Trends in Pesticide Concentrations in Corn-Belt Streams, 1996-2006

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National Water Quality Monitoring Conference
April 28, 2010

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NAWQA

Topics

- ➢ **Study background**
- **Trend assessment technique**
- **Summary of atrazine and metolachlor concentration trends**
- **Relation between concentration trends and pesticide use**

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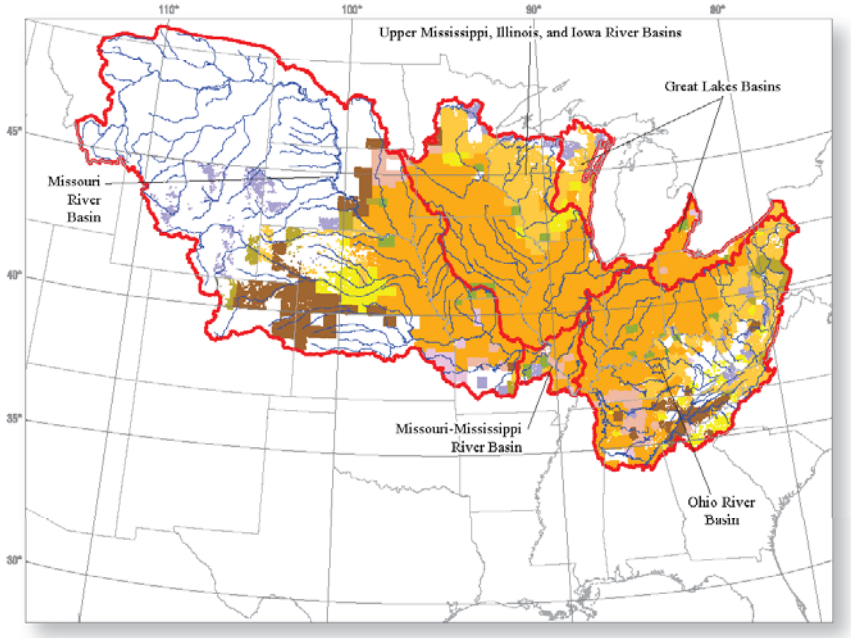
NATIONAL WATER-QUALITY ASSESSMENT PROGRAM

Trends in Pesticide Concentrations in Corn-Belt Streams, 1996–2006



Scientific Investigations Report 2009-5132

U.S. Department of the Interior
U.S. Geological Survey

USGS Report

By

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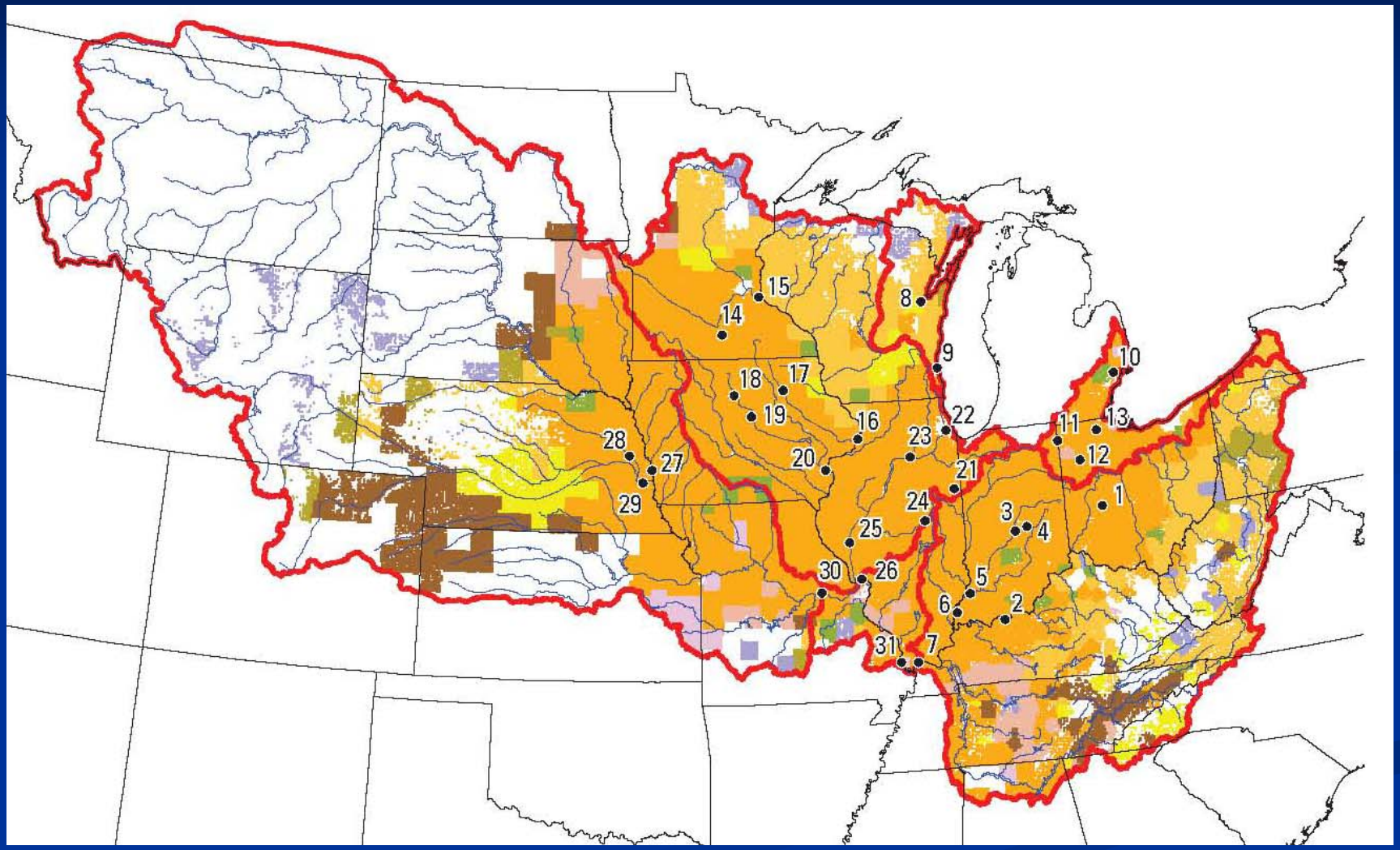
http://pubs.usgs.gov/sir/2009/5132/

Study Objectives

1) Evaluate the performance and applicability of statistical trend-assessment methods for pesticide data.
2) Assess trends in concentrations of commonly occurring pesticides in selected Corn Belt streams.
3) Assess the relative influences of pesticide use patterns and other potential factors, such as changes in management practices, on pesticide trends

31 USGS pesticide sampling sites in Cornbelt (culled from a national network of 201 NAWQA sites)



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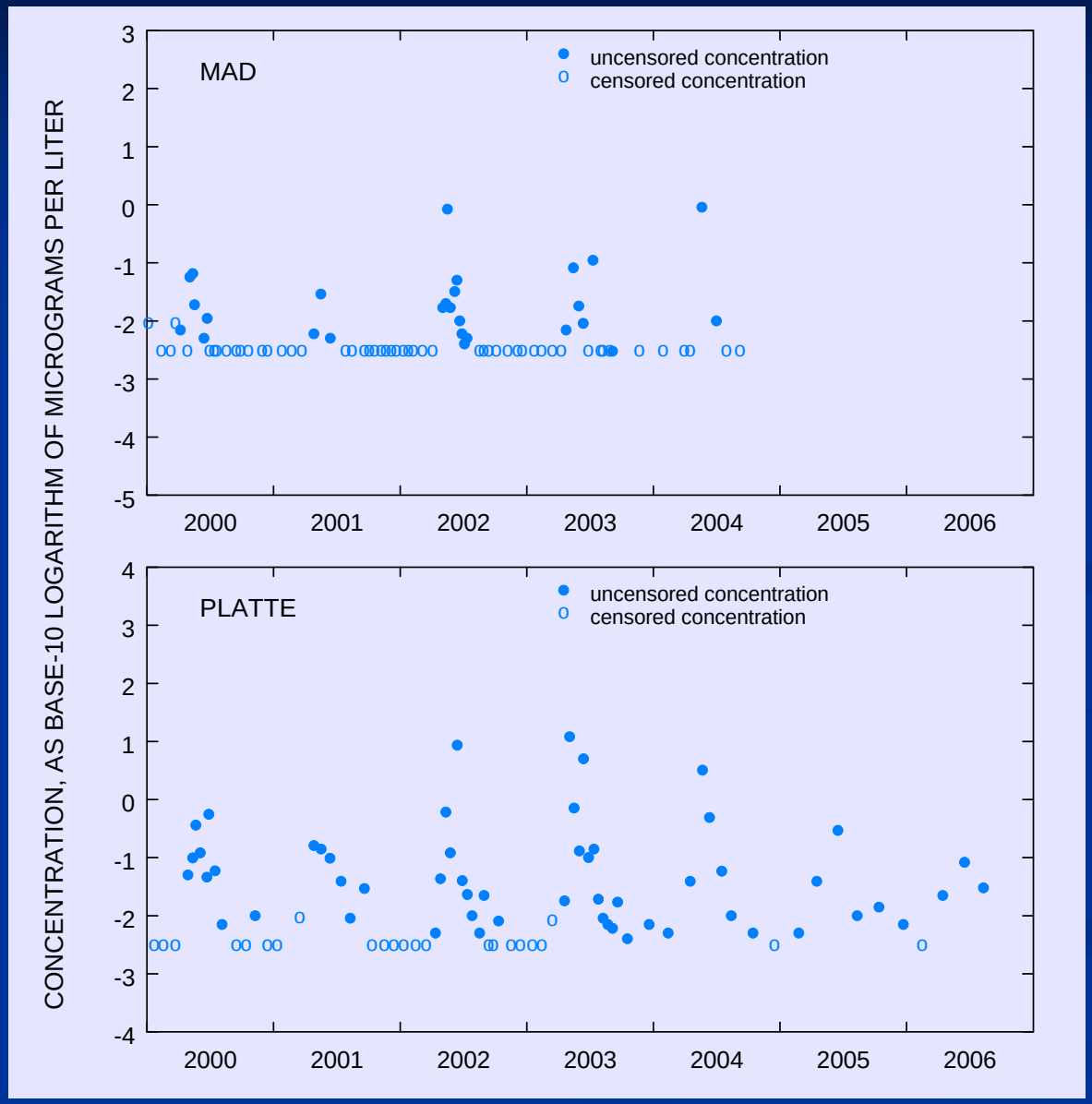
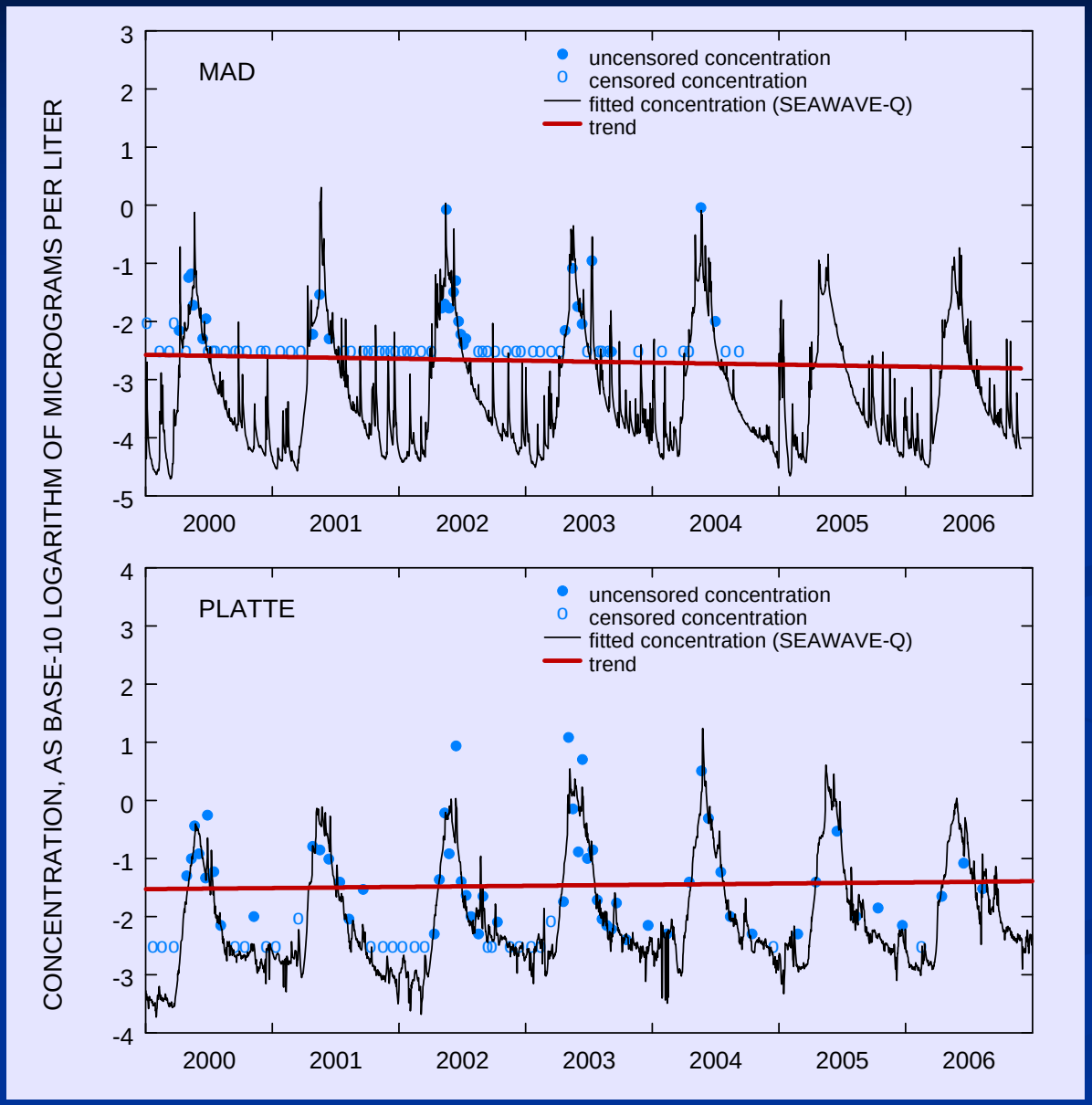
Acetochlor data for Mad River and Platte River



Trend-Method Requirements

- Repeatable
- Unbiased
- Efficient
- Robust:
  - Censoring
  - Sparse and changing sampling
  - High variability
  - Changing flow

Acetochlor data for Mad River and Platte River



SEAWAVE-Q

"seasonal wave w/streamflow adjustment"

Statistical model for concentration with:

- **Seasonal variability**
- **Flow-related variability**
- **Trend**
- **Error**

SEAWAVE-Q Model

"Seasonal wave with streamflow adjustment"

Log(Conc) = SWAVE + FLRV + TND + ERR

- **SWAVE = $\gamma_0 + \gamma_1 W(t)$**
  - ***W(t)* is a periodic function (period=1 yr)**
  - **$(d/dt)\, W(t) = \lambda(t + s) - \phi\, W(t)$**
  - **$\lambda(.)$ is a pulse input with $\lambda(.)>0$ during the "application season(s)" and $\lambda(.)=0$ otherwise**
  - ***s* is a seasonal shift**
  - **ϕ is a "decay rate"**

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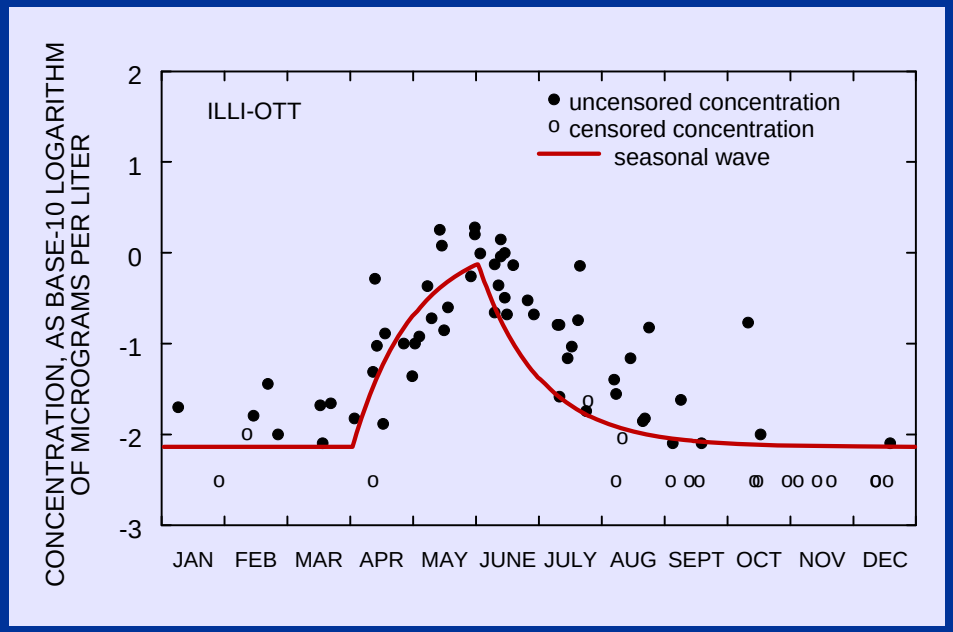
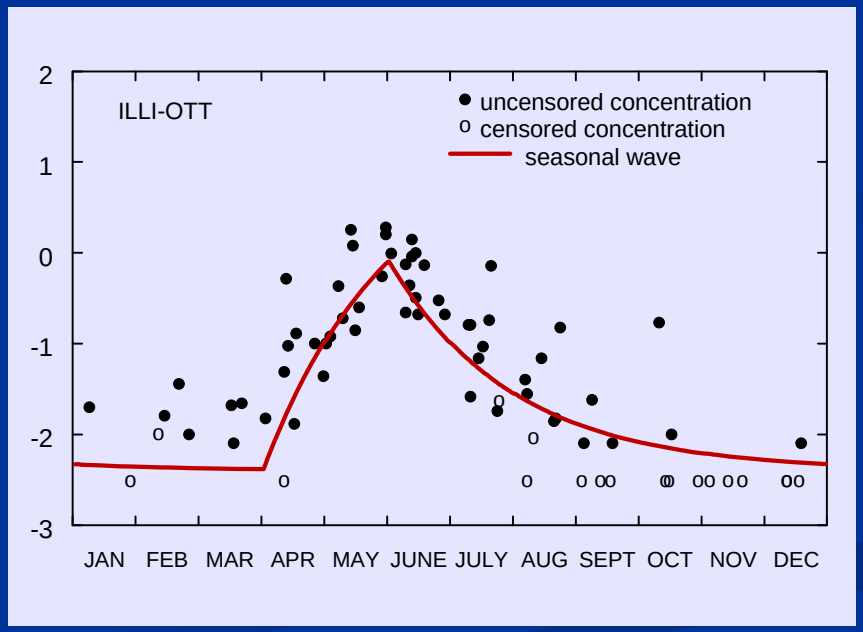
Seasonal wave for acetochlor – Illinois River at Ottawa, IL (2000-2006)

2-Month Application Season (Apr-June)

Decay rate too fast



Decay rate "just right"



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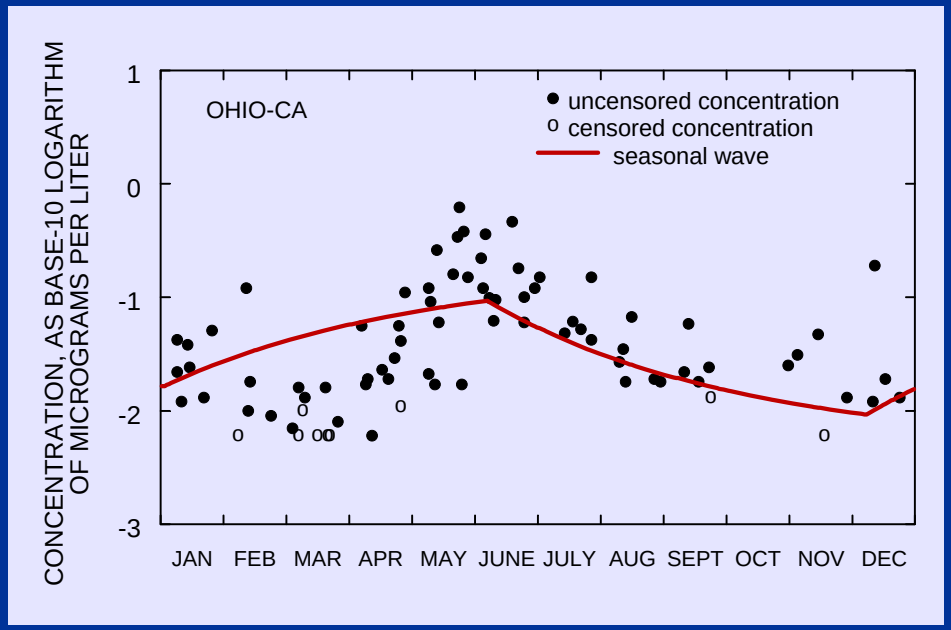
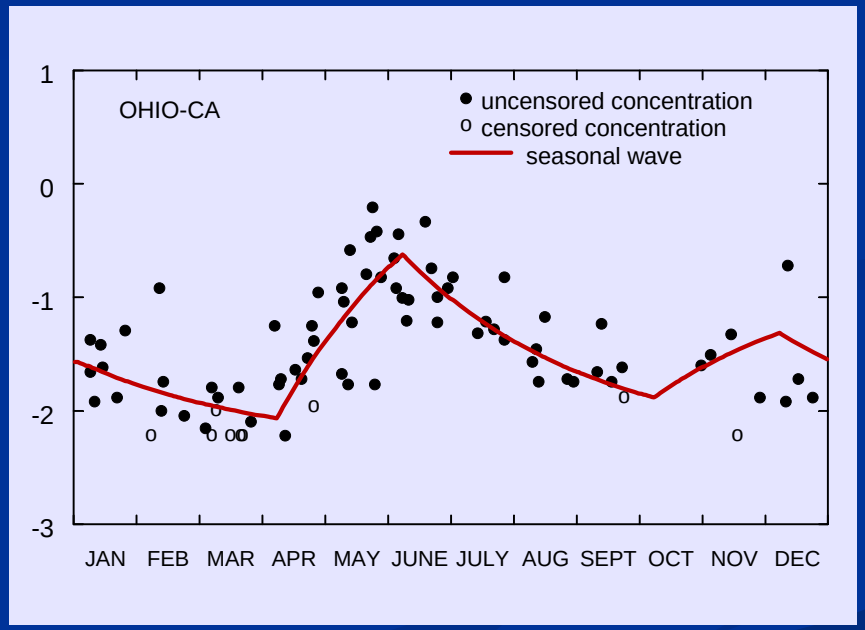
Seasonal wave for simazine - Ohio River at Cannelton Dam (2000-2006)

6-month application season (Dec-June)



Poor fit – model rejected

Two, 2-month application seasons (Oct-Dec and Apr-June)



Optimum fit – model accepted

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SEAWAVE-Q Model

Log(Conc) = SWAVE + FLRV + TND + ERR

- **FLRV = γ_2 LTFA(t) + γ_3 MTFA(t) + γ_4 STFA(t)**

  "Flow-related variability"

  - **Flow anomalies computed using log-transformed daily flow for USGS streamgage**
  - **LTFA(t) "long-term flow anamoly"**
    - **Low-frequency (annual) flow variability**
  - **MTFA(t) "mid-term flow anomaly"**
    - **Mid-frequency (seasonal) flow variability**
  - **STFA(t) "short-term flow anomaly"**
    - **High-frequency (day-to-day) flow variability**

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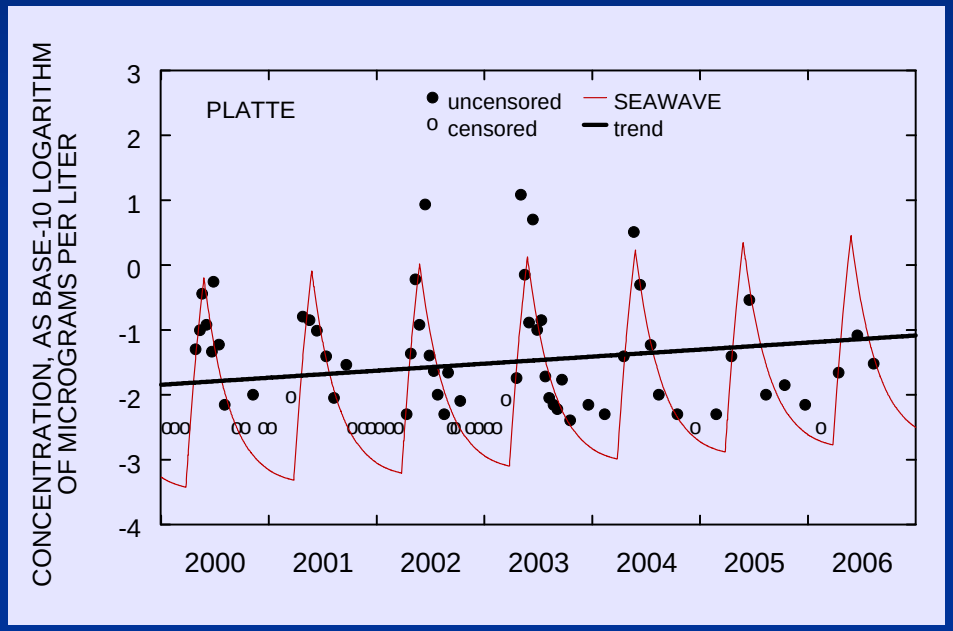
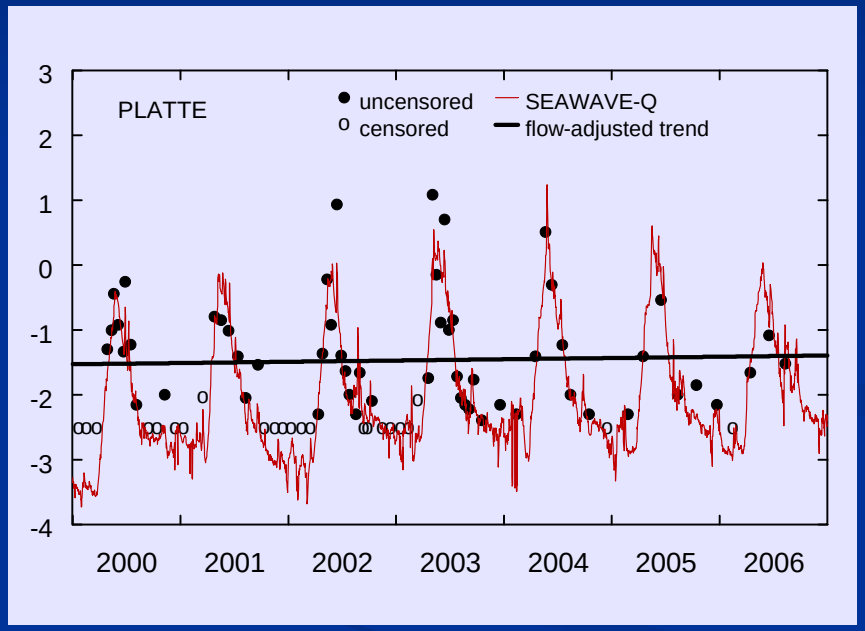
Acetochlor for Platte River at Louisville, NE

Without FLRV



With FLRV



Significant (p=0.006) upward trend (28 percent per year)

No significant flow-adjusted trend

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SEAWAVE-Q Model

Log(Conc) = SWAVE + FLRV + TND + ERR

- **TND = $\gamma_5 t$**
  - **Log-linear trend**
  - **"Flow-adjusted trend" (adjusted for FLRV)**
- **ERR**
  - **Random error**
  - **Assumed normal, uncorrelated**

Model parameters estimated using maximum likelihood with censored data ("Survival" or "Tobit" regression)

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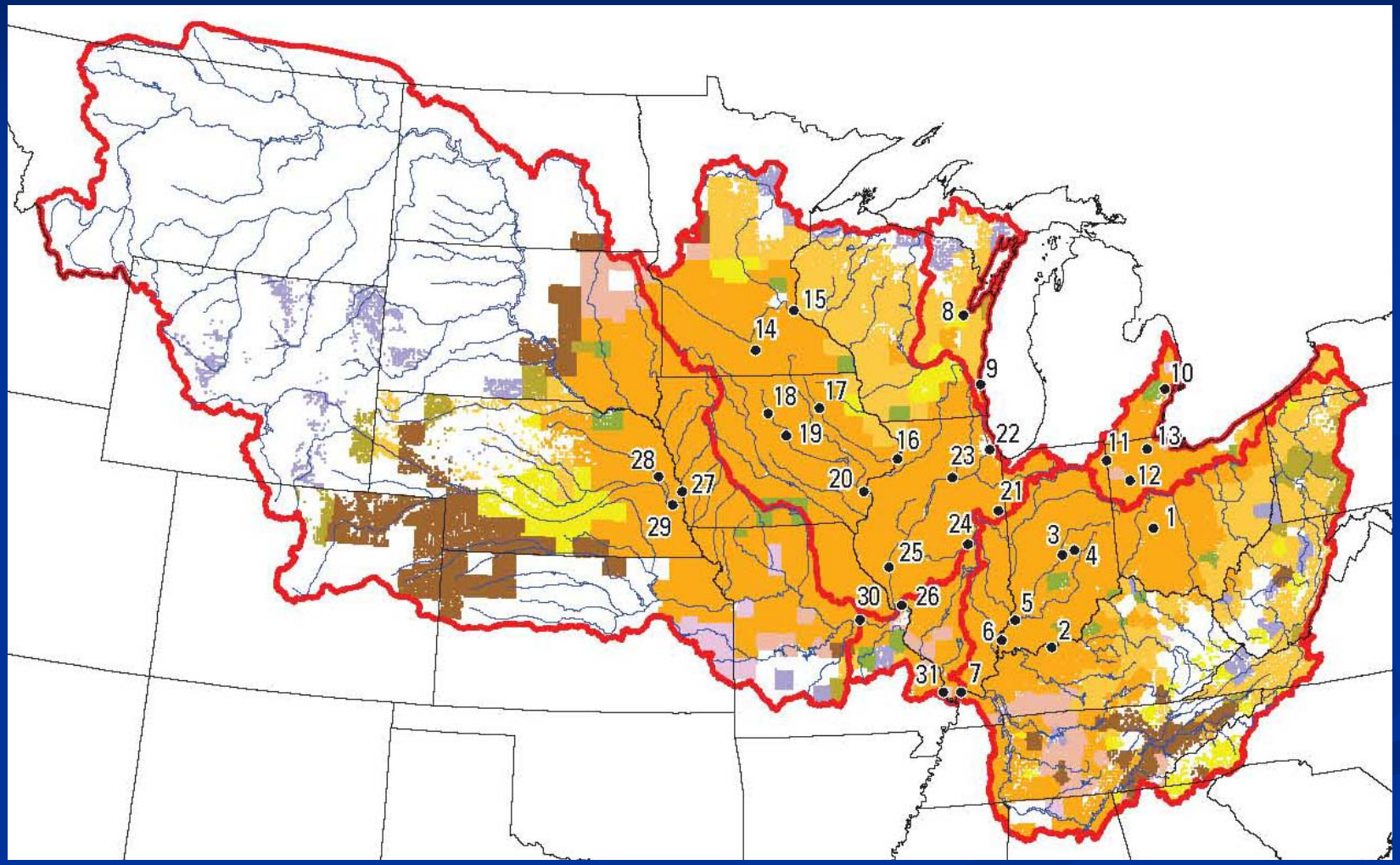
31 Pesticide Sampling Sites on Corn-Belt Streams



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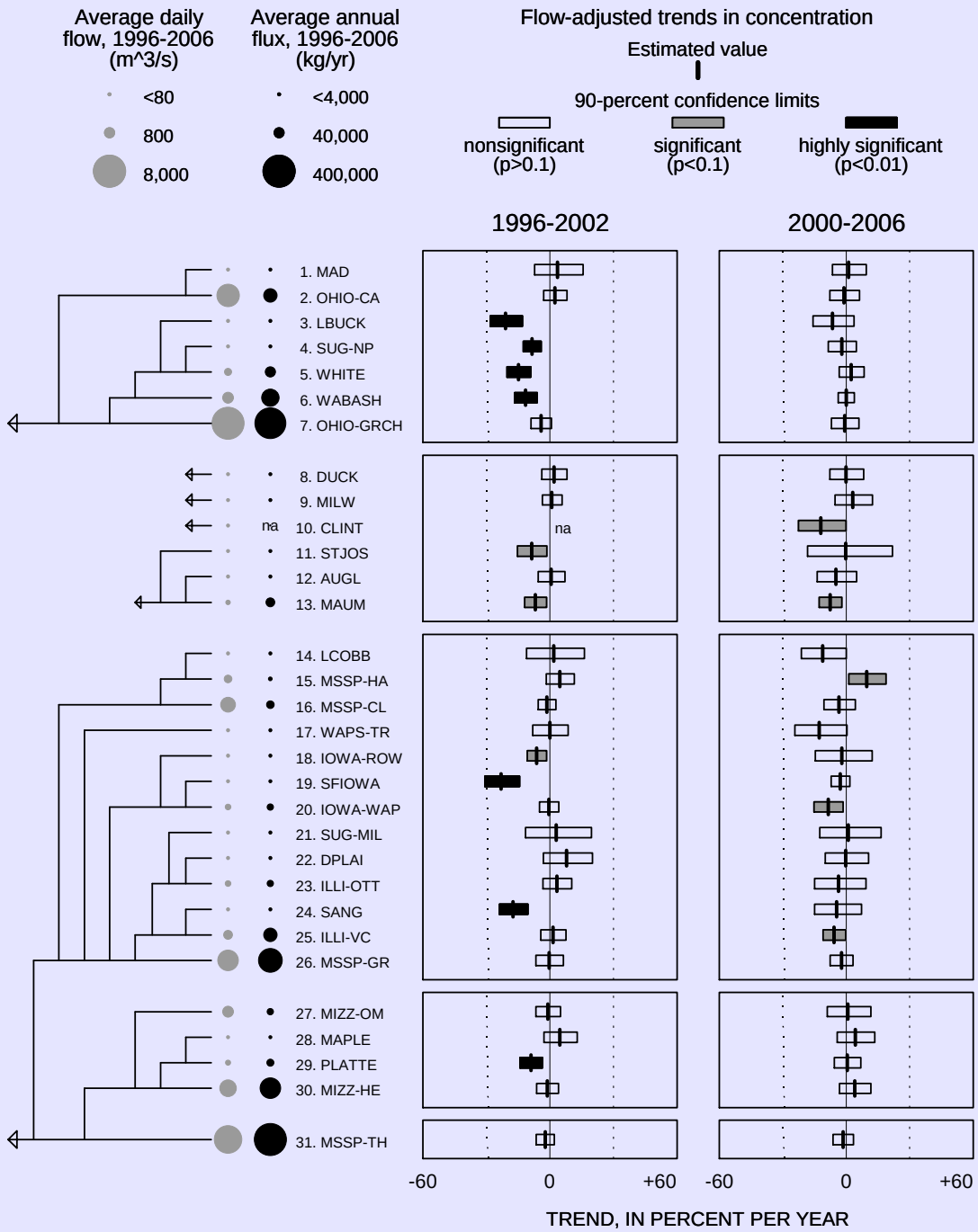
ATRAZINE TRENDS FROM SEAWAVE-Q

Ohio Basin

Great Lakes Basins

Upper Mississippi Basin

Missouri Basin



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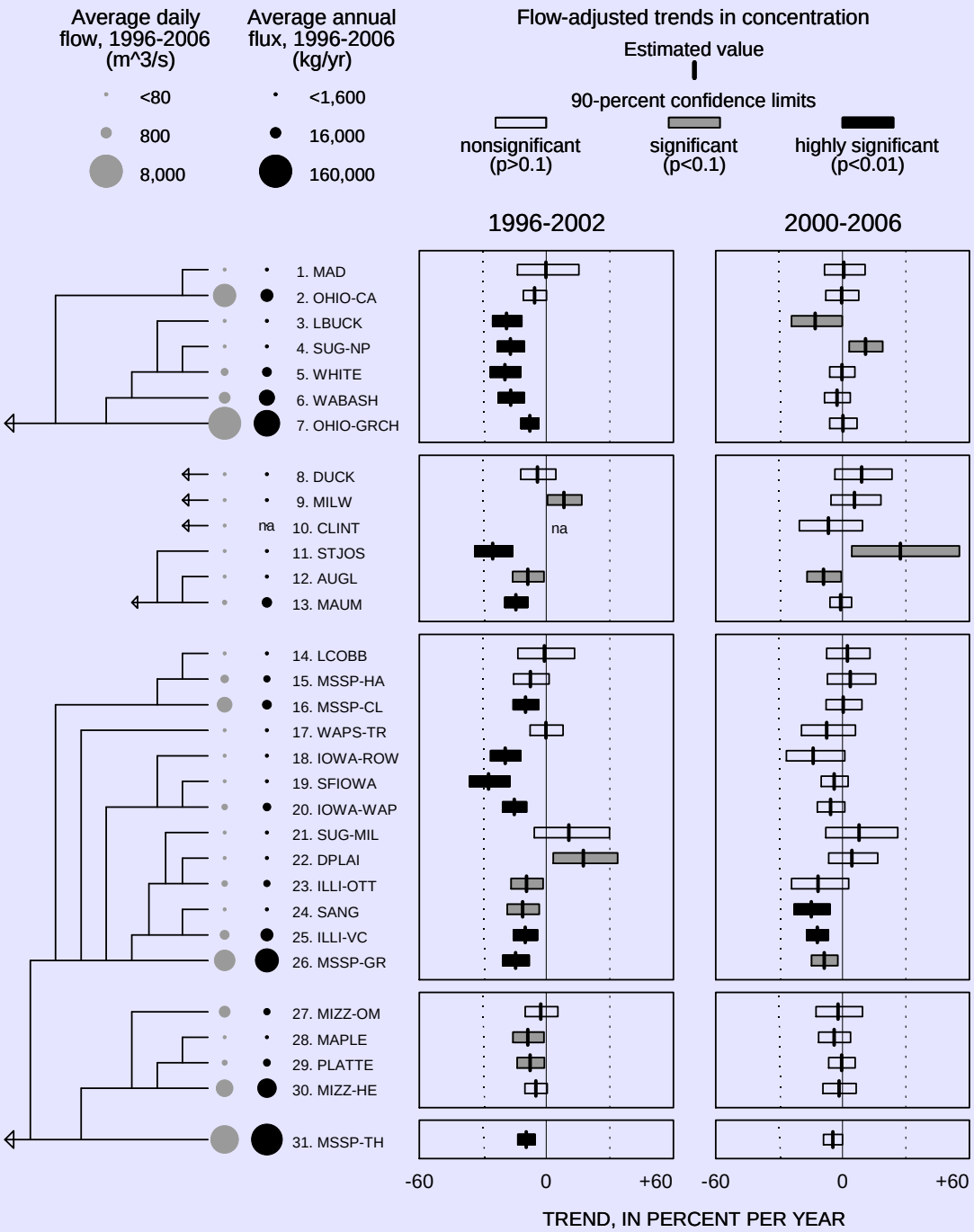
METOLACHLOR TRENDS FROM SEAWAVE-Q

Ohio Basin

Great Lakes Basins

Upper Mississippi Basin

Missouri Basin



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Questions

- How do pesticide trends in corn-belt rivers compare to changes in agricultural use?

- Are there other factors (land use changes, management practices, non-ag use, etc.) that may be contributing?

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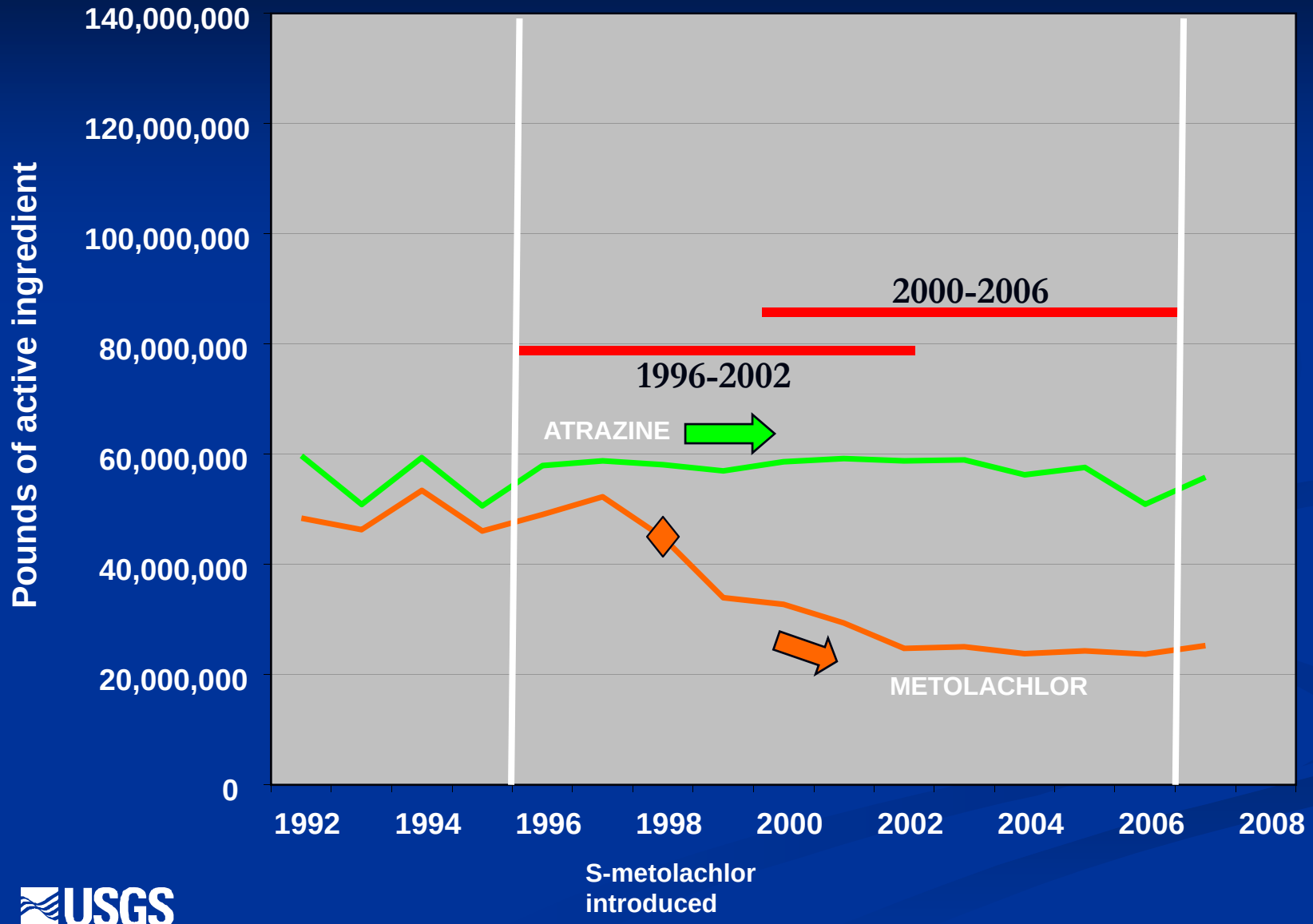
Metolachlor and Atrazine Use

12 States, >80% Corn and Soybean Acreage



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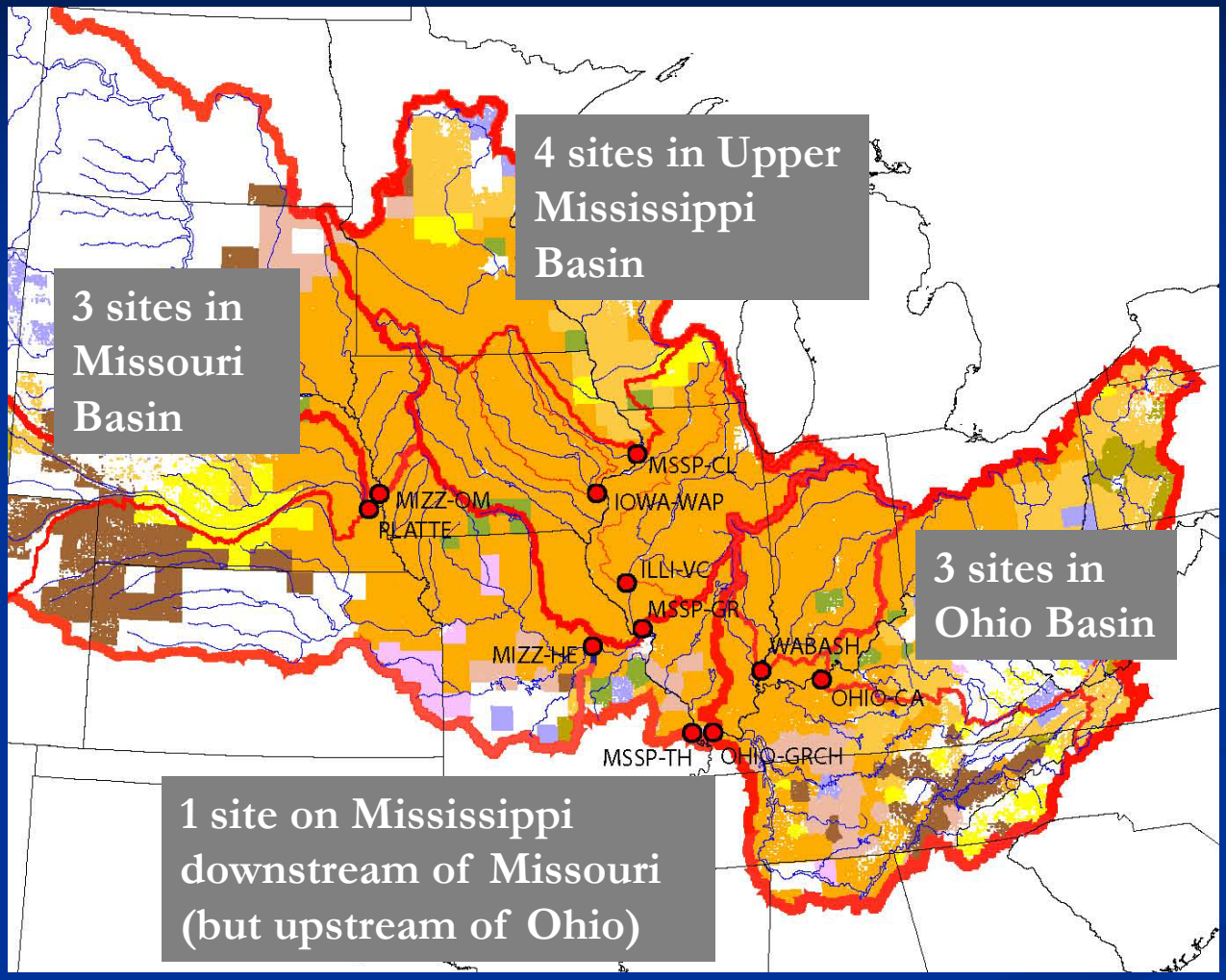
Graphic by USGS based on data provided by Dmrkynetec, Inc.

Focus on 11 sites on major rivers



Annual pesticide use estimates for each basin obtained from GIS coverage of crop data and pesticide application rates

Large basins ~ more accurate use estimates

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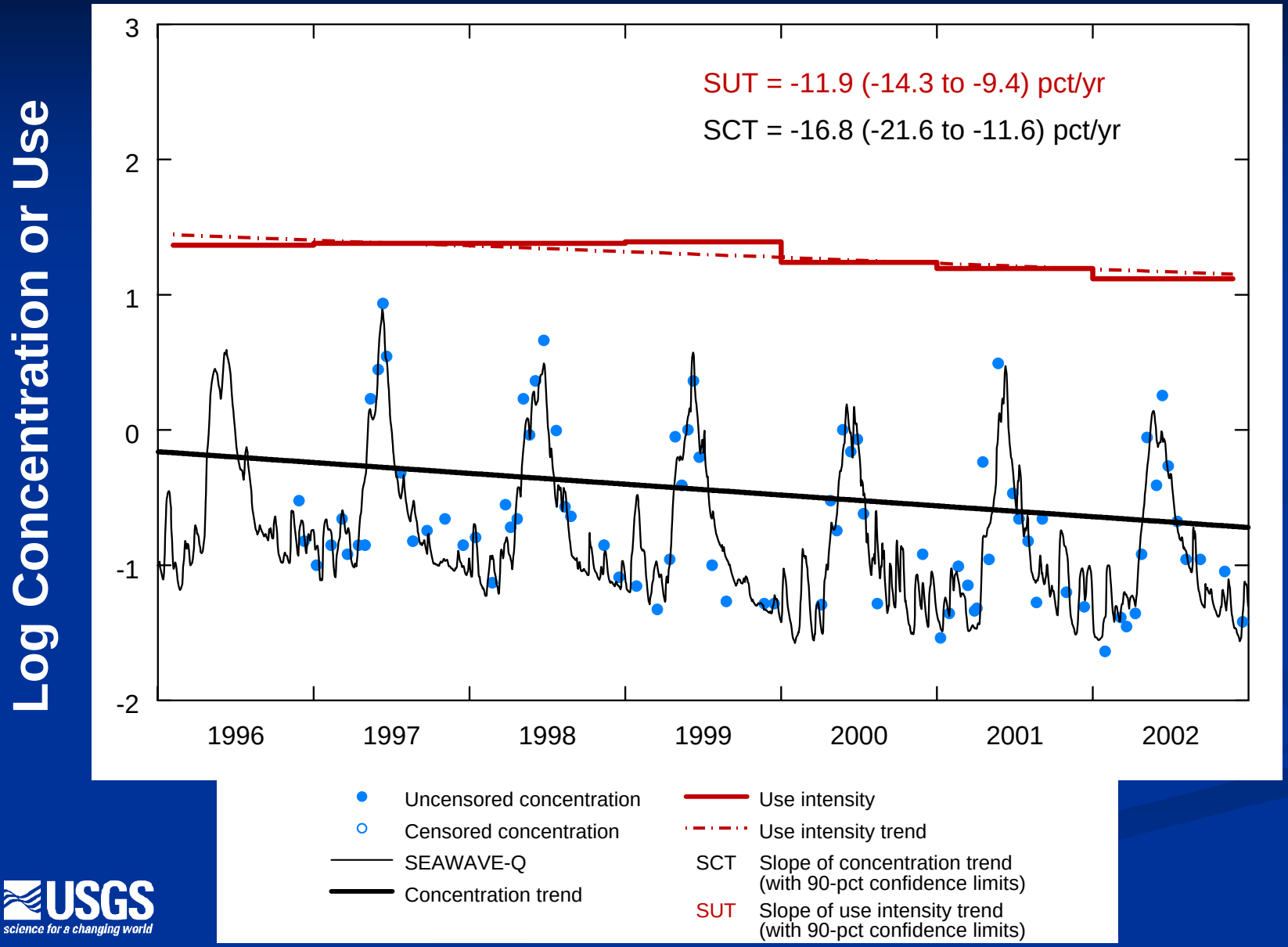
Metolachlor Concentration and Agricultural Use Trends Wabash River: 1996-2002



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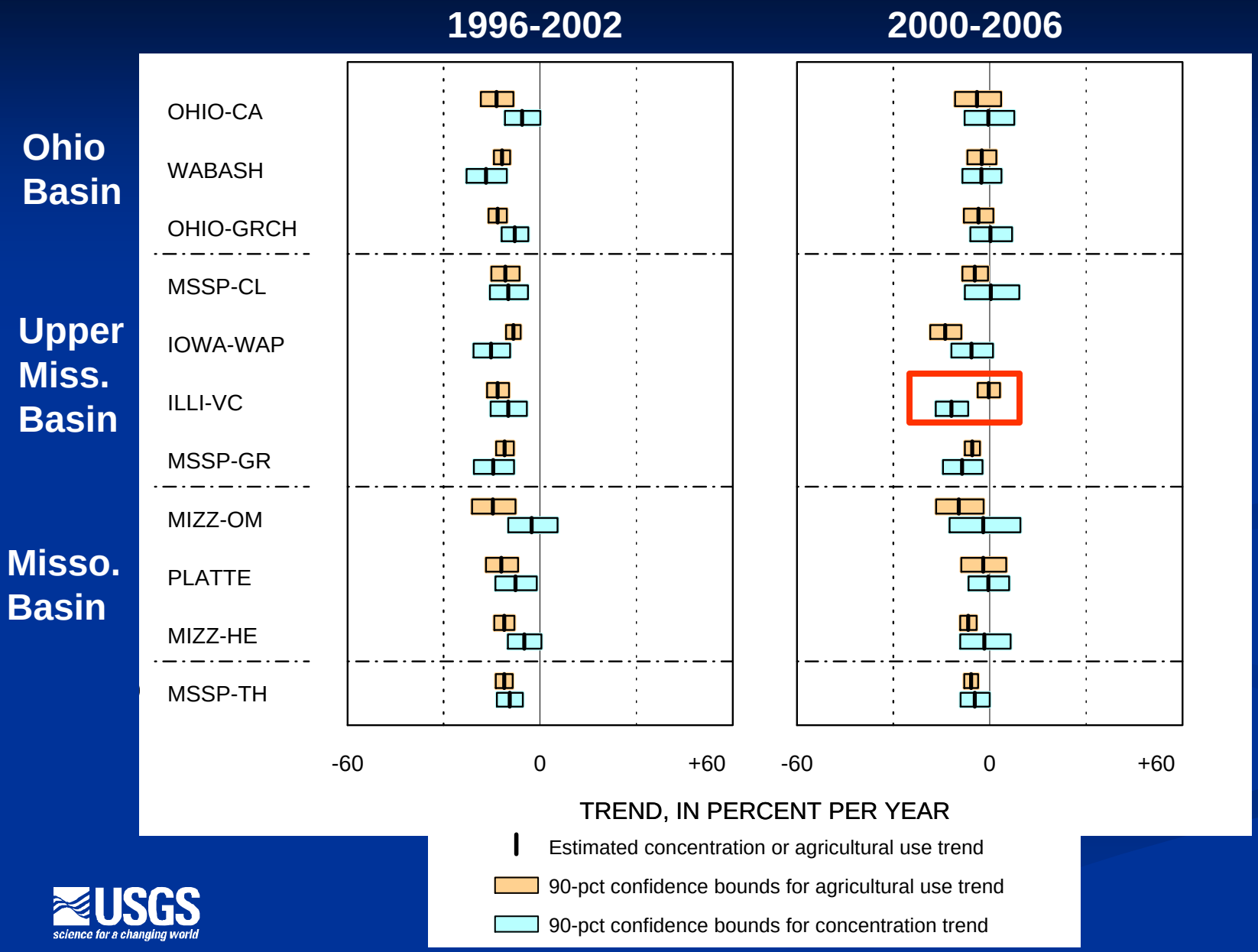
Concentration and Use Trends for Metolachlor



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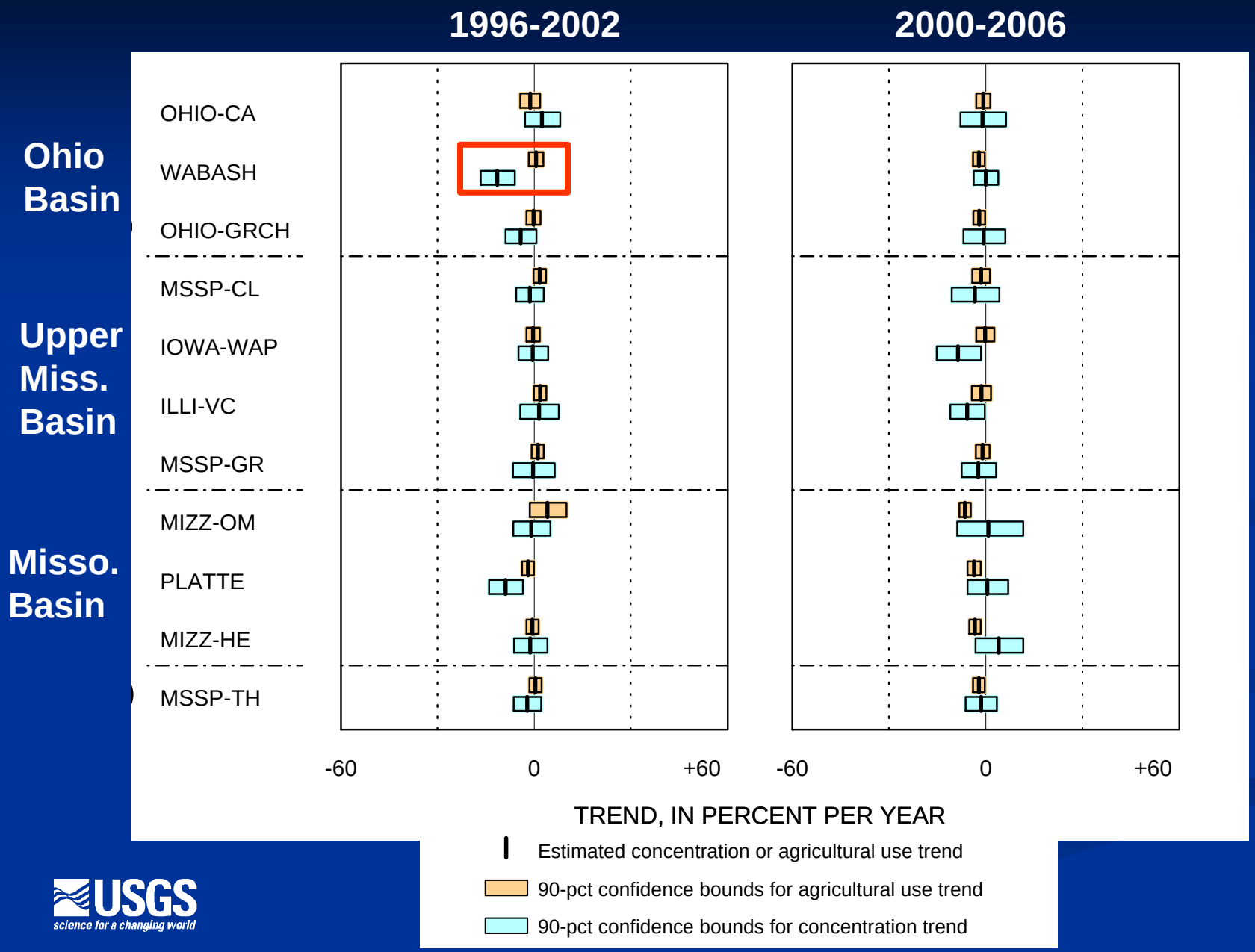
Concentration and Use Trends for Atrazine



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Implications for major agricultural herbicides in large Cornbelt rivers

- A multi-year trend in watershed use intensity generally produces a similar trend in river concentrations.
- Changes in non-use management practices during 1996-2006 have not had a statistically discernable effect on concentrations.
- Large-scale effectiveness of non-use management practices will be difficult to evaluate without improved information on implementation of practices.

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Thanks!

For more Information and copies of publications:

USGS
National Water Quality Assessment Program
Pesticide National Synthesis Project
http://water.usgs.gov/nawqa/pnsp/
or
avecchia@usgs.gov

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