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

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Introduction

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

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

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

2- Woodlands

3- Stream banks
Sample Collection

Sources → Stream bed

- Stream bank
- Uplands

Maps showing locations of sources and stream bed.
1. Select tracers that are able to discriminate between sources using Conservation Test.

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

3. Stepwise Discriminant Function Analysis to find the smallest combinations of tracers that maximize the difference between sources.

4. Mixing Model to determine the 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.
Relation Between Land Use and Sediment Sources

\[ y = 3.583x - 117.34 \]

\[ R^2 = 0.846 \]
Relation Between Land Use and Sediment Sources

\[ y = 2.1466x - 37.984 \]
\[ R^2 = 0.6333 \]
Relation Between Land Use and Sediment Sources

\[ y = 3.7008x - 120.72 \]
\[ R^2 = 0.8135 \]
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
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Thank you!

Questions?