Monitoring Methods Used to Improve Agricultural Conservation Practice Evaluations at the Edge-of-Field Scale

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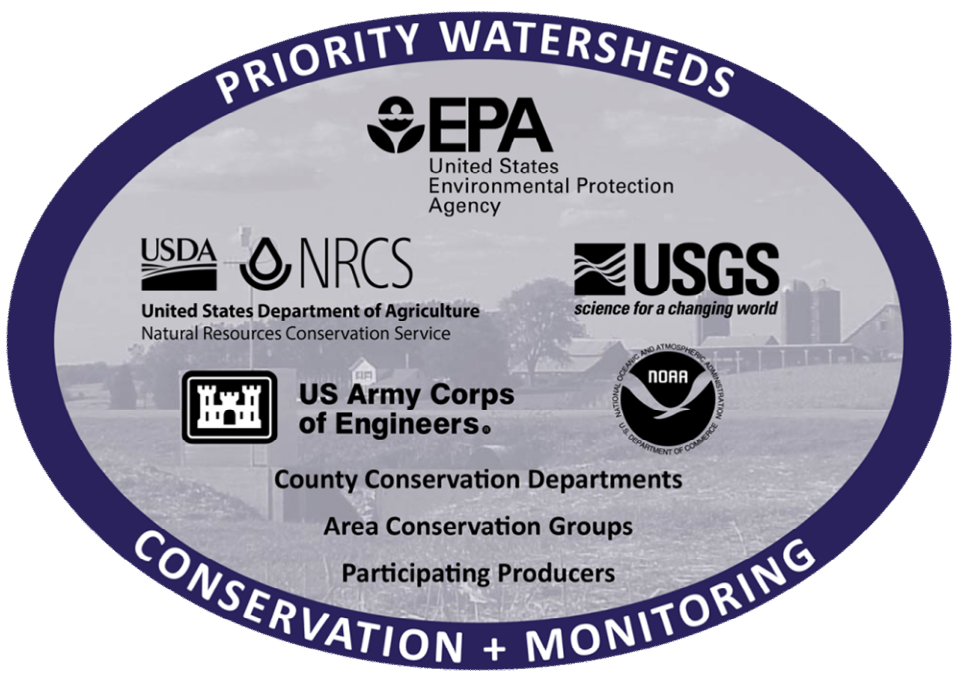

Executive Summary

- Phosphorus reduction in the Great Lakes is the current focus to reduce nearshore lake eutrophication and harmful algal blooms
- Multi-agency partnerships formed during GLRI to evaluate successes of voluntary, producer-based efforts
- Tiered monitoring and modeling is necessary to address complex processes at various scales
- Incorporation of monitoring efforts into the conservation programs and producer discussion are essential for the adaptive management of the conservation systems

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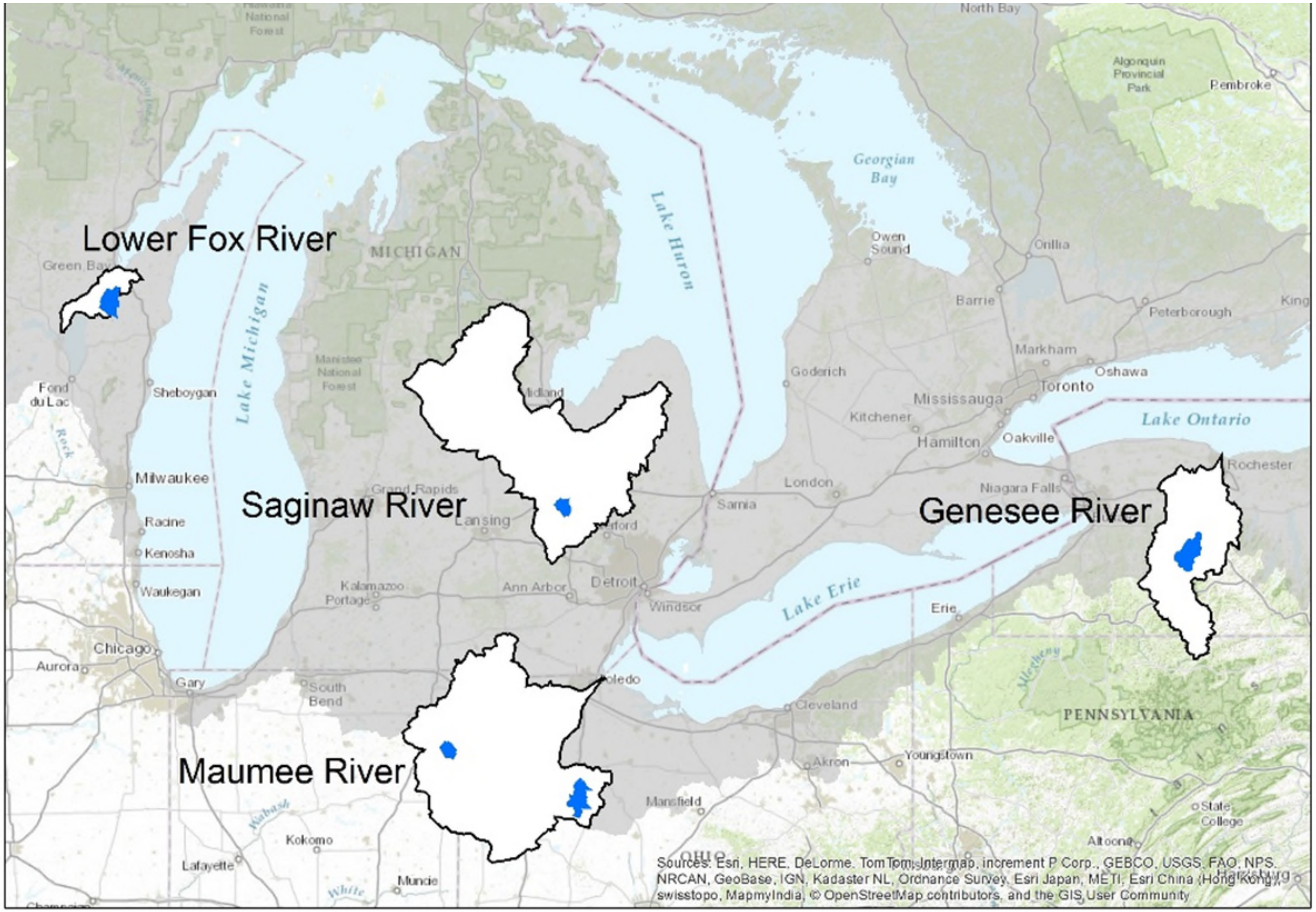
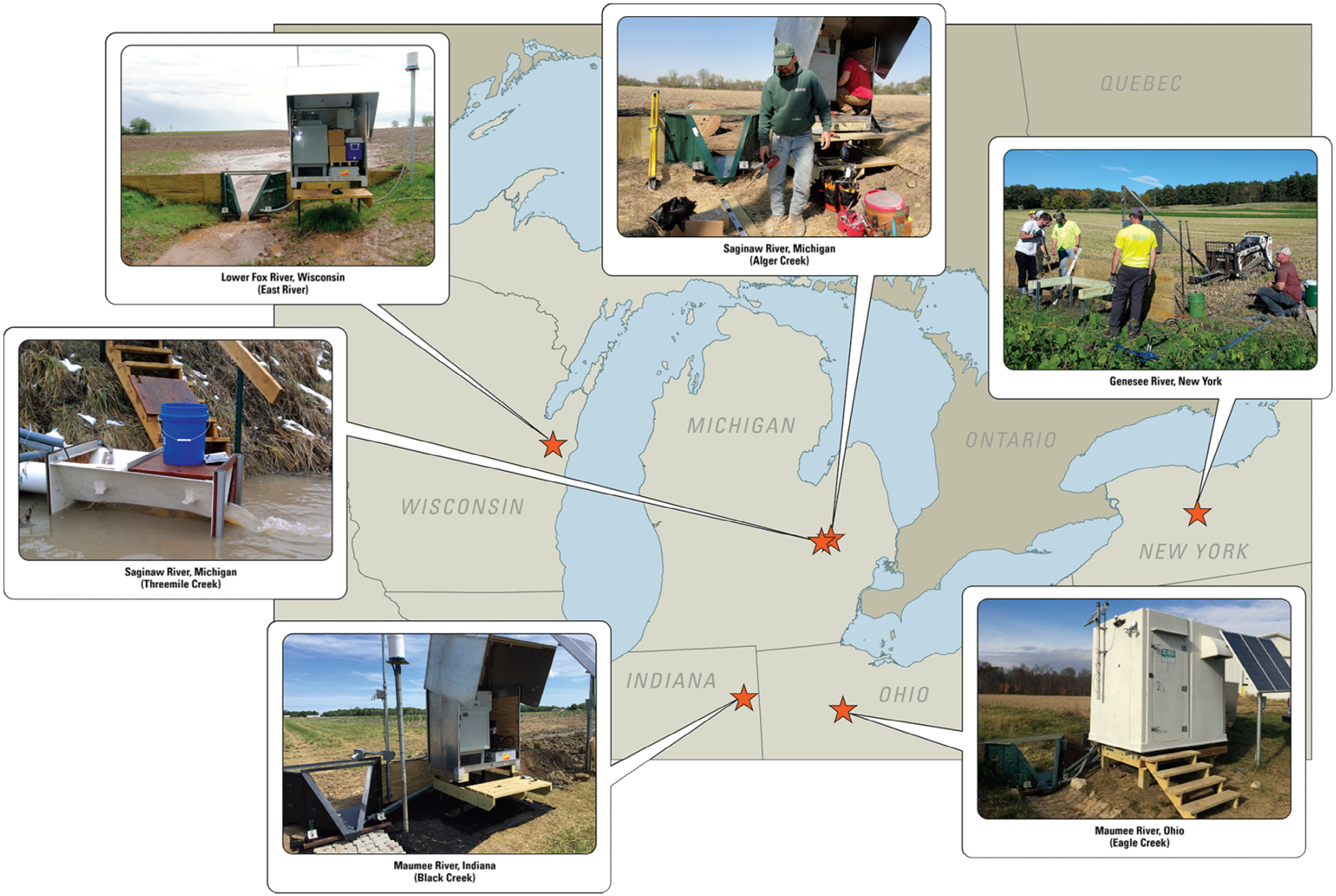
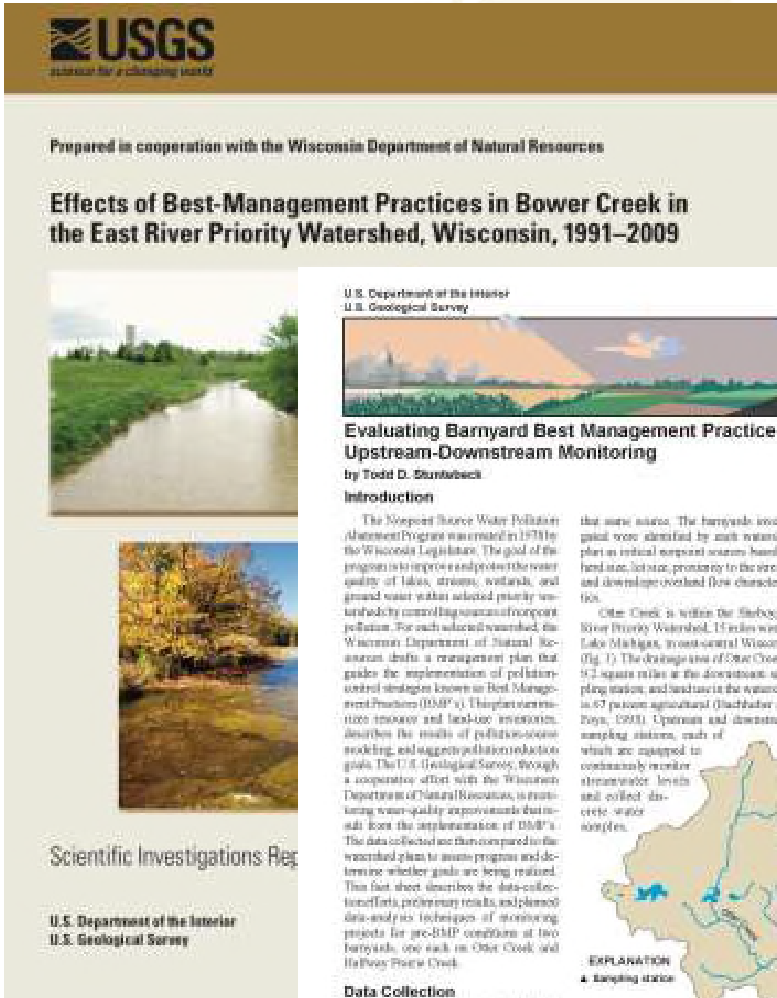
Priority Watersheds

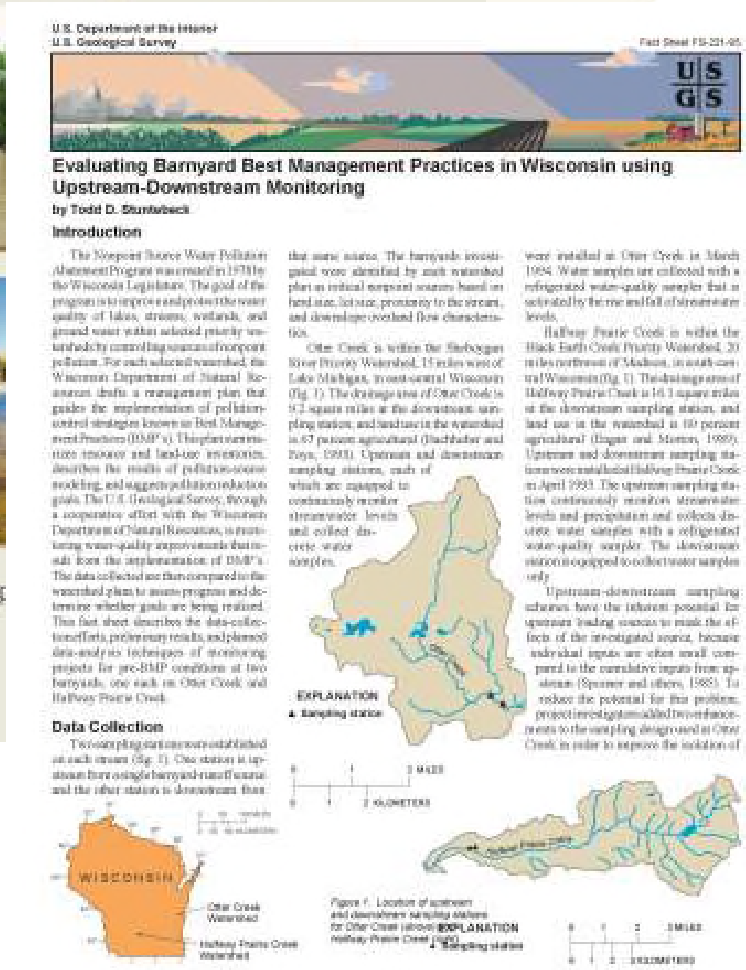


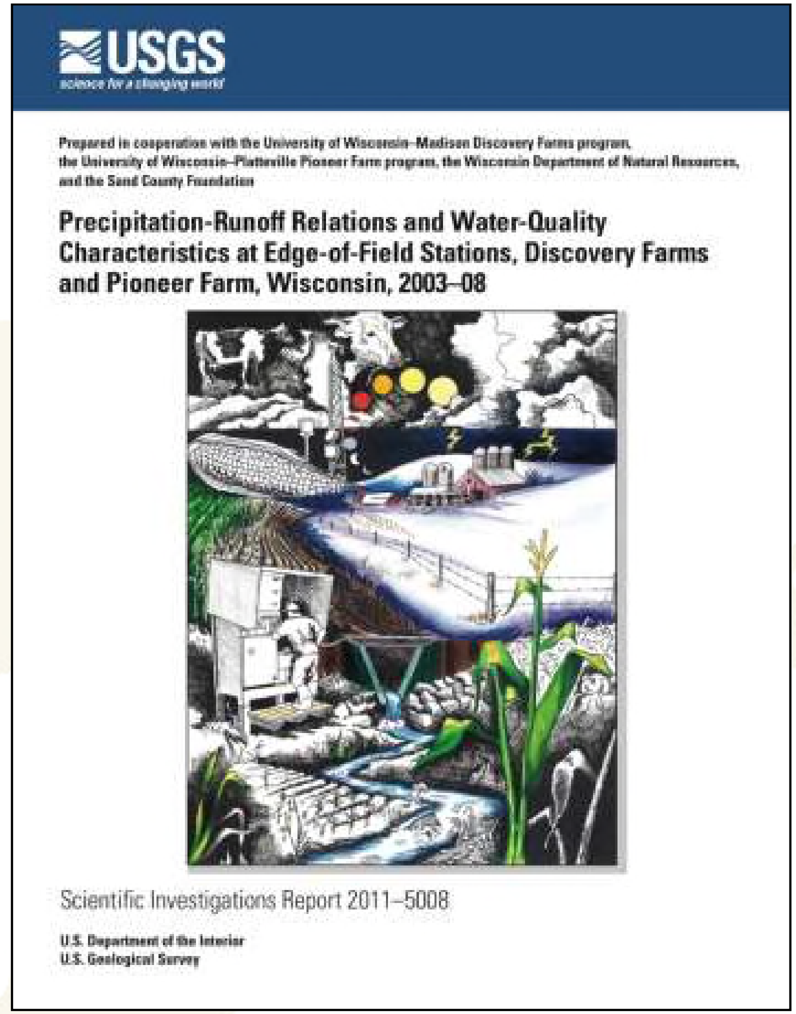
Priority Watersheds



Monitoring Scale – Streams to Field Edge







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What is EOF Monitoring?

- Small Ag basins
- Concentrated flow
- Year-round - natural rainfall/snowmelt
- Surface and/or Tile

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Why do EOF Monitoring?

- Better understanding of sources
- Effects of practices, field activities
- Improved models
- Shorter study duration
- Producer involvement

USGS EOF Monitoring History

- Projects since 2001:
  - Pioneer Farm (2001 – 2011) 13 Sites
  - Discovery Farms (2003 – ongoing) 36 Sites
    - Currently 11 EOF
  - Mississippi River Basin Initiative (2012 – 2014) 3 Sites
    - 2 EOF, 1 Tile
  - W. Branch Milwaukee River (2012 – 2015) 3 Sites
  - GLRI (2012 – ongoing) 22 Sites
    - Currently 14 EOF, 8 Tile
- 60+ EOF Surface Water Sites
  - > 250 site-years of record
- 16 Subsurface Tile Sites
  - > 50 site-years of record

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Not Your "Traditional" Sites

- Depending on site conditions, limited number of events
- Directly impacted by field treatments
- Variable concentrations during events

- Each site is custom to fit location and study objectives
- Need to minimize disturbance to agricultural activities
- **Need Flexibility**

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Equipment

Measure the quantity and quality of water leaving agricultural sites (edges-of-fields, streams and tiles)

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Typical Monitoring Station

- Datalogger
- Stage sensor
- Refrigerated Autosampler
- Power Source(s)
- Communication
- Time-lapse camera

- ~$20-$25K per station depending on power needs

Challenges

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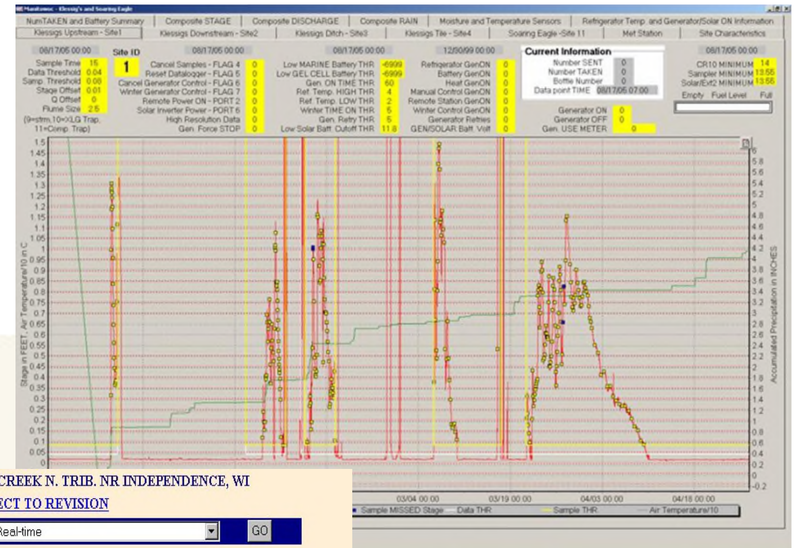
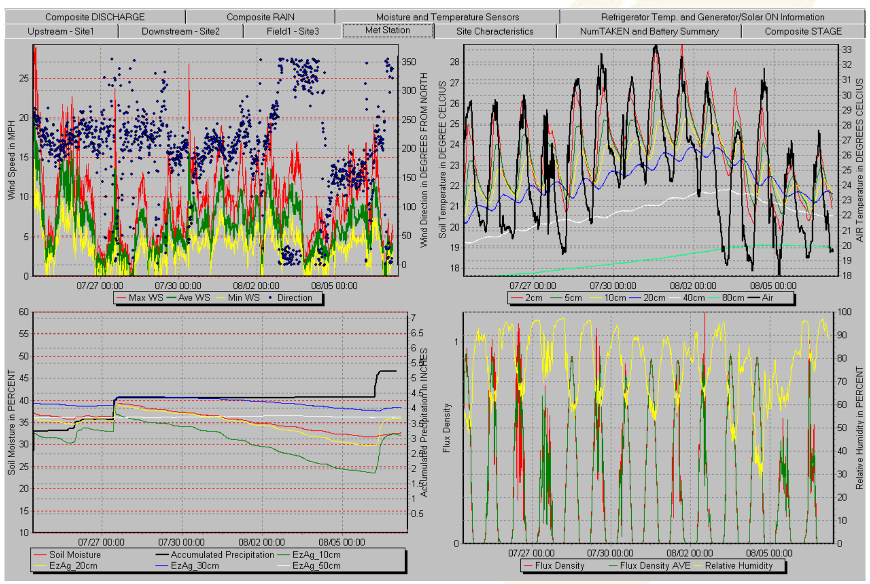
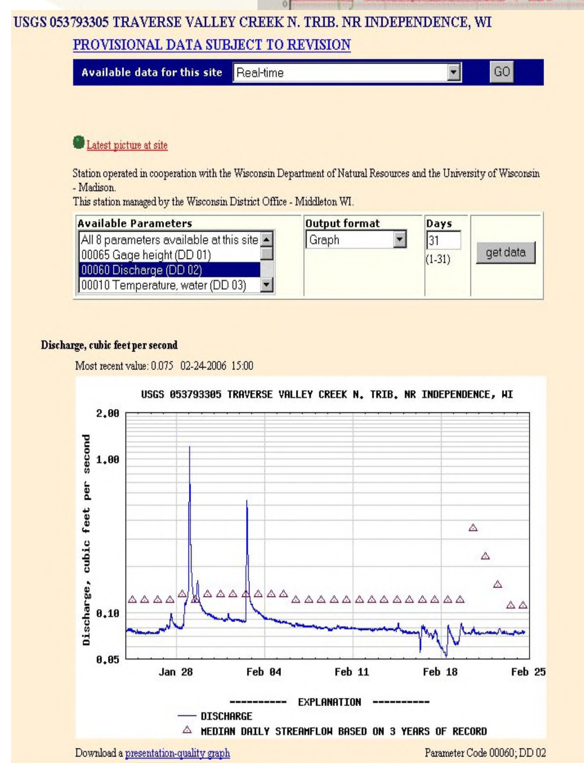
Turning Data into Information

- Collecting the data is only one step







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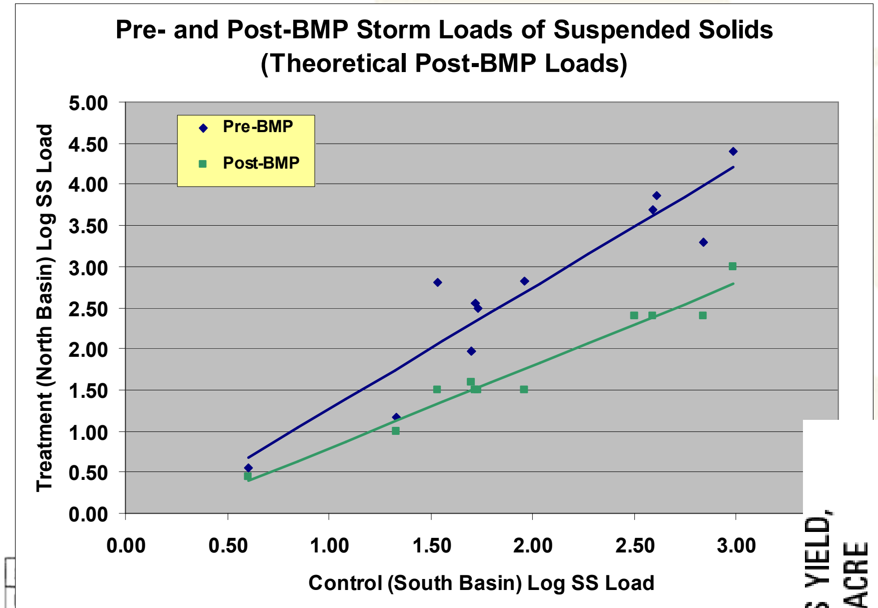
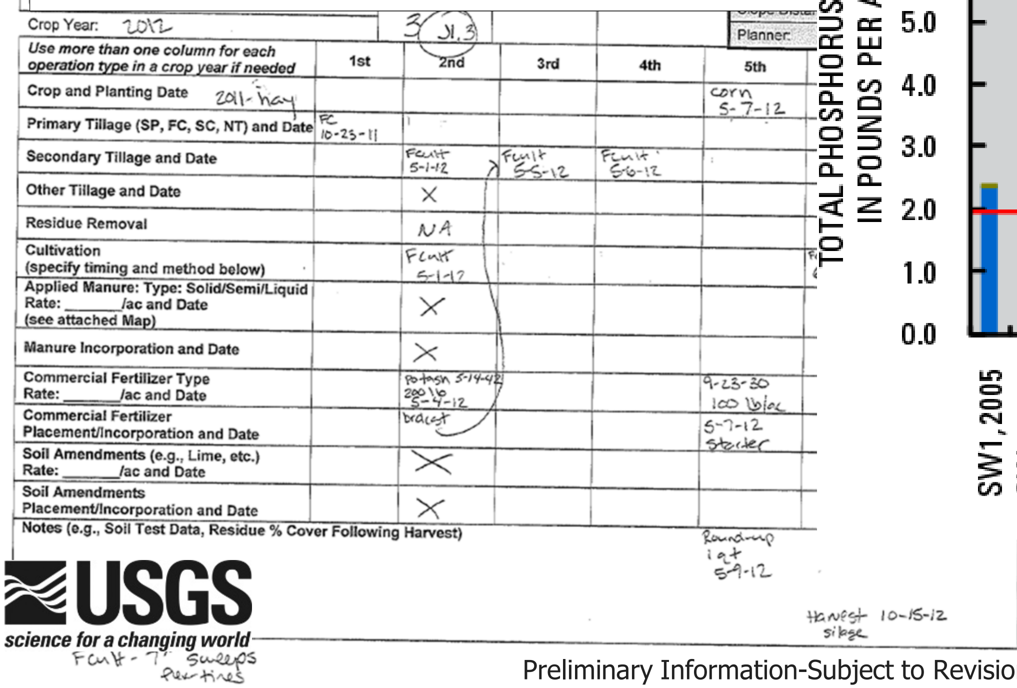
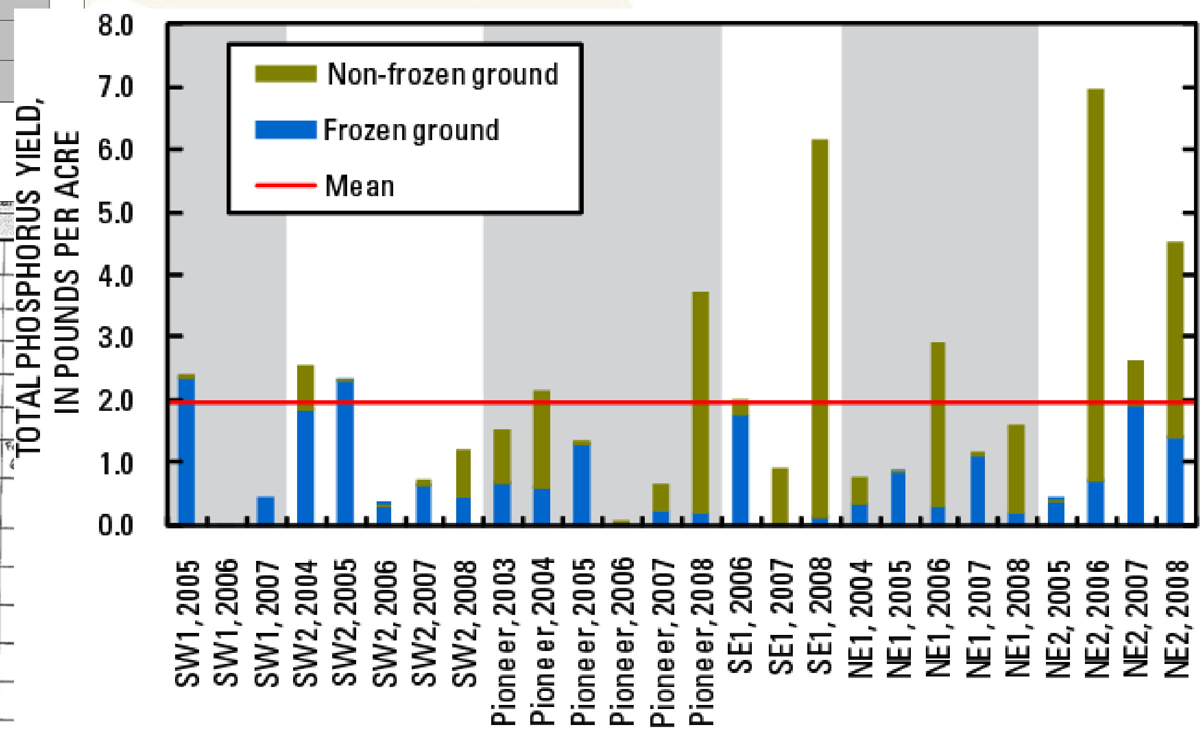
Turning Data into Information

- **Evaluation of a BMP**
- **Defining the impact of agricultural practices**
- **Calibration/validation data for models**







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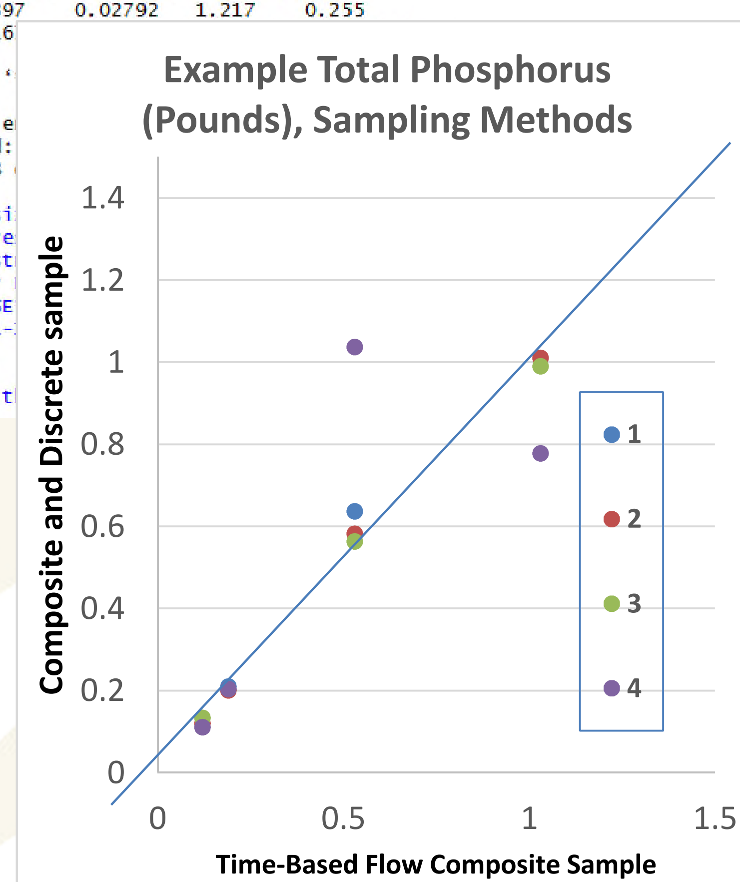
Meeting Needs

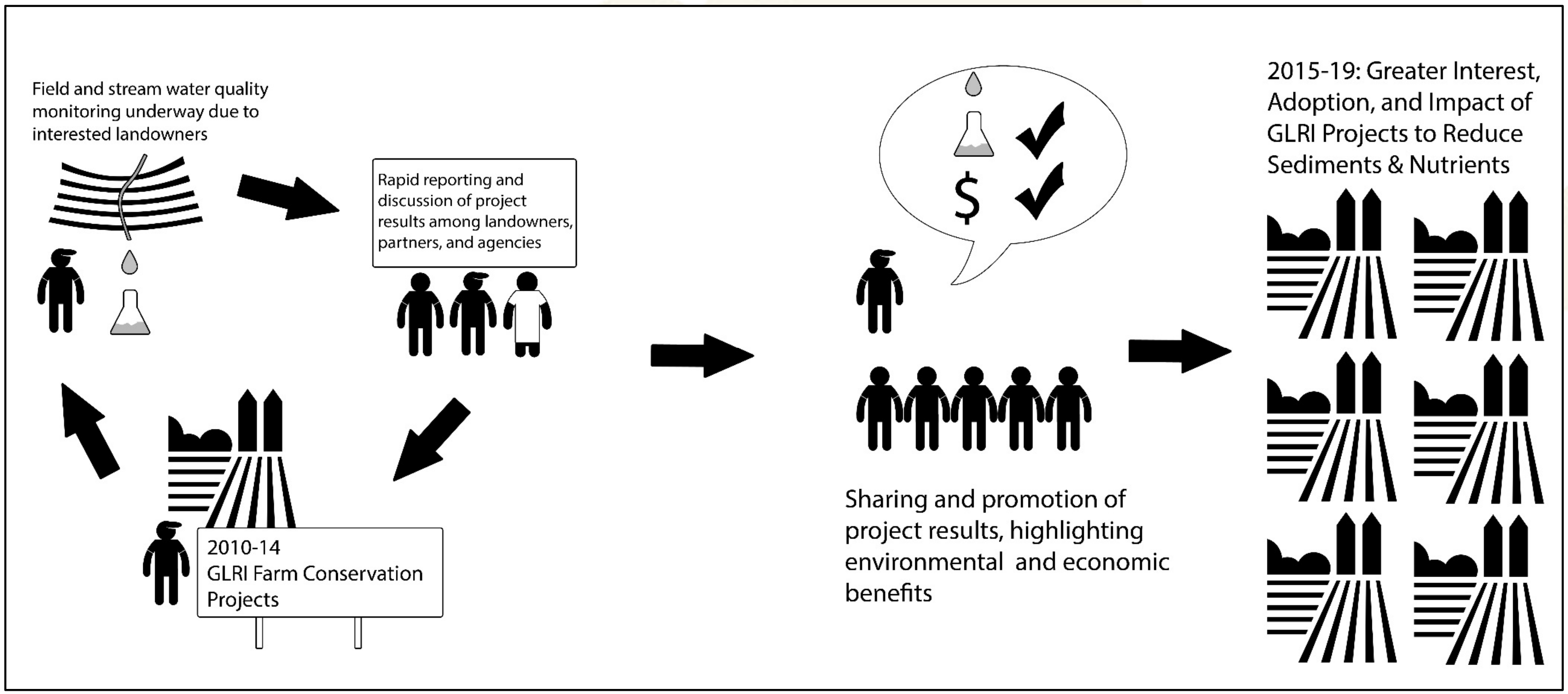
```
> #MINIMUM DETECTABLE CHANGE calculation without implementation data:
> model = lm(SW5_TP ~ SW4_TP, data=CalData)
> summary(model)

Call:
lm(formula = SW5_TP ~ SW4_TP, data = CalData)

Residuals:
      Min        1Q    Median        3Q       Max
-0.097262 -0.046951 -0.004939  0.037845  0.165306

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.03397    0.02792   1.217    0.255
SW4_TP       1.2816
---
Signif. codes:  0 '

Residual standard e
Multiple R-squared:
F-statistic: 350.8

> N <-11 #sample si
> MSE <-0.06843 #re
> #student's t-dist
> T <- -1.833 #for
> mdc <-T*(sqrt(MSE
> mdcPercent <- (1-
> mdcPercent
[1] 48.61309
> #48.6% #this is t
```

```
TPLoading at
Number of observations:  36
Distribution:  lognormal
Method:  AMLE
Degrees of freedom:  4
RMSE:  0.7192871
StdErrPercMean:  0.3233073
RSQ:  0.854123
Number of censored values:  0
TPLoading ~ (Intercept) + log(peakDisch) + p60max.inches.per.hour + log(rain_amount)

                    Term Coefficient StdError pvalue StCoef
1            (Intercept)       2.011    0.301  0.000  6.685
2         log(peakDisch)       1.502    0.115  0.000 13.104
3 p60max.inches.per.hour      -2.428    0.419  0.000 -5.790
4       log(rain_amount)       0.340    0.124  0.006  2.748
5               logSigma       0.517    0.119  0.000  4.358

Correlation matrix of coefficients:
                       (Intercept) log(peakDisch) p60max.inches.per.hour log(rain_amount) logSigma
(Intercept)                 1.0000         0.5913                -0.8677           0.5112    1e-04
log(peakDisch)              0.5913         1.0000                -0.4310          -0.0423    1e-04
p60max.inches.per.hour     -0.8677        -0.4310                 1.0000          -0.5065   -1e-04
log(rain_amount)            0.5112        -0.0423                -0.5065           1.0000    2e-04
logSigma                    0.0001         0.0001                -0.0001           0.0002    1e+00
```



Beyond Change Detection

- Education
- Producer Involvement
- Partnership building
- Model calibration



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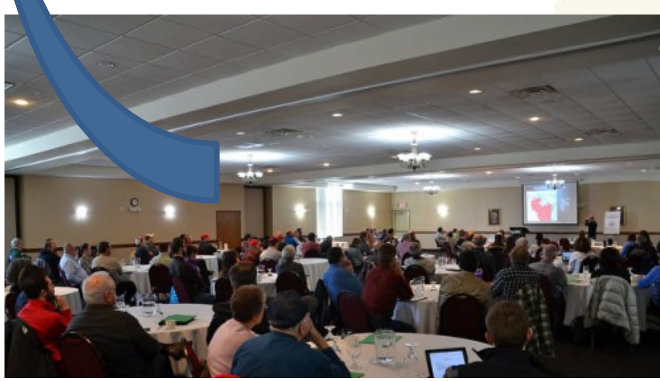
Advancing Science and Improving Conservation

Producer Meetings

Conservation Tours



Public

Policy

Research

"People here in the United States – and in many other countries – are learning that we must have soil conservation if we are to have continuous, abundant agricultural production. We are fast learning, too, that it must be effective conservation…"

Dr. Hugh H. Bennett, 1946, JSWC 1 (1): 21-24.

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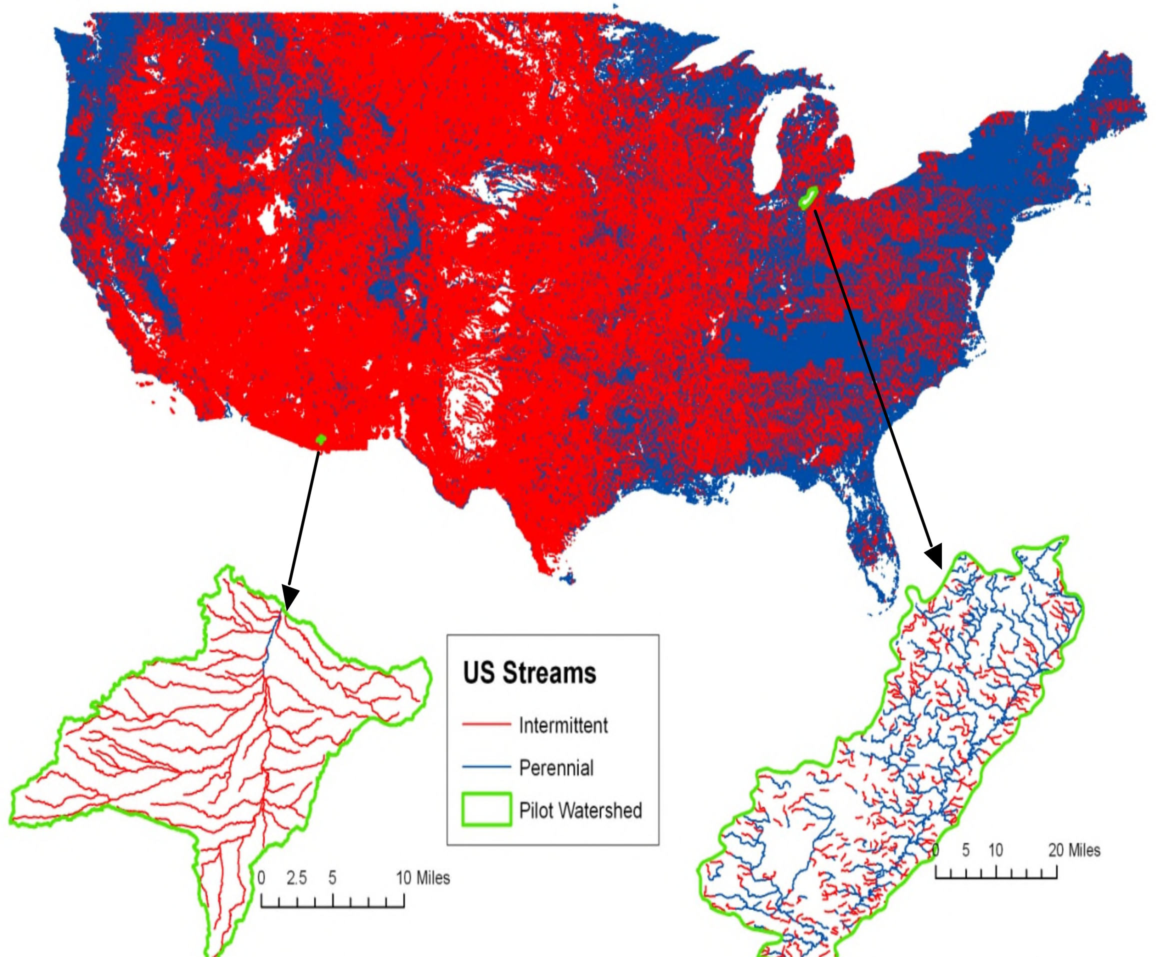
Who Needs Data and Why?

Producers, farm
managers, advi

- Feedback on part
practices, concer
- Support adaptive
management,
conservation plan



Cienega Creek Watershed
Percent Perennial = 1.7%

St. Joseph's Watershed
Percent Perennial = 58.5%

ncies, scientists

arch – understanding
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USDA

Map from Phil Heilman, USDA ARS

Water Quality Monitoring Is a Tool

CANNOT

- Conduct watershed planning
- Determine appropriate conservation practices
- Determine critical source areas
- Identify watershed farmers' attitudes toward conservation practices
- Maintain conservation practice
- Provide economic and technical assistance

CAN

- Help Identifying pollutant(s) of concern, sources, and hydrologic transport
- Help identify conservation practice effectiveness
- Inform future management decisions
- Provide information for outreach and adaptive management

Photo by Deanna Osmond, Rock Creek CEAP, 20

How Can NRCS Use EOF Data?

- Conservation Planning
  - Practice effectiveness (need under a range of conditions)
  - Practice interactions and systems, where we can test that, at field scale
- Practice Standards
- Modeling
  - algorithm development
  - need a range of weather, soils, hydrologic conditions
  - calibration, validation

Photo by Lisa Duriancik. EOF monitoring in Indiana.

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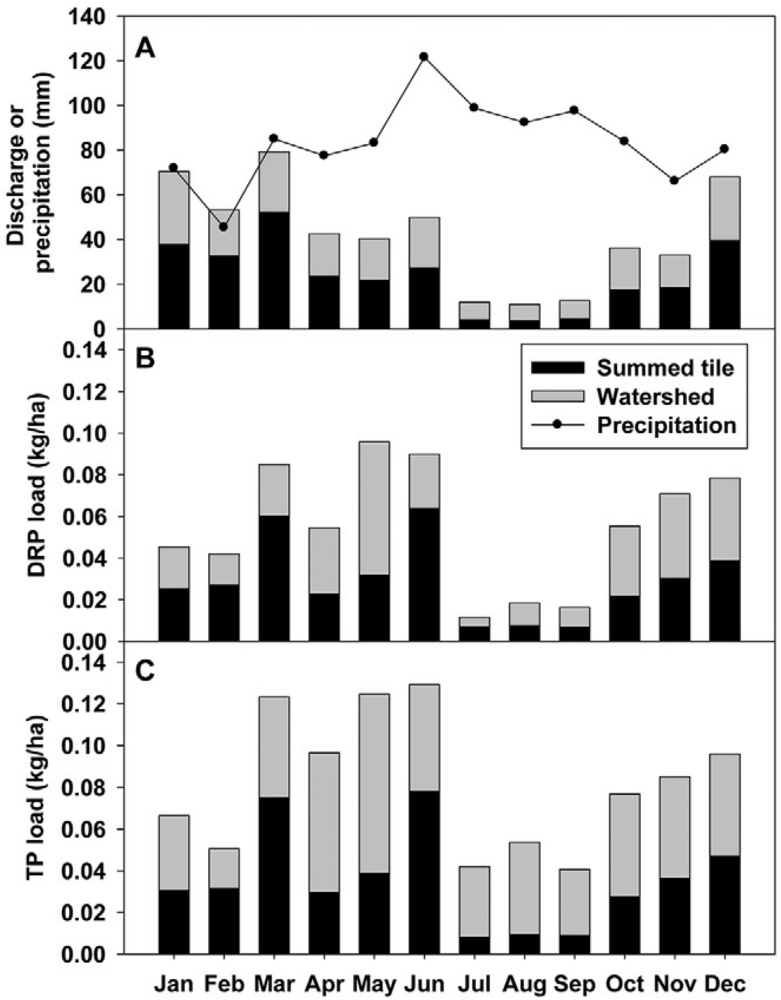
How Can NRCS Use Watershed Data?

Upper Big Walnut Creek ARS CEAP Watershed, OH



King, Kevin W., et al. 2014. JEQ.

- Primary constituents, sources and flow paths for planning
- Outcome reporting
  - Align with conservation implementation
  - Feedback into watershed conservation plan
- Explanatory variables
  - Why or why not?
  - Be explicit about conclusions
    - Articulate the nuances
  - EOF within helps
- Modeling to help understand and attribute effects
  - Combined approach often necessary

Considerations for Greater Utility of Water Quality Monitoring Data

Comprehensive scales and watershed designs more useful

- EOF, within watershed and at watershed outlet
- Combine locations regionally
- Model to evaluate broader effect

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ment?

Include groundwater where appropriate and feasible

Synthesize lessons learned

- I
- Sh
- Gu
  and
- Inform
  assess
  approac

The 3 Cs:
COORDINATE
COLLABORATE
COMMUNICATE

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