AQUATOX

Lower Boise Watershed Council

March 13, 2014

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Why Use a Water Quality Model?

- **Complex correlation between nutrients and eutrophication response in rivers**
- Models are useful tools for TMDL and numeric nutrient criteria development
- Can understand causal relationships and conduct what-if scenarios

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What is a Water Quality Model?

- A model is a tool for describing and understanding our environment.
- Water quality models are tools for simulating increased/decreased pollutants and the associated water quality impacts.

"Essentially all models are wrong, but some are useful" (George E. Box)

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Modeling TAC

- Modeling TAC meetings were facilitated by Troy Smith – DEQ
- Group met 11/28/2012 – present
  - 4 initial planning meetings and 31 model work meetings
- Decision process – group discussions with final decisions made by DEQ.
- Model was calibrated by Darcy Sharp – DEQ
- DEQ Documentation
  - Meeting agendas
  - Meeting summaries (decisions, presentations, action items)
  - Model Calibration Comment Log (113)
  - Model Decision Log
  - Model Report

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Modeling TAC

Core Group

- Troy Smith – IDEQ
- Darcy Sharp – IDEQ
- Ben Cope – EPA
- Bill Stewart – EPA
- Tom Dupuis – HDR
- Michael Kasch – HDR
- Matt Gregg – Brown and Caldwell
- Jack Harrison – HyQual
- Lee Van de Bogart –
- Caldwell
- Robbin Finch – Boise
- Kate Harris – Boise

Consultants

- Jonathan Clough – Warren Pinnacle Consulting
- Richard Park – Eco Modeling

Additional Assistance

- Alex Etheridge, Dorene MacCoy, Chris Mebane – USGS
- Clifton Bell – Brown and Caldwell

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Modeling TAC Process

- Determined performance requirements for water quality model
- Evaluated multiple models
- Chose water quality model
- Gathered data and/or collected more
- Chose variables to minimize complexity
- Set calibration goals (AME)
- Divided model into reaches
- Reviewed initial conditions for each segment
- Determined how to incorporate groundwater
- Reviewed process equation parameters
- Reviewed initial and updated versions of the model during the calibration process

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Why AQUATOX?

- IDEQ Calibration Report – page 4
- Models effects of pollutants on organisms
- Best suited to LBR TMDL needs – periphyton
- Model developers assisted in LBR set up and calibration
- AQUATOX in EPA's suite of recommended models

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What is Model Calibration?

Calibration is the adjustment of model parameters and constants to improve the agreement between model output and observed conditions

Sensitivity analyses – Monte Carlo simulations

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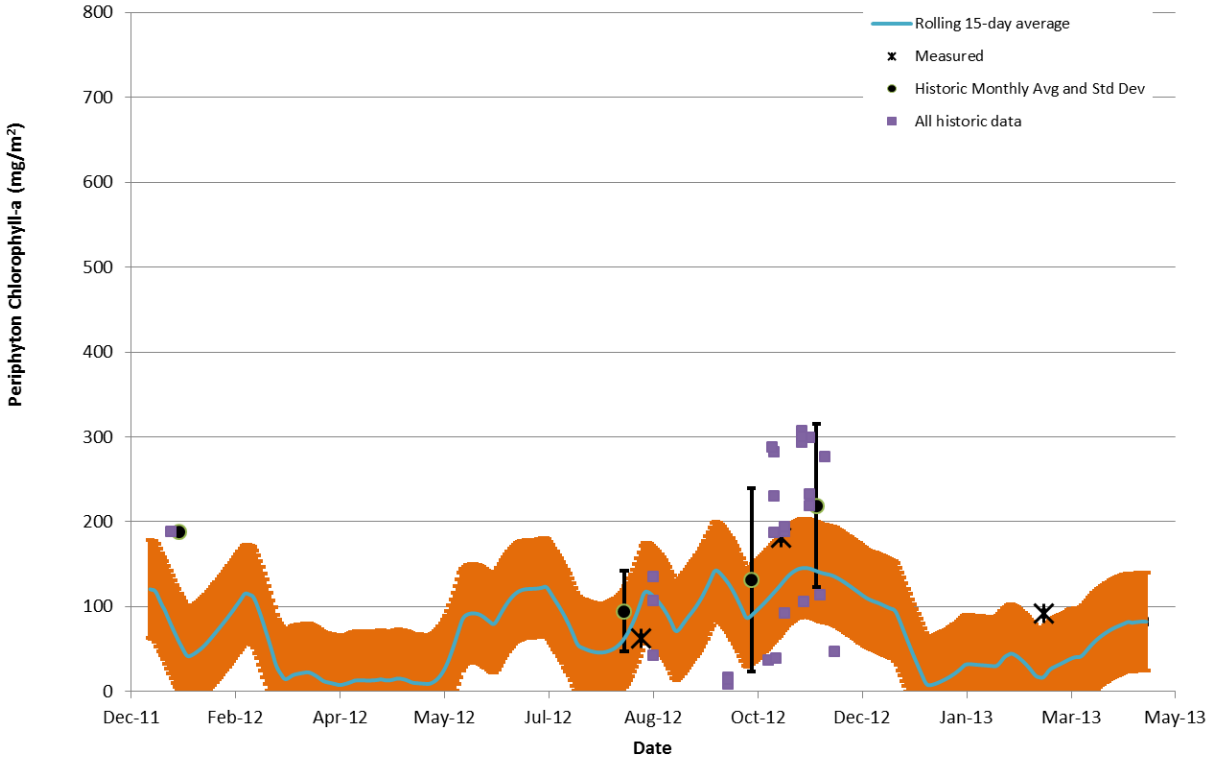
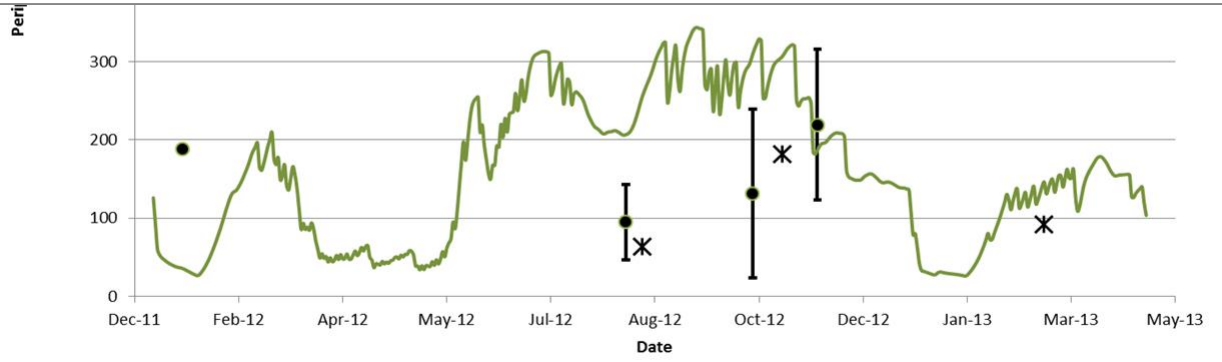
Segment 13 Periphyton Model Fit 2014_0203 Parameters
Measured and Historic Data at USGS 13213000 at Parma





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AQUATOX Model

- Thirteen segments
  - Diversion Dam to Parma
  - Average reach ~ 5 miles/reach
- Simplified
  - Fish and macroinvertebrates "turned off"
  - Initial run: Single Algal species
- Assumes well mixed condition
  - Inputs/withdrawals for reach averaged

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Limitation		Solution
AQUATOX is not:	Hydrodynamic model	Extensive water balance work external to AQUATOX; depth discharge spreadsheet developed; modeled vs. observed velocities compared
	Temperature model	Used observed temperature data and interpolated or used curve fitting analyses for missing data points
AQUATOX does not:	Model groundwater	The "unaccounted for flow" was apportioned between segments 10-13. Q and C interpolated.
	Include stormwater	TBD
AQUATOX did not:	Have data for all 13 segments	Some data was used for multiple segments (temperature, dynamic depth, etc.). DEQ did extensive analyses to establish appropriate initial conditions for each segment.

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How Do We Know it is Useful?

- Model was "realistic"
  - Similar Modeled and Actual Algal Community
  - Similar Modeled and Observed Results
- Calibration analyses
  - Outperformed AME goals established by TAC
  - Positive correlations between monthly simulations and historical data as well as between monthly simulations and measured data (except segment 1).
- Extensive review by model developers and Modeling TAC members

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Recommendation:

The Modeling Workgroup and TAC recommend WAG approval of the calibrated AQUATOX model for use in development of the Lower Boise River Total Phosphorus TMDL

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How Does AQUATOX Model Water Quality?

- Mechanistic model
- Requires input data
  - Driving variables (water temperature, pH and TSS)
  - State variables (total ammonia as N, nitrate as N, total soluble P; CO_2, dissolved oxygen; buried, sediment, and water column refractory and labile detritus; periphyton [low and high nutrient diatoms, blue green, Cladophora, green], phytoplankton (green, bluegreen, high and low nutrient diatoms])

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Algal parameters

- Optimal temperature
- Maximum temperature
- Temperature response slope
- Saturating Light
- Maximum photosynthetic rate
- Light extinction coefficient
- P half saturation constant
- N half saturation constant
- Inorganic C half saturation constant
- Exponential mortality coefficient
- Critical force for periphyton scour
- Percent periphyton lost in slough event

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