Assessing the Quality of the Nation's Waters

The Space Time Challenge and National Data Needs

Jeffery S. Horsburgh
David K. Stevens

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Utah Water Research Laboratory
UWRL
UtahState UNIVERSITY

USGS Water Quality Assessment

- The USGS **National Water-Quality Assessment Program (NAWQA)** program:
  - water-quality conditions and how those conditions vary locally, regionally, and nationally
  - whether conditions are getting better or worse over time
  - how natural features and human activities affect those conditions

http://water.usgs.gov/nawqa/

State WQ Assessment

- States set water quality standards with EPA oversight
  - Designated uses (i.e., cold water fishery, agricultural uses, etc.)
  - Numeric or other criteria/thresholds
  - Anti-degradation policy
- Monitoring to assess
  - compliance with standards and determine impairment
  - effects of water quality improvement projects

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The Academic/Research Perspective

- Why do water quality conditions vary over space and time?
- Why are conditions getting better or worse? What are the drivers?
- How do natural events/feature and human activities affect WQ conditions?

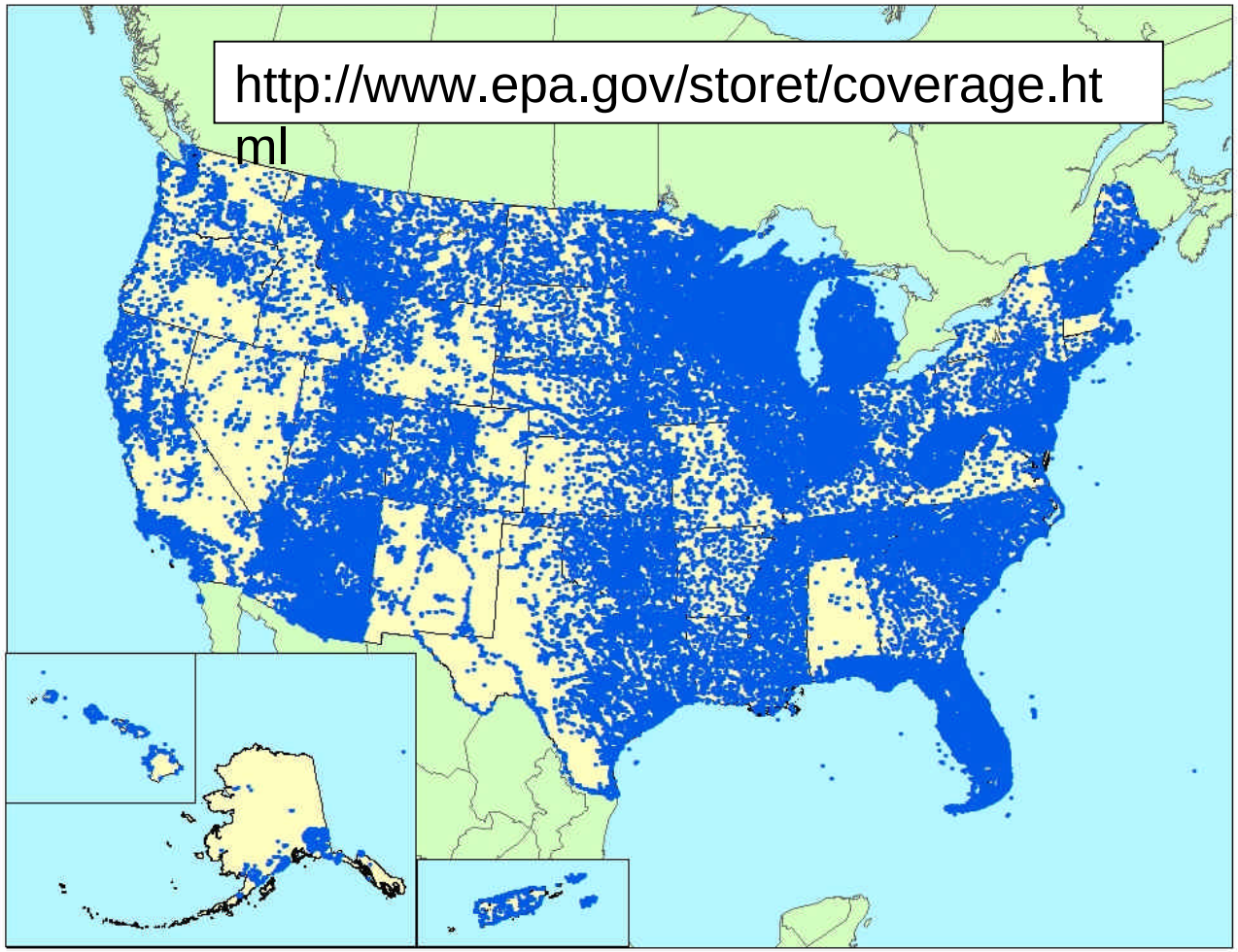
- **End Goal**: **Better understanding → Better predictions → support better management**

The Space Challenge

- How do water quality conditions vary locally, regionally, and nationally?

The Space Challenge

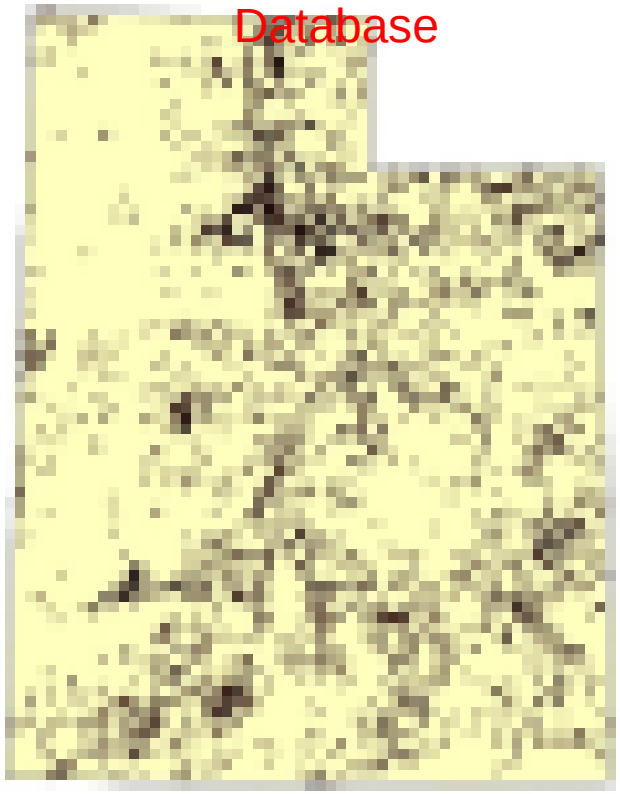
Monitoring Sites in USEPA's STORET Database



The Space Challenge

- State of Utah Division of Water Quality
  - Over 4575 stations in their database
  - Only 500 are “data rich”

Utah WQ Monitoring Sites from USEPA’s STORET Database



http://www.waterquality.utah.gov/Monitoring/index.htm

Individual Watershed

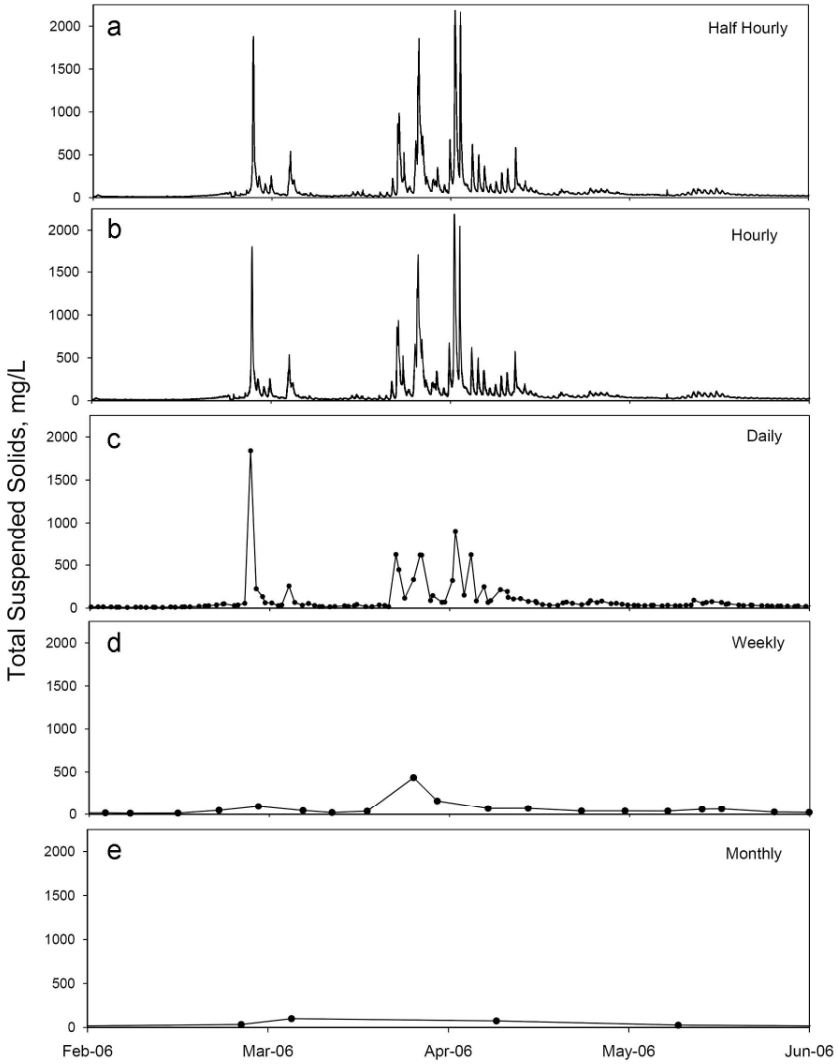
- **Little Bear River**
  - 740 km^2 (286 mi^2)
  - 45 STORET Monitoring Sites
  - **2 fall into the "data rich category"**
    - Long period of record
    - Large number of samples
    - Diversity of measured variables

The Time Challenge

- How and why does WQ change over time, and are WQ conditions getting better or worse?

The Time Challenge

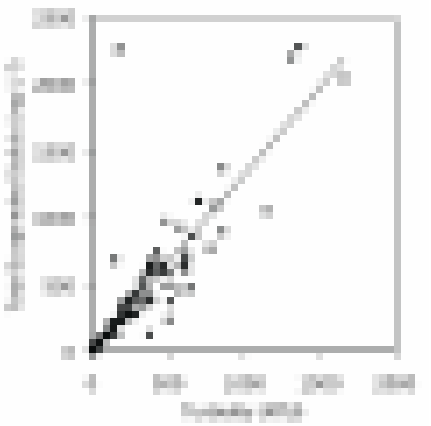
- Water quality is dynamic!
- Infrequent samples do not capture temporal variability

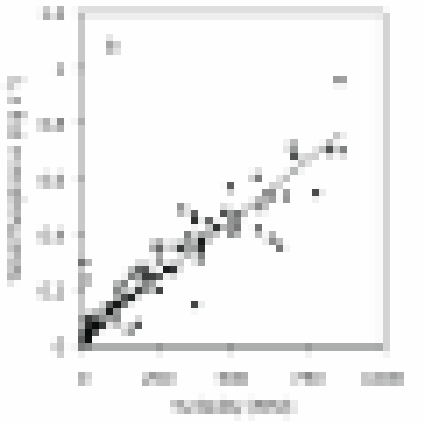


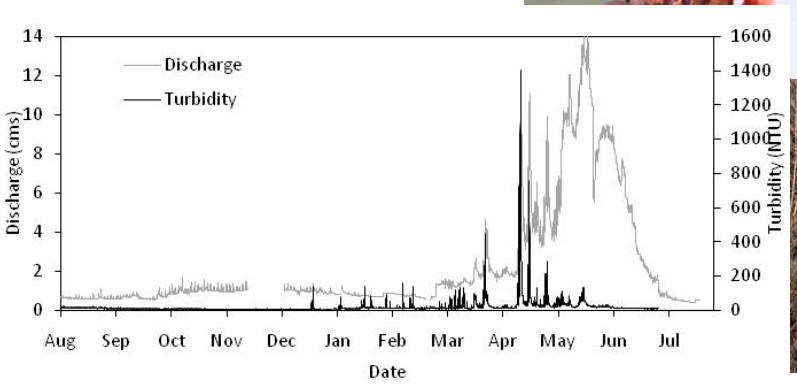
Kirchner, J. W., X. Feng, C. Neal, and A. J. Robson (2004), The fine structure of water-quality dynamics: the (high-frequency) wave of the future, *Hydrological Processes*, 18, 1353-1359, doi:10.1002/hyp.5537.

High Frequency Monitoring

How can high-frequency sensor data collected at multiple sites improve hydrologic and hydrochemical process understanding?

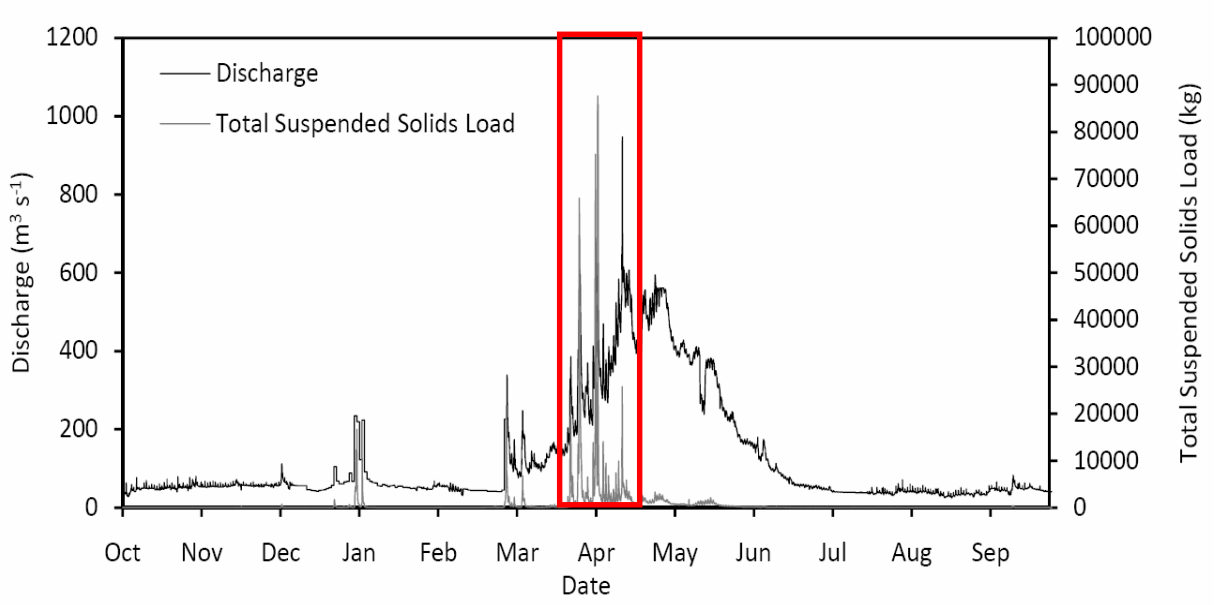


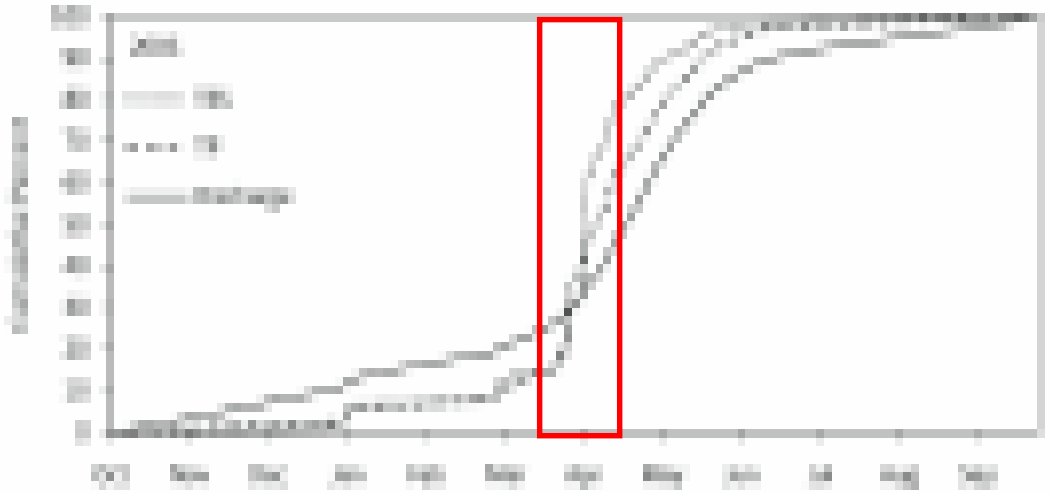




The Time Challenge

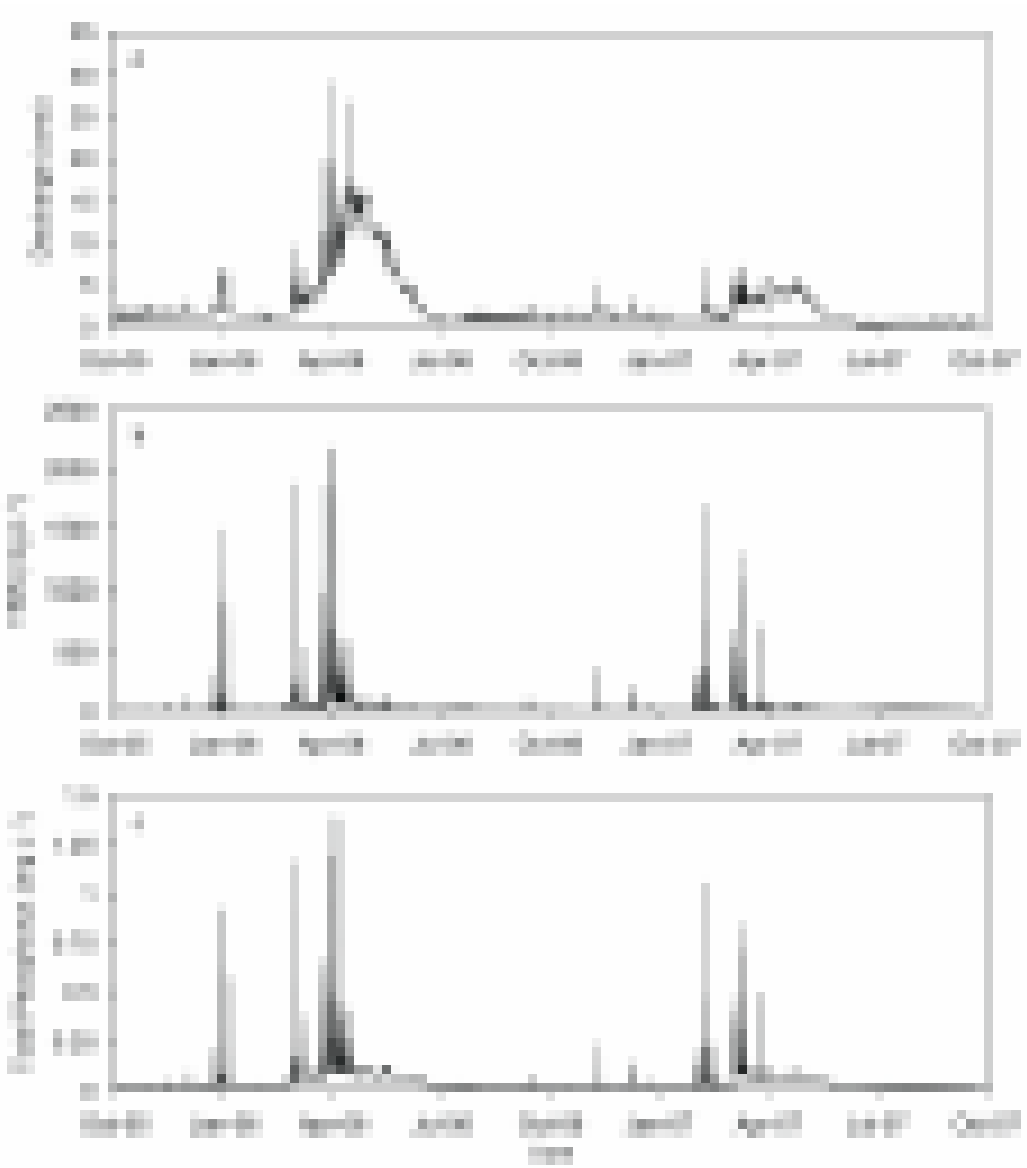
- Variability within a water year
- ~50-60% of the annual load occurs during one month of the year





The Time Challenge

- Variability across water years



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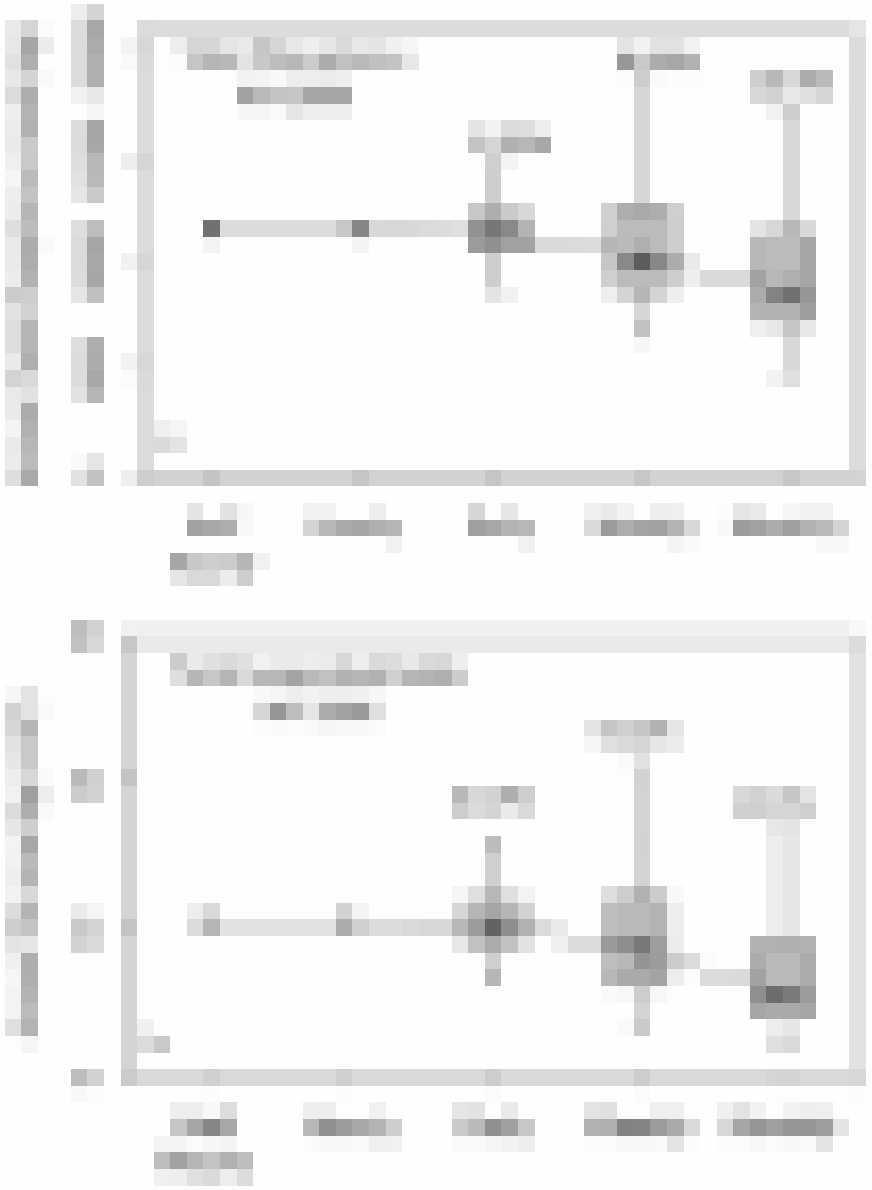
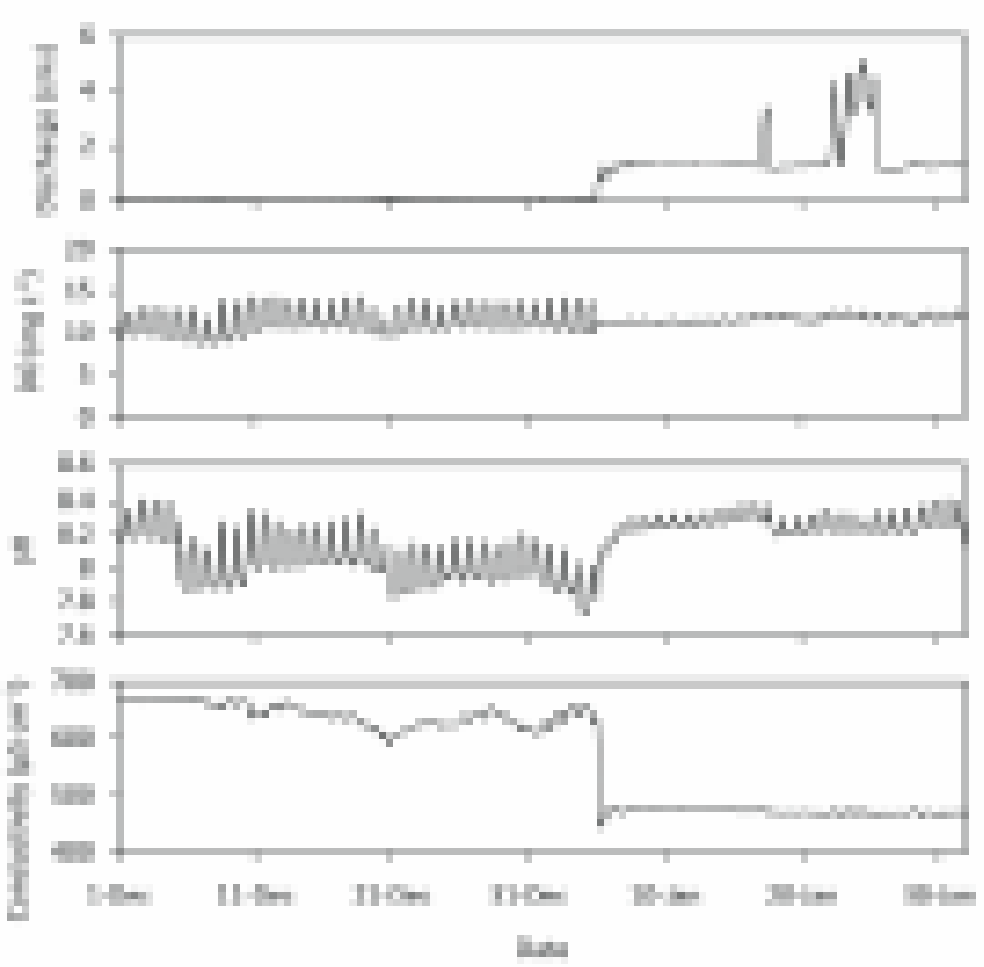
The Time Challenge

- Effects of sampling frequency on pollutant load estimates



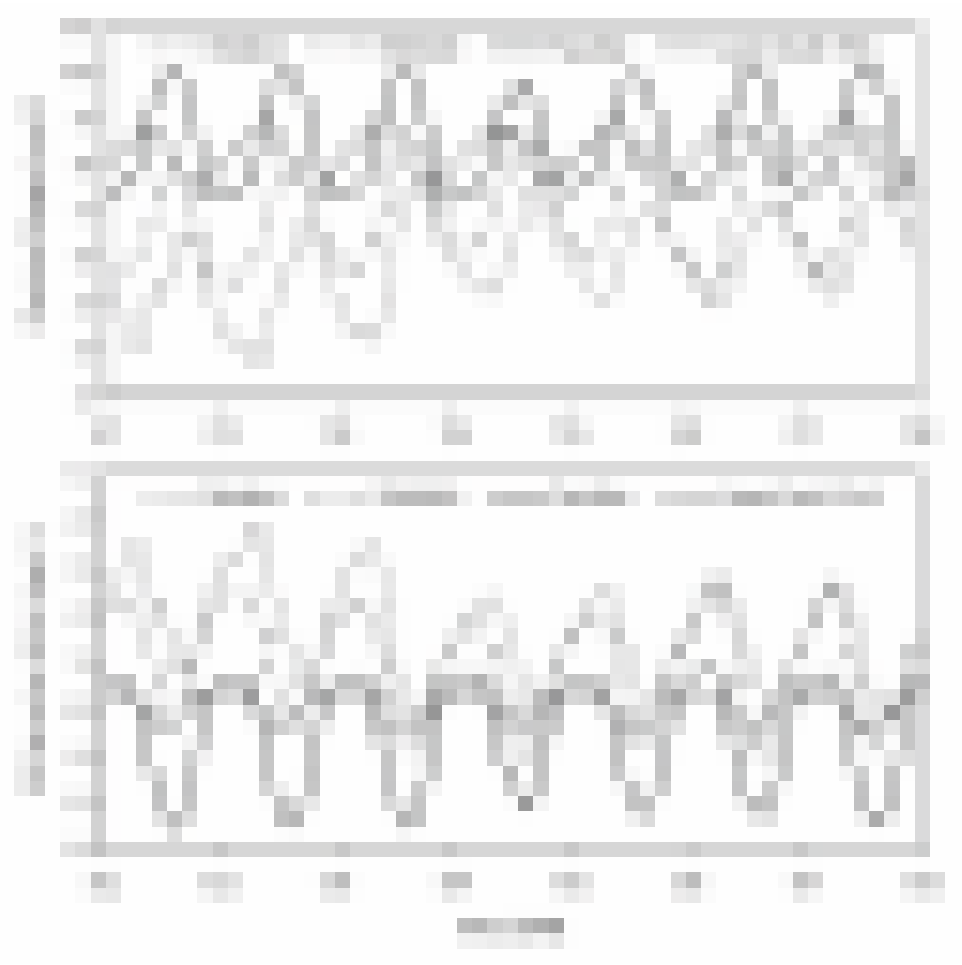
How do natural features and human activities affect WQ conditions?

- Affects of reservoirs on water quality
- Affects of agricultural diversions and return flows



Linking Time and Space

- Different behavior based on where you are on the river
- Linking physical, chemical, and biological



Water Quality Assessment Questions

- How can we possibly characterize water quality everywhere and at all times? **Do we need to?**
  - Monitoring
  - Modeling

Can we meet our assessment objectives with the data that we have and are collecting now?

- Assessing compliance with WQ standards
- Identifying and quantifying pollutant sources
- Identifying and quantifying pollutant pathways
- Assessing the effectiveness of conservation practices

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Water Quality Data, Needs, and Tools

- Solving the Space Time Challenge
  - Integrating Existing Water Quality Data
    - National scale cyberinfrastructure for water data
  - High-frequency monitoring
    - Infrastructure – communications
    - Sensors – NSF priority
    - Inter-agency cooperation
  - Better models/predictions
    - National network of environmental observatories

Acknowledgments

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  - National Science Foundation
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  - States of Utah, Idaho, Wyoming