Use Of Fallout Radionuclides And Inorganic Tracers To Identify In-Stream Sediment Sources

Jasmeet Lamba
Biosystems Engineering Department, Auburn University, Auburn, AL

K.G Karthikeyan and Anita Thompson
Biological Systems Engineering Department, University of Wisconsin-Madison, Madison, WI

Introduction

- Major NPS pollutants
  - Sediments
  - Nutrients
  - Pathogens
  - Metals

Introduction

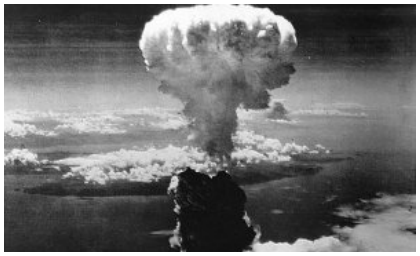
- Implementation of best management practices (BMPs)
- In past four decades little or no improvement in NPS-watershed projects (Meals et al., 2010; Sprague and Gronberg, 2012)
  - Need for targeted BMPs
    - Identification of sources contributing disproportionately high amount of sediment
- Better understand sediment transport processes

Sediment Fingerprinting

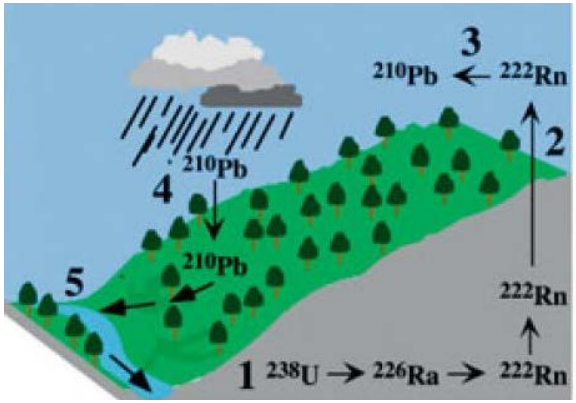
- gerprinting properties
  allout radionuclides)
- Apportion sedimen
  e in-stream sediment transpo
  (e.g., sediment age 210Pb$_{xs}$ ratio)

Atmospheric Fallout Radionuclides

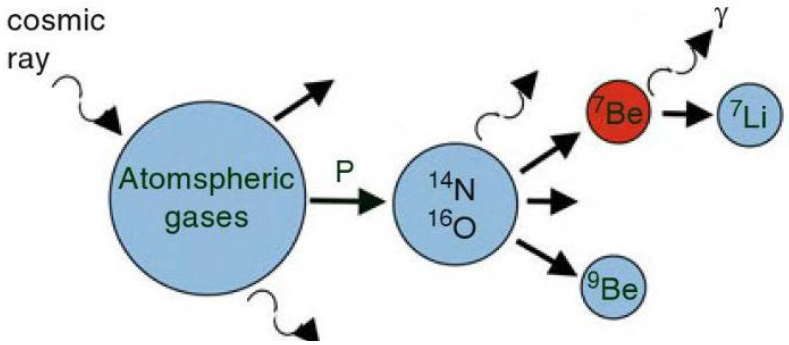
- Anthropogenic
  - Cesium-137 (^{137}Cs)
    - Half life = 30.2 years



- Natural
  - Lead-210 ($^{210}Pb_{xs}$)
    - Half life = 22.3 years



  - Beryllium-7 (^{7}Be)
    - Half life = 53.3 days

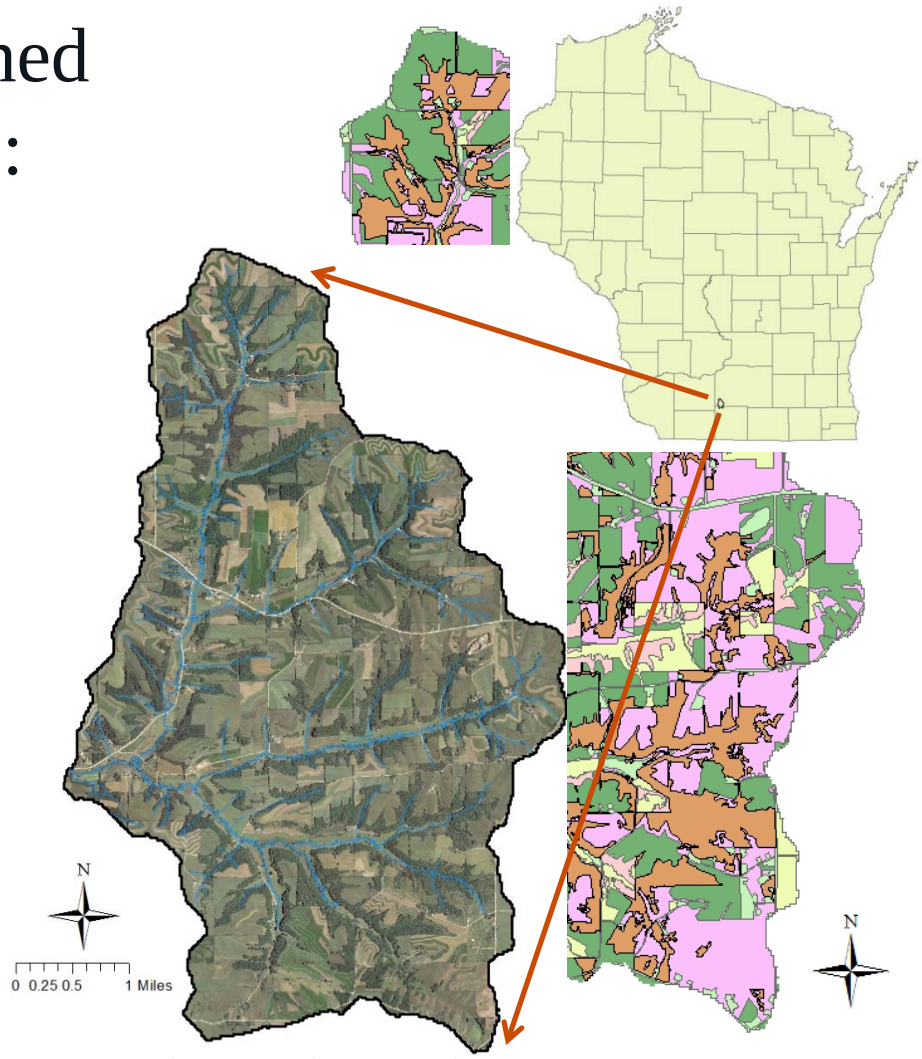


Objectives

- Identify sources of fine sediment deposited on the stream bed and suspended sediment using inorganic tracers
- Elucidate sediment transport dynamics in an agricultural watershed using fallout radionuclides (^{7}Be and $^{210}Pb_{xs}$)
- Determine sources of suspended sediment using ^{137}Cs and $^{210}Pb_{xs}$

Study Site

- Pleasant Valley Watershed
- Dominant land uses are:
  - Cropland
  - Pasture
  - Forest
  - Grassland
- Area ~19 sq miles
- Average slope is 11%
- Silt loam soils



Sample Collection

- Potential sources of sediment:

Agriculture

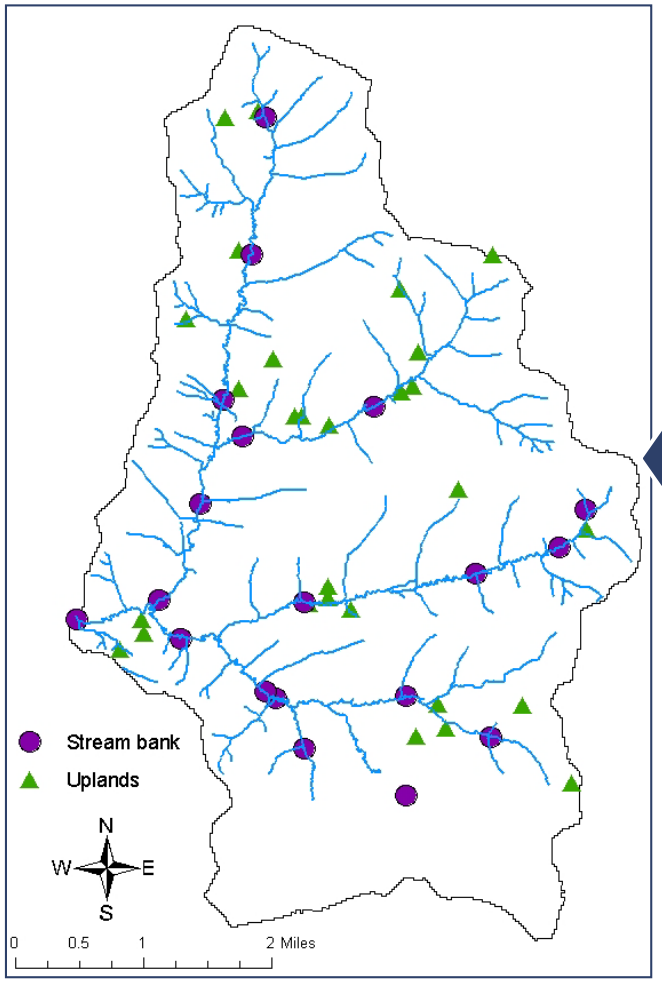
Woodlands

Stream banks

- In-stream suspended sediment samples collected using time integrated trap samplers

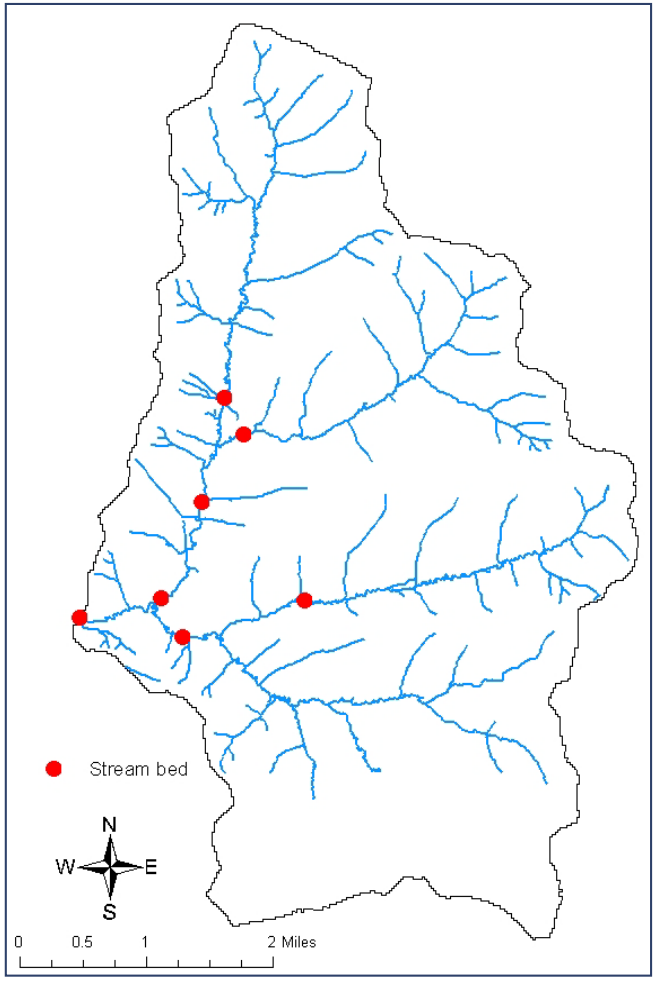
- Stream bed sediment samples were 2.0 cm deep

Sample Collection

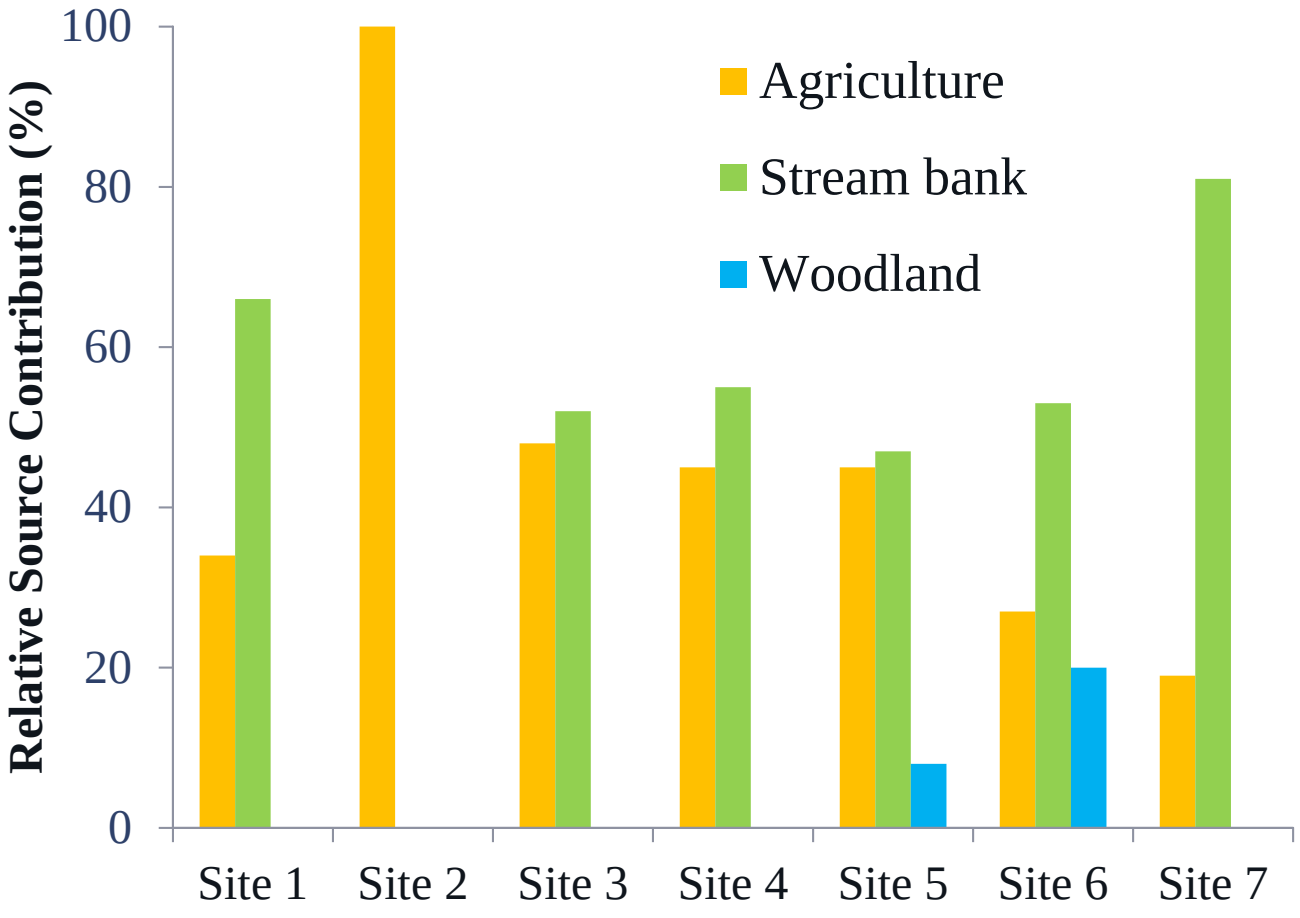


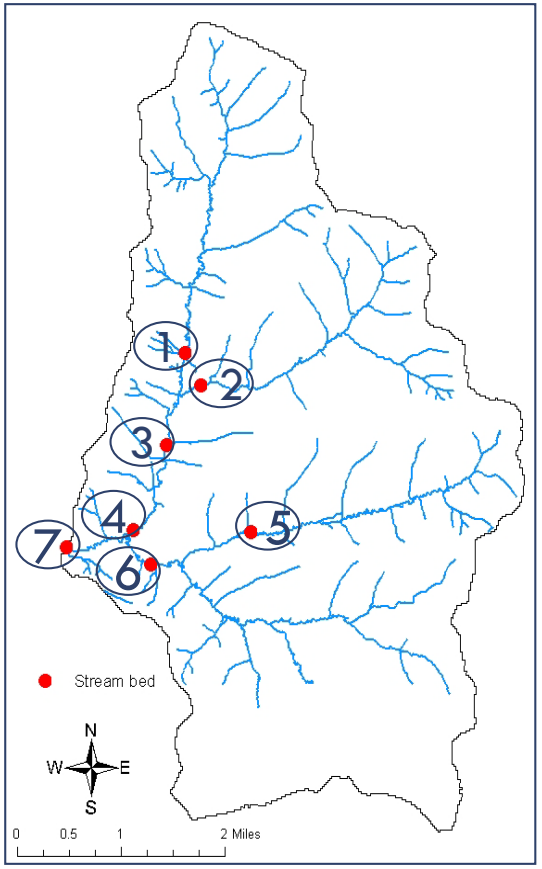
Sources

Stream bed

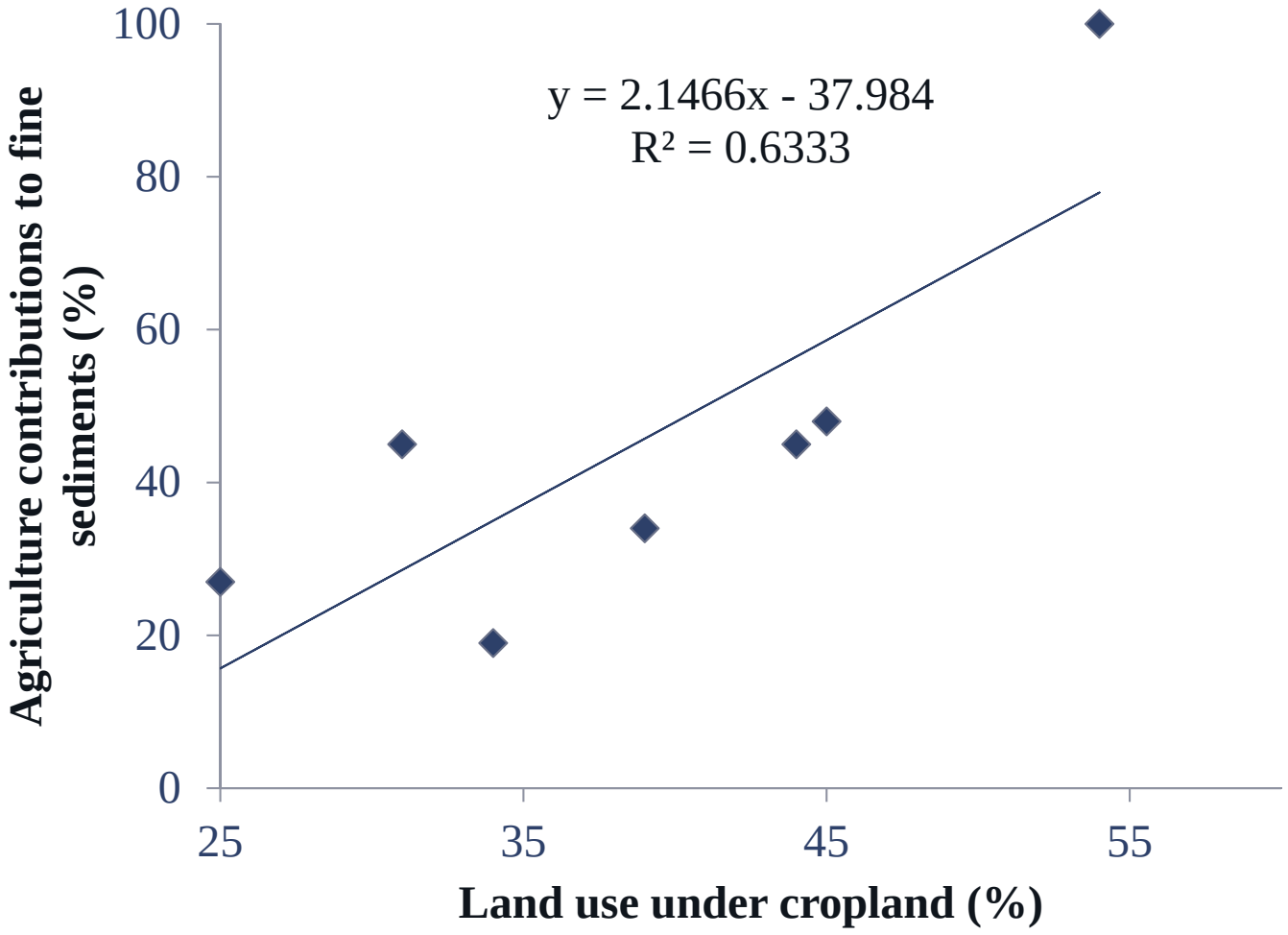


Source Apportionment

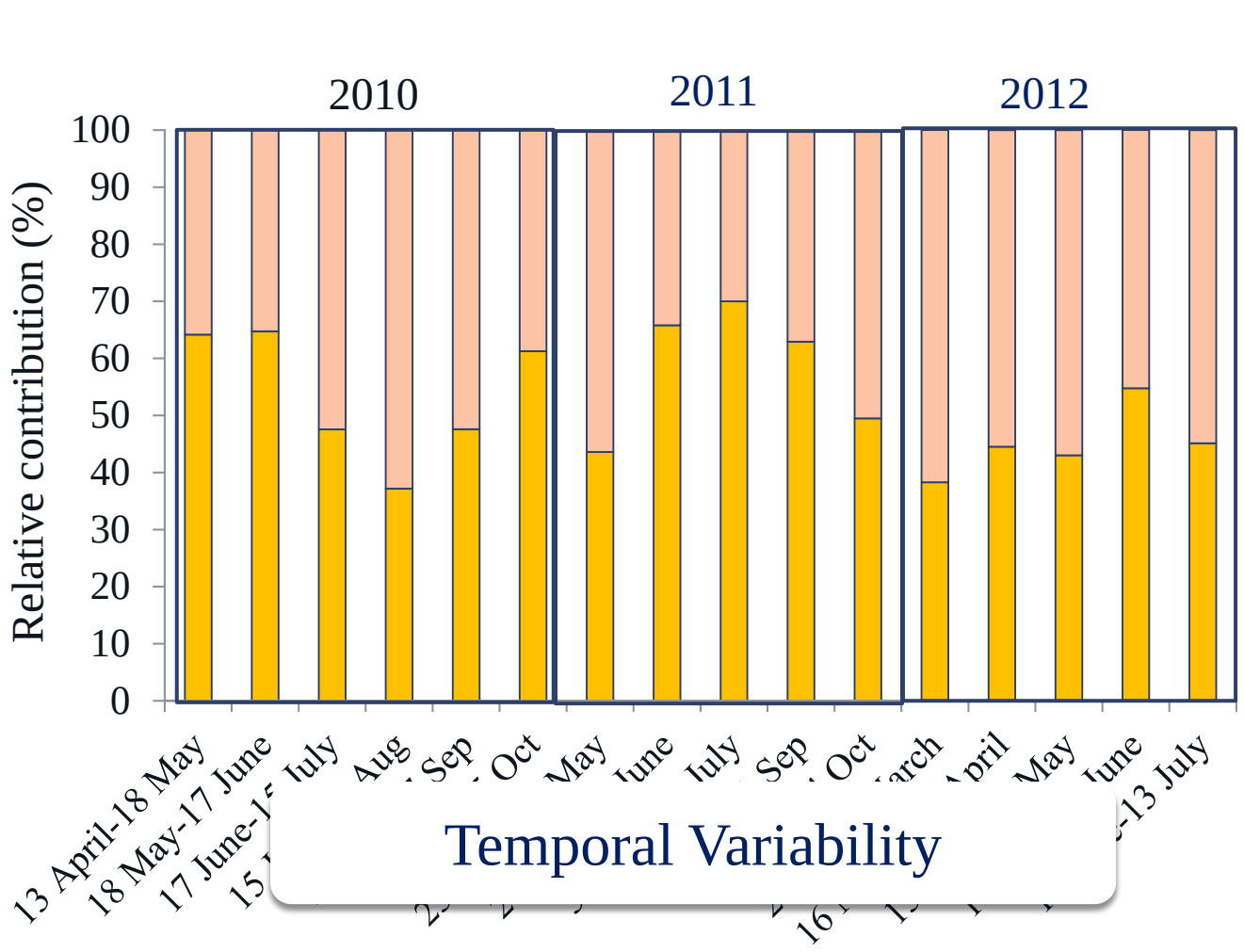


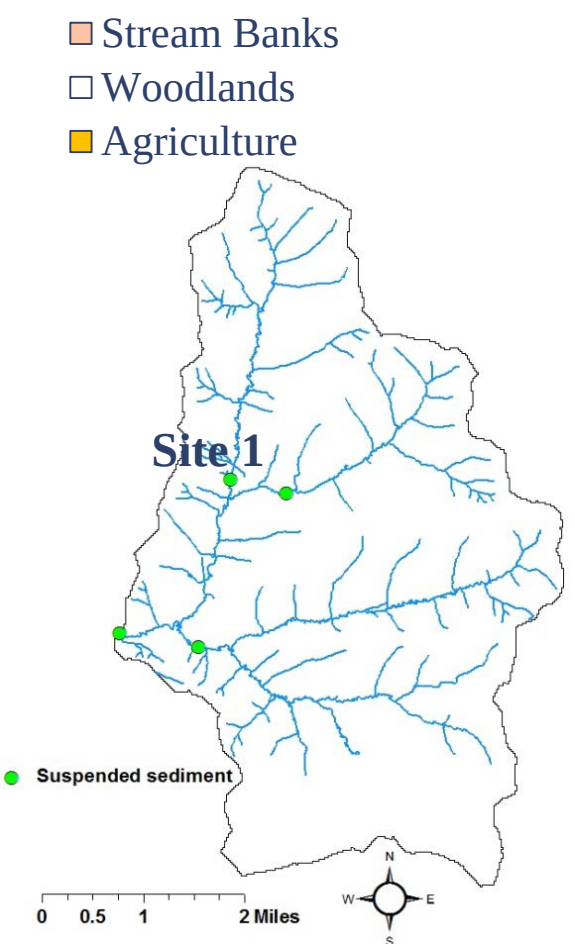


Effect of Land Use on Sediment Sources



Suspended Sediment Sources Using Inorganic Tracers





Storm Event Sampling

- Rainfall Events:
  - Event I
    - 11.9 mm of rainfall fell over 5 hours
  - Event II
    - 58.9 mm of rainfall fell over 39 hours
  - Subwatersheds: Different land use characteristics
    - Cropland Dominated
    - Mixed Land-use

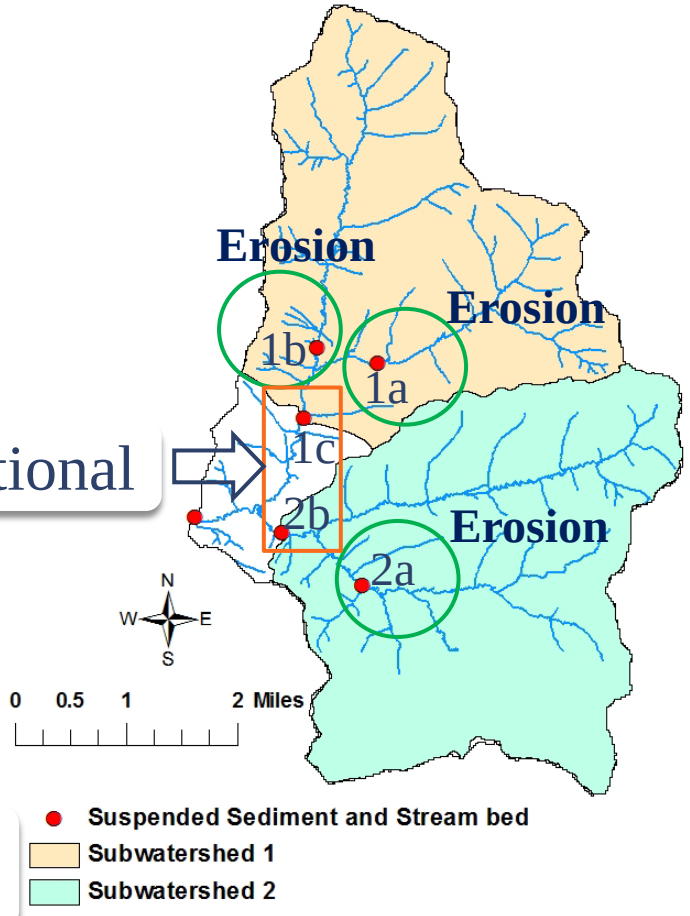
Bed Sediment Erosion/Deposition Rates

Sites

- **Site 1a**
- **Site 1b**
- **Site 1c**
- **Site 2a**
- **Site 2b**

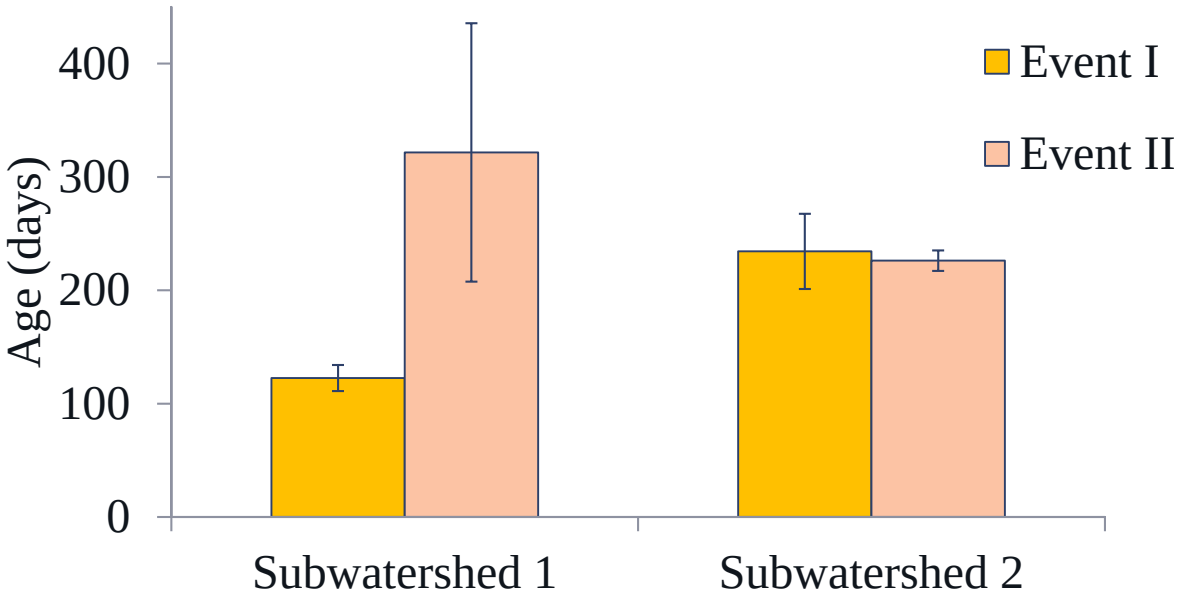
Larger Event

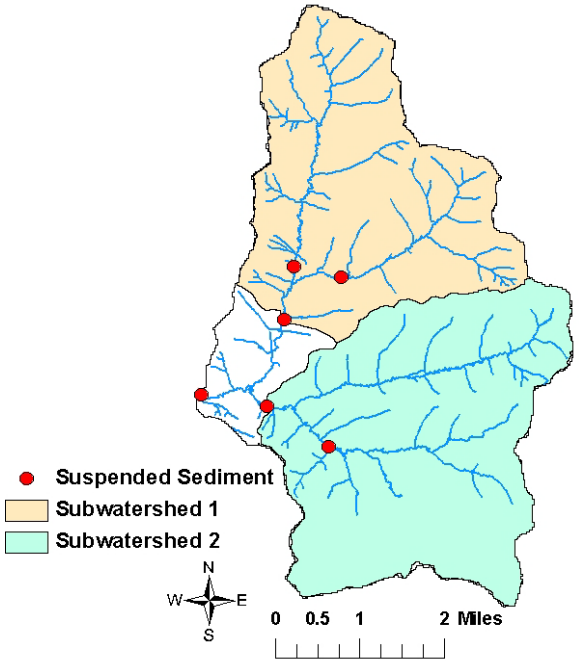
Depositional



Legacy sediment can be an important source

Suspended Sediment Age

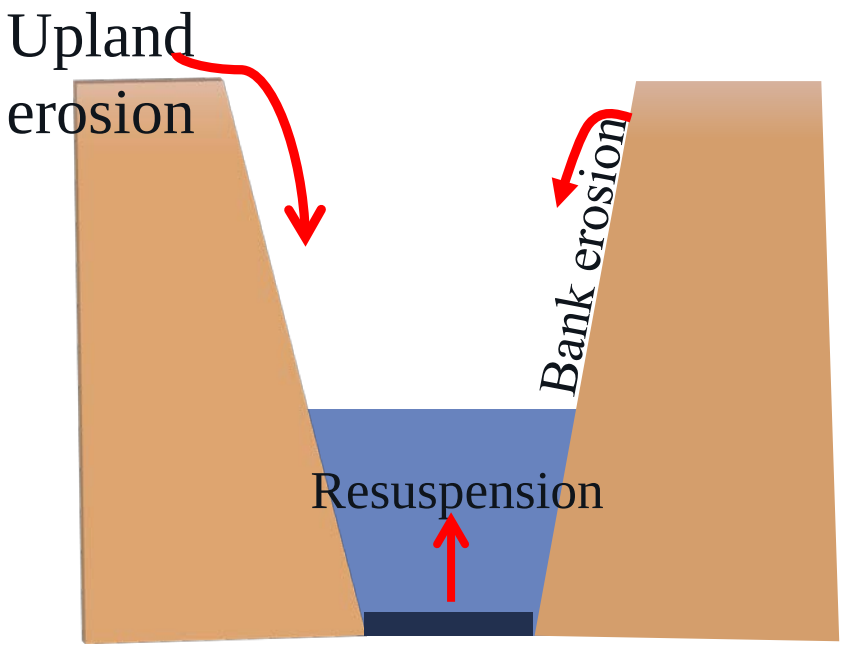




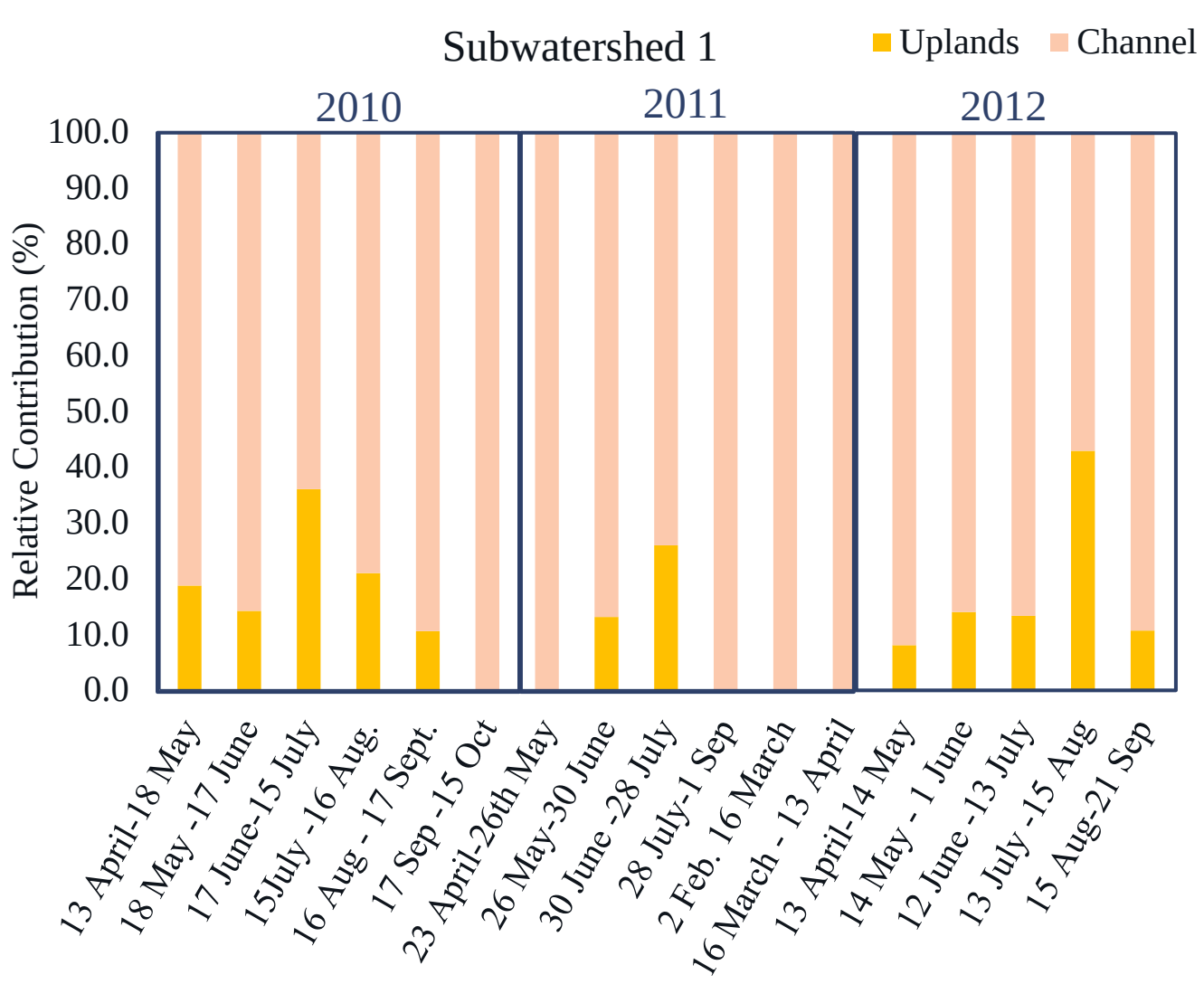
Older Sediment more prevalent during the larger event (Event II)

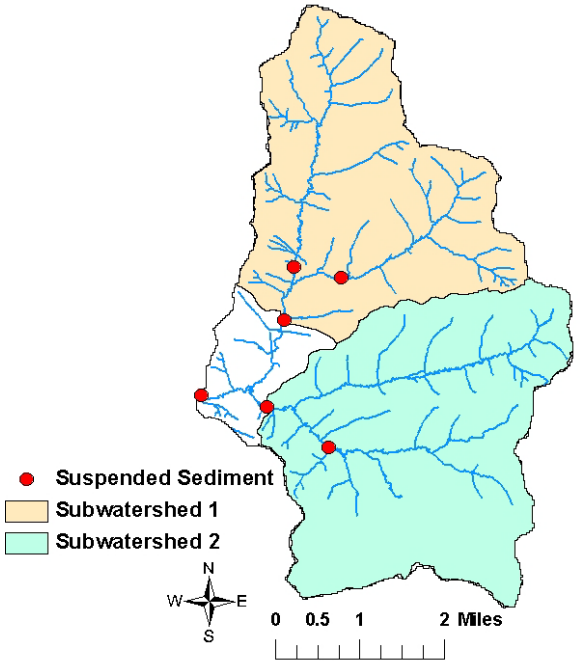
Source Apportionment

- Two main potential sources
  - Agriculture
  - Channel (stream bank + fine sediment deposited on the stream bed)
- ^{137}Cs and $^{210}Pb_{xs}$ used as tracers

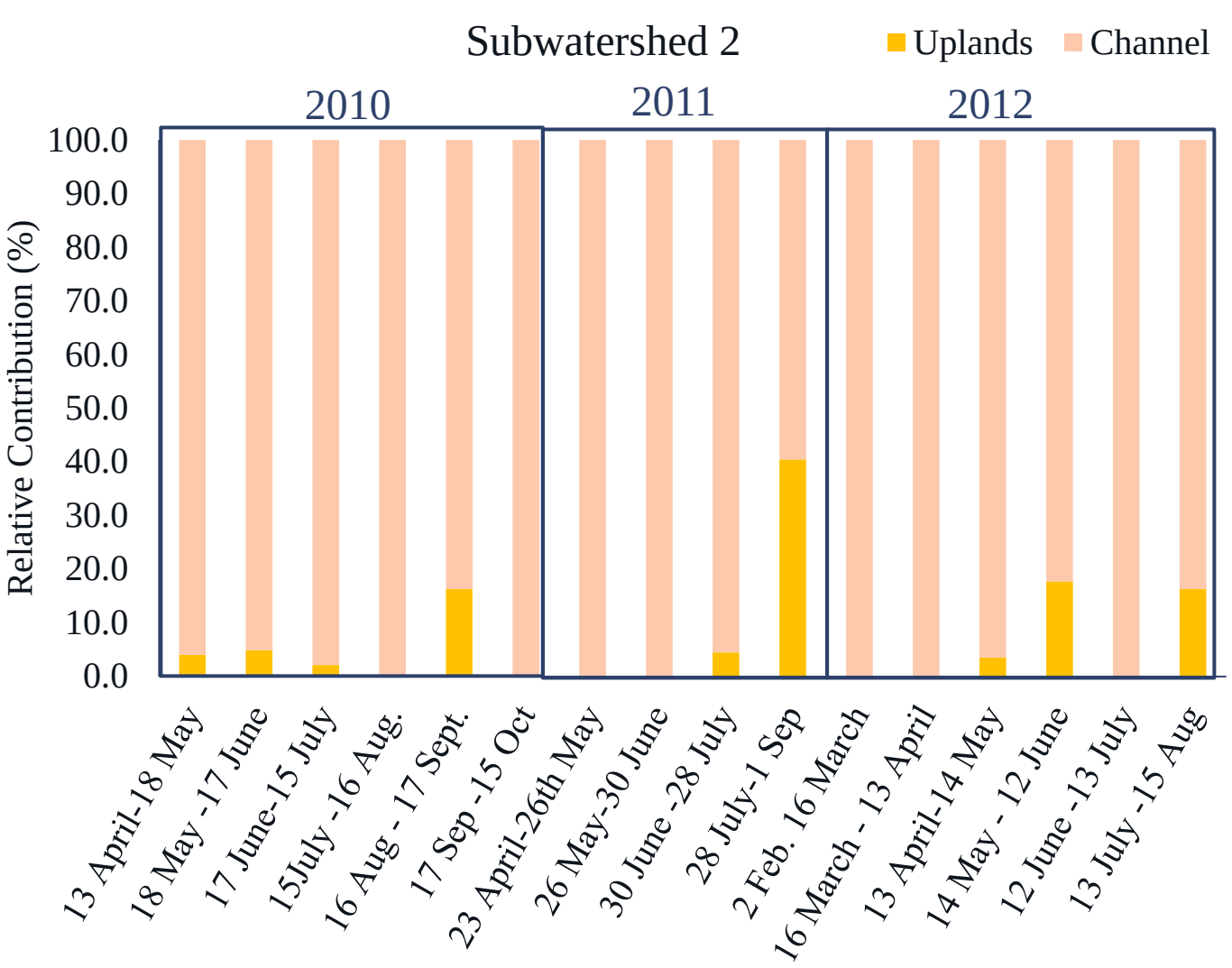


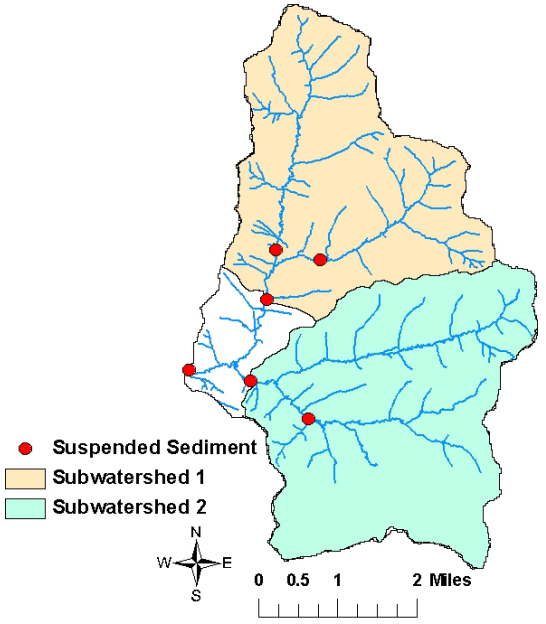
Suspended Sediment Sources





Suspended Sediment Sources





Conclusions

- Resuspended bed sediment is an important contributor to suspended sediment load at the watershed outlet
- Stream banks and agriculture are dominant sources of suspended and bed sediment
- Sources of suspended and bed sediment vary temporally and spatially within this watershed
  - It is important to identify sediment sources at subwatershed level
- Fine sediment deposited on stream beds can cause “legacy effect”

Thank you!

Questions?