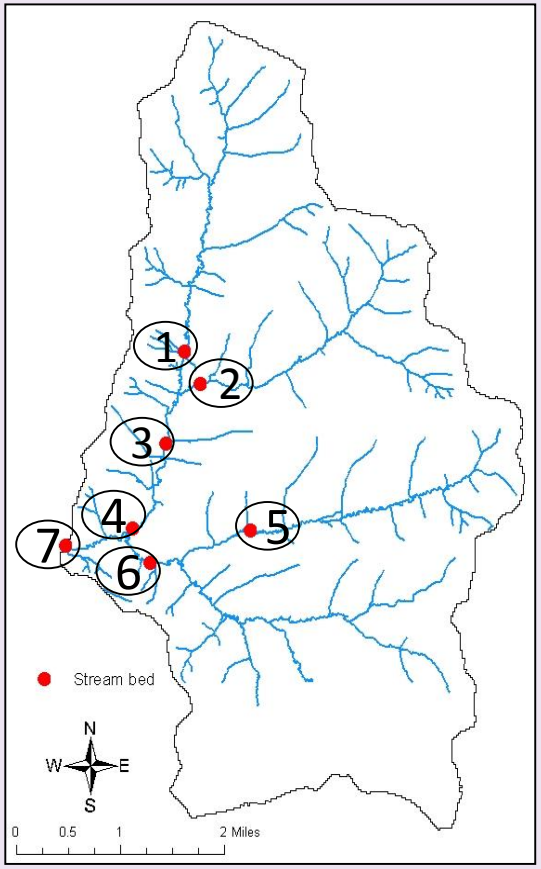
Goodness-of-fit and Uncertainty

- Goodness-of-fit of the optimized mixing model was assessed by comparing the actual fingerprinting property concentration in the bed sediment samples with the values predicted by the optimized mixing model.

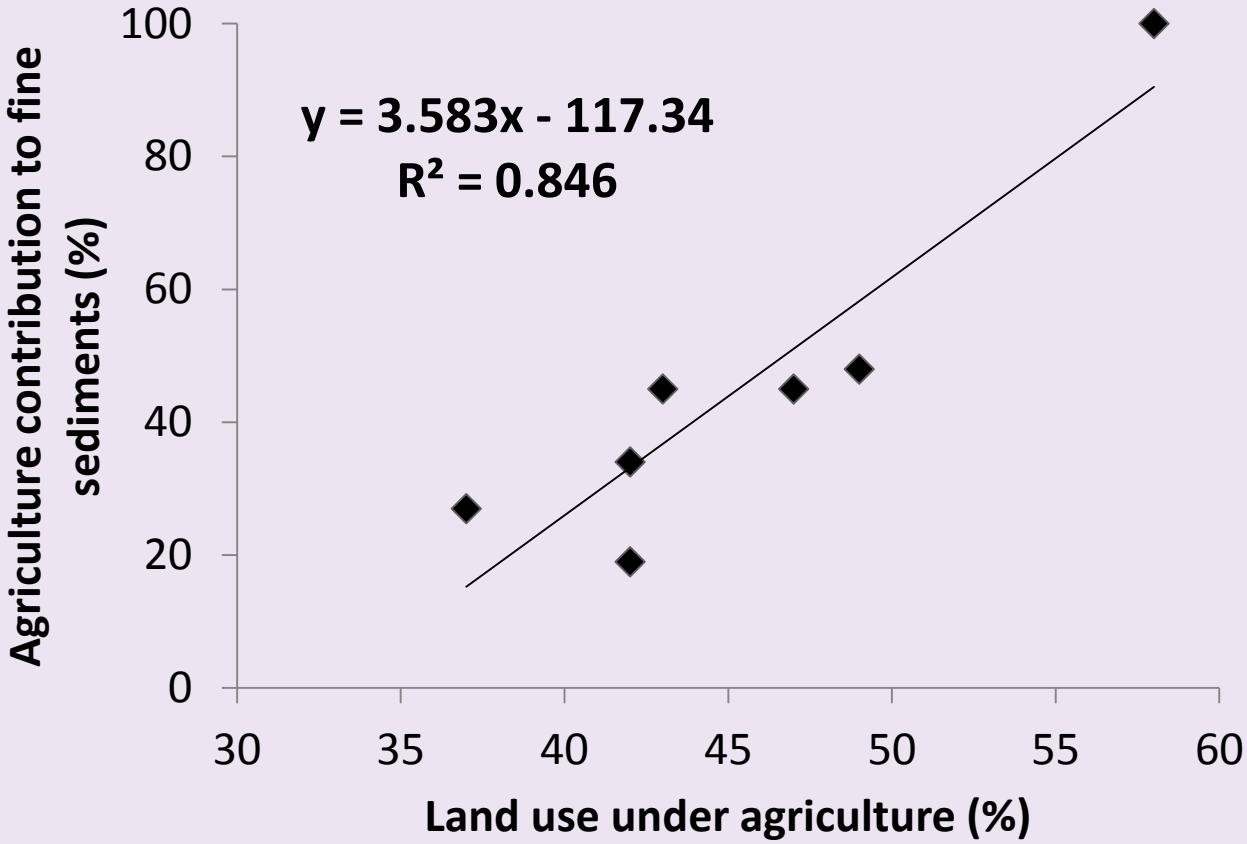
- To assess the uncertainty in relative source contributions results by use of mean source fingerprinting property concentration in the mixing model, a Monte Carlo approach was used.

Stream Bed Sediment Sources

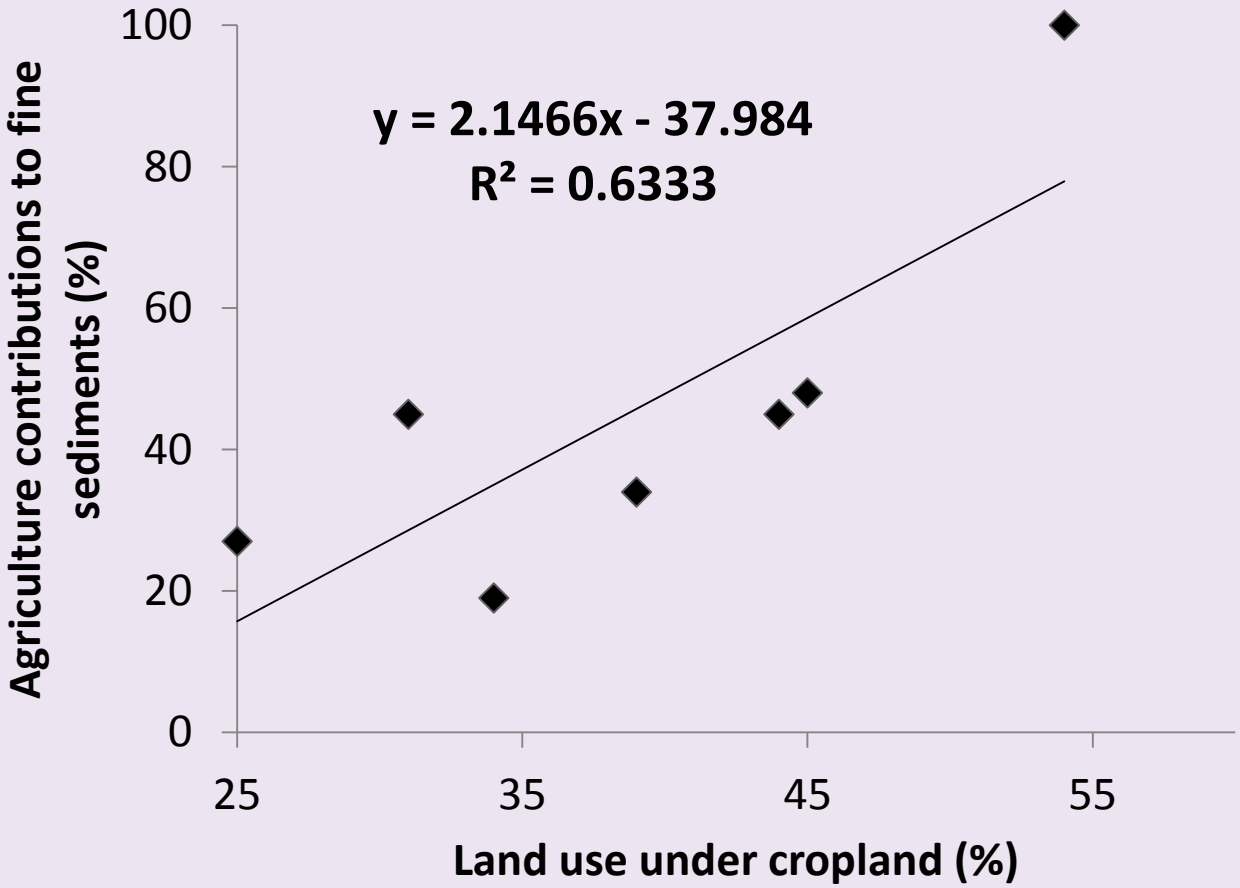




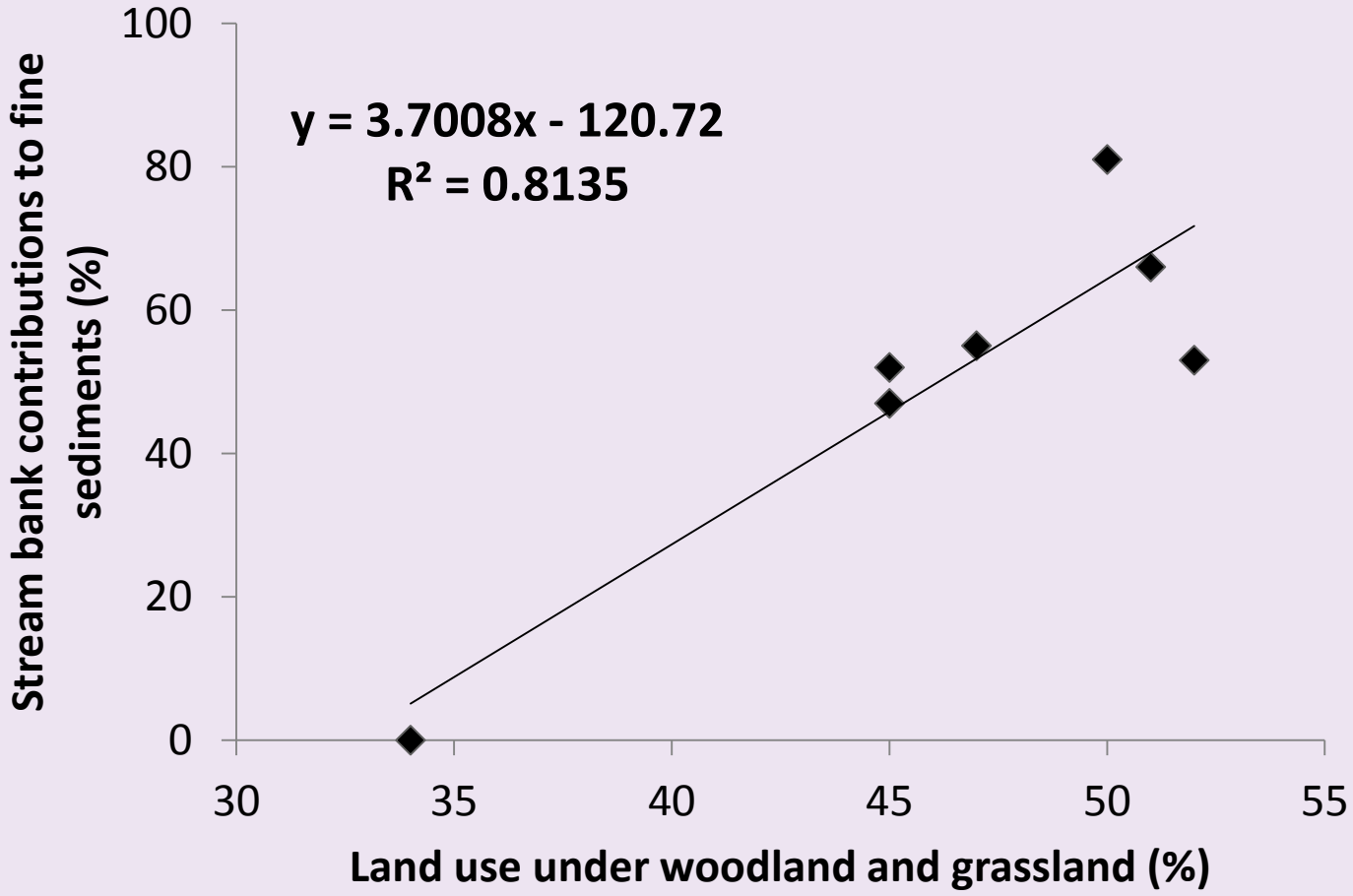
Relation Between Land Use and Sediment Sources



Relation Between Land Use and Sediment Sources



Relation Between Land Use and Sediment Sources



Goodness-of-fit and Uncertainty

- Goodness-of-fit
  - For all sites the estimates of Relative Mean Error ranged from 4 to 25% within this watershed
- Monte Carlo
  - For all sites source contributions to fine sediments were within 5% of the source contributions determined from the mixing model when mean fingerprinting property concentrations of the source samples was used in the mixing model

Conclusions

- Stream banks and agriculture are dominant contributors to stream bed sediment
- Increase in land use under agriculture results in greater relative contributions from agriculture to stream bed sediment
- Increase in land use under woodland and grassland results in greater relative contributions from stream bank

Conclusions

No Till

Limiting Grazing

Cattle Access to Streams

Banks Stabilization

Acknowledgments

- Funding for this project was provided by USDA NIFA, The Nature Conservancy, and Wisconsin Department of Natural Resources.

- We thank John Panuska, Laura Good, Zach Zopp, Faith Fitzpatrick, and staff at Dane County Land Conservation Division, Dane County, Wisconsin for their assistance in this study.

Thank you!

Questions?