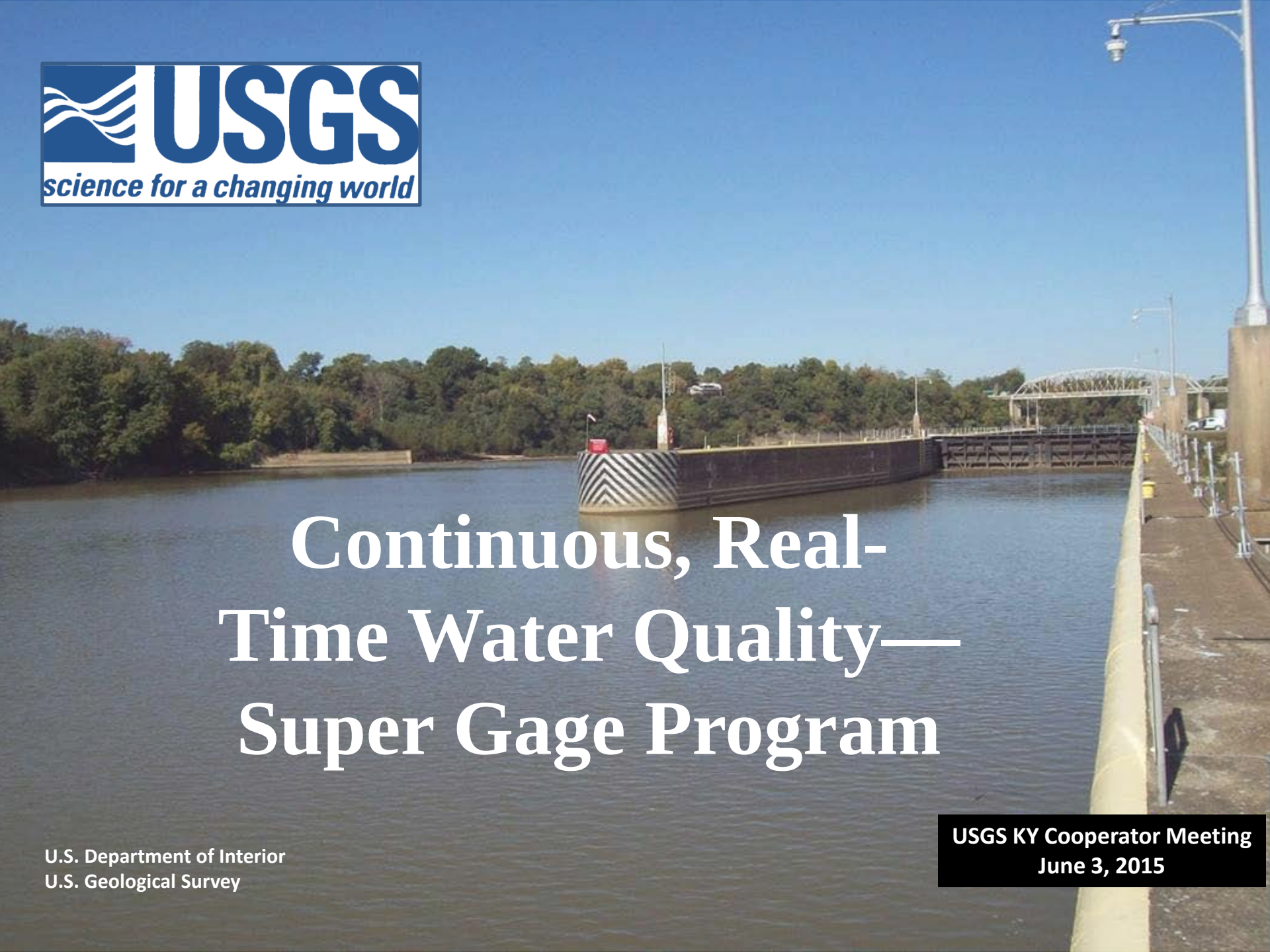


Continuous, Real-Time Water Quality—Super Gage Program

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

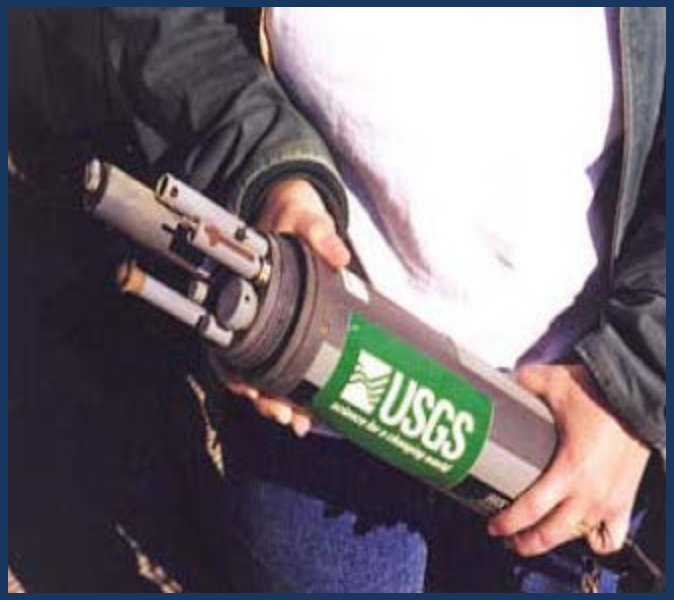
USGS KY Cooperator Meeting
June 3, 2015

Why monitor water quality continuously?

- **Time-dense continuous water quality (in real-time) improves our understanding of hydrology and water quality that are used by management agencies to improve the quality of human life and the environment**
- Provides warning for water supply and recreation
  More accurately estimate constituent concentrations and loads
- Optimizes the timing of sample collection

USGS

Conventional Approach
for real-time, continuous water-quality monitoring



- pH
- Water temperature
- Dissolved oxygen
- Specific conductance
- Turbidity
- Total Chlorophyll

USGS

USGS Super Gage instrumentation

Ultraviolet nitrate sensor

Automated phosphorus analyzer

Automatic sampler

Multi-parameter sensors on water-quality sonde

Turbidity sensor

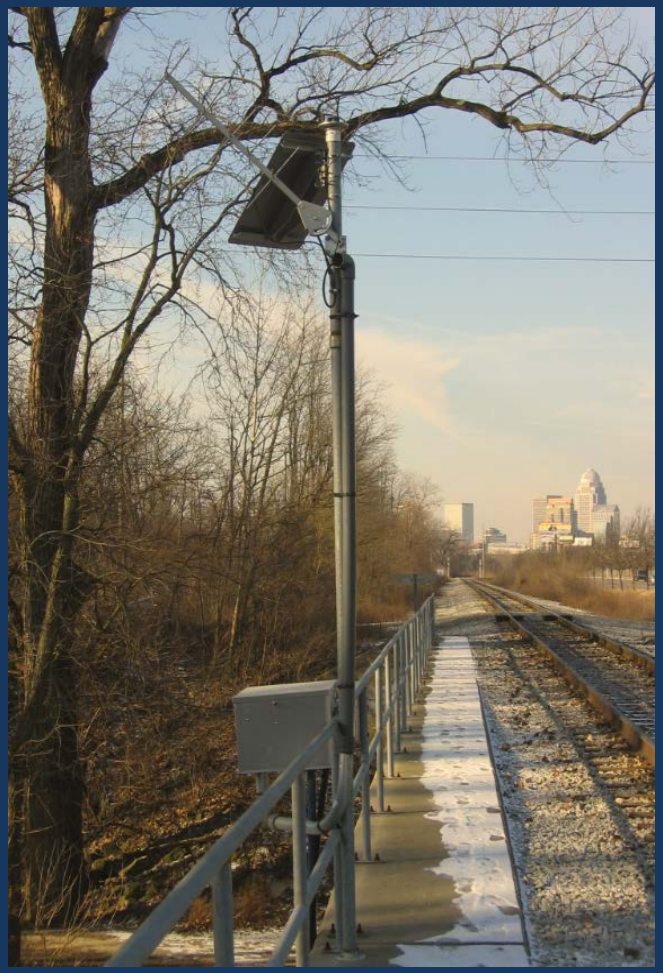
Monitoring well with telemetry

Precipitation gage

What is a USGS Super Gage?

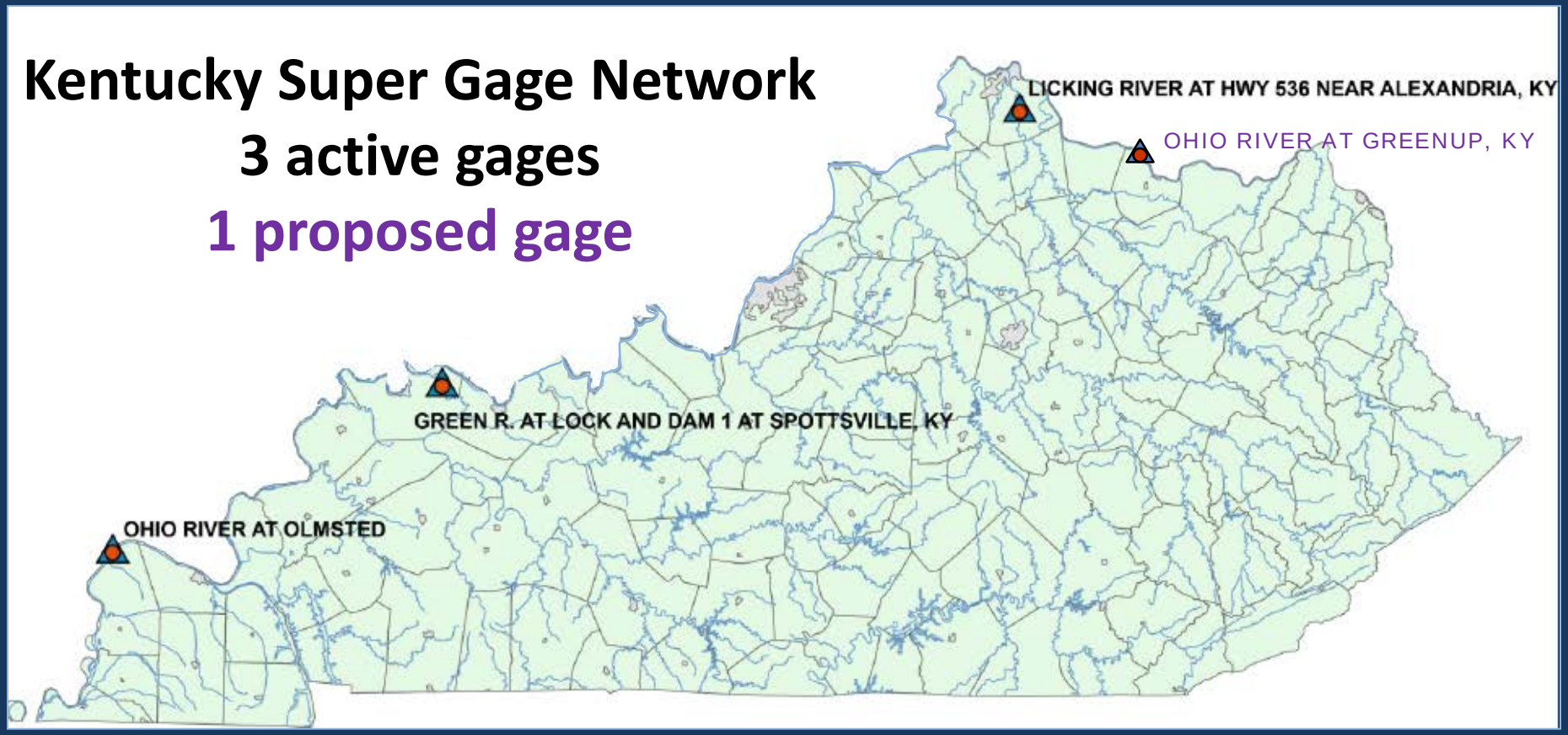
What is a USGS Super Gage?

- Conventional streamflow gage supplemented with:
  1. Continuous water-quality monitors
  2. Representative sampling
  3. Surrogate modeling
- Designed to answer specific questions on a:
  - Watershed scale
  - Regional scale and/or
  - National scale



USGS

How many USGS Super Gages are in Kentucky?



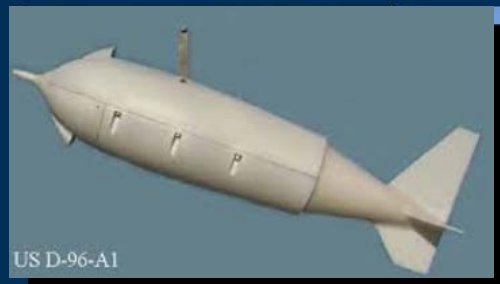
USGS

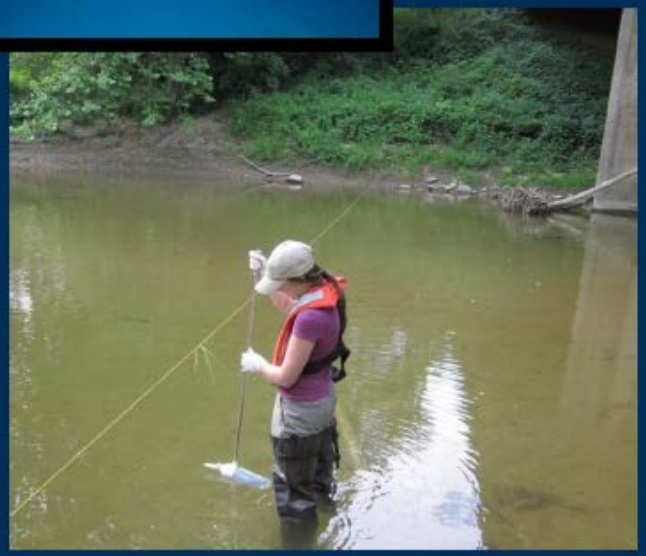
USGS Super Gage Approach

- Upgrade USGS stream gaging stations with water-quality monitors
- Collect representative samples over the range of hydrologic conditions
- Estimate concentrations and loads from continuous data
- Develop statistical surrogate models using collected samples and sensor values

USGS

Representative sampling





Stream-width and depth-integrated water samples for laboratory analysis to verify super gage sensor data and for development of surrogate models.

USGS Super Gage Approach

- Upgrade USGS stream gaging stations with water-quality monitors
- Collect representative samples over the range of hydrologic conditions
- Estimate concentrations and loads from continuous data
- **Develop statistical surrogate models using collected samples and sensor values**

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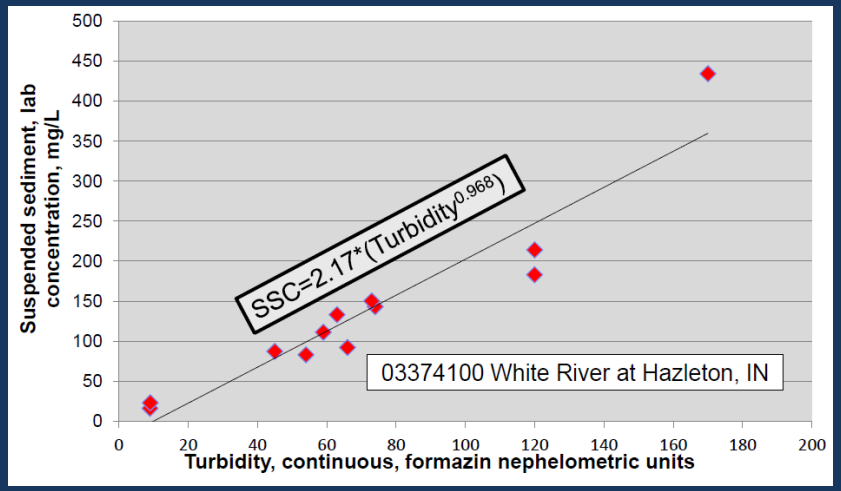
Statistical Surrogate Models

- What are they?
  - Continuous in-stream sensor measurements used to compute or estimate a concentration constituent of greater interest
    - EXAMPLE….turbidity, specific conductance, acoustic doppler backscatter

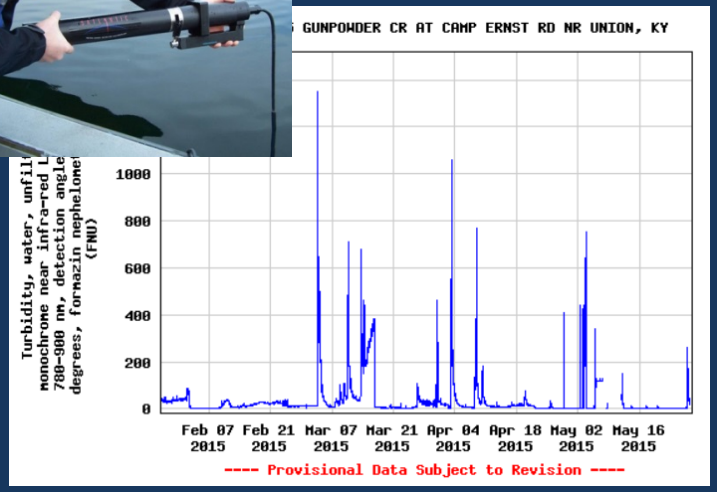


- How are they developed?

How are surrogate models developed?

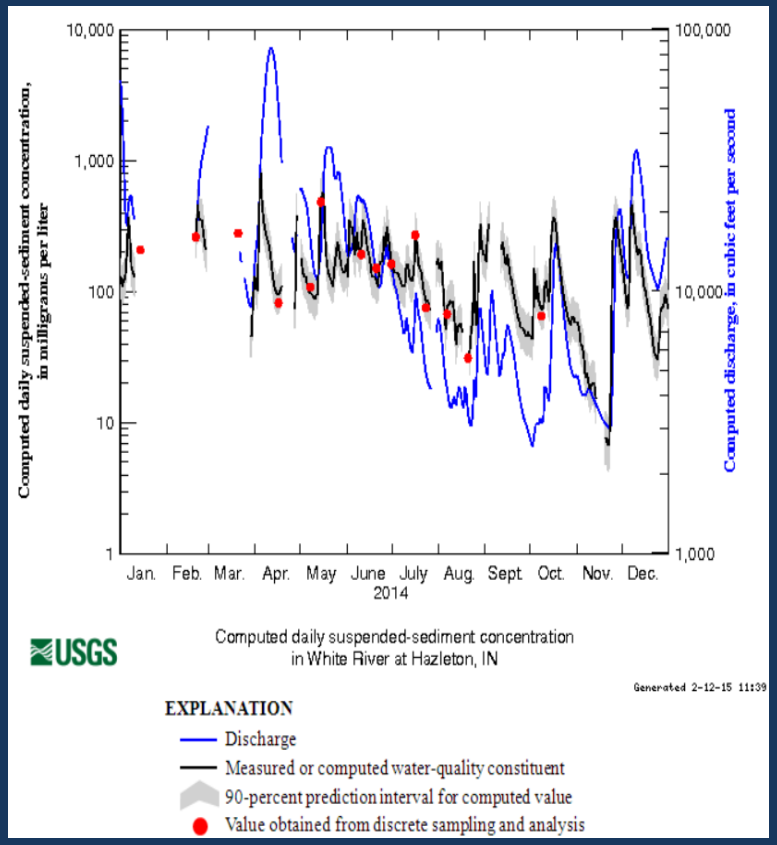
Example: Suspended sediment

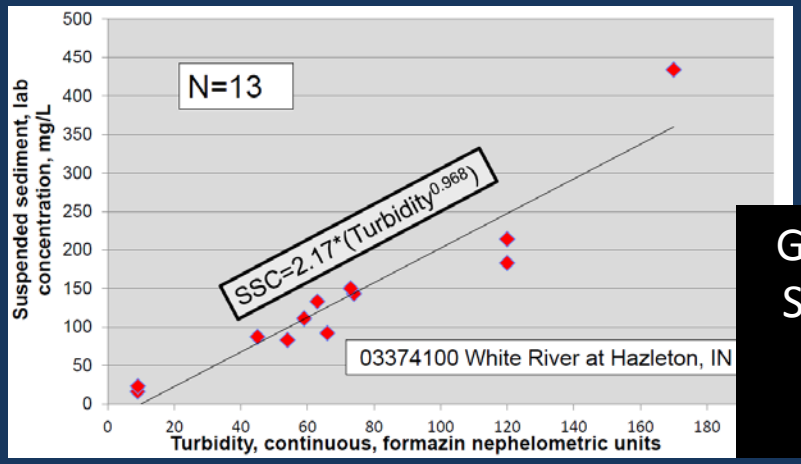
1. Install optical turbidity monitor and transmit data in "real" time
2. Collect discreet water-quality samples over range of hydrologic and chemical conditions
3. Develop regression model using discreet water samples and in-stream sensor values



How are surrogate models developed?

4. Estimate concentrations and/or loads
5. Publish regression models
6. Display estimates on the internet
7. Continue sampling to verify models and relations





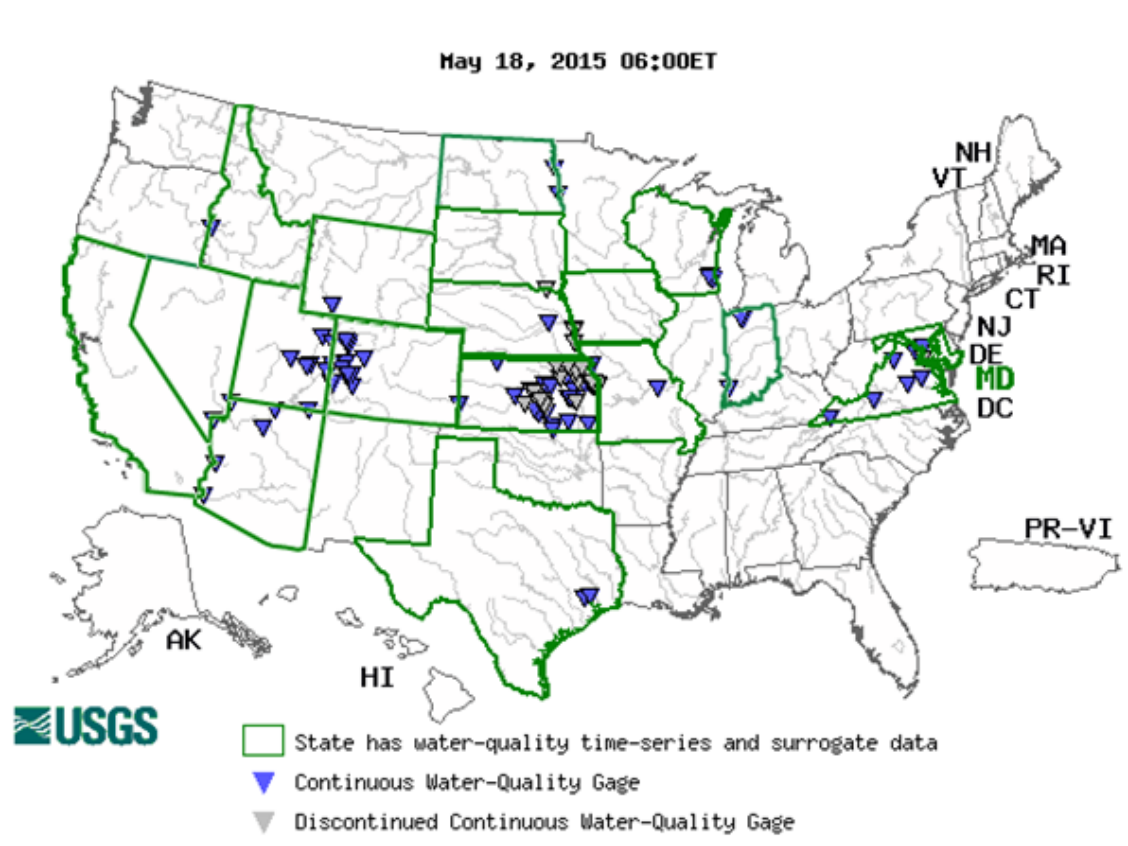
Guidelines and Procedures for Computing Time Series Suspended-Sediment Concentrations and Loads from In-Stream Turbidity-Sensor and Streamflow Data

Rasmussen and others, 2009

Accessing the data

- USGS National Real-Time Water Quality website

http://nrtwq.usgs.gov



Plot | Data Table | Statistics | Duration Curve | Site Info | Model Info

USGS station: 03374100 White River at Hazleton, IN

Go to NWISWeb

Constituent: Computed suspended sediment | concentration | hourly | < Go >

Time period: Year 2014 | All

Continuous Water-Quality Data

Date-Time	Computed instantaneous suspended sediment	Computed instantaneous suspended sediment, lower 90% confidence	inst
	in mg/L	in mg/L	
05/18/2015 07:00	180	130	
05/18/2015 06:00	170	120	
05/18/2015 05:00	170	120	
05/18/2015 04:00	160	110	
05/18/2015 03:00	150	110	
05/18/2015 02:00	150	100	
05/18/2015 01:00	150	110	
05/18/2015 00:00	150	110	
05/17/2015 23:00	160	110	
05/17/2015 22:00	180	120	
05/17/2015 21:00	170	120	
05/17/2015 20:00	180	130	
05/17/2015 19:00	180	130	
05/17/2015 18:00	150	110	
05/17/2015 17:00	140	100	
05/17/2015 16:00	120	86	
05/17/2015 15:00	110	81	
05/17/2015 14:00	110	78	

Model Form #1

$$\log_{10}(\mathbf{SSR}) = 0.3302 + 0.9682 \log_{10}(\mathbf{TURB})$$

where:

- SSR is computed suspended sediment, in milligrams per liter
- TURB is turbidity, YSI model 6136, in formazin nephelometric units

Model Calibration

Basic Data

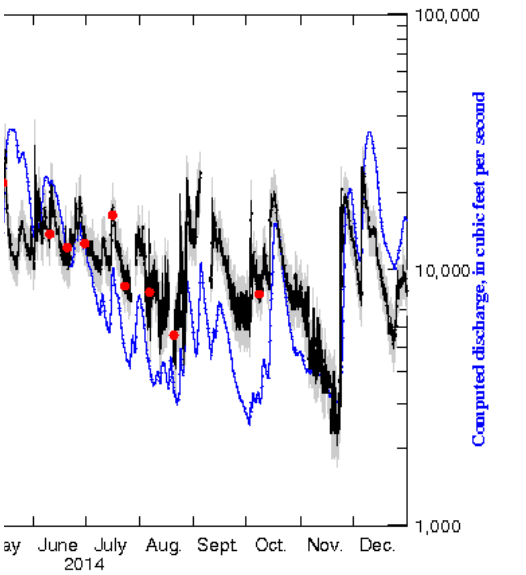
Number of measurements:	13
Mean squared error:	0.00641601
Multiple R^2:	0.95
Bias correction (smearing) factor:	1.015

Explanatory Variables

Variable	Value	Standard error
Intercept	0.3302	0.1071
$\log_{10}$(TURB)	0.9682	0.0606

Correlation Matrix

	Intercept	$\log_{10}$(TURB)
Intercept	1	-0.9782
$\log_{10}$(TURB)	-0.9782	1



ieous suspended-sediment concentration
hite River at Hazleton, IN

Generated 2-12-15 11:32

computed water-quality constituent
ediction interval for computed value
d from discrete sampling and analysis
ed using laboratory analysis and discharge
..... water-quality criteria

USGS

THANK YOU!

ANY QUESTIONS?