Jordan Lake Watershed & Water Quality Modeling to Assess Historical and Projected Eutrophication

Dan Obenour,
Jonathan Miller
Matthew Aupperle
Sankar Arumugam

3 April 2019
Jordan Lake
Nutrient Management Study
Research Symposium
Part 1: Watershed Modeling

1) Research Questions:
   a) What types and ages of watershed development have the greatest impact on nutrient (N & P) loading?
   b) What other large-scale watershed attributes (e.g., stream buffers) significantly influence nutrient fate and transport?
   c) How are watershed nutrient loads likely to change in the future?
   d) How do the answers to (a-c) vary under different hydro-climatological conditions?

2) Approach:
   a) Develop a multi-decadal watershed model to simulate nutrient loading dynamics on an ~monthly time scale.
   b) Assimilate prior research and historical data in a Bayesian framework to update our knowledge of nutrient loading and transport rates.
   c) Apply the model to evaluate future management and climate scenarios.

3) Management/policy implications:
   a) Characterize the extent to which watershed developments elevates nutrient loading.
   b) Compare the efficacy of various management strategies.
Bayesian Inference and Uncertainty Characterization

![Bayesian Inference and Uncertainty Characterization](image)

Legend:
- **Prior**
- **Likelihood**
- **Posterior**

- **Agricultural TN Export Rate (mass/area/year)**
Watershed modeling framework

27 observational loading stations, 80+ subwatersheds
Data Compilation

- Land use
- Point source
- Livestock
- Precipitation

Monthly (PRISM) precipitation

40-yr change in impervious cover

% change in IC
- 0.0 - 0.4
- 0.5 - 1.3
- 1.4 - 3.1
- 3.2 - 7.2
- 7.3 - 11.5

TN loads from major WWTPs
Part 2: Lake Modeling

1) Research Questions:
   a) How important is the sediment layer as a source or sink for nutrients, relative to external watershed loads?
   b) What are the primary controls on lake chlorophyll concentrations (e.g., nutrients, turbidity, flushing, light)?
   c) How do the answers to (a) and (b) vary over time and in different regions of the lake?

2) Approach:
   a) Develop a multi-decadal mass-balance water quality model to simulate nutrients and predict chlorophyll.
   b) Assimilate recent experiments and historical data in a Bayesian framework to update our knowledge of reservoir processes.
   c) Apply the model to evaluate future management and climate scenarios.

3) Management/policy implications:
   a) Compare the efficacy of various management strategies.
   b) Estimate how long it will take nutrient reductions to produce measurable changes in water quality.
Water Quality Modeling Framework

• Lake is longitudinally segmented based on major constrictions.
• Lake is modeled over three decades at a monthly time step.
• Explore N, P, Chl-a, and inorganic turbidity.
Inputs and Calibration data

Incoming TN (from WRTDS)

Incoming TP (from WRTDS)

Algae (Chl-a)

TN:TP
Project Timeline

• Develop WRTDS loading estimates of nitrogen and phosphorus (December 2018).
• Develop Jordan Lake watershed nutrient loading model (September 2019).
• Develop Jordan Lake reservoir water quality model (September 2019).
• Apply models for scenario forecasts (November 2019).
• Final report (December 2019).
Thank you!
Questions?