Opening Plenary Seminar for Continuous Real-Time Monitoring: Direct Measures and Surrogates

Andy Ziegler (USGS)–
Overview of Continuous Real-time Session track,
Continuous Real-time Water Quality Today and Tomorrow–Introduce closing session

Stewart Rounds (USGS)—
Historical perspectives-examples from Oregon

Mario Tamburri (ACT)—
Tools for coastal and ocean monitoring

Heather Powell (NEON)—
Overview of NEON Network and measuring reference conditions

Seventh National Monitoring Conference
Monitoring from the Summit Sea
April 26, 2010

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

Opening Plenary goals:

- Whet your appetite for the fantastic collection of presentations for the next 3 days in the Continuous Real-Time Monitoring sessions

- Present an overview of continuous monitoring, some history, tools, and networks

- Spur discussions and introduce some general questions for the closing session

USGS

And……

Collaborate to:

- Move this innovative science tool forward
- GET MORE SITES and cohesive approaches and networks implemented to answer the needs of society and the environment
- If we can think of “it”, we can do “it”– let’s define “it” and *Just Do It!*

USGS

Overview of RTWQ sessions

- **Fantastic subjects**
- **Talented speakers**
- **Excellent sessions throughout**
- **Opportunity to interact and collaborate and to MAKE A DIFFERENCE**

USGS

Do you want to know if water-quality monitors and operation have improved? use for targeting? Improve information display?

Do we have the session for you!

Monday- 1:30-3:00 pm

Session A1, Rm. 14: Continuous Real-Time Monitoring: Operation and Data Evaluation

Rob Ellison, Kevin Richards, Trudy Bennett, Chuck Dvorsky, and Bradley Garner

Are you trying to figure out how or whether to do nitrate or organic carbon (UV) monitors and sensors?

You can't miss any of these presentations!

Monday 3:30-5:00 pm

B1, Rm. 14: Evaluation and Application of New Technologies for Real-time monitoring

Janice Fulford, Rob Middlemis-Brown, Brian Pellerin, Larry Feinson

USGS

What is the latest and greatest on methods and tools to enhance quality and comparability of data?

It doesn't get any better than this!

Tuesday 8:00- 11:30 am

C7 and D Rm 10: Sensors Basics: Tools to Enhance the Quality and Comparability of Sensors Data for Continuous Real-Time Monitoring, Part 1 and Part 2 Dan Sullivan (USGS Co-Chair Methods Board)

Dan Sullivan, Gayle Rominger, Chuck Spooner, Chuck Dvorsky, Revital Katznelson, Mike Cook, Mike Sadar, and Cristina Windsor.

Is there anything special about operating a monitor in a Lake or Estuary?

These folks definitely know the answers!

Tuesday 1:00-2:30 pm

E1, Rm. 14: Continuous Real-Time Monitoring: Applications in Lakes and Estuaries

- Reed Green, Glenn Warren, Jennifer MacDonald, David Schoellhamer

USGS

How do we operate monitors in streams?

Some local and National examples!

Tuesday 3:30-5:00 pm

F1, Rm. 14: Continuous Real-Time Monitoring: Applications in Rivers and Streams

Ken Hyer, Andrew Cross, Pat Rasmussen, David Graczyk, and Ken Leib

What about using continuous monitors in regulatory applications?

Some examples!

Wednesday 8:00 – 9:30 am

G1, Rm. 14: Continuous Real-Time Monitoring: Regulatory Perspectives Chuck Spooner (EPA) Moderator

Lara Autry, Renee Patterson, John Yagecic, Philip Russell

AND---- There are additional presentations in other sessions that use continuous monitoring as a tool in understanding the environment

USGS

And Finally—How can YOU make a difference?

Take the survey during the week and attend!

Wednesday 10:00-11:30 am

H8, Rm. 10: Closing Interactive Panel Discussion for Continuous Real-Time Monitoring

Interactive Panel/discussion session of moderators and participants: Andy Ziegler, Reed Green, Ken Hyer, Janice Fulford, Dan Sullivan, Rob Ellison, and Chuck Spooner.

- **Where do we need to go? (What isn't getting done that is needed for instruments, new gizmos, protocols, databases, etc.?)**
- **Why aren't we there? (What are the technological and other impediments?)**
- **How do we fill these gaps to get where we need to go?**

Goal of session is to MAKE A DIFFERENCE and move the science/technology and applications in regulation forward

USGS

If you know that you are interested in continuous water quality monitoring….

Attend ALL of the sessions!

If you aren't sure if you are excited----

See me……

Let's talk……….

……………………….You will be!

Continuous Real-time Water-Quality Monitoring—Today and Tomorrow

Andy Ziegler

USGS Kansas Water Science Center

With contributions, collaboration, and occasional disruption from

Vicki Christensen,
Trudy Bennett,
Walt Aucott,
Bob Hirsch,
John Gray,
Brad Garner,
Jerry Blain
Ken Hyer
Dale Blevins
Jerad Bales
Dennis Helsel

Xiaodong Jian,
Teresa Rasmussen,
Tim Cohn,
Dave Lorenz,
Tim Miller,
Jerry Feese
Harry Lins
Dave Wolock
Dave Rus
Charlie Demas
….

Pat Rasmussen,
Casey Lee,
Dave Mueller,
Doug Glysson,
Cherie Miller
Tom Stiles
Art Horowitz
Dave Schoellhamer
Callie Oblinger
Terry Schertz

and many, many, many others

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

Seventh National Monitoring Conference
Monitoring from the Summit Sea
April 26, 2010

Outline:

- **So what and who cares?**
- **Worldwide perspective**
- **Vision for RTWQ**
- **Today and Tomorrow**
- **National Network**
- **Closing session – *MAKE A DIFFERENCE***

USGS

Why monitor water quality continuously?

- Improves our understanding of hydrology and water quality and can lead to more effective resource management
- Provides warning for water supply and recreation
- Captures seasonal, diel, and event-driven fluctuations
- Improves concentration and load estimates with defined uncertainty (8,760 hourly values per year)
- Optimizes the collection of samples

USGS

AND…..

SO WHAT? and WHO CARES?

Continuous instantaneous real-time water quality MEETS OUR INFORMATION NEEDS for time-dense information that are used to improve the quality of human life and the environment

Today--Worldwide—lots of sites added

- Lots of similarity of sensor measurements
  - Stage, Q, wave height, Temp, sc, pH, DO, turbidity, fluorescence, some nitrate, carbon, few others

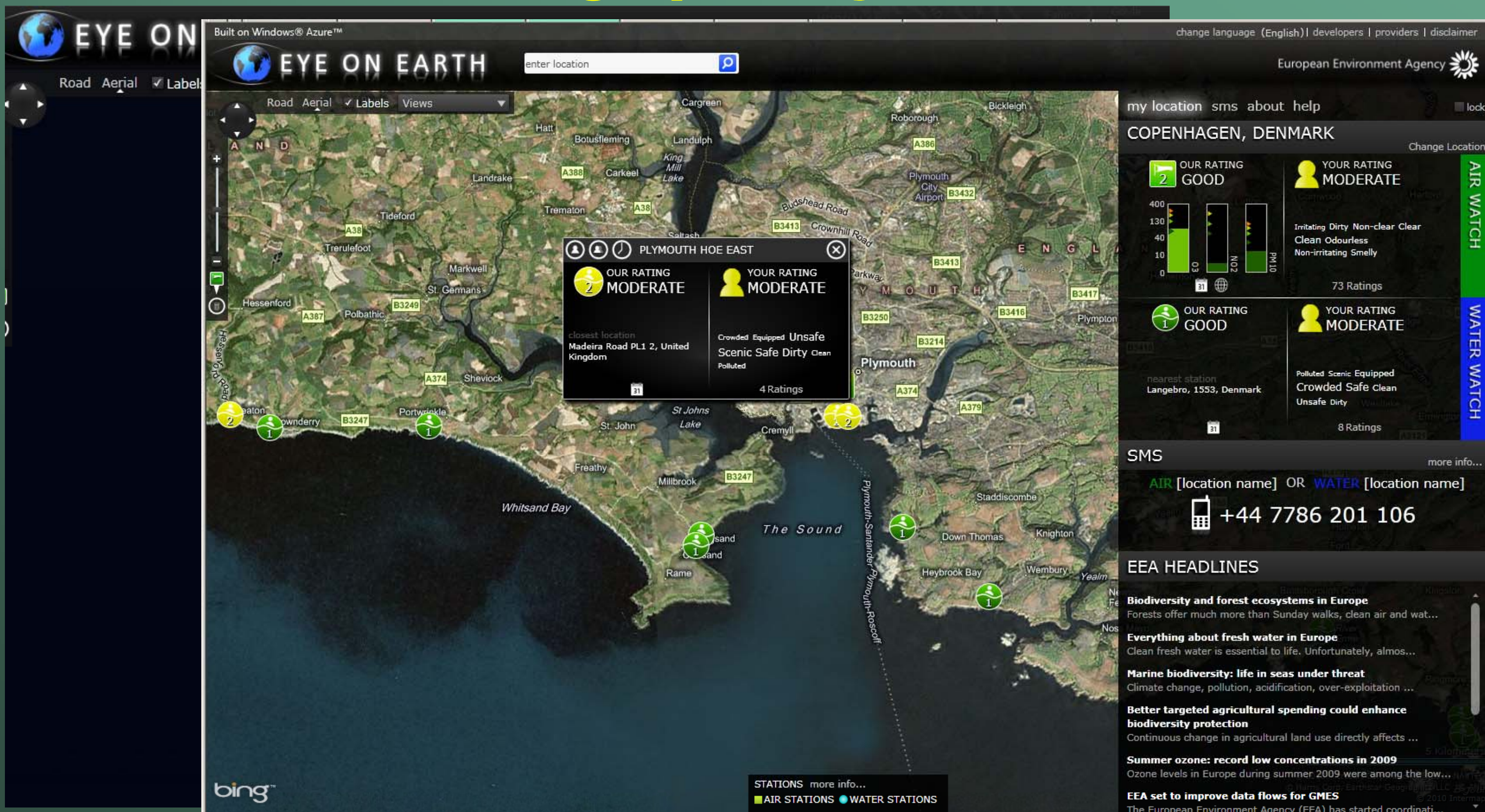
- Display of values measured last 30 (or so) days. Some access to “old” continuous data

- Wide variability in complexity of display and user ability to select information

- Surrogates?

USGS

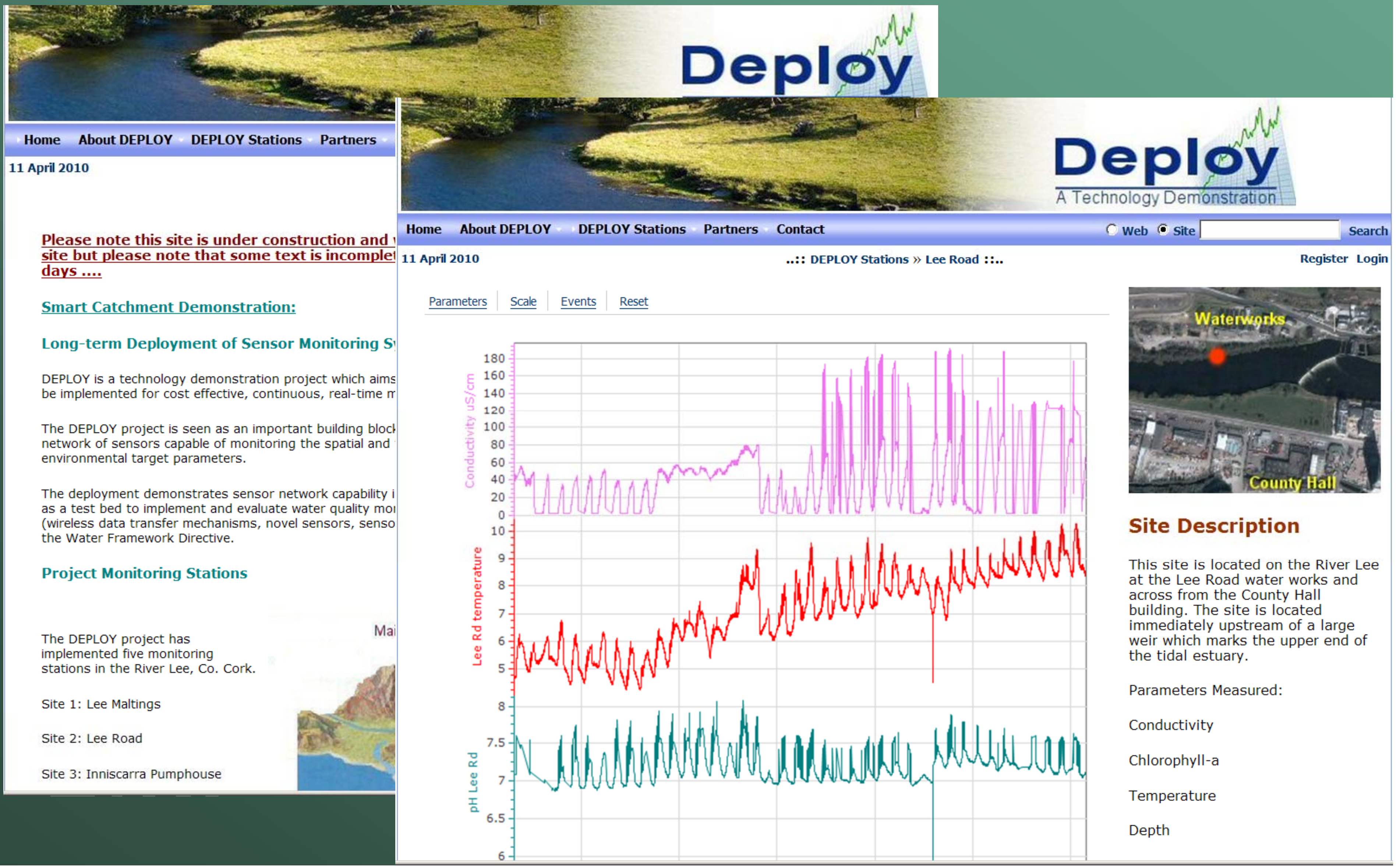
Eye-On-Earth European Union
Air and Bathing quality



USGS

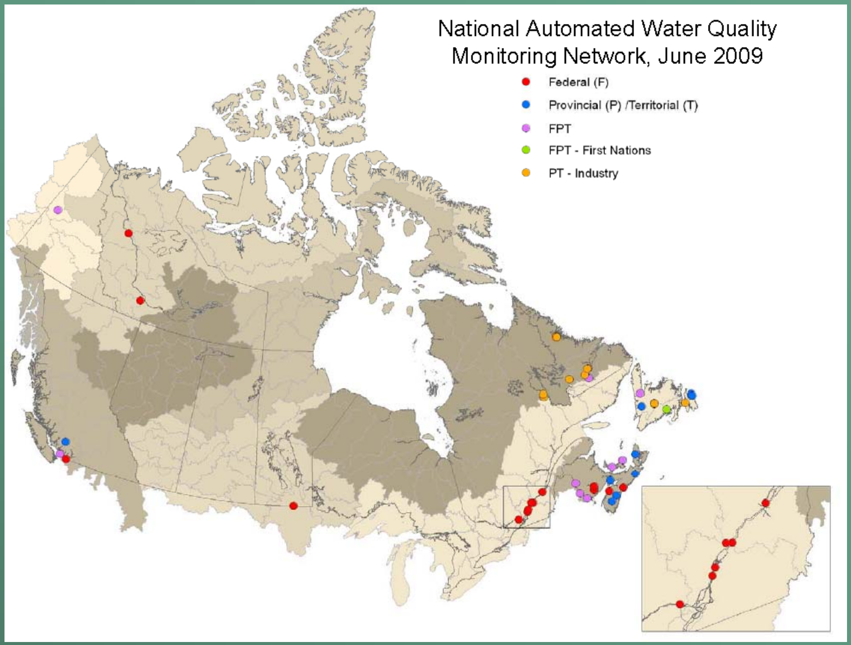
http://eyeonearth.cloudapp.net/

Deploy– Ireland
http://89.124.67.3/deploy/Home/tabid/36/Default.aspx



Canadian National Monitoring Network

- **Goal—Bring together existing automated sites, implement new sites and expand with interested partners**
- **Maximizing integration with the hydrometric network**
- **Benefits:**
  - **Demonstrate technology, cost effective, primary water quality screening, early warning, background and trend data and provide real-time information to public and more rapid intervention**



http://www.env.gov.nl.ca/env/Env/waterres/WQMA/RTWQM_Workshop_2009/Agenda_2009.asp

USGS

Towards a National Automated Real-Time Water Quality Monitoring Network - Geneviève Tardif (Environment Canada)
Real-Time Water Quality Monitoring Workshop 2009, St. John's, NL

Newfoundland-Labrador and Fraser

Environment and Conservation
Government of Newfoundland and Labrador - Canada

Government Home | Search | Sitemap | Contact Us

Newfoundland Labrador

Newfoundland and Labrador Real-time Water Quality Monitoring Stations

Due to the volume and frequent updating of the data available on this Web site the streamflow and water quality data is PROVISIONAL and has not undergone quality control checks. These data may be subject to significant change.

Networks	Partners	Station Name	Installation Date
	Vale Inco Newfoundland and Labrador (Voisey's Bay, Labrador) and NL WRMD	NF03NE0009 - Reid Brook at Outlet of Reid Pond	July 2003
		NF03NE0010 - Camp Pond Brook below Camp Pond	July 2003
		NF03NE0011 - Lower Reid Brook below Tributary	July 2003
		NF03NE0012 - Tributary to Reid Brook	July 2006
		NF03NE0008 - Voisey's Bay - Well After Tailings Dam	July 2006 – currently not installed due to location conditions
	Vale Inco Newfoundland and Labrador (Long Harbour, Newfoundland) and NL WRMD	NF02ZK0023 -Rattling Brook below Bridge	December 2006
		02ZK007 - Rattling Brook Big Pond	December 2006
		NF02ZK0025 - Rattling Brook below Plant Discharge NEW!	October 2009
Industry Partners Network	Duck Pond Operations, Teck Cominco Limited (Central Newfoundland) and NL WRMD	NF02YO0190 - Tributary to Gills Pond Brook	May 2006
		NF02YO0192 - East Pond Brook	August 2006

Home
Fraser River Water Quality Buoy Overview
About the Project
Buoy Location
Buoy Instrumentation
Protocols
Data Online
Online Resources
Publications
Photo Gallery
FAQ

BRITISH COLUMBIA

This buoy has been deployed in partnership with the British Columbia Ministry of Environment

Fraser River Water Quality Buoy

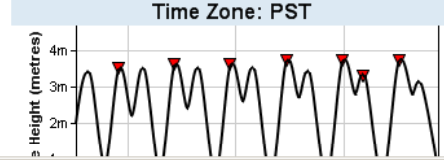
Federal-Provincial Automated Monitoring Station

For more information on the location of the buoy click here

Environment Canada, in partnership with the BC Ministry of Environment, has deployed a new water quality monitoring and surveillance buoy in the Main Arm of the Fraser River. The buoy has a variety of instrumentation that will collect water quality, water quantity and meteorological information.

The data and information collected are transmitted via cellular telemetry and will be available to the public in real-time on this website. The data can also be viewed on your cellphone, Blackberry or other Internet-enabled mobile device at http://www.waterquality.ec.gc.ca/waterqualityweb/rtwq.aspx

Steveston
7 Days Tidal Prediction
Time Zone: PST



10/04/13 19:12

Live Image (Click to enlarge)

Real-Time Fraser River Buoy Readings

Water Quality Observations

Turbidity	10.8NTU
Specific Conductivity	229uS/cm
Water Temperature	7.63°C
pH	7.82
Dissolved Oxygen	103.5%

Water Depth and Flow

Water Depth	13.8m
Stream Velocity	0.15m/s (0.3kn) to SW (230.58°)

Meteorological Observations

Wind Speed	10.44km/h
Wind Direction	From E (73°)
Air Temperature	9.4°C
Relative Humidity	84.7%
Pressure	1017.62mb

From December 1st, 2009 till December 8, 2009 the water quality observations will be

USGS

http://www.env.gov.nl.ca/wrmd/RTWQ/RTWQ.asp
*www.**waterquality**.ec.gc.ca/**waterquality**web/**realtime**index.aspx*

U.S.– lots of sites on-line in the last 4 years

- Our Lake—Central NY http://www.ourlake.org/index.html
- Near Real-Time Water Quality Monitoring and Data Distribution in the San Joaquin Valley Wetlands (currently not available)
- Mystic River http://www.mysticriveronline.org/
- Susquehanna River Basin Commission
  - http://www.srbc.net/programs/remotenetwork.htm
- Eyes on Bay- Chesapeake
  - http://mddnr.chesapeakebay.net/eyesonthebay/index.cfm
- IOOS (Integrated Ocean Observing System)
  - http://www.obsregistry.org/map.php
- Central & Northern CA
  - http://www.cencoos.org/sections/conditions/waterquality.shtml
- Texas Commission on Environmental Quality
  - http://tceq.net/cgi-bin/compliance/monops/water_monitors.pl

USGS

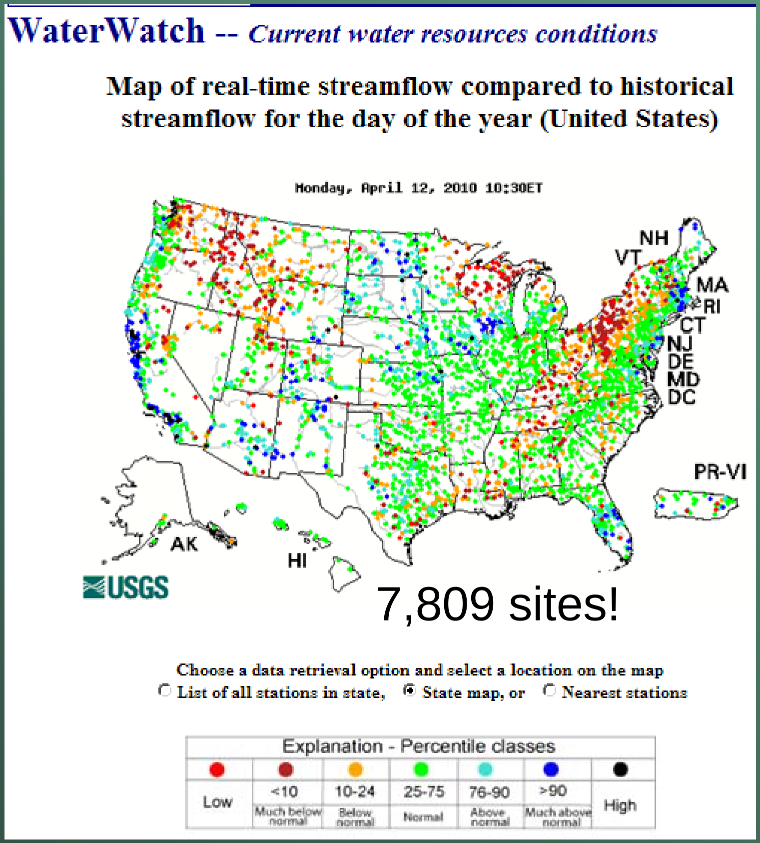
Neat sites and different approaches to presenting information
Check them out!

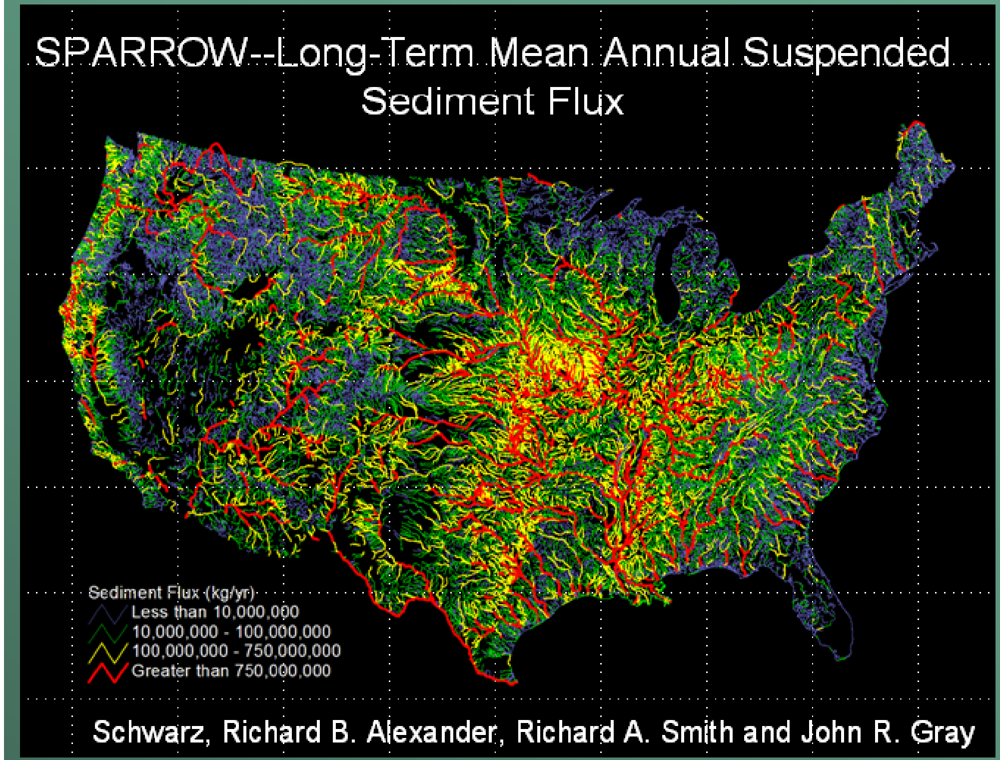
USGS TODAY– Some USGS examples of providing instantaneous continuous data and "surrogate" computations on the web

- CA- SF Bay- Sediment, etc. Since 1989
  http://sfbay.wr.usgs.gov/sediment/cont_monitoring/index.html
- KS (1999)-MD (soon adding IA, MO, NE, SD, TX, and WI)– bacteria, sediment, chloride, atrazine, geosmin, etc., http://nrtwq.usgs.gov/ks/
- CO- Total dissolved solids transport-
  http://co.water.usgs.gov/projects/ArkQW/index.cfm
- OH-beachwatch- bacteria-http://www.ohionowcast.info/index.asp
- MT/WY- Sodium absorption ratios-
  http://tonguerivermonitoring.cr.usgs.gov/

USGS

Vision: Water-quality information, anywhere at anytime (Thank you, Bob Hirsch!)





Our goal should be to provide water-quality concentrations and loads with associated uncertainty on all time and spatial scales with a historical perspective …

USGS

Where we are:

- WaterQualityWatch -- Continuous Real-Time Water Quality of Surface Water in the United States
  - http://water.usgs.gov/waterwatch/wqwatch/
  - Linkage to NWISweb data with some value added- Only current unit values are presented for last 120 days
- NATIONAL REAL-TIME WATER QUALITY
  - http://nrtwq.usgs.gov/
  - Page to present all past and current computed “surrogate” and measured water quality for concentrations, loads, and model information

USGS

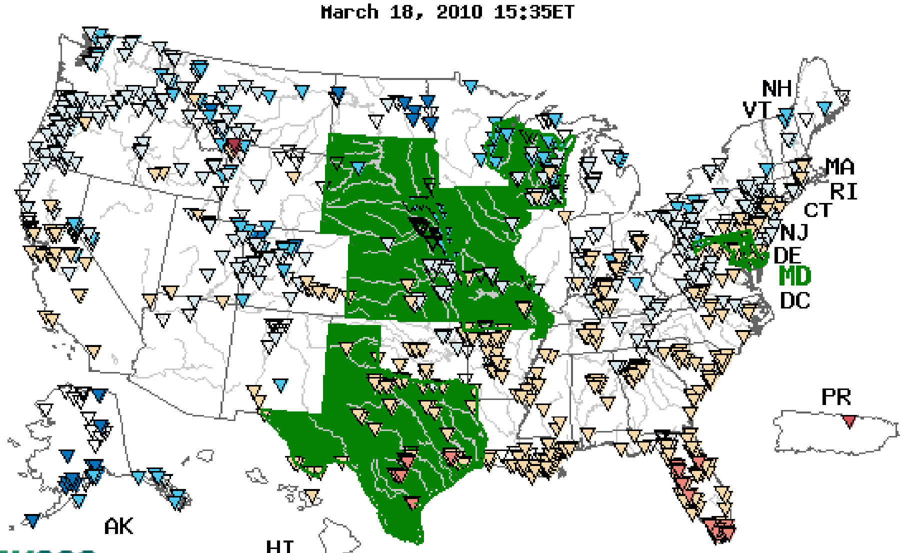
NRTWQ– 321 turbidity sites (90 in 2000)

US Geological Survey Real-Time Water Quality Data For the Nation

NATIONAL REAL-TIME WATER QUALITY

Map of Real-Time Water Temperature, in °C

March 18, 2010 15:35ET



USGS

State has continuous computed water-quality data

Explanation							
<1	1-4.9	5-9.9	10-19.9	20-29.9	30-35	>35	No Data

Temp | Cond | pH | D.O. | Turb | Disch

Continuous real-time water-quality data are used for decisions regarding drinking water, water treatment, regulatory programs, recreation, and public safety. Sensors in streams typically measure streamflow, water temperature, specific conductance, pH, dissolved oxygen and turbidity. Additionally, these measurements can be used as surrogates to compute real-time concentrations and loads of other water-quality constituents.

Click the Map for Real-Time Water-Quality Data. This Will Either Show:

1. This National Real-Time Water Quality (NRTWQ) website (currently Iowa, Kansas, Maryland, Missouri, Nebraska, South Dakota, Texas, and Wisconsin) provides hourly computed concentrations and loads for sediment, nutrients, bacteria, and many additional constituents; uncertainty values and probabilities for exceeding drinking water or recreational criteria; frequency distribution curves; and all historical hourly in-stream sensor measurements.

2. WaterQualityWatch presents colorful maps of recent hourly measurements of streamflow, water temperature, specific conductance, pH, dissolved oxygen, and turbidity. The most recent 60 days of real-time data also are available for download. Similar to NRTWQ, its data are obtained from the USGS National Water Information System.

USGS

http://nrtwq.usgs.gov/

http://waterwatch.usgs.gov/wqwatch

USGS science for a changing world

Real-Time Water Quality for Kansas

Home | View Data | Methods | Constituents

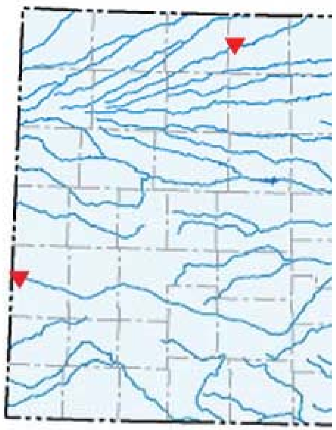
NRTWQ Home >> Kansas

Kansas Real-Time Water Quality

Real-time computed concentrations of water-quality constituents su
regression models. The results of these models, along with direct w

Ordinary least squares regression models on this site use convent
dissolved oxygen) to compute concentrations and loads of other wa
constituents in real time for public safety without the lengthy time de

Please select a site from below to start viewing data. You also can r
each page.



▼ Continuou
▼ Discontinu

USGS science for a changing world

USGS Home
Contact USGS
Search USGS

Kansas Real-Time Water Quality

Home | View Data | Methods | Constituents | Models | Bibliography | Links

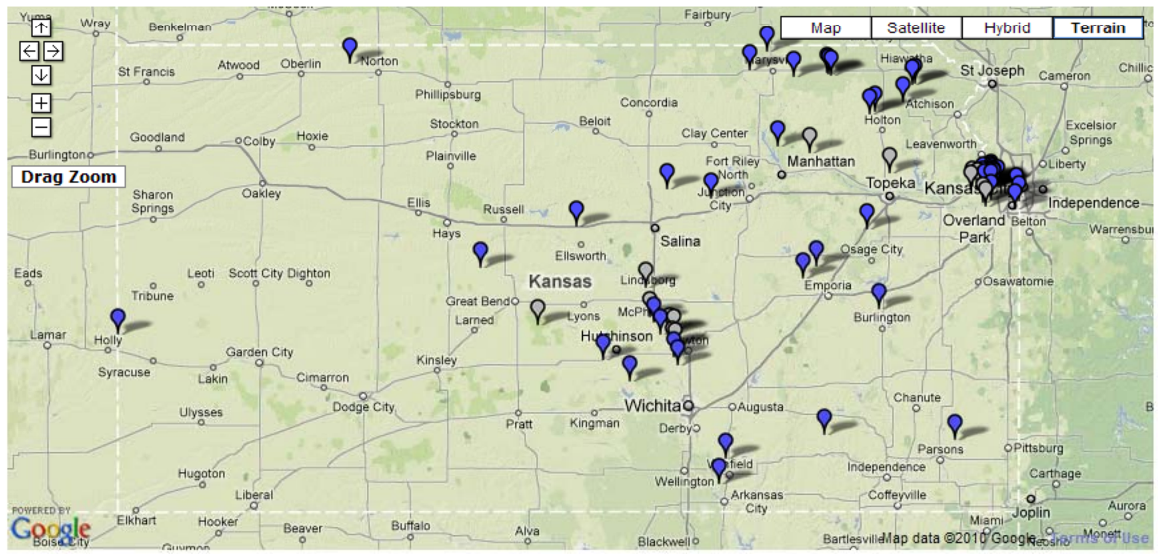
NRTWQ Home >> Kansas

Kansas Real-Time Water Quality

Real-time computed concentrations of water-quality constituents such as suspended sediment, total nitrogen, and total phosphorus are calculated using ordinary least squares regression models. The results of these models, along with direct water-quality measurements, can be viewed here as time-series graphs, or downloaded as tabular data.

Ordinary least squares regression models on this site use conventional sensor measurements (for example, discharge, temperature, pH, specific conductance, turbidity, and dissolved oxygen) to compute concentrations and loads of other water-quality constituents in real time. This makes it possible to compute instantaneous values of many constituents in real time for public safety without the lengthy time delay of collecting a sample and waiting for analysis of a sample at a laboratory.

Please select a site from below to start viewing data. You also can read more about the methods, measured constituents, and disclaimers by using the navigation bar at the top of each page.



Map Legend

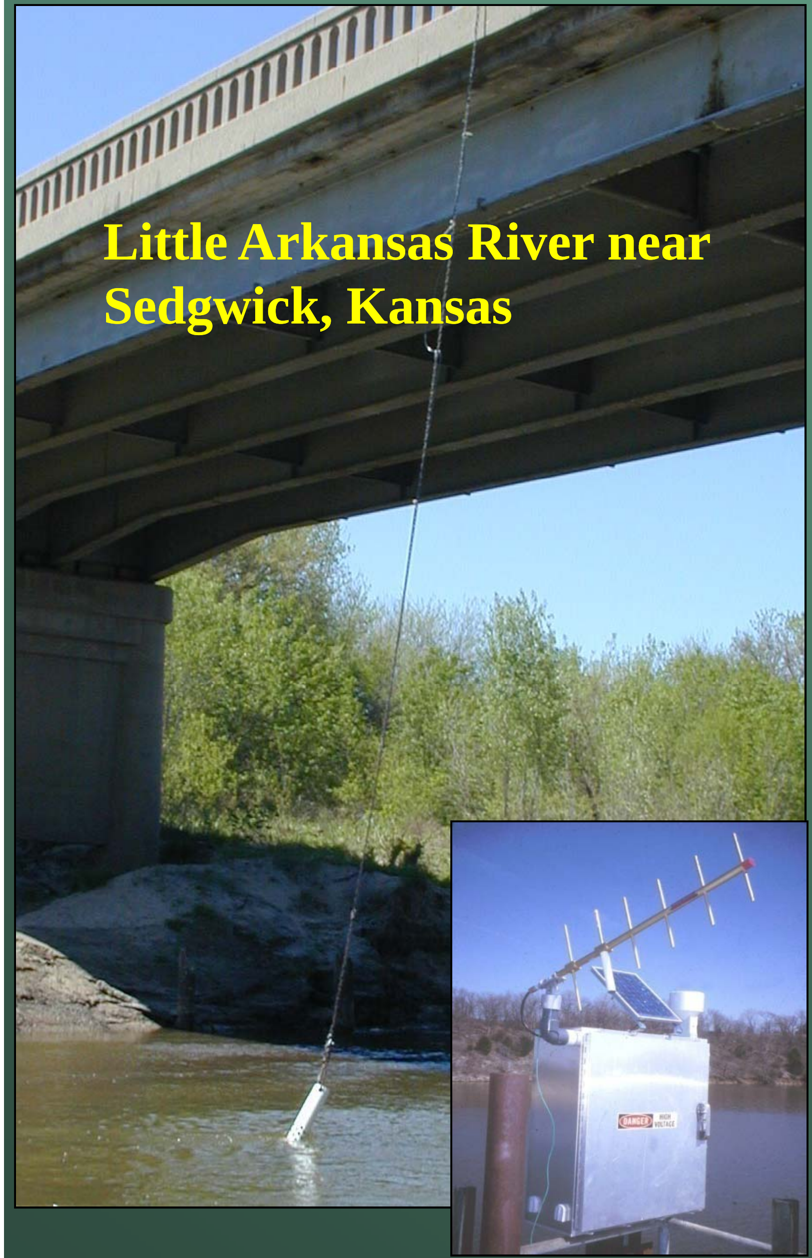
Continuous Water-Quality Gage

Discontinued Continuous Water-Quality Gage

USGS

http://nrtwq.usgs.gov/ks/

USGS Real-Time Water Quality Approach:



- Add water-quality monitors at streamgages and transmit data “real” time
- Collect water samples over the range of hydrologic and chemical conditions
- Develop site-specific regression models using samples and sensor values
- Compute concentrations and loads
- Publish regression models
- Display computations, uncertainty, and probability on the Web
- Continued sampling to verify models

Rasmussen, Gray, Glysson, and Ziegler, 2009,
http://pubs.usgs.gov/tm/tm3c4/

“Surrogates” are “calibrated” sensors

- Use in-situ measurements when direct measurement sensors are not available
- Calibrate the in-situ sensor with samples collected over range in conditions using statistics and develop models (the simpler, the better)
- Compute concentrations, loads, uncertainty, and probability of exceeding water-quality criteria and display on web

USGS

Parameter Directly measured	Parameter Computed
Gage Height/Stage/velocity	Streamflow (discharge)
Specific Conductance	Chloride, alkalinity, fluoride, dissolved solids, sodium, sulfate, nitrate, atrazine
Turbidity	Total suspended solids, suspended sediment, fecal coliform, *E. coli*, total nitrogen, total nitrogen, total phosphorus, geosmin

USGS

Why do surrogates work?

Because there is a physical relation between the measured sensor value and the constituent of additional interest—

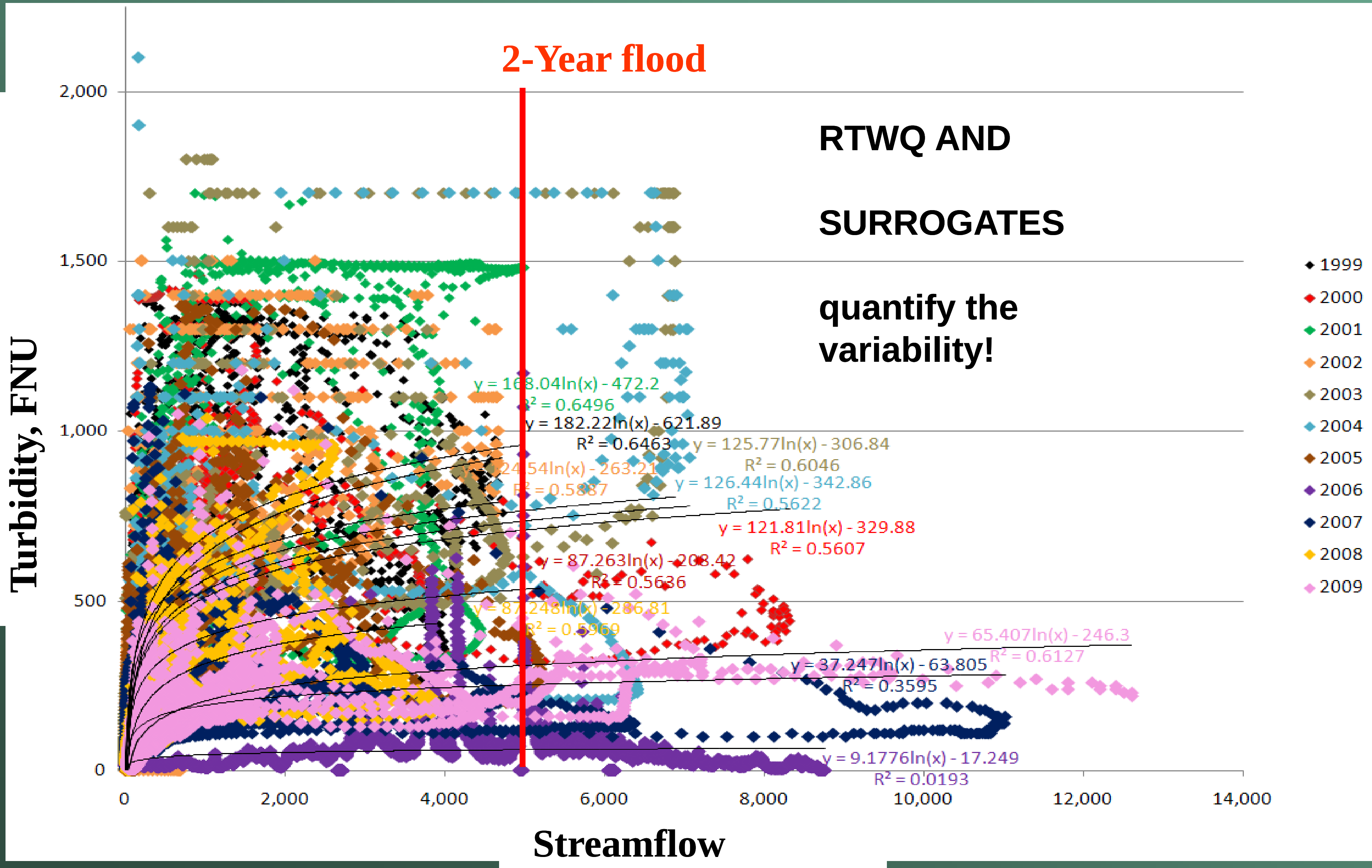
Sediment directly *causes* turbidity
Chloride directly causes specific conductance

In other cases, there is an *association* between the constituent of interest and the in-situ measurement--bacteria

Relations are likely site specific and robustness of relations depends on the sources of the constituents

Streamflow relation to water quality is complex and variable

Can we capture, quantify, understand, and regulate this water-quality variability with 6 or 10 or 20 samples per year?



Turbidity provides the best estimate of suspended-sediment concentrations

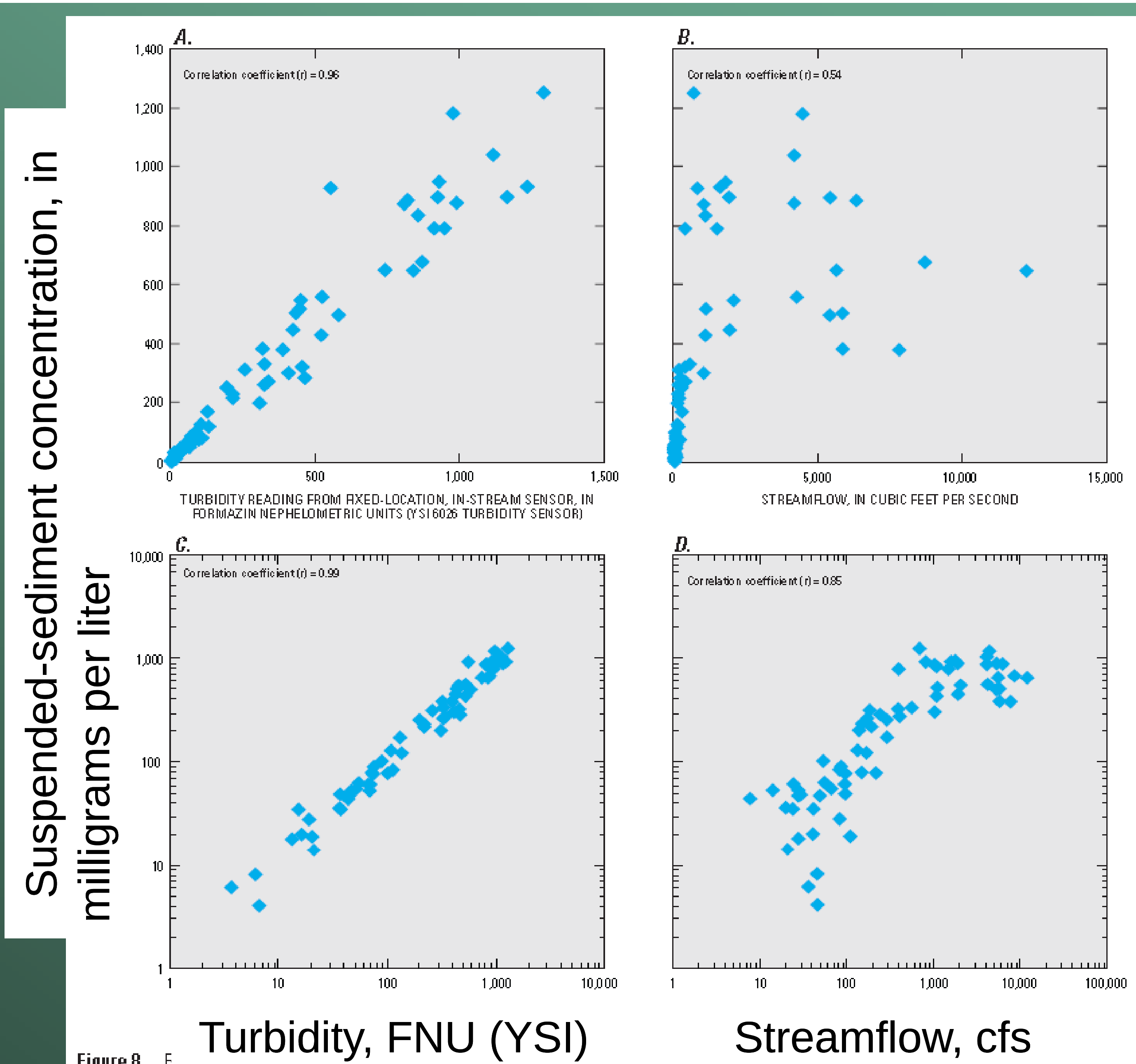


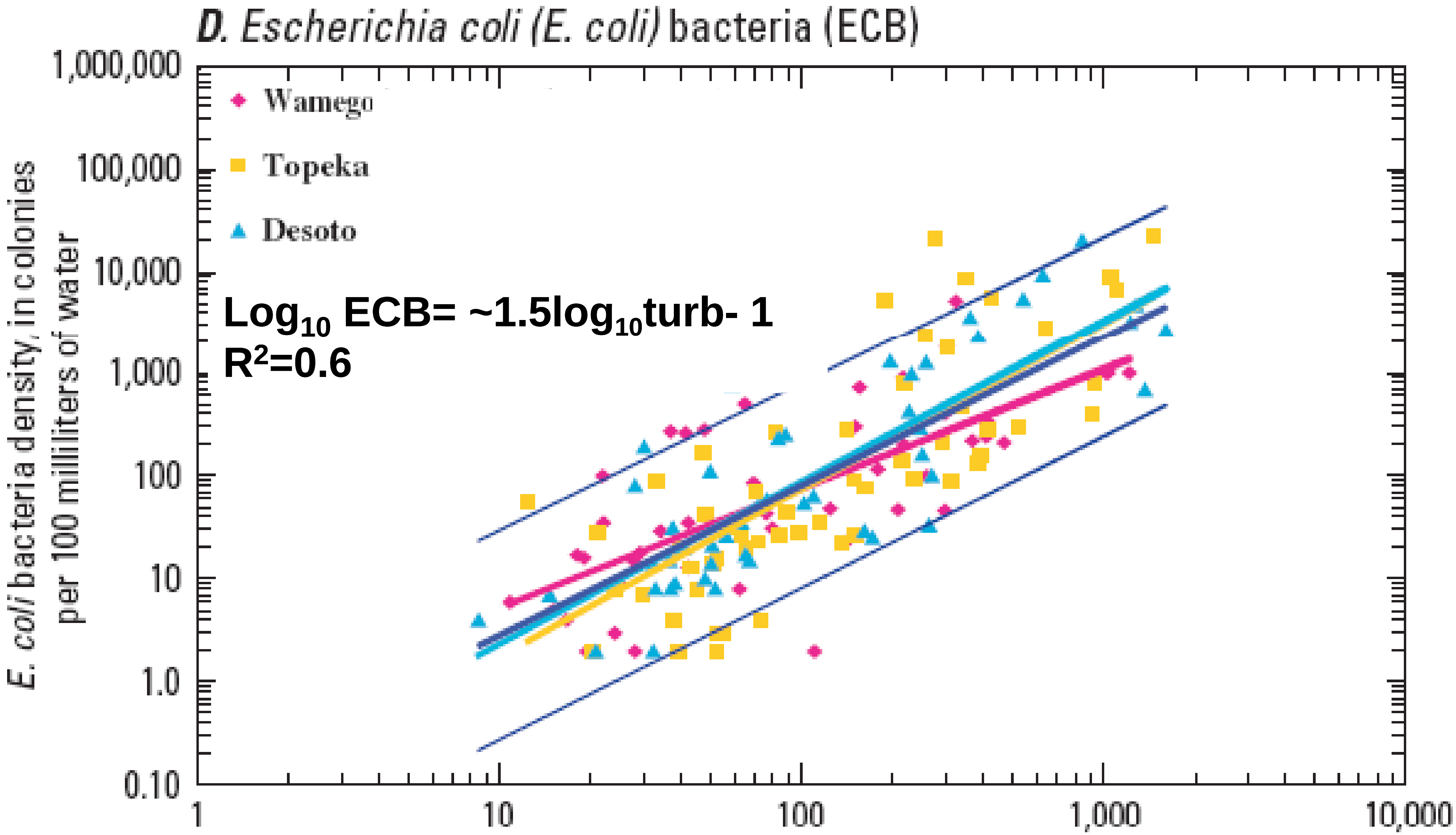
Figure 8. F

concentration in linear space, *(C)* turbidity and suspended-sediment concentration, and *(D)* streamflow and suspended-sediment concentration in $\log_{10}$ space for U.S. Geological Survey streamgage on Little Arkansas River near Sedgwick, Kansas, 1999–2005.

USGS

Rasmussen and others, 2009

Turbidity estimates *E. Coli* reliably

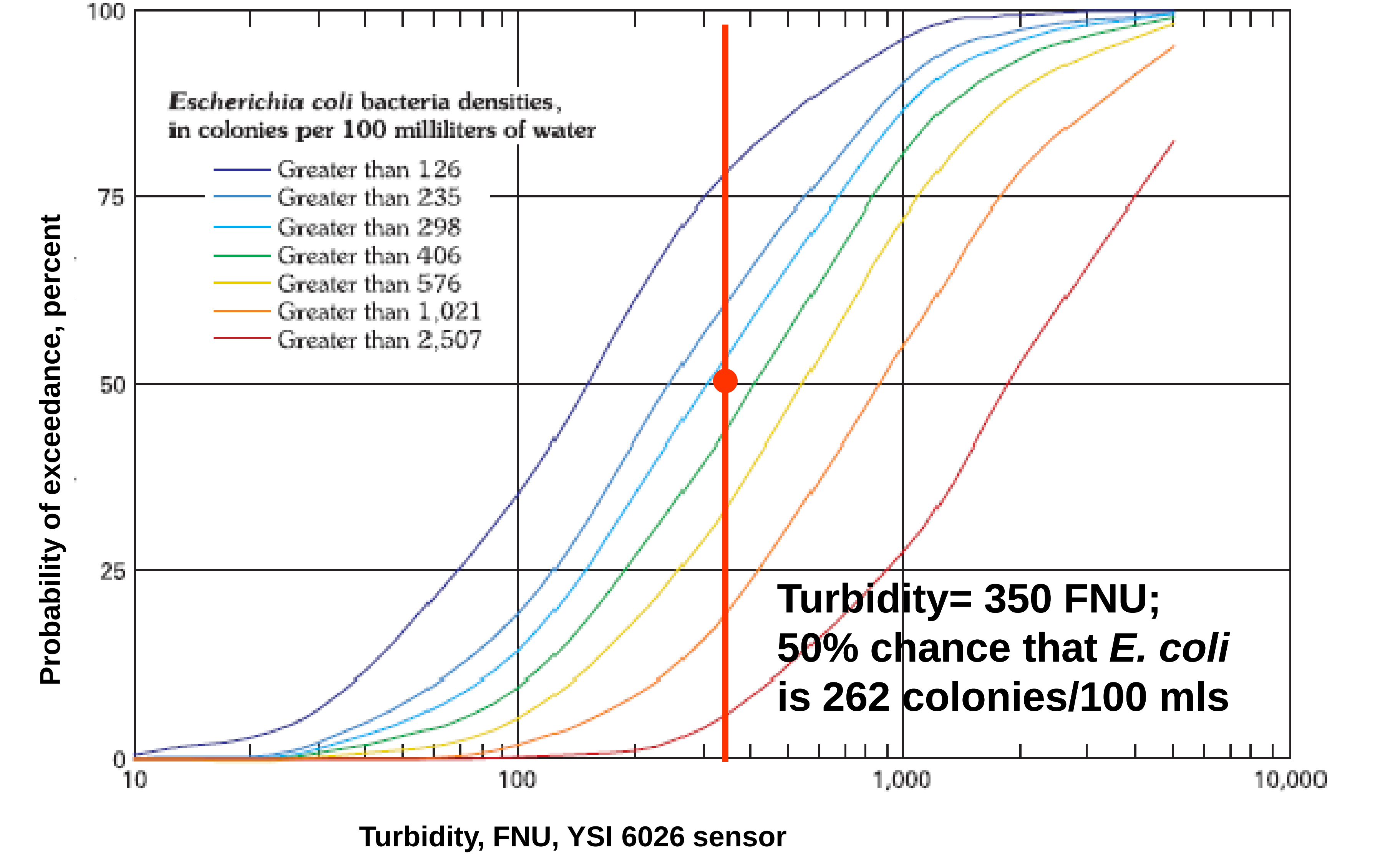


Log_{10} ECB= ~1.5$\log_{10}$turb- 1
R^2=0.6

USGS

Rasmussen, Ziegler, and Rasmussen, 2005

Using turbidity to estimate probability of exceeding E. coli criteria



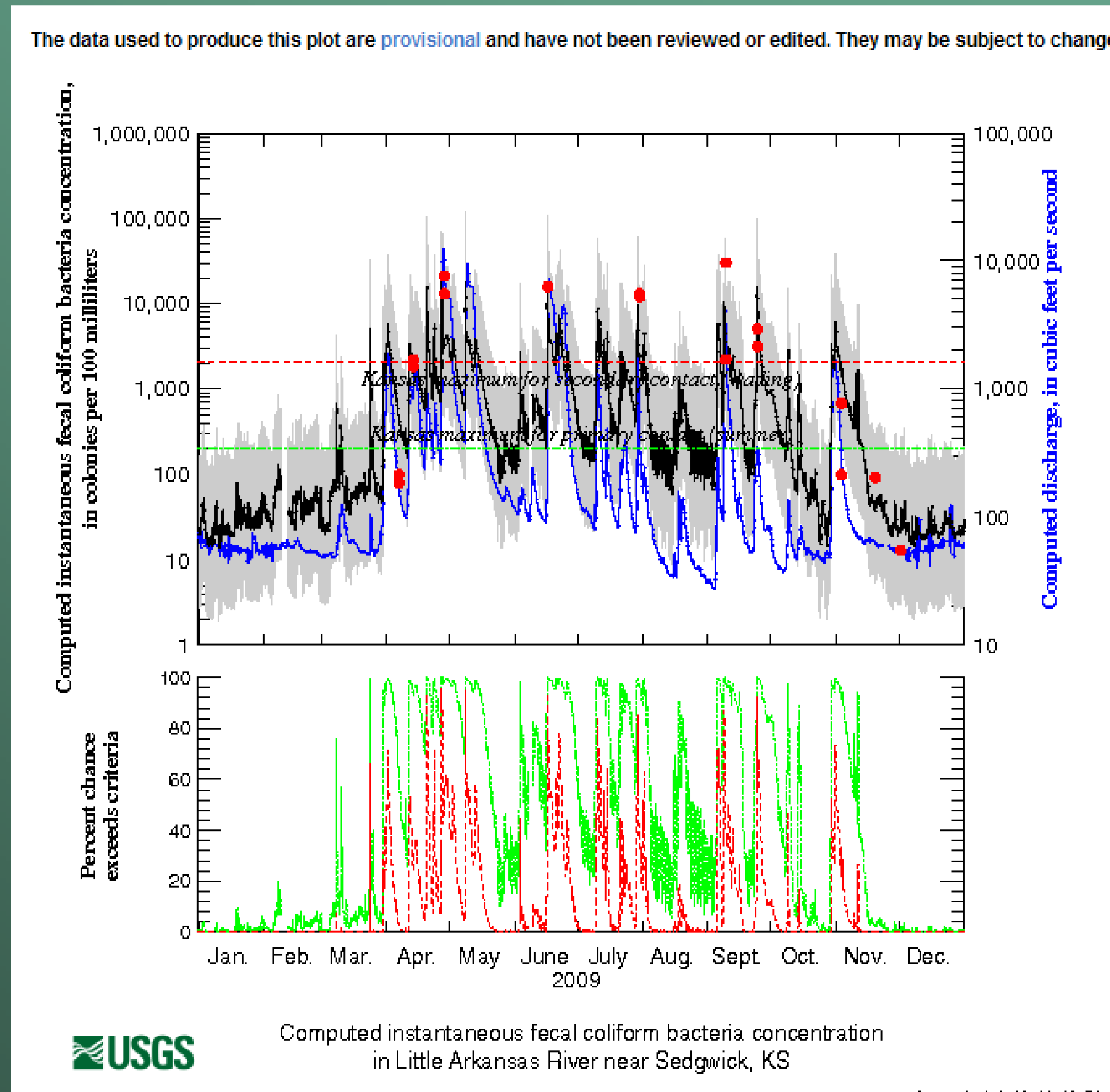
USGS

Rasmussen and Ziegler, 2003

Bacteria frequently exceed water-quality standards

Real-time computed concentrations of bacteria, uncertainty, and probability of exceeding WQ criteria

(look at the sample data….) Aren't continuous surrogates better?



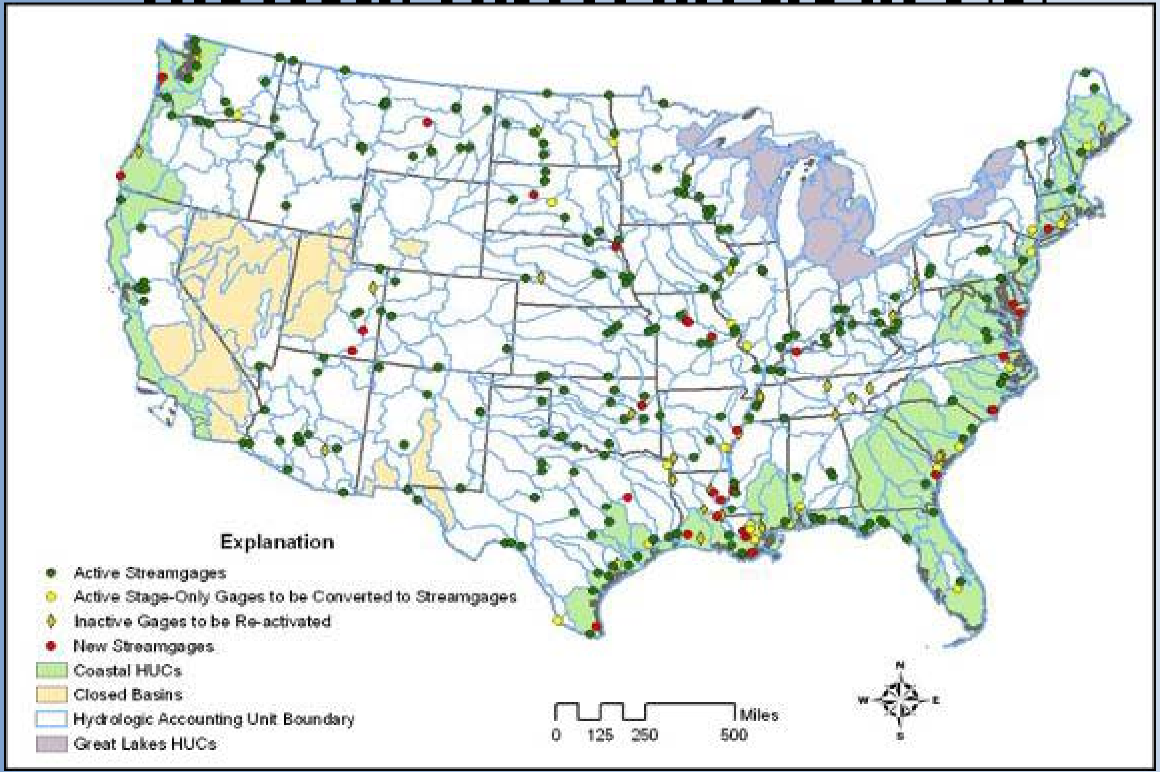
Concentration more important than load for health

http://nrtwq.usgs.gov/explore/plot?site_no=07144100&pcode=31625&period=2009_all&timestep=uv

Isn't it time for a National Continuous WQ network?

YES!

The Network for Rivers in U.S.



The Network for rivers is designed to assess:

- streamflow, contaminant loads, biological conditions at the outlet of each Hydrologic Accounting Unit at HUC6
- streamflow and constituent loads from coastal rivers.

USGS

http://acwi.gov/monitoring/network/

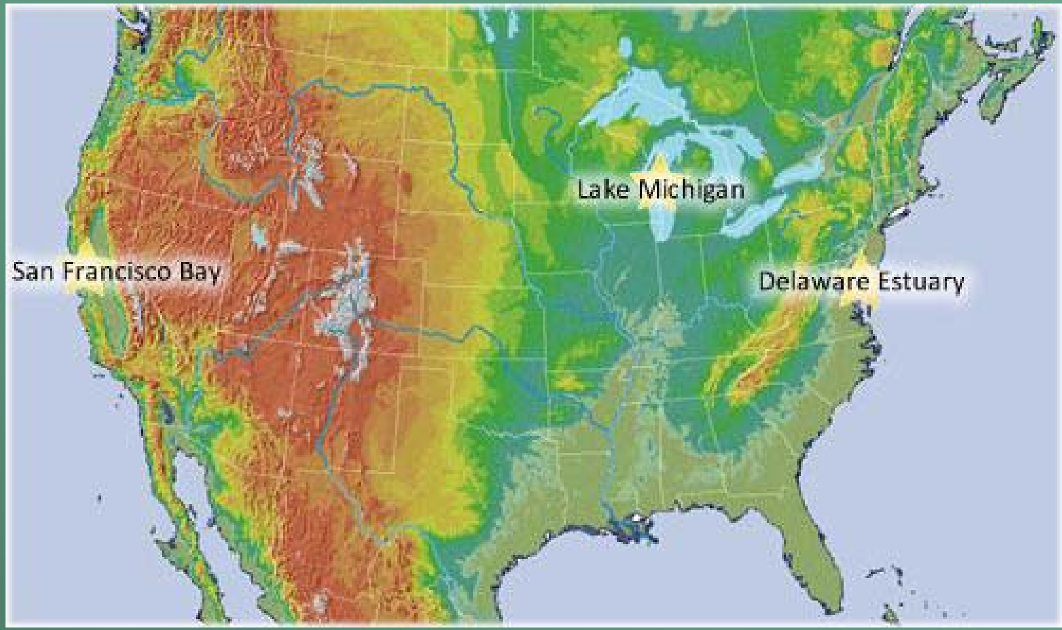
What do we gain from a National Continuous Water-Quality Network?

- Information to assess, describe, and understand water quality for all uses—drinking water, recreation, environment
- Infrastructure that measures water quality in large river and estuary systems—like the Mississippi—that typically are not assessed
- Information using today's technology rather than approaches developed 50 (or more) years ago that are only sufficient for annual loads—at best
- Evaluate the effectiveness of investments in many and large and expensive programs designed or thought to improve water quality (but are these measurements made on the time scale that answers these questions?)

USGS

NMN Pilots in Lake Michigan, Delaware, and San Francisco Bay

- Pilots represent 20 federal, state, local, academic, NGOs



- Fully implemented network will contribute to many of the most important resource management issues

http://acwi.gov/monitoring/

- Improvements in data management needed

- Gaps in numbers of sites, sampling frequency (nutrients) and need for additional analytes (chemicals related to fish consumption, nitrogen fluxes, effects of non-natives)

USGS

Annual estimated costs for each network estuary and its tribs would be in the range of $5-7 million each depending on size and complexity. Based on Lake Michigan, the costs for each Great Lake would be $12 million.

Proposed National Sediment and Water-Quality Monitoring Program Piloted in the Mississippi River Basin – A Synopsis

representing an interagency group that also includes:

Dale W. Blevins (USGS), Charlie Demas (USGS), John Gray (USGS), Dave Heimann (USGS), Art Horowitz (USGS), Dave Rus (USGS), Chuck E. Shadie (COE), Jim Stefanov (USGS), Rick Wilson (USGS), Andy Ziegler (USGS), and many additional USGS/COE/NOAA/EPA colleagues

ftp://ftpext.usgs.gov/pub/er/va/reston/jrgray/mrb_proposal/

USGS

Vision: A National Sediment & WQ Monitoring Program

USGS/COE Proposal that will…

Establish a long-term, base-funded, network-designed national monitoring program to generate sediment, nutrient, and sediment-associated chemical concentrations, loads, budgets and temporal trends that are integrated within existing networks.

Mississippi Basin will be the pilot program that grows into a national network

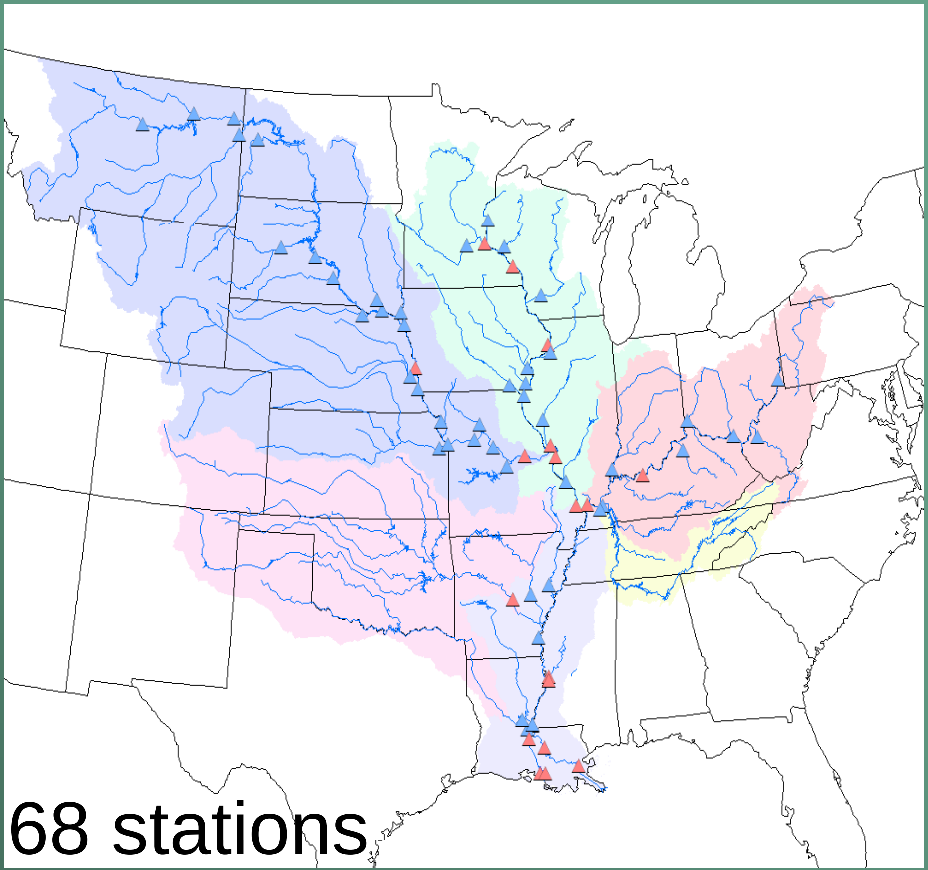
National Program Cost/Benefits

400-450 stations about $ 100 M annually

- **Pilot program in Mississippi River Basin proposed at $17.6M in FY2012—hopefully….**

National program cost is <1% of estimated sediment costs/damages annually

Not to mention the Gulf Hypoxia costs…….



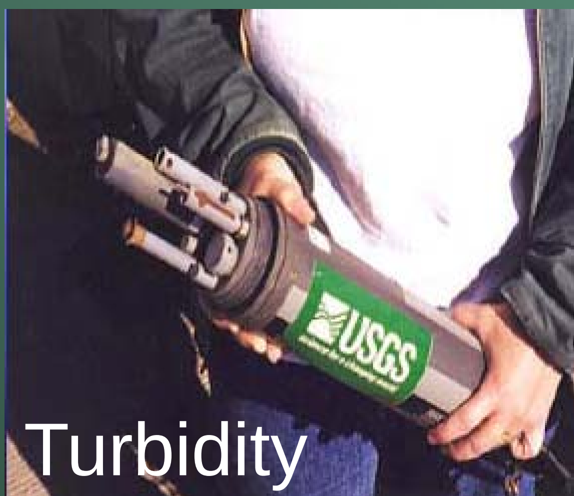
68 stations

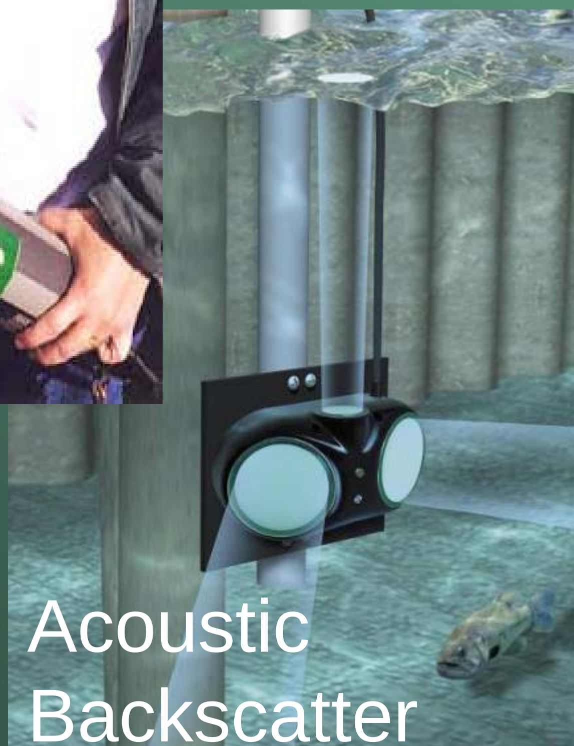
Max use of USGS gages & programs

20 sites Priority 1:
Large-scale processes
48 sites Priority 2:
Watershed proc./issues

Improved Sensors!

- ***Streamflow, Turbidity*, *acoustic backscatter*, *ultraviolet nitrate, laser-based* sensors**





Laser-Based

But we need even better sensors

Sensor needs—turbidity example

A sensor that:

- Reads values that are equivalent in an independent standard—not just formazin
- Ranges from <1 to more than 50,000 mg/L equivalent suspended-sediment concentrations with precision
- Has the ability to provide multi-scatter angles to infer or measure grain sizes of material
- Is unaffected by particle or fluid color
- Is self cleaning
- Transmits data wirelessly from the monitor to the gage for relay

USGS

Achieving click anywhere anytime?

- **Balance between:**
  - **Field data collection (discrete and continuous)—**
    MORE SITES—National Network!
    Process studies to improve our understanding—
    MORE THINKING
    Statistical and spatial modeling estimates (qualified with the uncertainty) to extrapolate/interpolate our information
    MORE MODEL APPLICATIONS
    Information dissemination to our customers
    MORE NATIONALLY-CONSISTENT WEB DISPLAY AND "AUTOMATED" REPORTS

Progress is being made, but the pace must increase to meet our information needs.

USGS

Three Areas needed to accomplish "Water Quality-anywhere anytime"

- Data and databases
- Statistics and models
- Information dissemination

USGS

Future—Data and databases

- Use new technology-More sensors/direct measurement
- Low maintenance or self-cleaning sensors
- MCERTs—NWQMC– ASTM– some standardization
- National Network- start with sediment/nutrients
- Continued Nationally consistent protocols for;
  - O&M of sensors
  - Generic testing protocols for new gizmos
  - Data storage and method delineation
- Automated data entry–
- Automated record processing/working tools
- Storage of estimates/computations
  - National "surrogate" web page for estimates/computations and retaining the historical statistical models
- Acceptance of these Qaed data in regulatory enforcement

USGS USGS-Pat Rasmussen focus is to automate the data processing to enhance the quality and save time

Future: Statistics and models

- National Consistency
  - T&Ms for instantaneous constituent concentrations and loads
    - Ohio bacteria
    - KTR line
    - LOADEST– (annual)
    - Instantaneous Turbidity/sediment protocol- Pat Rasmussen and others, 2009
  - Generic T&M protocol for computation of any constituent
- Automated statistical calibration model development done consistently with specific numeric criteria-
- Scenario testing/ future water-quality prediction– Recreational forecasts, Water-treatment forecasts, etc.
- Marriage of instantaneous point estimates with spatial models- Water Quality anywhere, anytime

USGS

Future: Information transfer

- **THINK, collect DATA, MODEL, PUBLISH, and repeat**
  - **Is more data more better? What do we need to know – process studies, customer needs, …..**

- **NRTWQ-National real-time computations web page:**
  - **Past, current, and eventual forecasts of water quality**
  - **Provides consistency of stats and display of uncertainty, probability, duration curves, ….**
  - **Comparison to water-quality criteria and probability of exceeding environmentally-relevant criteria**
  - **Dynamic user-specified comparisons in addition to static informational displays**

If we can think of it, we can do it !

USGS

Selected Real-Time Water Quality Publications

- **Helsel and Hirsch, 1992, (2002),** Statistical Methods in water resources —Hydrologic Analysis and interpretation: Techniques of Water Resources Investigations of the U.S. Geological Survey, chap. A3, book 4, 510p.
- **Christensen, V.G., Jian, Xiaodong, and Ziegler, A.C., 2000,** Regression analysis and real-time water-quality monitoring to estimate constituent concentrations, loads, and yields in the Little Arkansas River, south-central Kansas, 1995–99: U.S. Geological Survey Water-Resources Investigations Report 00–4126, 36 p.
- **Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., 2000,** rev. **2006**, Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods 1–D3, 51 p. + 8 attachments; accessed April 10, 2006, at *http://pubs.water.usgs.gov/tm1d3*
- **Rasmussen, P.P and Ziegler, A.C., 2003,** Comparison and continuous estimates of fecal coliform bacteria and *Escherichia Coli* bacteria in selected Kansas streams, May 1999 through April 2002, Water Resources Investigations Report, 03-4056, 97p.

USGS

More Real-Time Water Quality Publications

- **Runkel, Robert L.; Crawford, Charles G.; Cohn, Timothy A., 2004**, Load estimator (LOADEST): a FORTRAN program for estimating constituent loads in streams and rivers: U.S. Geological Survey Techniques and Methods Book 4, Chapter A5, 69 p.

- **Francy, D.S., and Darner, R.A., 2006,** Procedures for Developing Models To Predict Exceedances of Recreational Water-Quality Standards at Coastal Beaches: U.S. Geological Survey Techniques and Methods 6–B5, 34 p.

- **Granato, G.E., 2006,** Kendall-Theil Robust Line (KTRLine -version 1.0)__A visual basic program for calculating and graphing robust nonparametric estimates of linear-regression coefficients between two continuous variables: Techniques and Methods of the U.S. Geological Survey, book 3 chap. A7, 31p.

- **Rasmussen, Patrick P.; Gray, John R.; Glysson, G. Douglas; Ziegler, Andrew C., 2009,** Guidelines and Procedures for Computing Time-Series Suspended-Sediment Concentrations and Loads from In-Stream Turbidity-Sensor and Streamflow Data: Techniques and Methods of the U.S. Geological Survey, book 3 chap. C4, 54p.

USGS

Questionnaire-feedback for closing session http://www.surveymonkey.com/s/YZL2LSC

- **We will use your input to *Make A Difference***

Wednesday at 1:00 pm in the closing session

Real-Time Continuous Monitoring Questionnaire

Exit this survey

1. Please answer the following questions

The purpose of this questionnaire is to gather the thoughts of the monitoring community prior to the panel session (closing session) of the real-time continuous monitoring session.

Denver, CO, April 26-29, 2010

1. Where do we need to go (what is needed for instruments, protocols, databases, etc.)?

Need a National Network with in-situ instruments that reliably measure what we are interested in with defined uncertainty and all of the attributes are stored with these data. Self maintaining/cleaning, Uniform protocols, wireless data transmission, handheld computing, data and uncertainty display and data access, etc.

2. Why aren't we there? What are the technological and other impediments?

Other impediments-- Need to have regulatory community develop acceptance criteria that will allow for these data to be used in enforcement activities--this feeds back into instrument design being done consistently and protocols-- EA MCERTS; ASTM, ISO 9001 and 14001

3. How do we fill these gaps to get where we need to go?

Funding, More sites, Standardization? ? ASTM, EPA QAP, MCERTS, ?

Done

- **Where do we need to go? (What isn't getting done that is needed for instruments, new gizmos, protocols, databases, etc.?)**

Need a National Network with in-situ instruments that reliably measure what we are interested in with defined uncertainty and all of the attributes are stored with these data. Self maintaining/cleaning, Uniform protocols, wireless data transmission, handheld computing, data and uncertainty display and data access, etc.

- **Why aren't we there? (What are the technological and other impediments?)**

Other impediments-- Need to have regulatory community develop acceptance criteria that will allow for these data to be used in enforcement activities--this feeds back into instrument design being done consistently and protocols-- EA MCERTS; ASTM, ISO 9001 and 14001

- **How do we fill these gaps to get where we need to go?**

Funding, More sites, Standardization? ? ASTM, EPA QAP, MCERTS, ?

USGS

Continuous Water Quality Pledge!

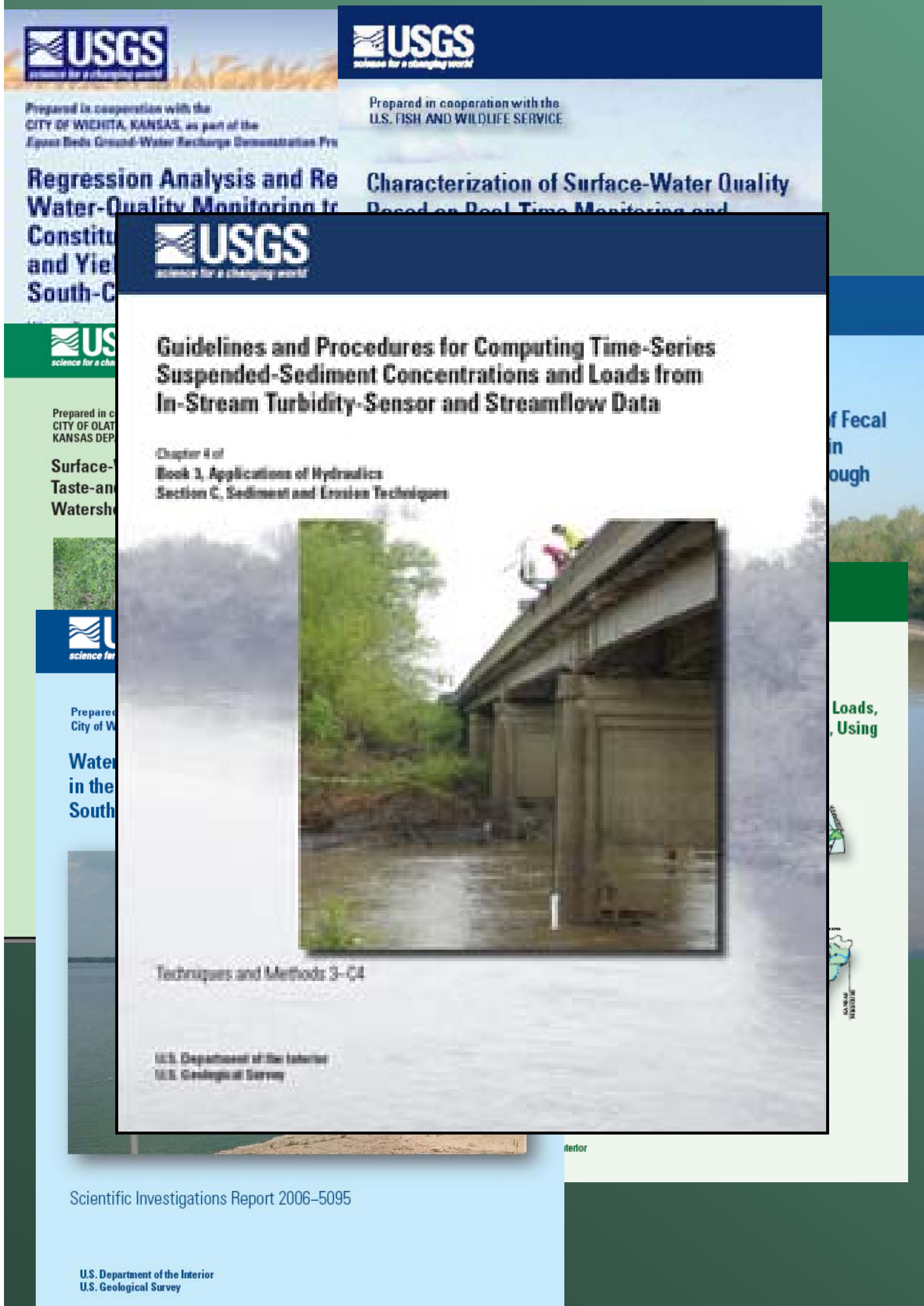
- I (state name), pledge to look for any and all opportunities to install, improve, and promote continuous water quality monitors at more sites to develop national and international networks, applications meeting regulatory needs, and look at and think about these data to improve our understanding of the environment.

- Short version:

RTWQ—*Just do it!*

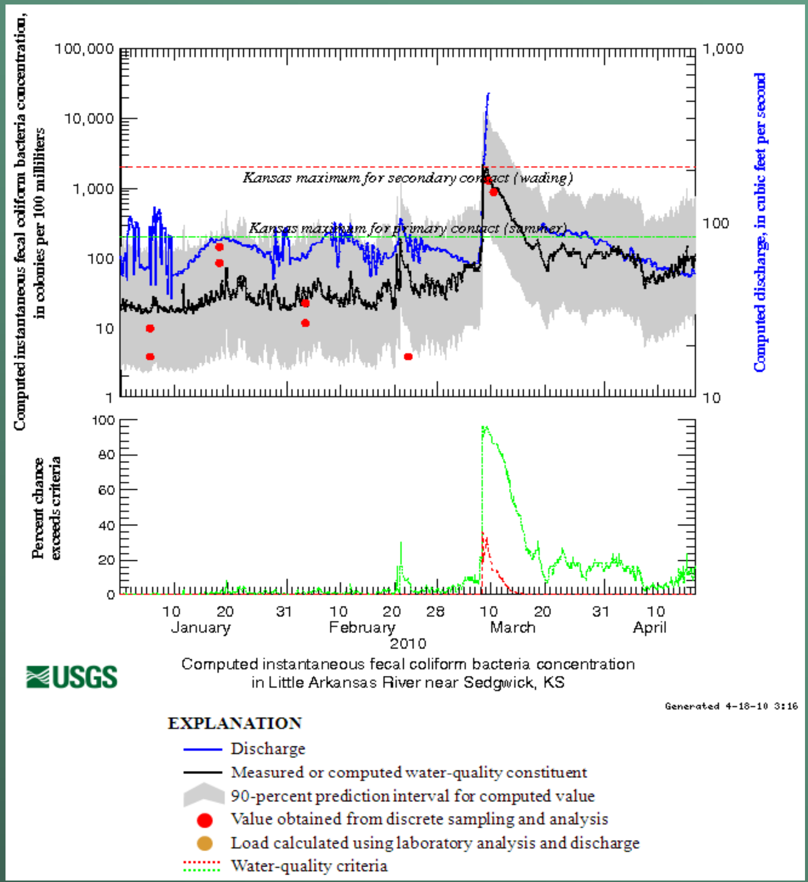
USGS

Kansas Real-Time Web Page and Reports



For more information:

Andy Ziegler
aziegler@usgs.gov
785-832-3539



http:// nrtwq.usgs.gov/ks/