30-year Trends in Sediment Concentrations in Ohio Tributaries to Lake Erie

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Topics

- Approach: Analyzing sediment trends: the how and why
- Results: Observed trends 1975-2005
- Discussion: *Cause and Effect:* Are these trends due to management or “climate change”?

I. Sediment trends: loads or concs?

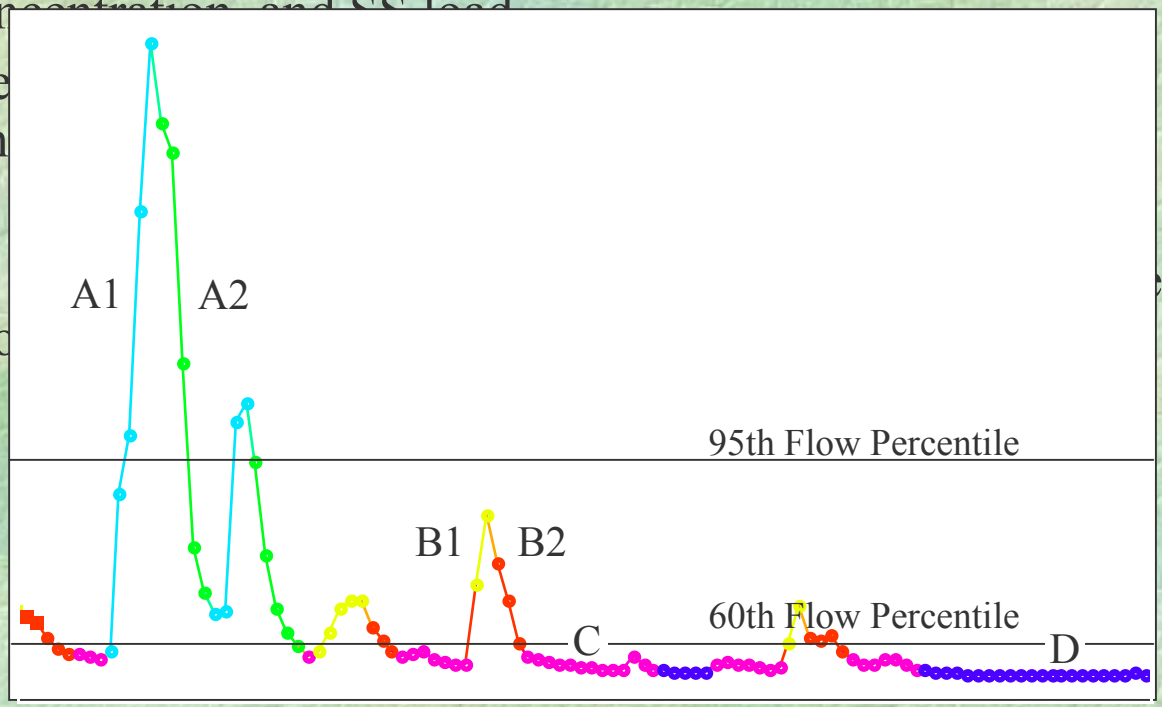
- For many (but not all) management issues, loads are what's important
  - P inputs to Lake Erie; N inputs to Gulf of Mexico
  - Dredging of shipping channels; siltation of reservoirs
- However, loads are affected by flow as well as concentration, and changes in flow are largely beyond our control
- Therefore understanding trends from the standpoint of *what we can do* may be easier if we look at trends in concentration rather than loads

Sediment trends: loads or concs?

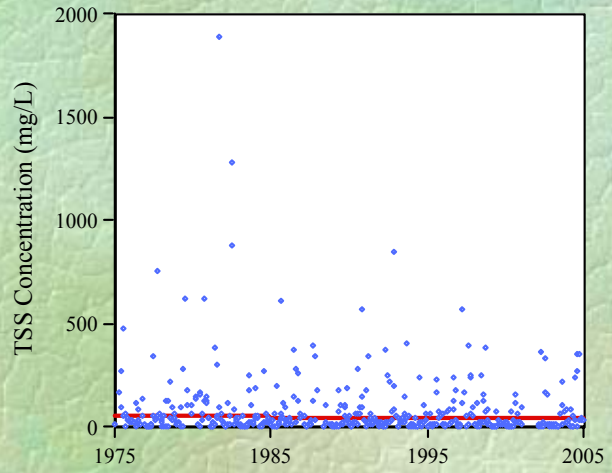
- Even concentrations are affected by flow, so we adjust concentrations for their relationship to flow
- Statistical considerations argue for doing trend analysis on log-transformed concentrations rather than untransformed
- While the trend numbers differ somewhat, and statistical significance is enhanced by these transformations, the basic patterns of the trends do not change greatly
- If you want, talk to me for details of the approach!

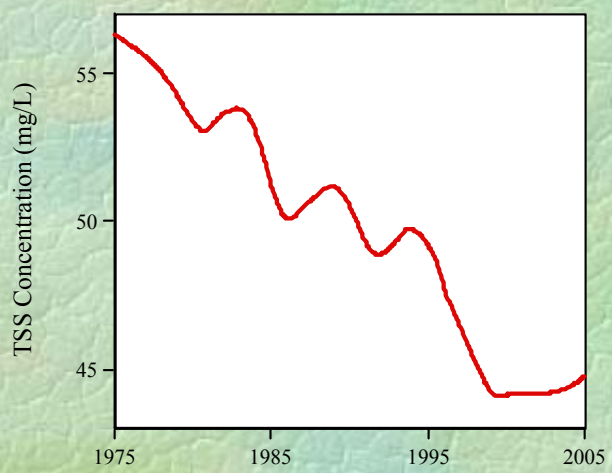
II. Sediment trends

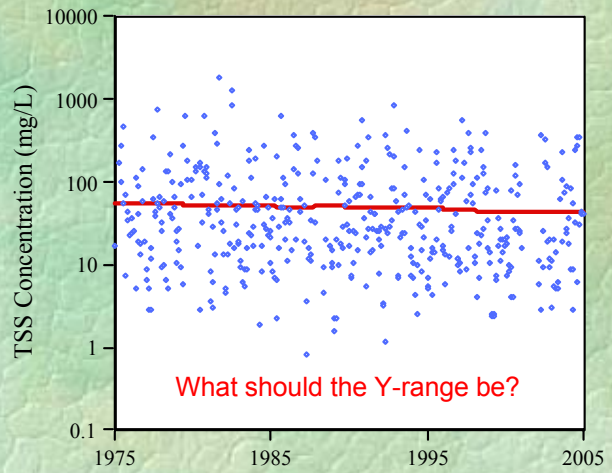
- Next four panels show, for Maumee, Sandusky, Cuyahoga, and Grand, trends in:
  - Flow, SS con
  - Flow-adjuste
    is the "rough
  - Adjusted SS
  - Adjusted SS
    in average co

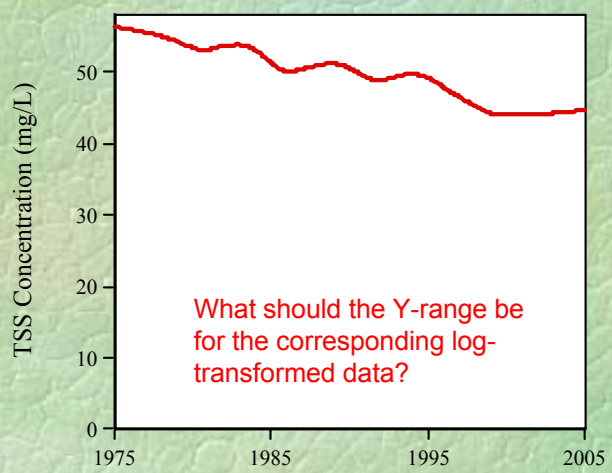


Sediment trends: An issue of scale







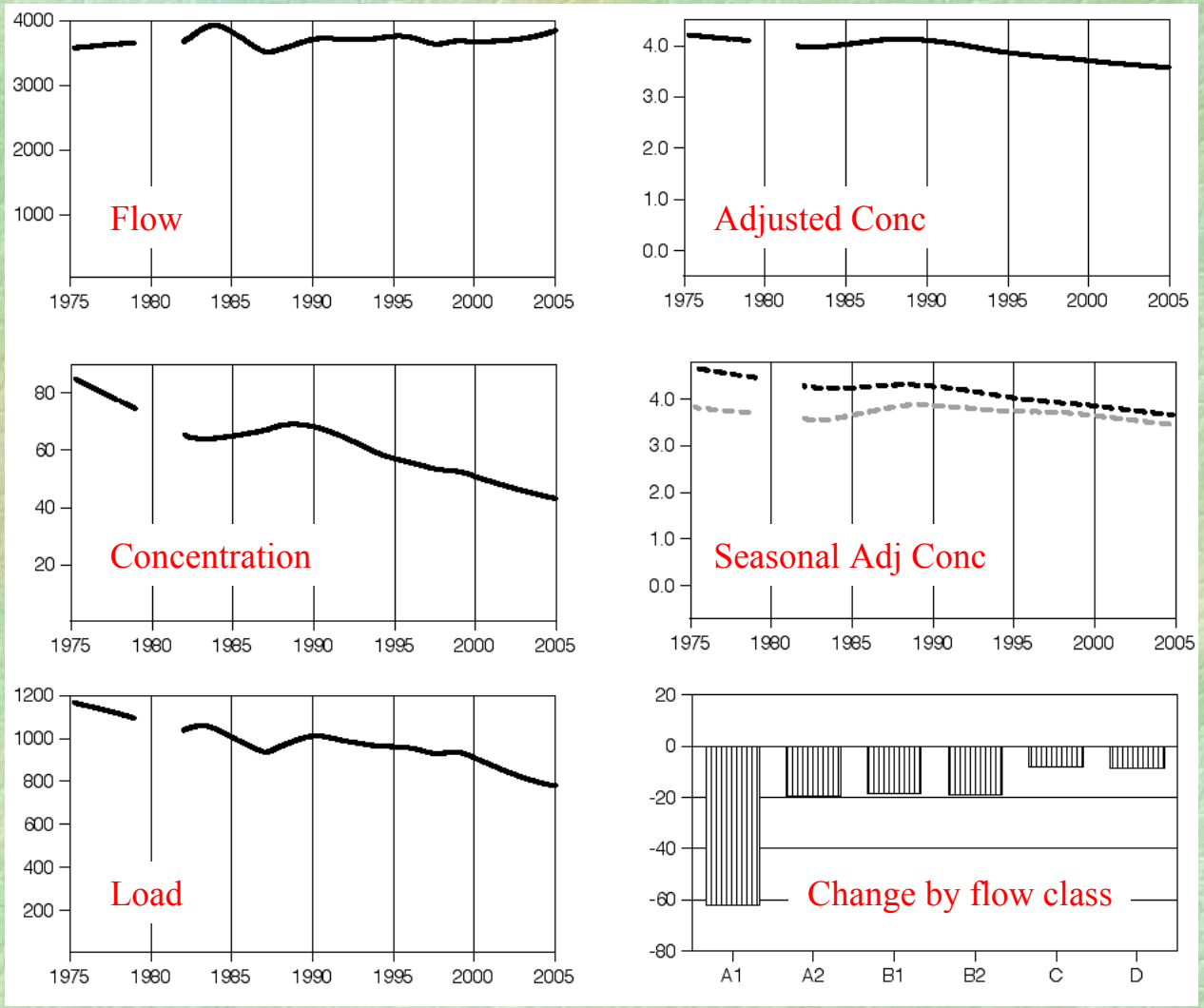


Rules:

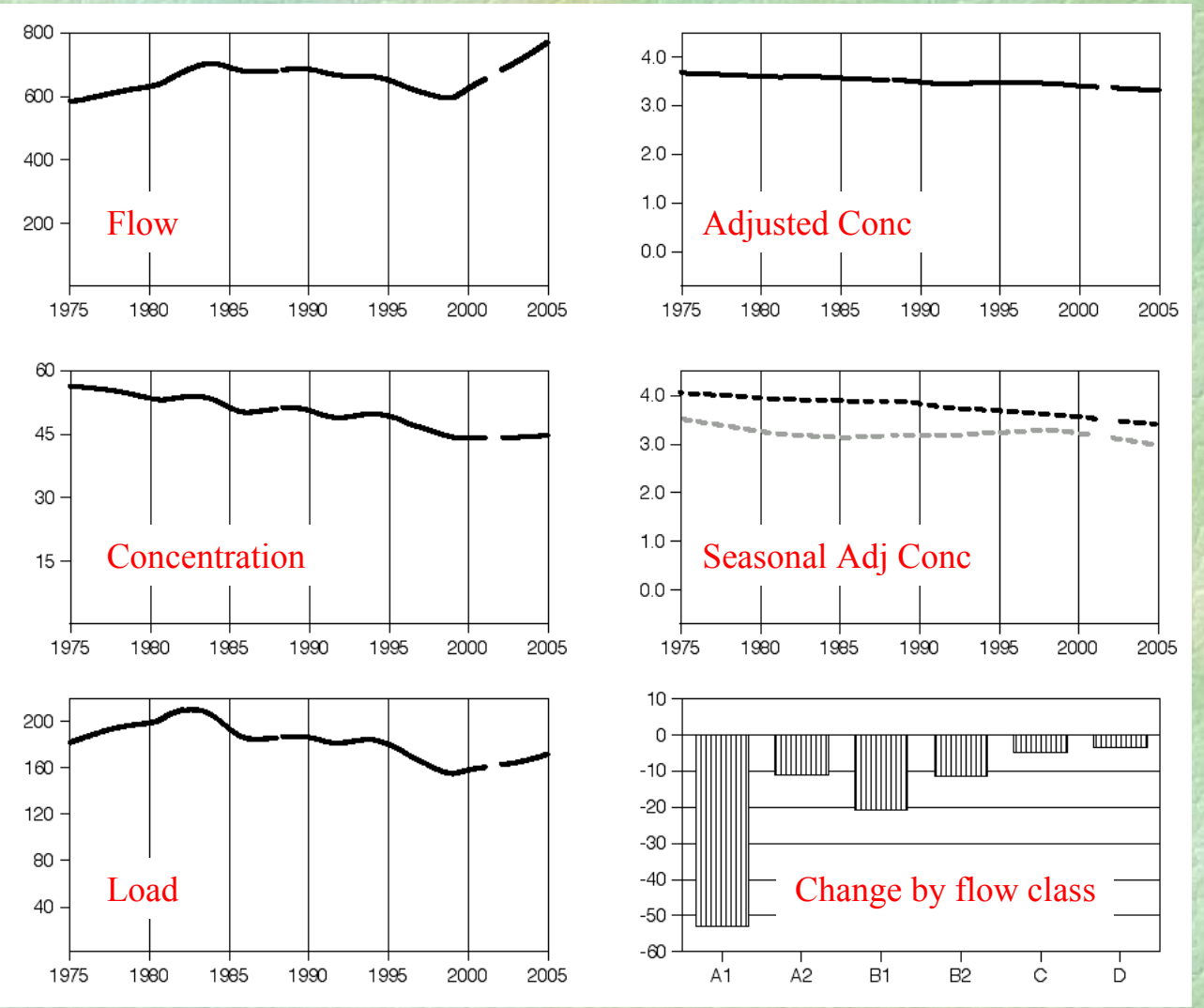
1. Use 1% of LOWESS median as Y-min
2. Use same value, log-transformed, for Y-min for trend in transformed data
3. Mean of flow-adjusted log SS is approximately 0, so add mean of log SS to preserve scaling

Note: log transform "stretches" low range, so curve will be "compressed" compared to untransformed…

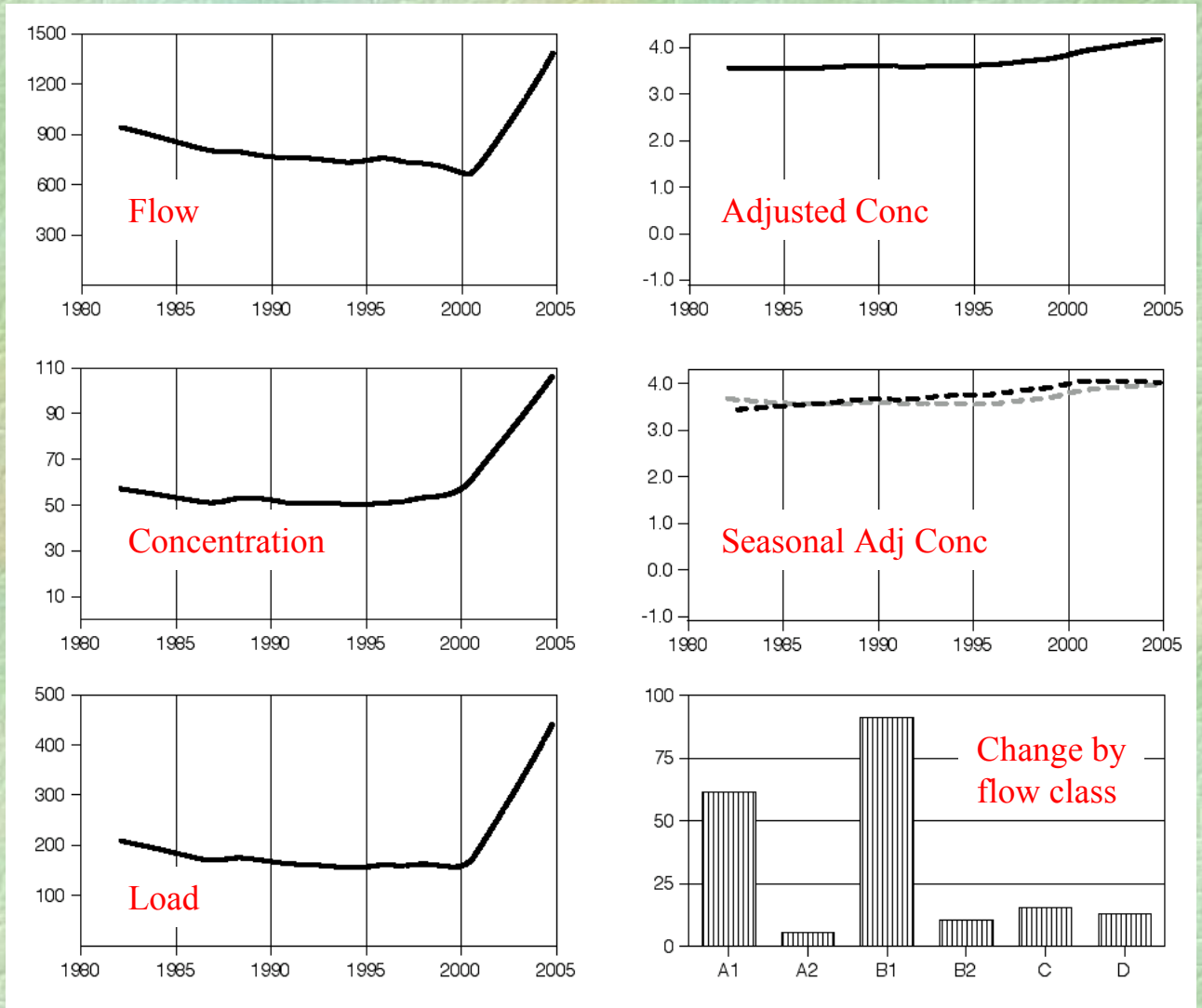
Sediment trends: Maumee



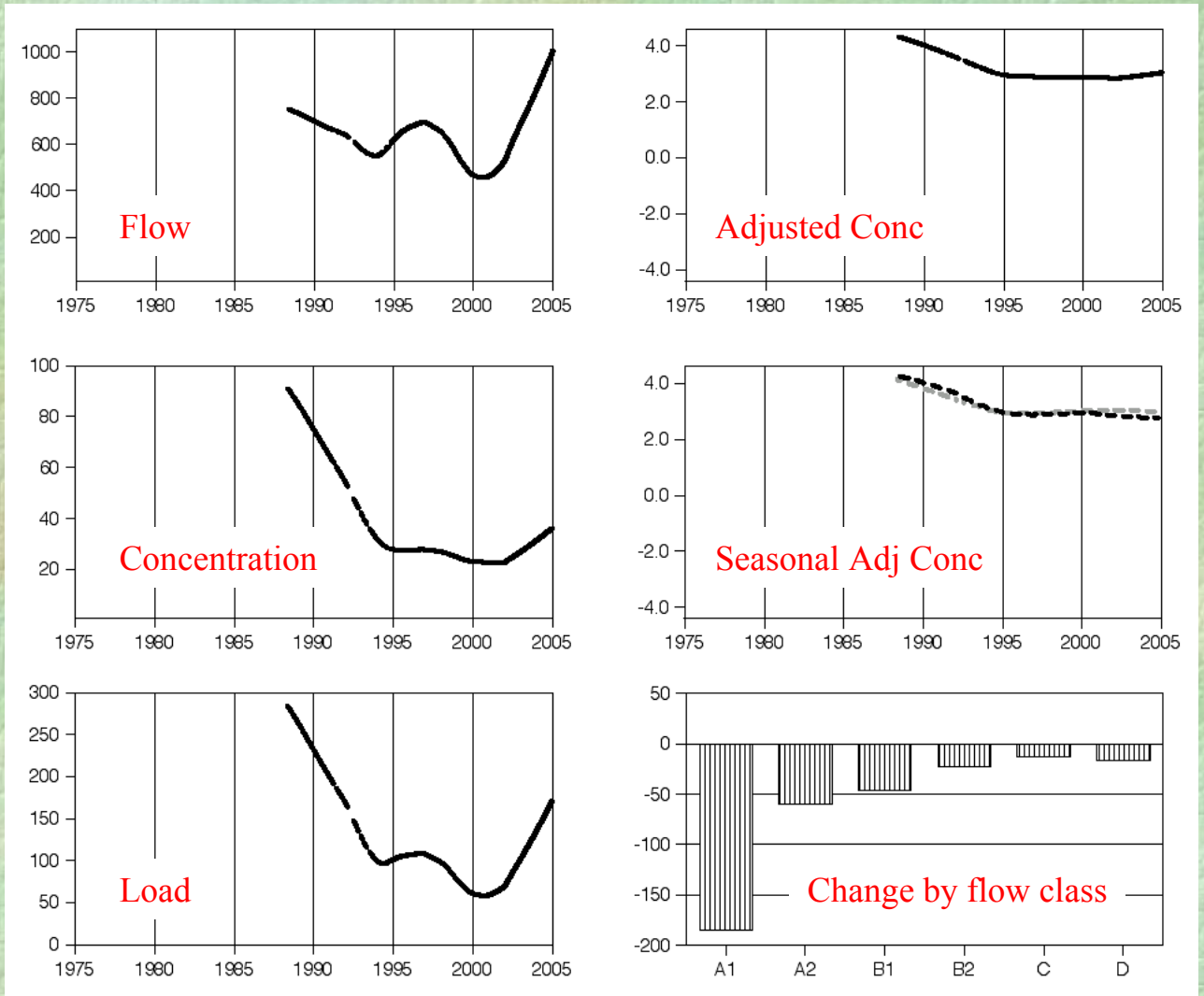
Sediment trends: Sandusky



Sediment trends: Cuyahoga



Sediment trends: Grand

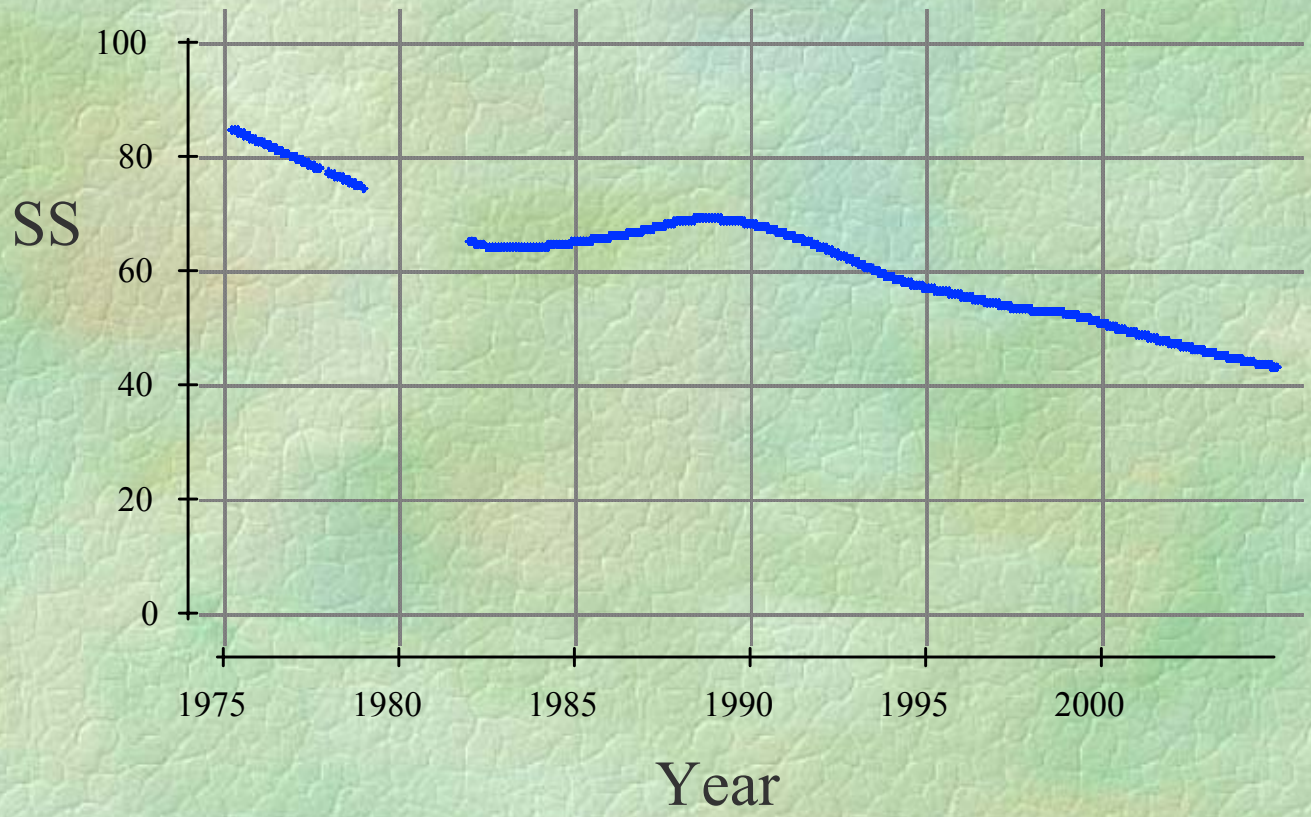


III. Weather Effects on Trends: A New Approach

- Analysis for Maumee River only
- Examine concentration-flow relationships in relationship to time

Weather Effects and Trends

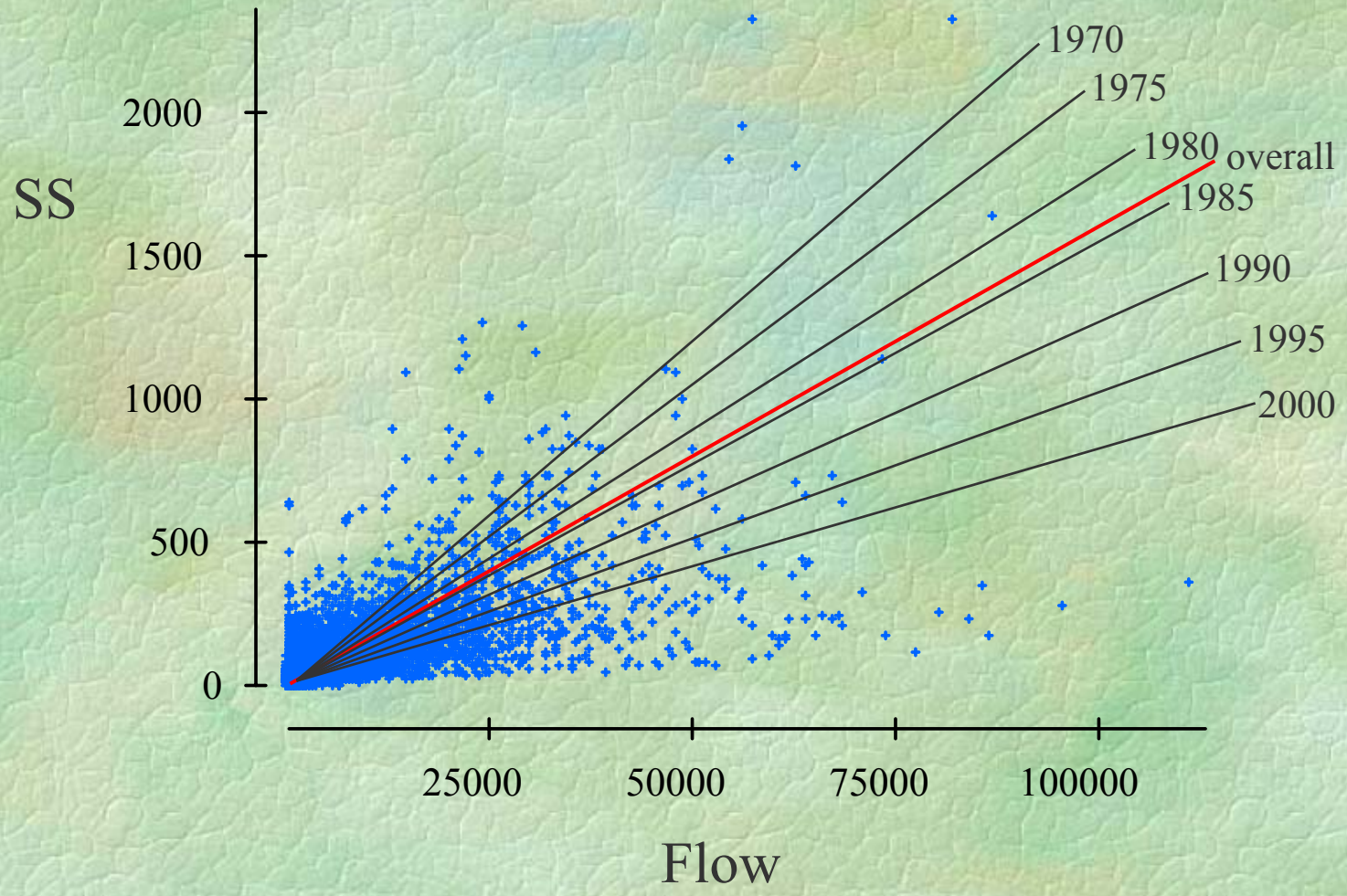
- LOWESS smooth of Maumee SS:



Weather Effects Can Be Questioned…

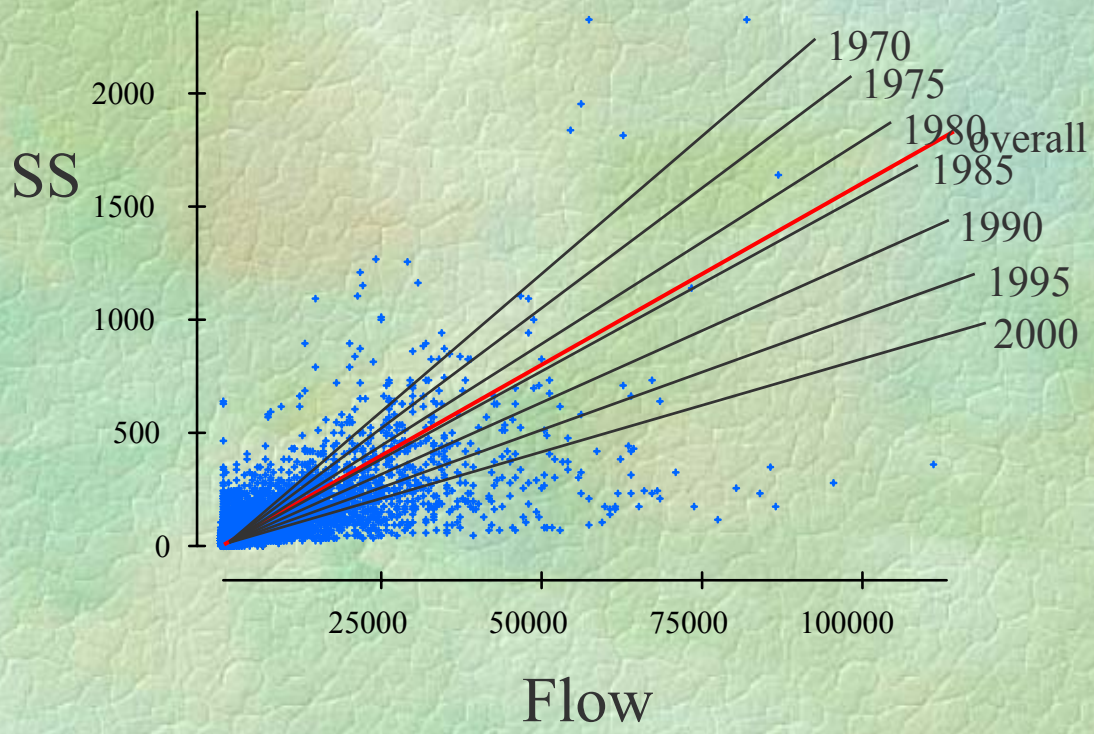
- Not much historical change in flow
- Flow adjustment does not change SS trend slope much, just lowers MSE
- …but it would be nice to have a more quantitative evaluation

Weather Effects and Trends



Weather Effects and Trends

- Need to do the analysis in log-log space…



$SS = k_y * Flow$

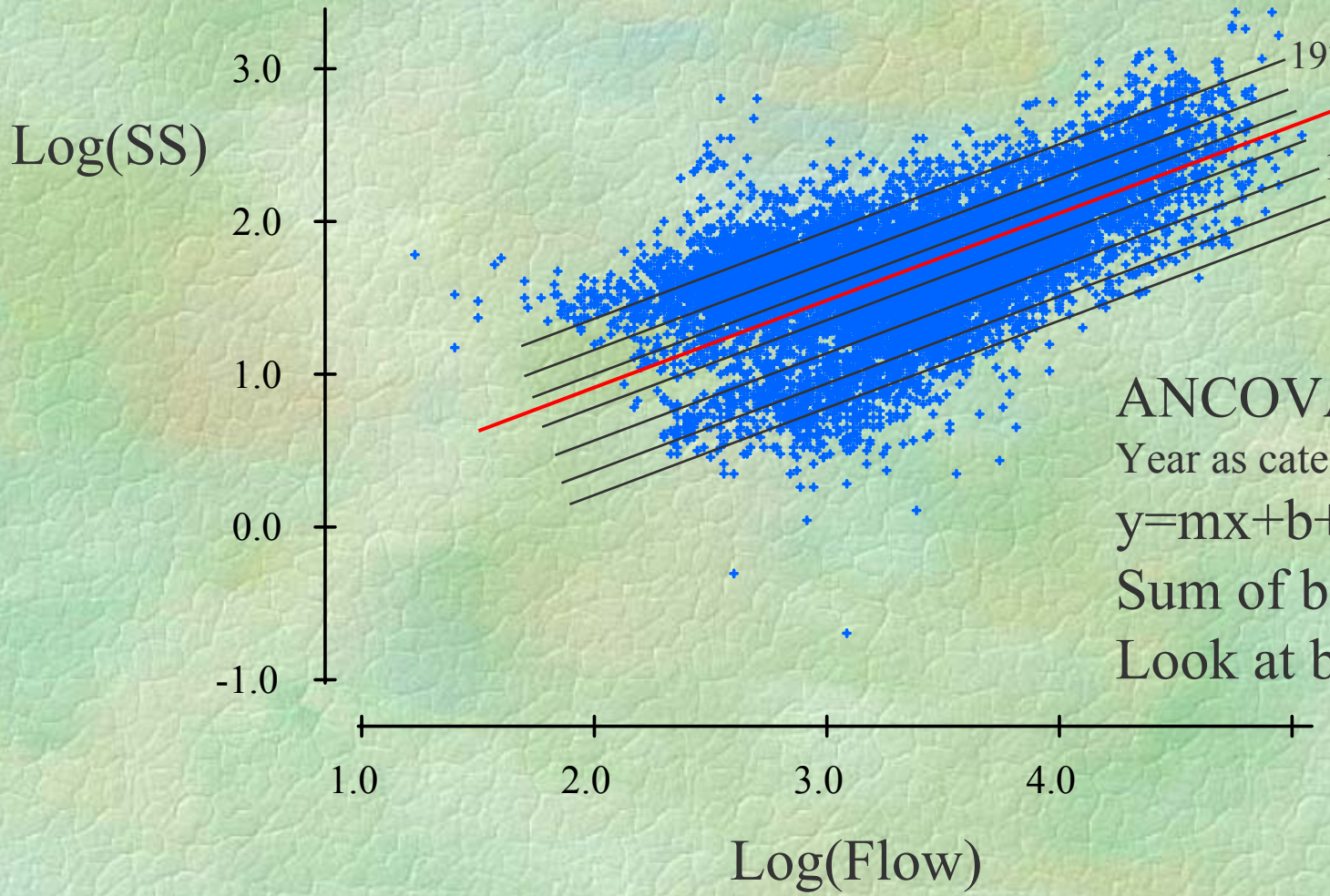
$\log(SS) = \log(k_y * Flow)$

$\log(SS) = \log(k_y) + \log(Flow)$

constant

(part of intercept term)

Weather Effects and Trends



ANCOVA

Year as categorical variable

$y=mx+b+bdif_{year}$

Sum of $bdif_{year}$ is 0

Look at bdif vs year

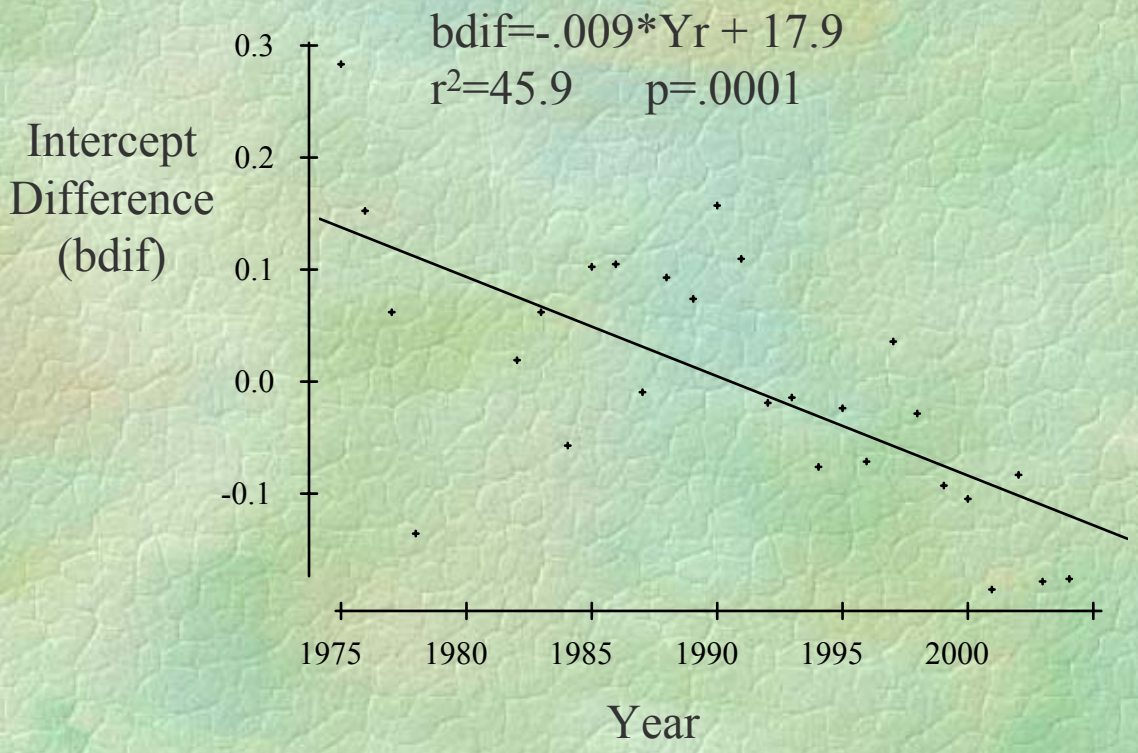
Weather Effects and Trends

Analysis of Variance For **LogSS**
No Selector
9102 total cases of which 62 are missing

Source	df	Sums of Squares	Mean Square	F-ratio	Prob
Const	1	26198.9	26198.9	234182	Š 0.0001
LgQ	1	565.480	565.480	5054.6	Š 0.0001
WY	26	105.821	4.07003	36.380	Š 0.0001
Error	9012	1008.21	0.111874		
Total	9039	1745.43			

Level of WY	Coefficient	Level of WY	Coefficient	Level of WY	Coefficient
1975	0.2831	1985	0.1021	1995	-0.0232
1976	0.1533	1986	0.1036	1996	-0.0708
1977	0.0616	1987	-0.0089	1997	0.0353
1978	-0.1354	1988	0.0931	1998	-0.0281
1979	no data	1989	0.0734	1999	-0.0931
1980	no data	1990	0.1569	2000	-0.1049
1981	no data	1991	0.1086	2001	-0.1853
1982	0.0202	1992	-0.0193	2002	-0.0822
1983	0.0620	1993	-0.0149	2003	-0.1774
1984	-0.0565	1994	-0.0767	2004	-0.1766

Weather Effects and Trends



Conclusion: highly significant decrease in sediment concentration as a function of flow over 30 years!

Weather Effects and Trends

- Further analysis shows:
  - Most of this change is associated with the "summer" months (May-October)
  - The Sandusky shows the same changes, though not as strongly

Conclusions

- Sediment concentrations and loads are decreasing overall in the Maumee, Sandusky, and Grand, but increasing in the Cuyahoga.
- Increases in last 5 years partly due to flow.
- Decreasing relationship between SS concentration and flow in Maumee indicates that trends reflect management success, not weather effects.