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Estimation of Nutrient Loads using Continuous Water-Quality Monitoring and Regression Analysis

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National Water Quality Monitoring Conference, Madison, WI, May 22, 2002

Nutrient Load Calculations

- Historically, discrete nutrient samples are regressed against discharge
- Computer programs have automated this process, but most still rely on discharge only
- Discrete nutrient concentrations can be regressed against turbidity, leading to more accurate load calculations for some sites

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Approach

- Upgrade USGS stream gaging stations with water-quality monitors
- Collect nutrient samples over the range in hydrologic conditions
- Develop regression equations using collected samples and sensor values
- Estimate concentrations from the regression equations and loads from continuous data.

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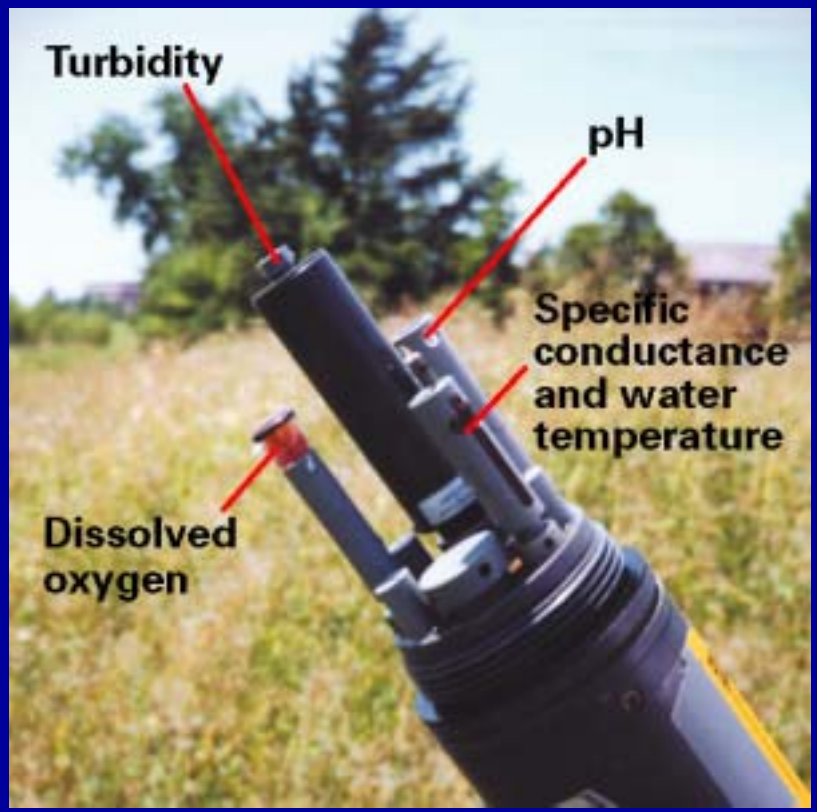
Real-time, Continuous Water-Quality Monitor



- pH
- Water Temperature
- Dissolved Oxygen
- Specific Conductance
- Turbidity
- Fluorescence

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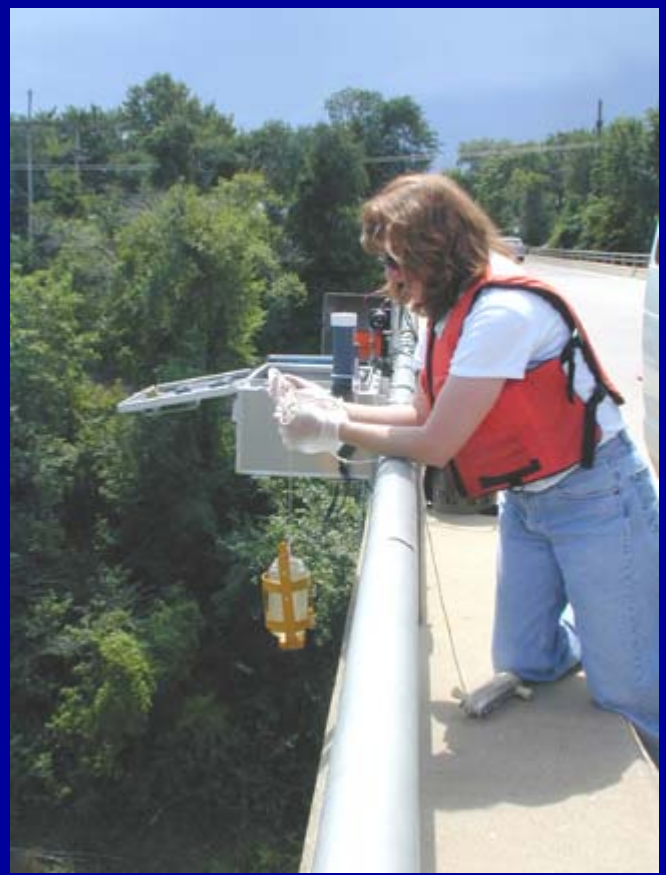
Collection of manual samples

- **Collected throughout the range of expected hydrologic conditions**
- **Analyzed for nutrients**
- **Use EWI or EDI methods**



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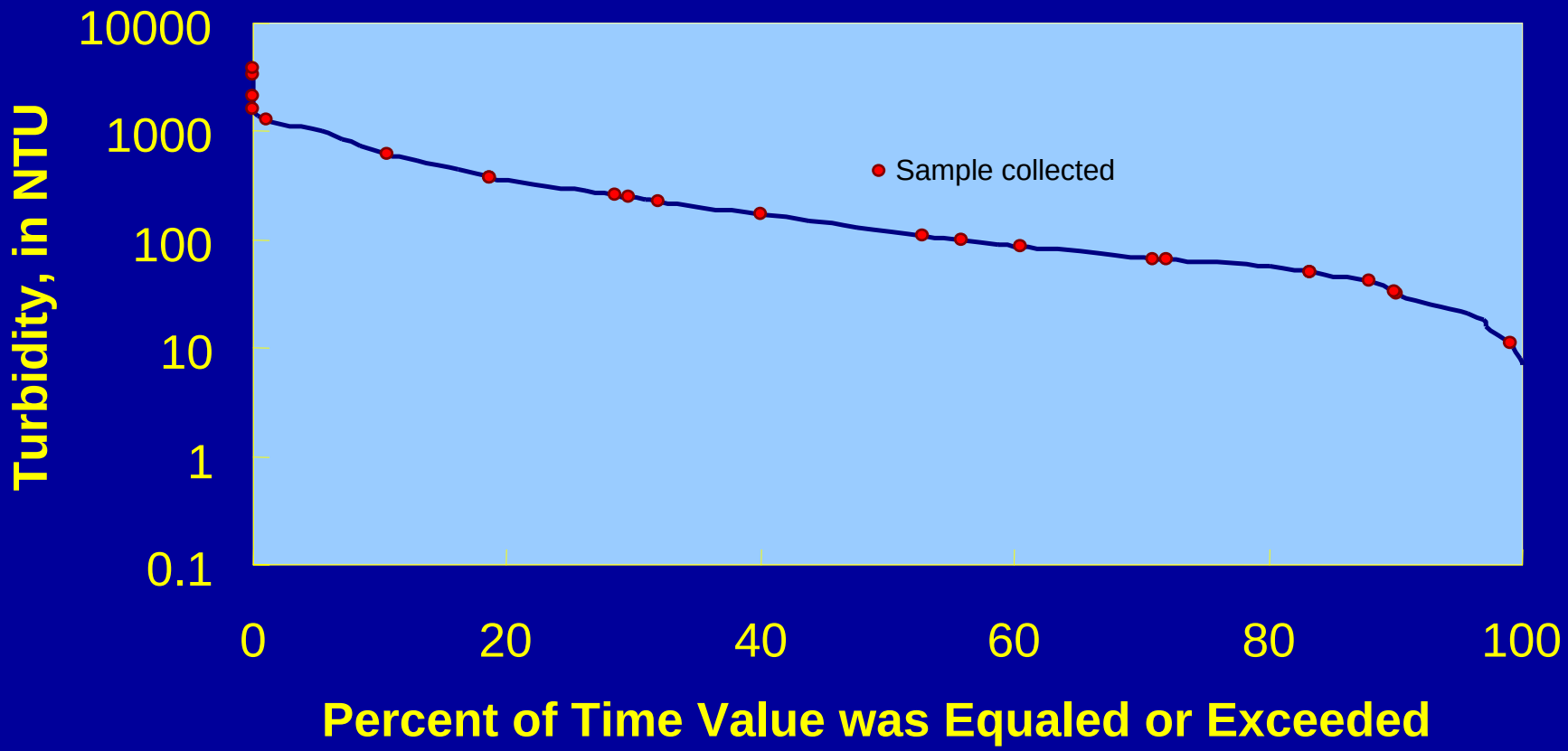
Turbidity Duration Curve



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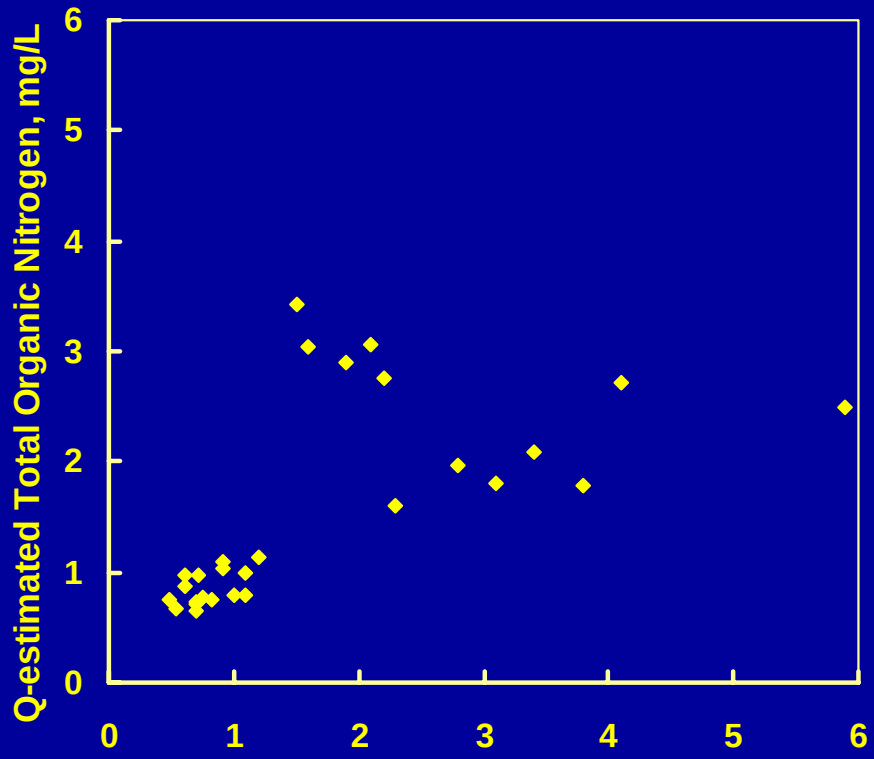
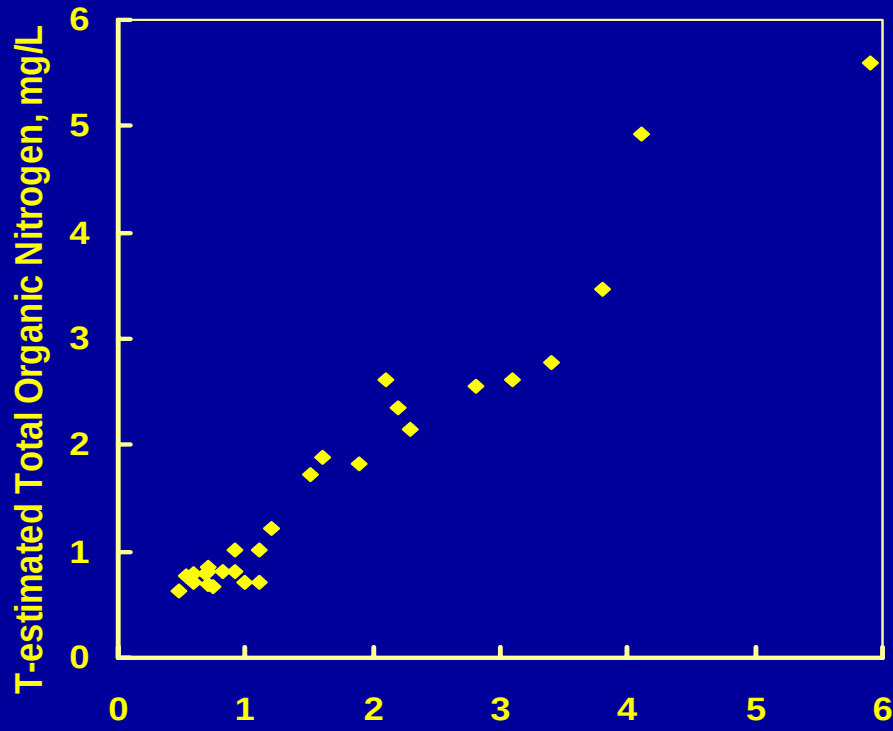
Measured Nitrogen vs Streamflow- and Turbidity-estimated Concentrations

Little Arkansas River near Halstead

Streamflow-estimated



Turbidity-estimated



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Measured Total Organic Nitrogen, mg/L

Total Nitrogen vs Streamflow or Turbidity

Comparison of R^2 for Simple Regression

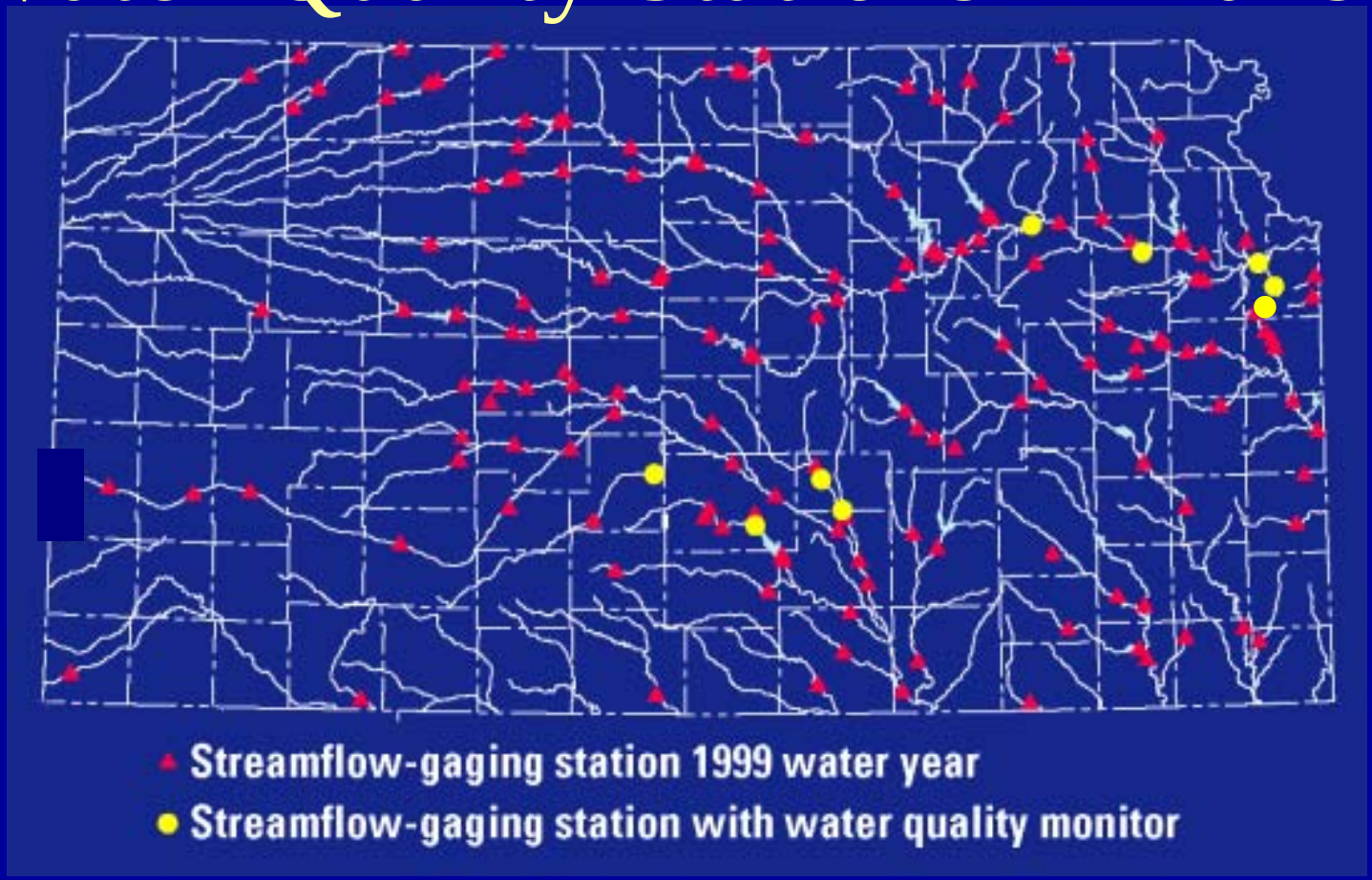
	Station	R^2 streamflow equation	R^2 turbidity equation
*	06887500	0.23	0.99
*	06889000	0.30	0.98
*	06892350	0.14	0.49
*	06892440	0.88	0.60
*	06892450	--	0.42
*	07142575	0.25	0.71
*	07143672	0.65	0.95
*	07144100	0.54	0.74
	07144601	0.13	0.70
	07144660	0.65	0.85
	07144680	0.48	0.84
	07144730	0.47	0.88
*	07144780	0.27	0.73
	07144795	0.27	0.02
	MEDIAN	**0.27**	**0.74**

Total Phosphorous vs Streamflow or Turbidity

Comparison of R^2 for Simple Regression

	Station	R^2 streamflow equation	R^2 turbidity equation
*	06887500	0.60	0.99
*	06889000	0.70	0.98
*	06892350	0.14	0.52
*	06892440	0.92	0.78
*	06892450	--	0.15
*	07142575	0.51	0.81
*	07143672	0.60	0.90
*	07144100	0.29	0.52
	07144601	0.50	0.87
	07144660	0.20	0.59
	07144680	0.59	0.67
	07144730	0.44	0.84
*	07144780	0.58	0.89
	07144795	0.57	0.95
	MEDIAN	**0.57**	**0.82**

Streamflow-Gaging and Real-Time Water-Quality Stations in Kansas



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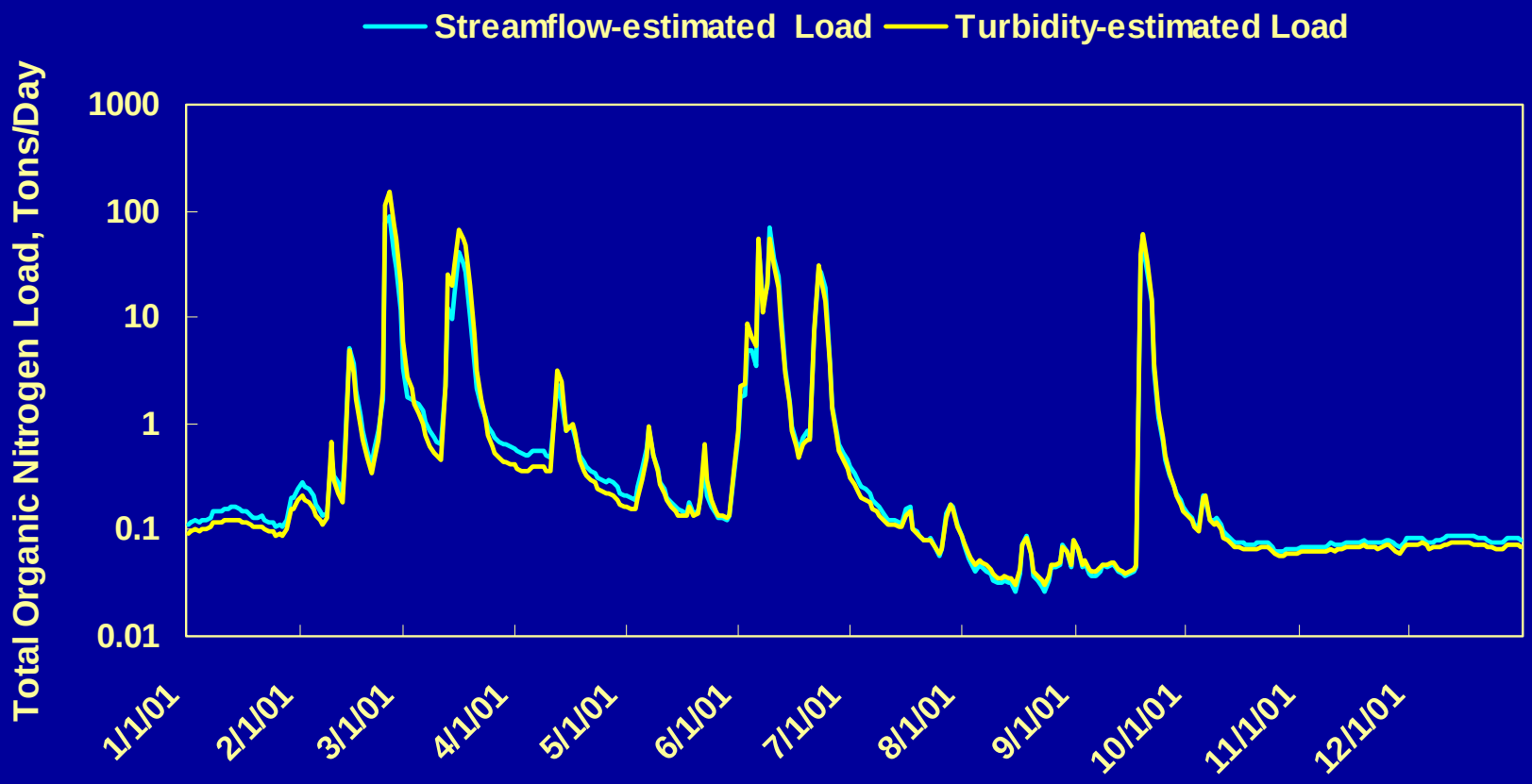
Comparison of Streamflow- and Turbidity-estimated Loads

Little Arkansas River at Sedgwick



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Little Arkansas River

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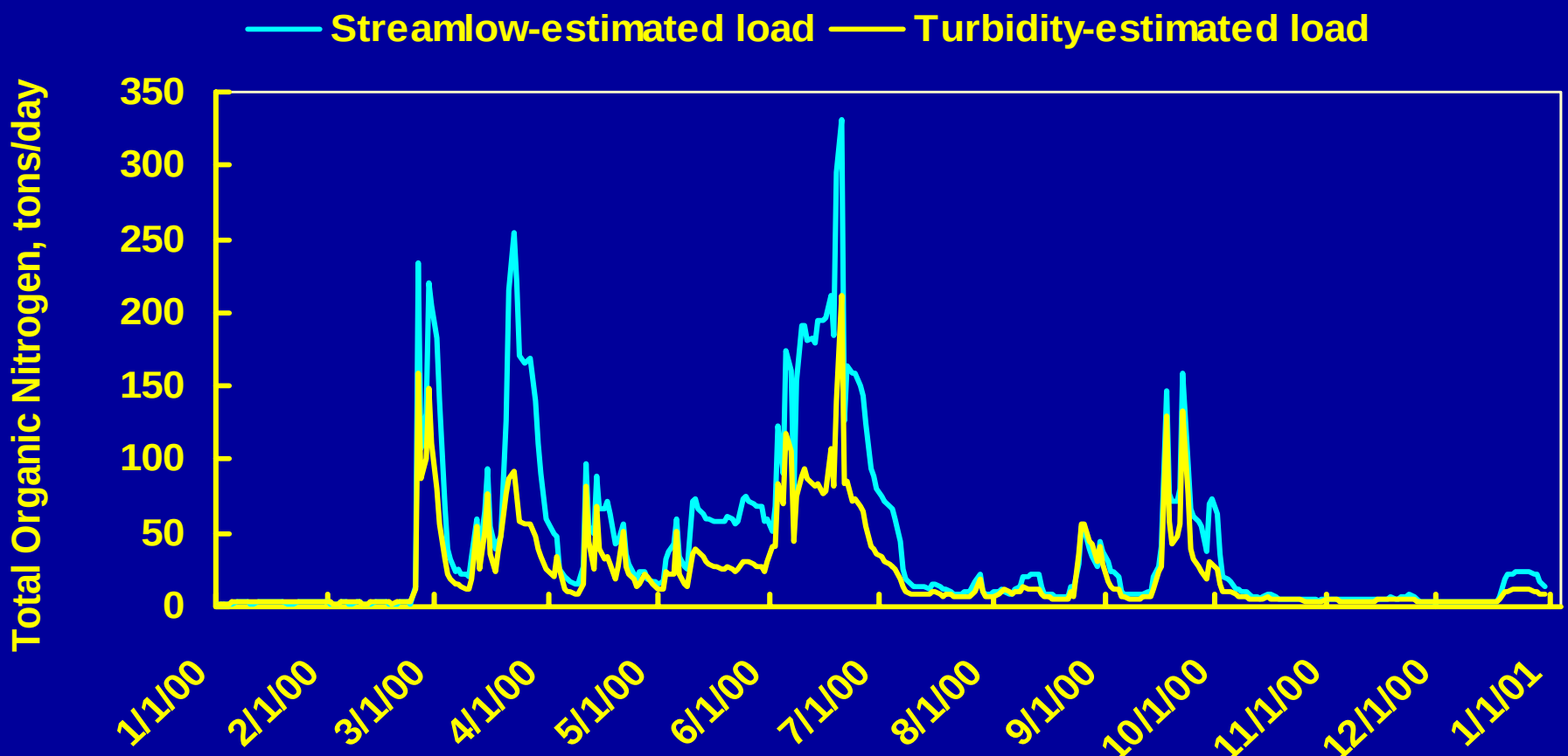
Comparison of Streamflow- and Turbidity-estimated Loads

Kansas River at Wamego



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Kansas River

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Multiple Regression Analysis--Nitrogen

	Station	Lowest PRESS
*	06887500	Turbidity
*	06889000	Turbidity
*	06892350	Turbidity, Q
*	06892440	Q
*	06892450	Water Temperature
*	07142575	Turbidity, Q, Water Temperature
*	07143672	Turbidity, Q
*	07144100	Turbidity
	07144601	Turbidity
	07144660	Turbidity
	07144680	Turbidity, Q
	07144730	Turbidity, Q
*	07144780	Turbidity, Water Temperature, Q
	07144795	Water Temperature

Multiple Regression Analysis--Phosphorus

	Station	Lowest PRESS
*	06887500	Turbidity, Q
*	06889000	Turbidity, Q
*	06892350	Turbidity, Q, Water Temperature
*	06892440	Q, Turbidity
*	06892450	Water Temperature
*	07142575	Turbidity, Q, Water Temperature
*	07143672	Turbidity, Water Temperature
*	07144100	Turbidity
	07144601	Turbidity
	07144660	Turbidity
	07144680	Turbidity, Q, Water Temperature
	07144730	Turbidity, Q
*	07144780	Turbidity
	07144795	Turbidity, Q

Conclusions

- At 12 of 14 sites, nitrogen was more significantly correlated to turbidity than to streamflow
- At 13 of 14 sites, phosphorus was more significantly correlated to turbidity than to streamflow
- Very large differences between annual loads estimated with turbidity vs streamflow at some sites (especially those with altered flow conditions)
- Multiple regression analysis (turbidity and streamflow) should be considered for all sites

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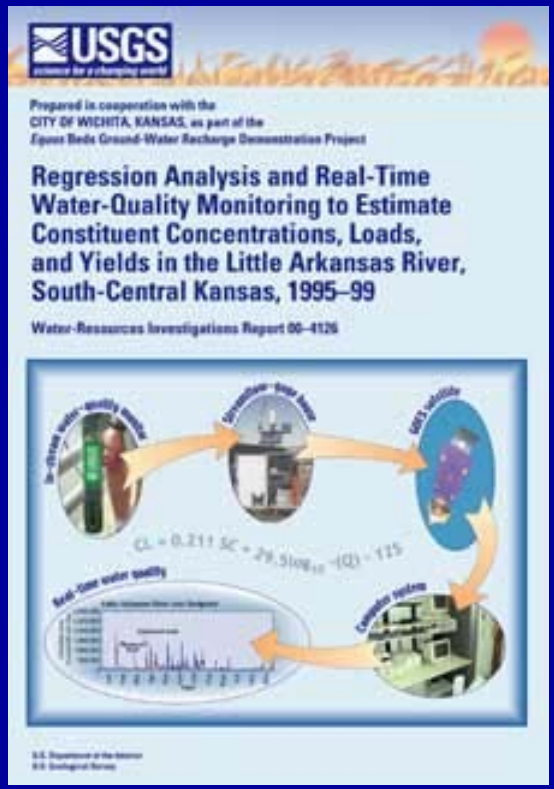
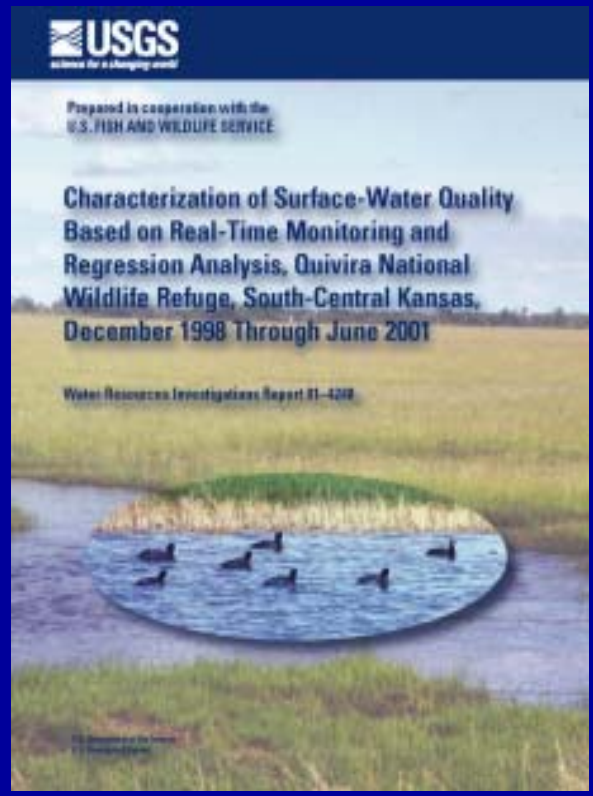
For more information on continuous monitoring in Kansas:





http://ks.water.usgs.gov/Kansas/rtqw/

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