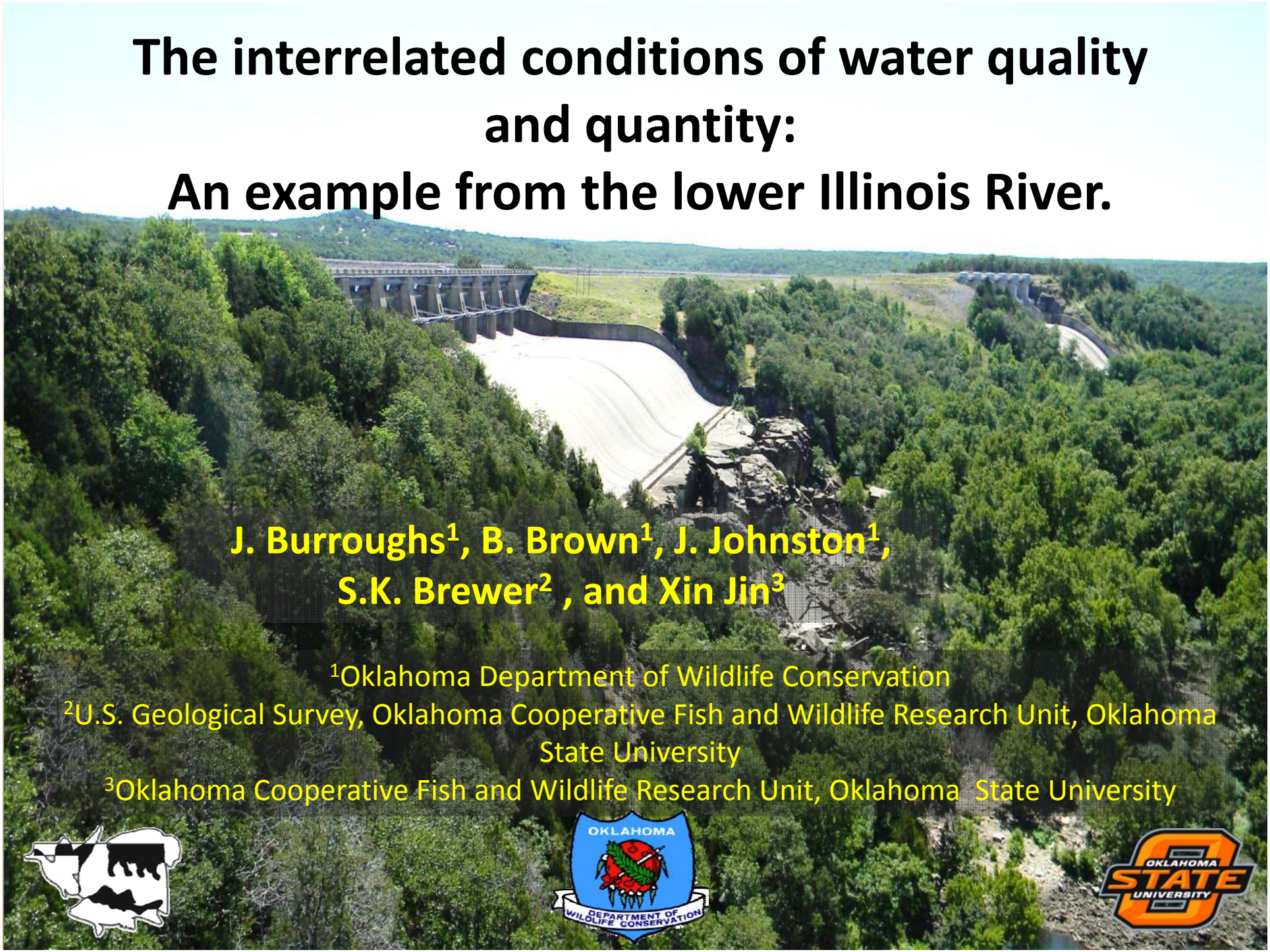
The interrelated conditions of water quality and quantity: An example from the lower Illinois River.

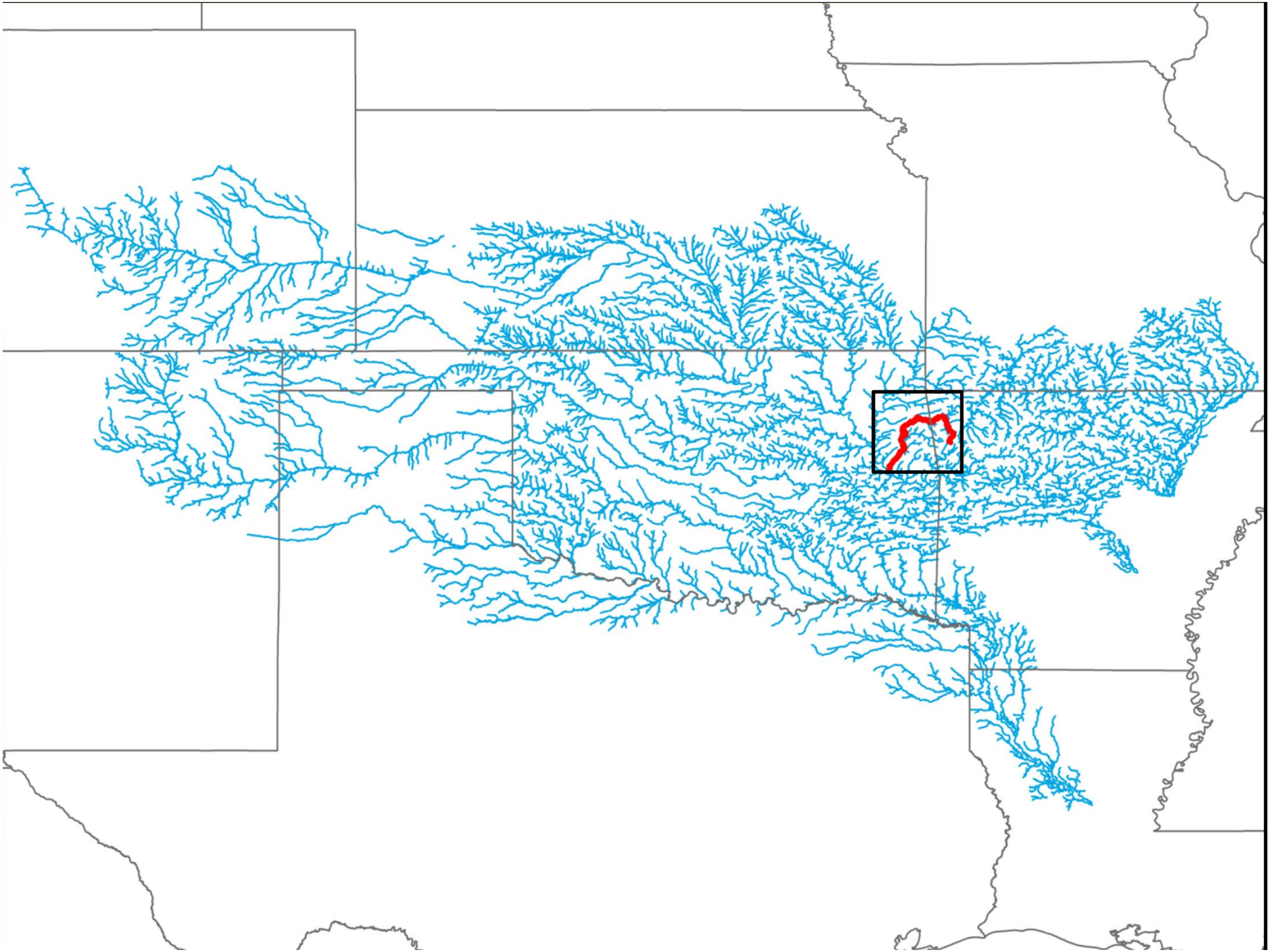


J. Burroughs[1], B. Brown[1], J. Johnston[1], S.K. Brewer[2] , and Xin Jin[3]

[1]Oklahoma Department of Wildlife Conservation

[2]U.S. Geological Survey, Oklahoma Cooperative Fish and Wildlife Research Unit, Oklahoma State University

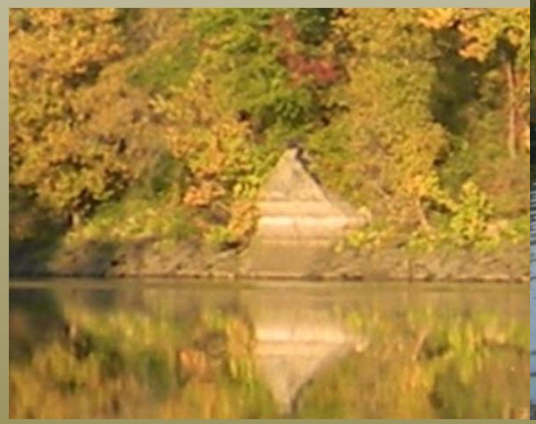
[3]Oklahoma Cooperative Fish and Wildlife Research Unit, Oklahoma State University



Year round Trout Stream

- 1965
- 12.5 km
- 10 km of bank access

Subject to daily flow extremes.



Low dissolved oxygen

Resulting Fish Kills

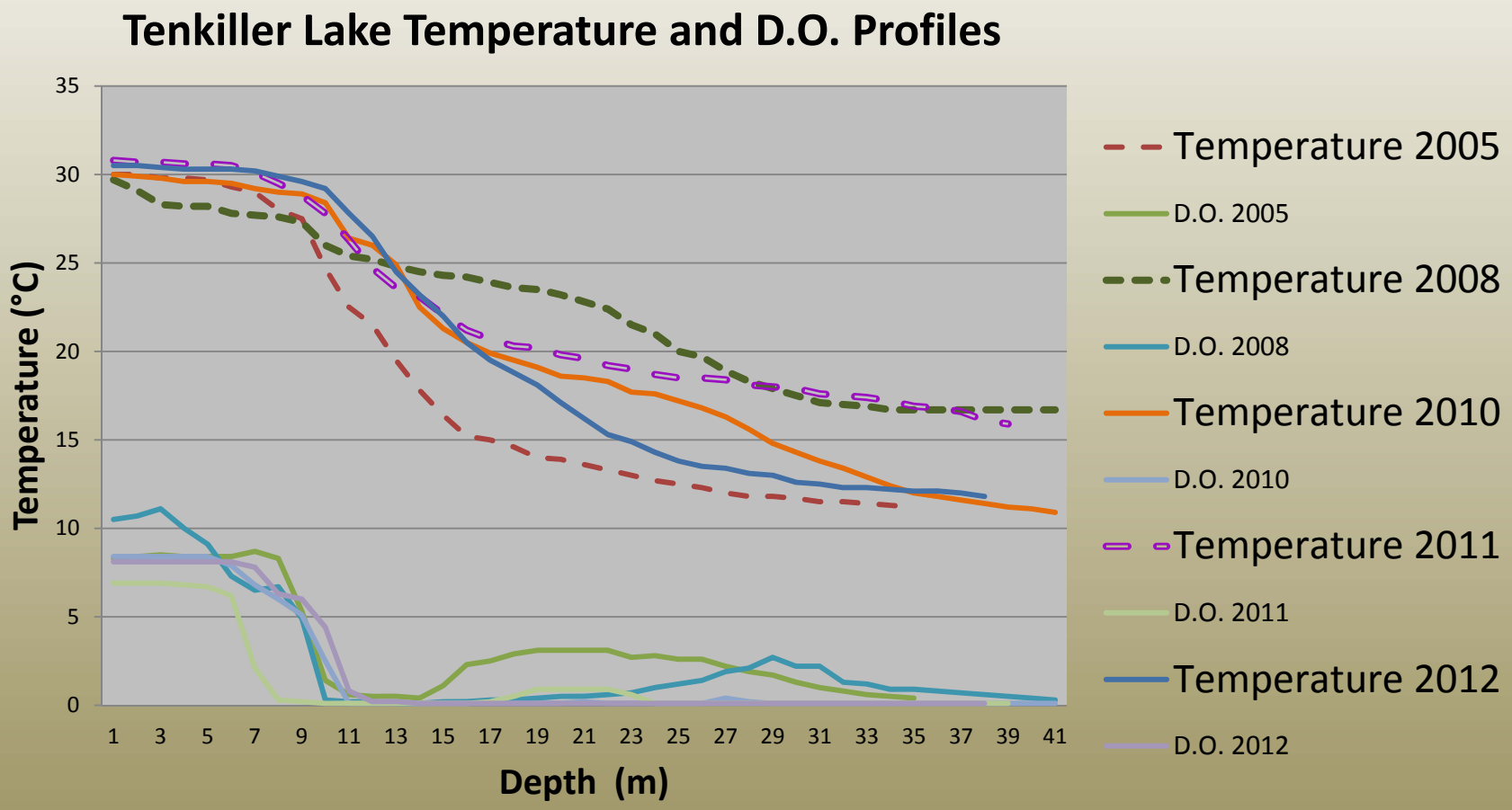
- **Two fish kills were documented in 2011**
  - **DO below dam and the sluice pool <1mg/L**
  - **Trout and native fish**

DO values <5mg/L are a violation of state water quality standards

High Water Temperatures

- 2008's spring rains caused a rare occurrence.
  - Flood water was released through sluice gates and generators
  - Cold water stored in hypolimnion was lost
  - Trout stocking was suspended for 3 months
- 2011's spring flood posed a similar threat.

Temp and DO Compilation over Time

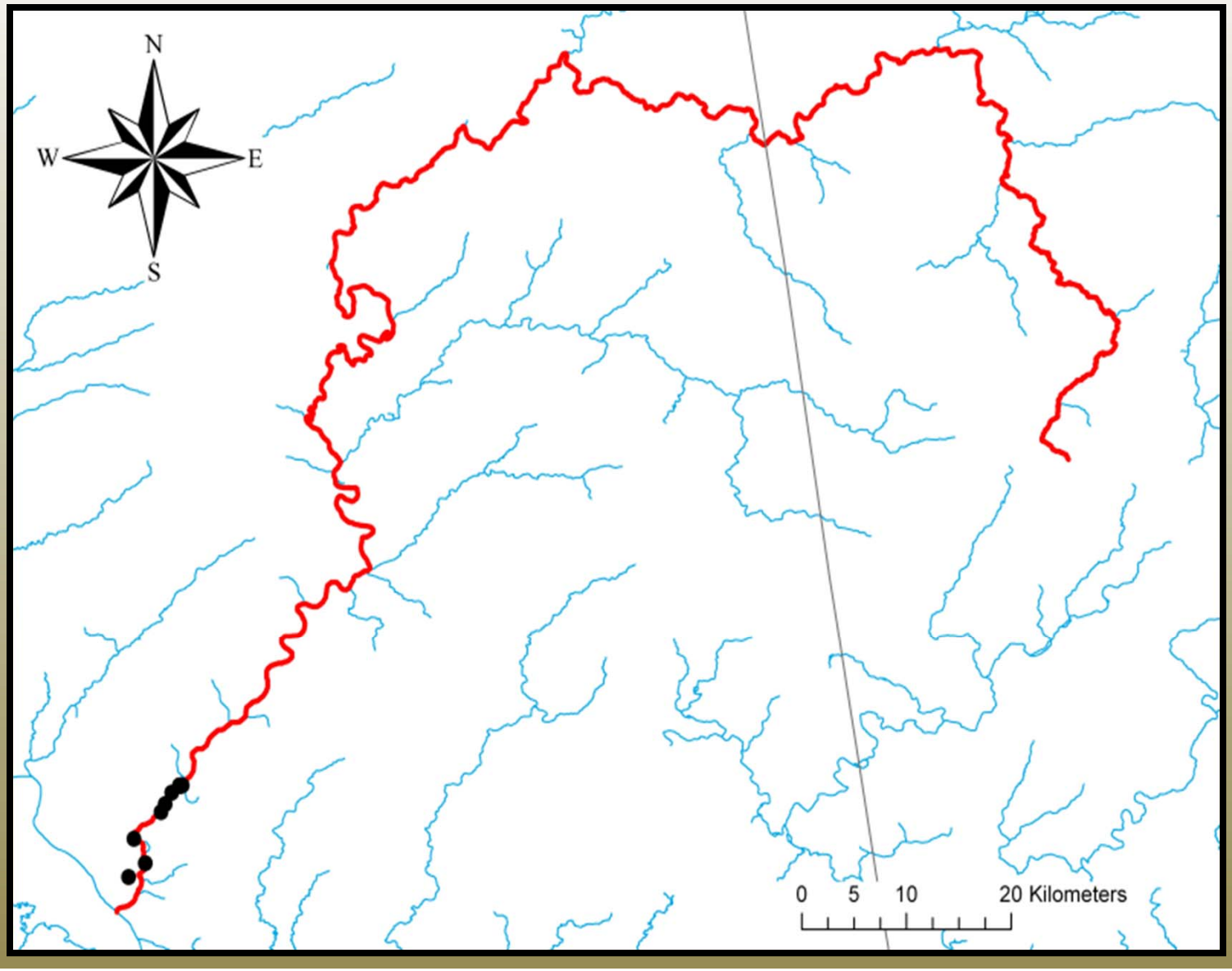


Temperature and DO Loggers

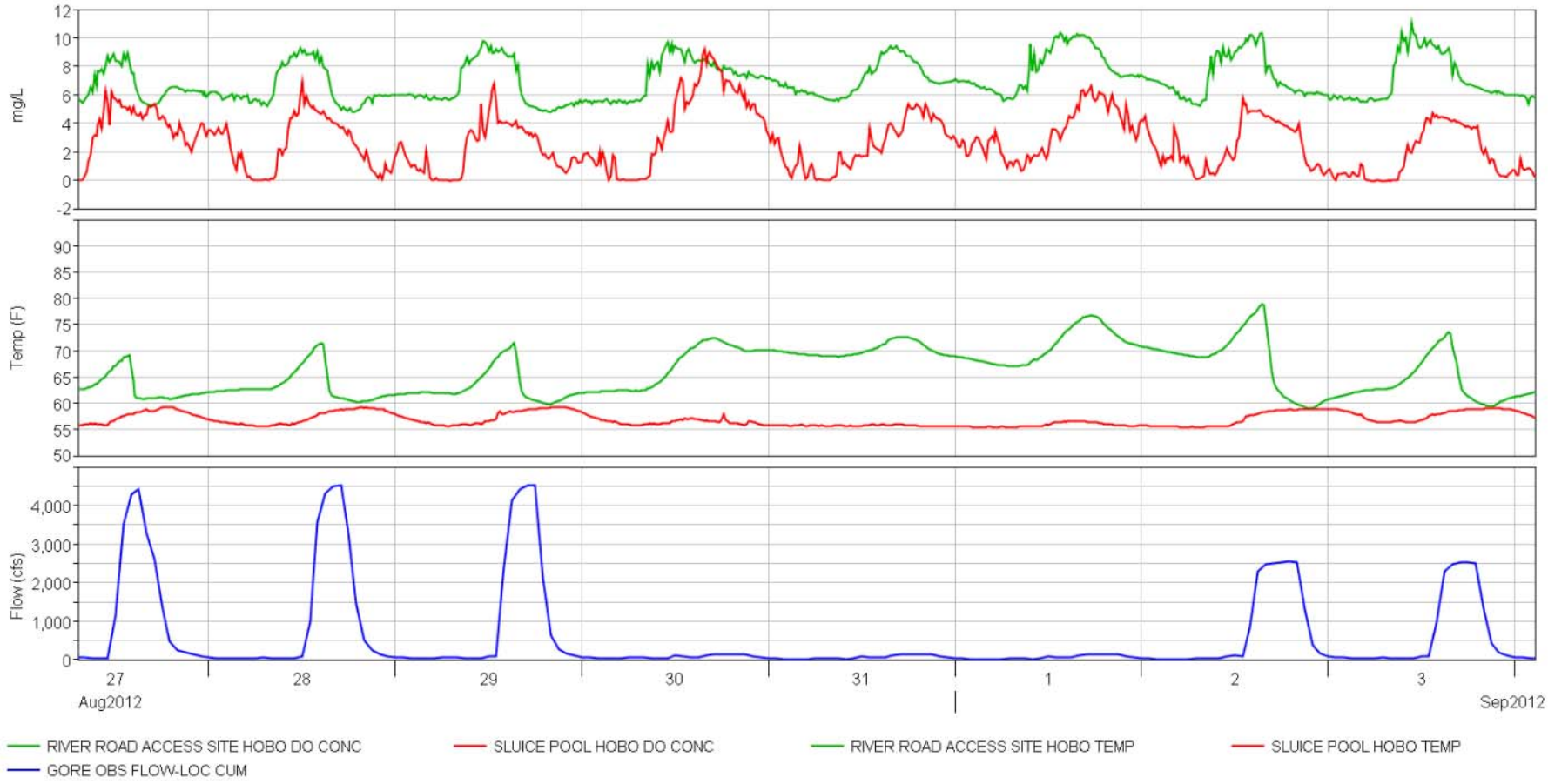
Launch and Data Download

Anchoring System

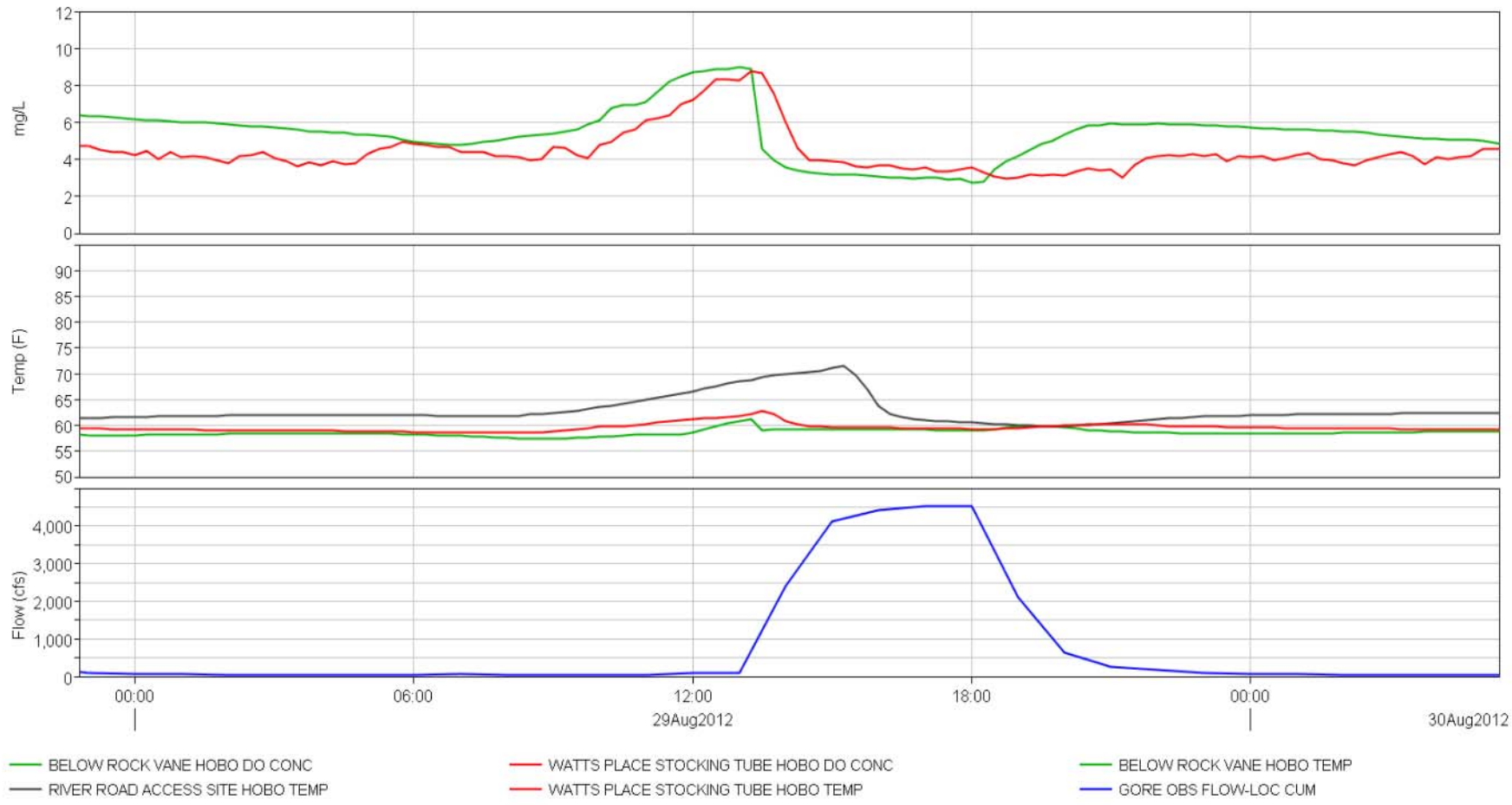
Probe Locations



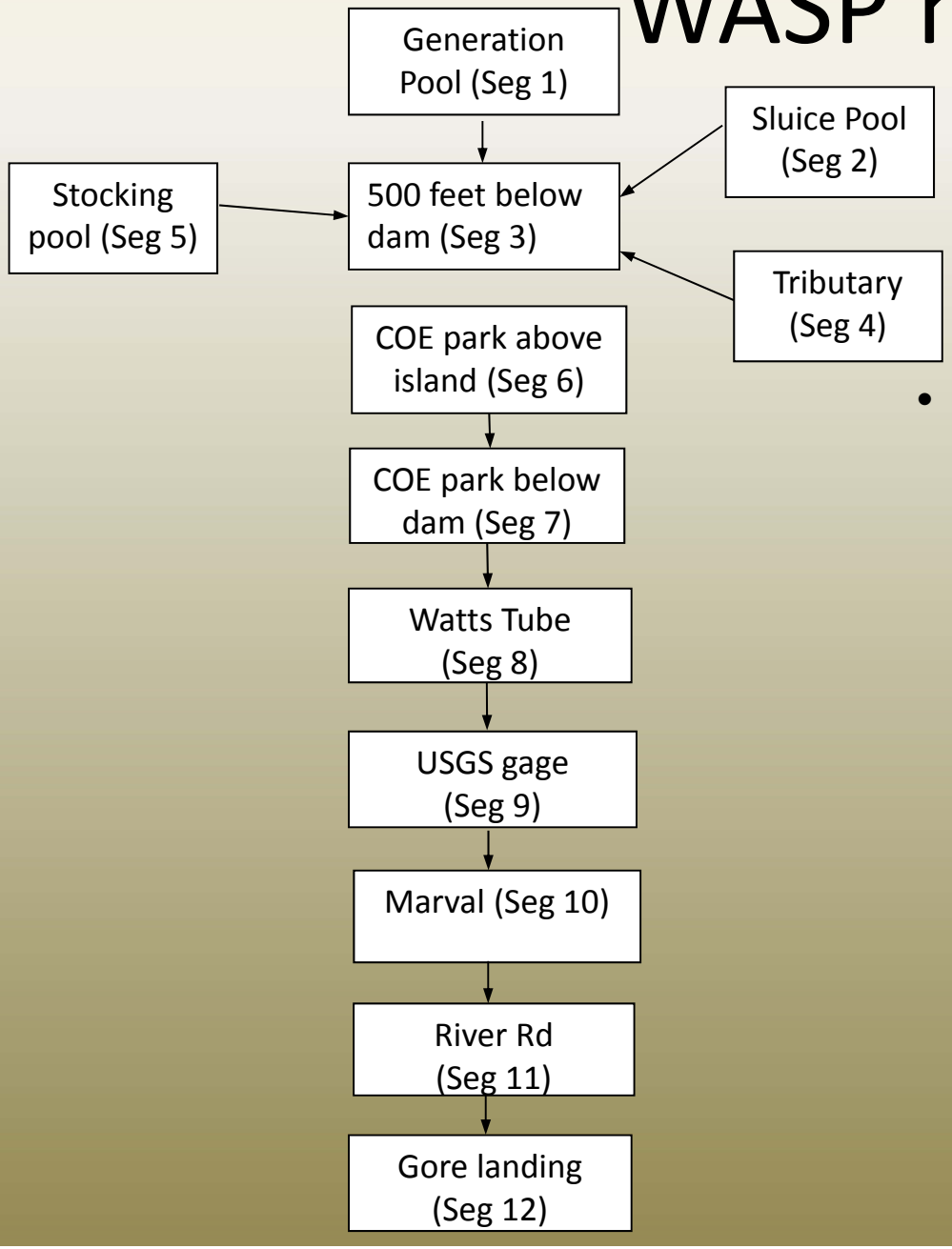
DO Temperature Flow



DO Temperature Flow



WASP model schematic



Generation Pool, Sluice Pool, Tributary, Stocking Pool and Gore Landing are boundaries of this simulation model.

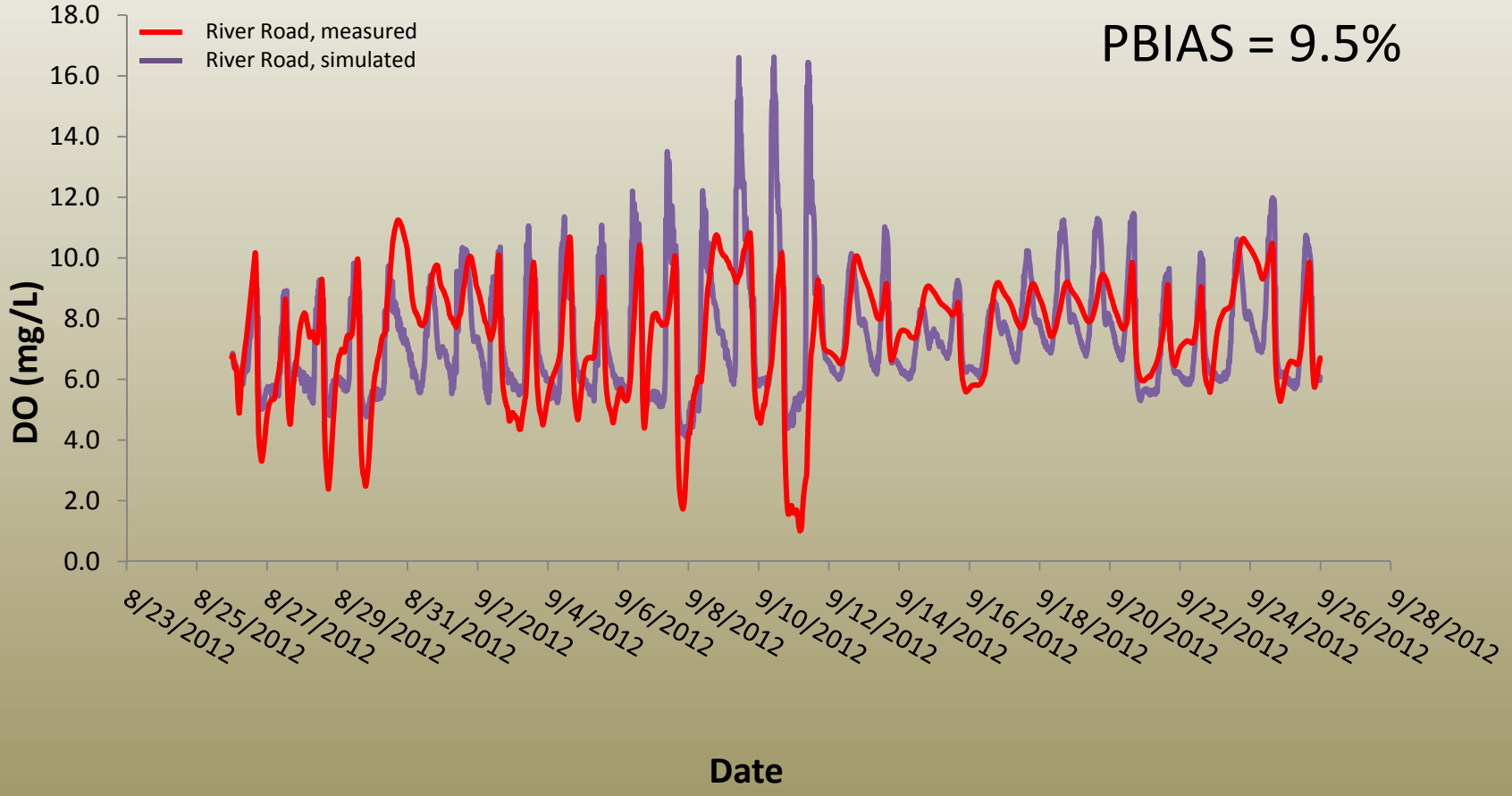
- ***Water Quality Analysis Simulation Program(WASP)***
  - Developed by Environmental Protection Agency
  - 3-D water quality model that can simulate the vertical directional distribution of water quality components.
  - It can simulate DO-BOD interaction, but also more complex phytoplankton-nutrient interaction.
  - Peer reviewed software

WASP model calibration

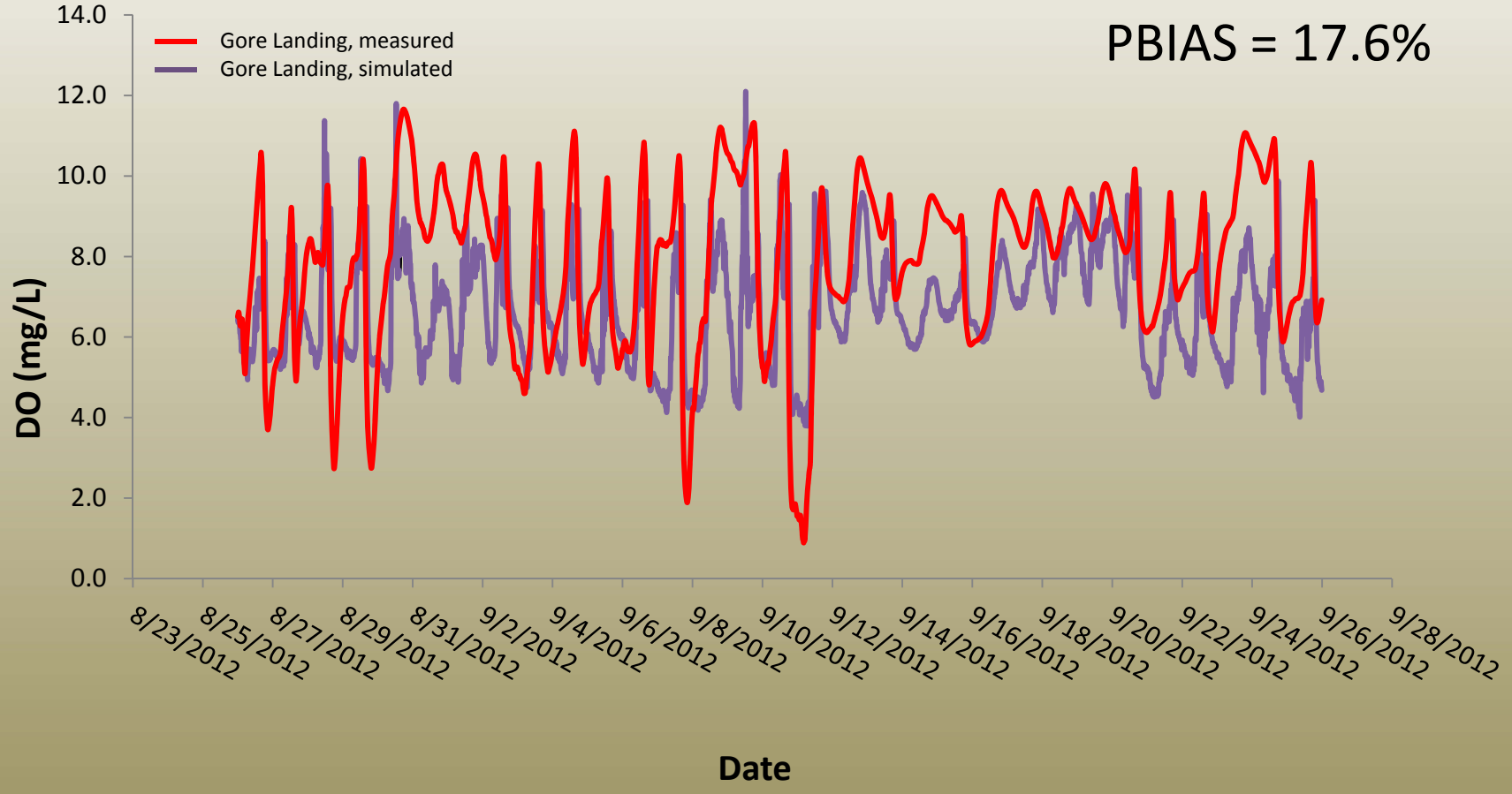
- Model calibration
  - Reaeration rate and BOD were very sensitive parameters
    - Initial adjustments were made using values published in peer-reviewed literature
    - BOD obtained from upper river estimates
  - Final adjustments were made using a time-series approach
    - Parameters were adjusted for each of the 12 segments
    - Values were adjusted to correspond with DO (higher DO = high reaeration rates)
  - Error rates between simulated and actual values:
    - PBIAS, defined as:

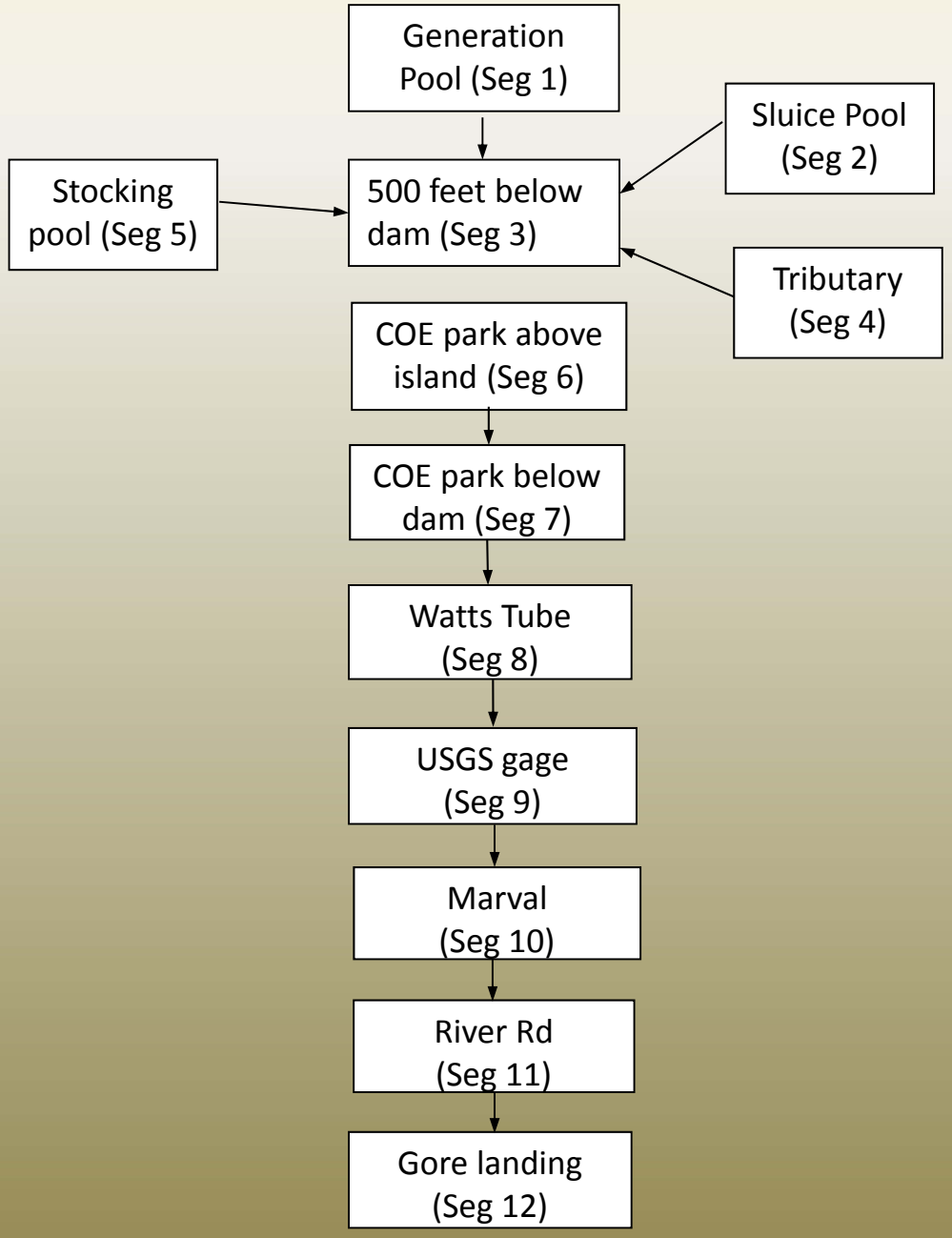
$$PBIAS=\Sigma((DO_{measured}-DO_{simulated})*100\%)/\ \Sigma\ DO_{measured}$$

WASP Model Calibration



WASP Model Calibration





Summary Data

- Error rate
  - Ranged from 9-23%
  - < 25% is considered acceptable (Moriasi et al, 2007)
  - Greater accuracy farther from the dam
  - Accuracy will be improved by increasing measured properties near the dam (many contributions to flow and velocity at this point); increasing measured BOD across segments; adding another validation set

Future Modeling

- 2013
  - Repeat transects to collect another validation set.
  - Conduct additional transects. Emphasis upstream near dam.
  - Conduct transects designed to factor new release mechanism.
  - Collect BOD across segments

Improve model calibration and validation.

Developments 2013

Bypass Pipe

Pipe Location

Special Thanks to:

- The Oklahoma Department of Wildlife Conservation
- Oklahoma Cooperative Fish and Wildlife Research Unit
- ODWC staff of the East Central Region
- USGS
- Corps of Engineers
- Southwest Power Administration
- Sport Fish Restoration
- Trout Unlimited