

Phosphorus Trends, 1975-2005

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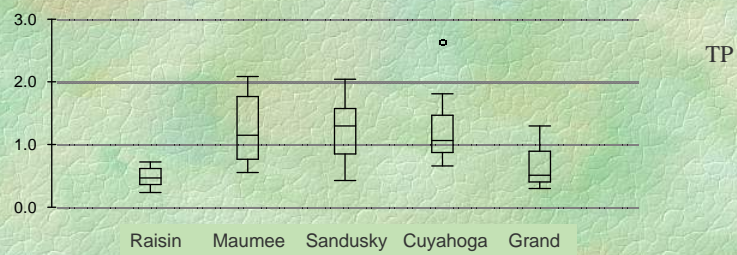
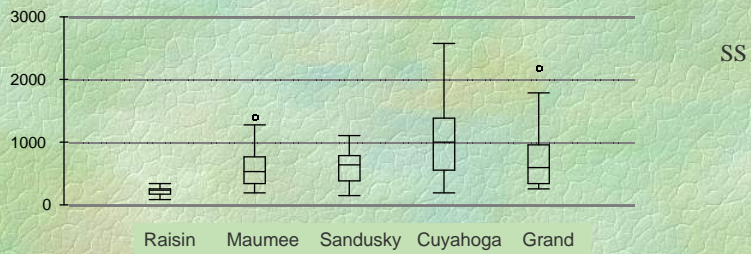
Ohio Environmental Protection Agency

March 27, 2007

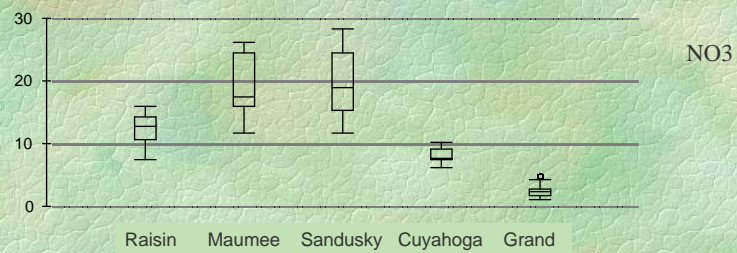
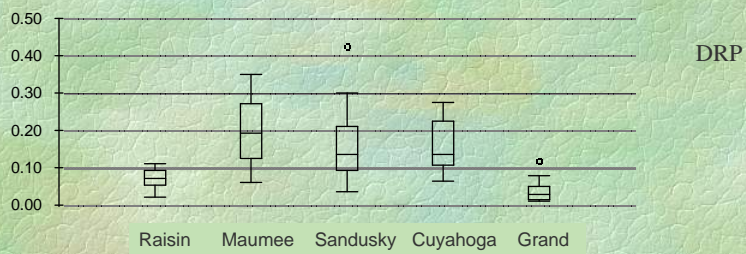
Road Map...

- ⌘ Characteristic loads and concentrations
- ⌘ Trends in loads to Lake Erie
- ⌘ Potential sources of confirmatory information

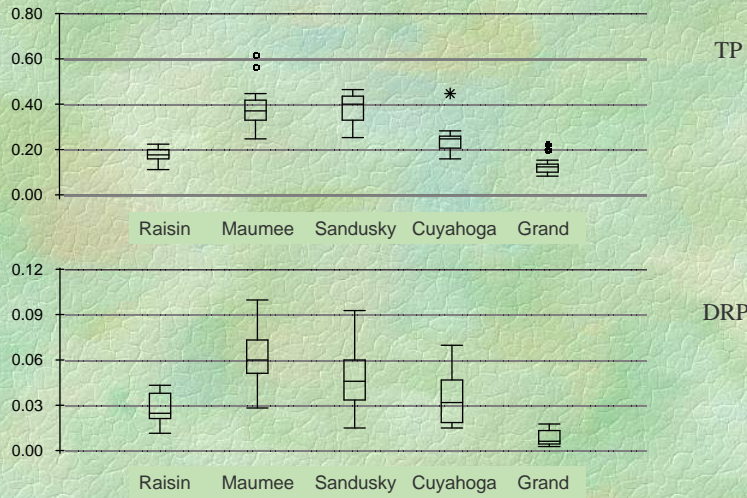
Unit Area Loads (kg/ha/year, 1990-2004)



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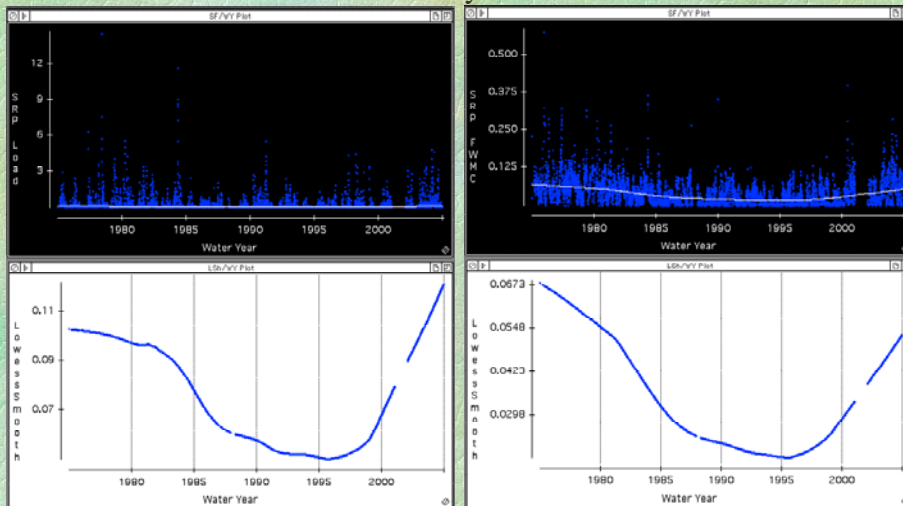


Flow-Weighted Mean Concentrations (mg/L, 1990-2004)



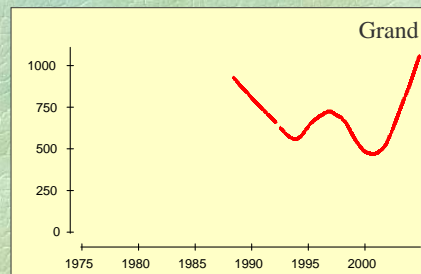
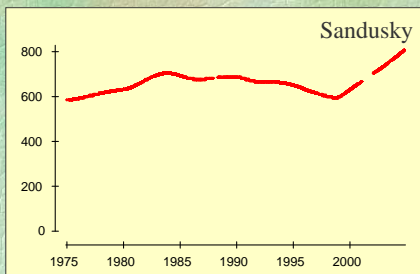
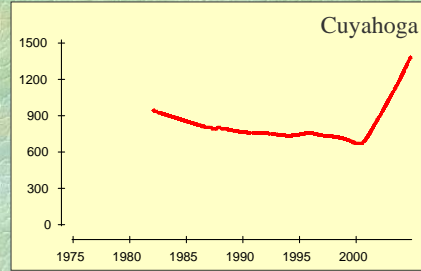
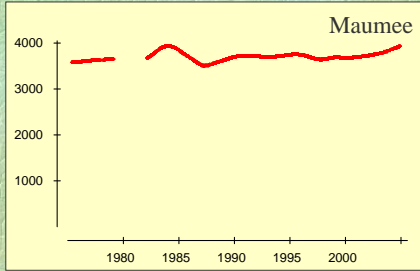
Dissolved Reactive Phosphorus

Loads Sandusky River Concentrations



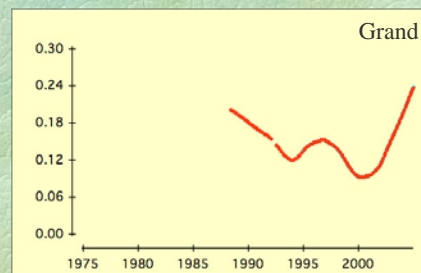
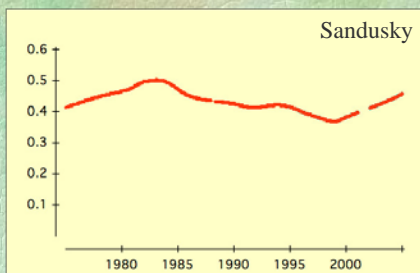
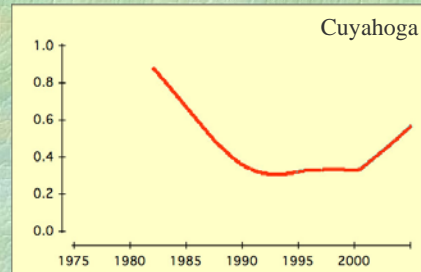
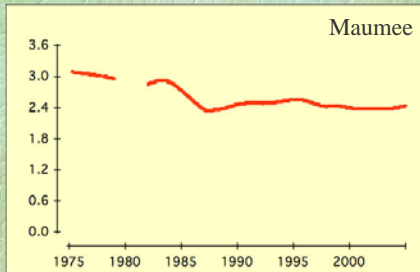
Discharge

LOWESS smooths of daily discharge,
units of million cubic meters



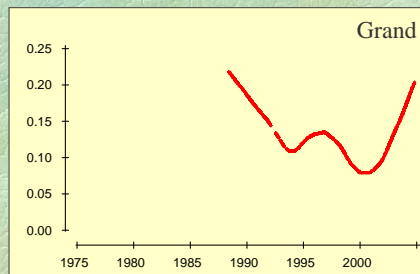
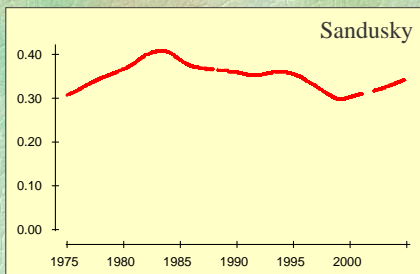
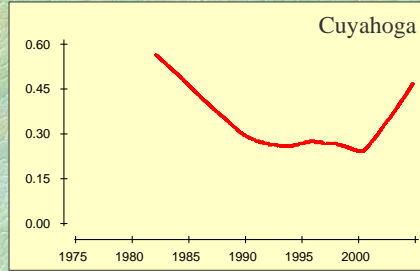
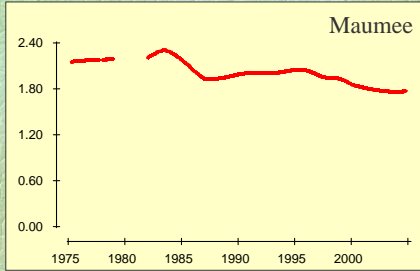
Total Phosphorus

LOWESS smooths of daily loads,
units of metric tons per day



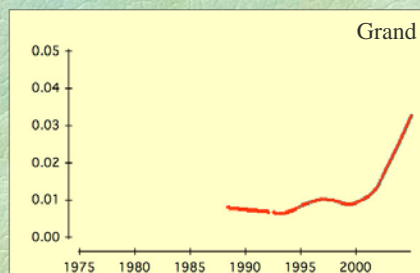
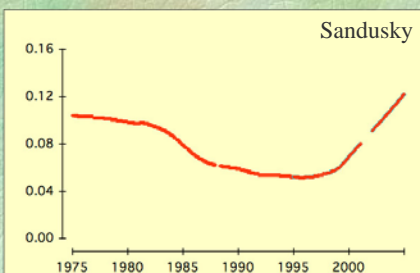
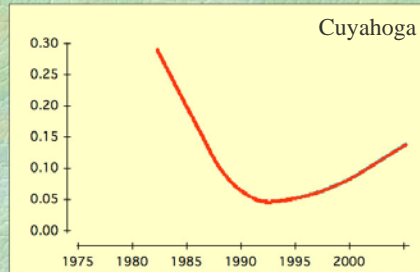
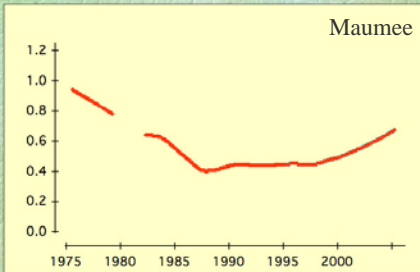
“Particulate” Phosphorus

LOWESS smooths of daily loads, units of metric tons/day



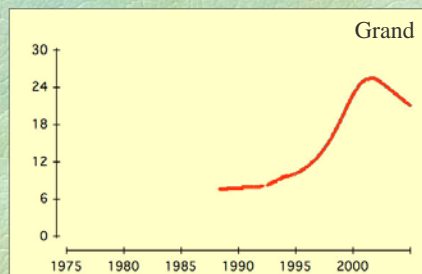
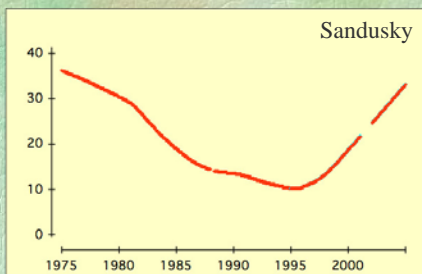
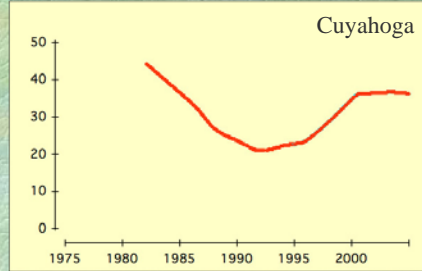
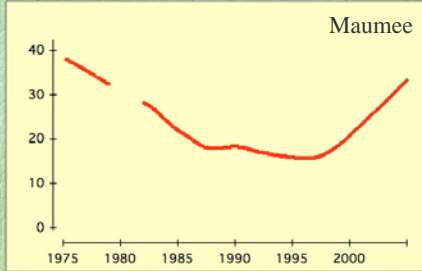
Dis. Reactive P

LOWESS smooths of daily loads, units of metric tons per day



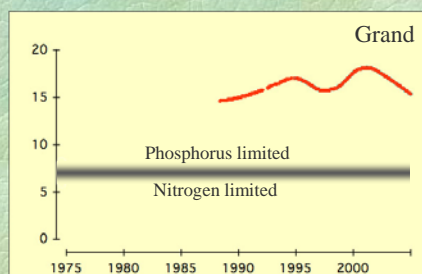
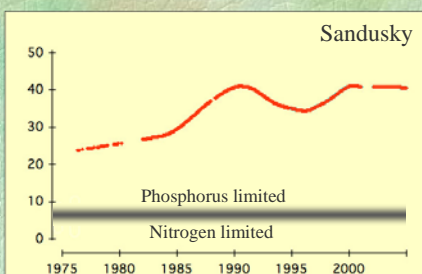
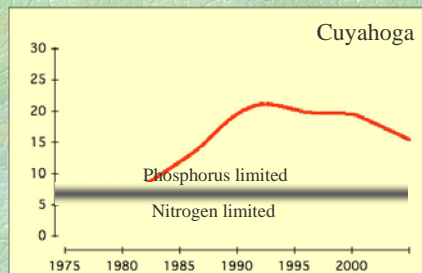
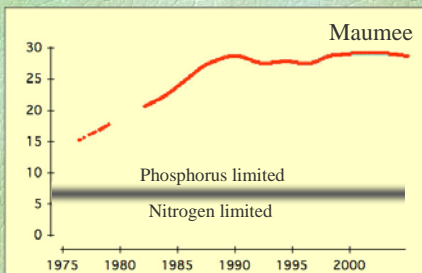
DRP/TP

LOWESS smooths of ratios of daily loads, units of percent



TN/TP

LOWESS smooths of ratios of daily loads, unitless. Compare with Redfield ratio ~ 7.



Trends, period of record

Regression on ln-transformed daily loads,
numbers are percent change per decade

River	TP	PP	DRP	DRP/PP
Maumee	-17	-14	-29	-14
Sandusky	-14	-10	-28	-17
Cuyahoga	-25	-4	-27	-24
Grand	-7	-24	118	147

Trend Numbers, early and late

Regression on ln-transformed daily loads,
numbers are percent change per decade

River	Period	TP	PP	DRP	DRP/PP
Maumee	1975-1995	-21	-8	-58	-78
	1995-2005	-5	-40	151	185
Sandusky	1975-1995	-26	-11	-64	-55
	1995-2005	15	-40	273	300
Cuyahoga	1975-1995	-63	-41	-86	-62
	1995-2005	14	-14	124	96
Grand	1975-1995	-74	-72	-68	4
	1995-2005	10	-14	167	151

Verification (DRP)

∞ Other possible sources of data

- USGS NAWQA etc
- Ohio EPA with biological samples

∞ Is it just due to more flow? No...

- Trends in concentrations similar to trends in loads
- Adjusting concentrations for flow relationship does not change trend slopes

Verification (DRP)

∞ Ruling out analytical drift problems

- Trends start at different times in different rivers
- Trends of different magnitudes in different rivers
- Trends are mostly low-flow in Cuyahoga and Grand, mostly high-flow in Maumee and Sandusky
- Trends not apparent in Scioto and Great Miami

Some Conclusions

- On a unit area basis, Sandusky and Maumee have relatively high loads compared to other U.S. tribs
- TP, “PP”, DRP, DRP/TP have all decreased between 1975 and 2005 (except Grand DRP and DRP/TP)
- Since 1995, all parameters except PP have increased, or have decreased more slowly
- DRP has the largest increases and is most bio-active, therefore of greatest concern
- The increase in DRP appears to be real and independent of trends in discharge

