

Utah Lake Water Quality  
Study  
Science Panel Meeting  
March 11-12, 2019  
Salt Lake City, UT

## Literature Review

Utah Lake Nutrient Criteria  
Development Technical  
Support



# Objective

- Provide overview of literature review
- Discuss SP feedback

## Utah Lake Water Quality Study— Approaches for Developing Numeric Nutrient Criteria: A Literature Review DRAFT

March 7, 2019



### PRESENTED TO

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### PREPARED BY

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# Literature Review

- Goal: “Summary technical memo of applicable approaches for developing nutrient criteria for shallow lake ecosystems like Utah Lake”
- Sources: Existing reviews and libraries, SNAPIT, online review
- Search and screening strategy

# Literature Review Outline

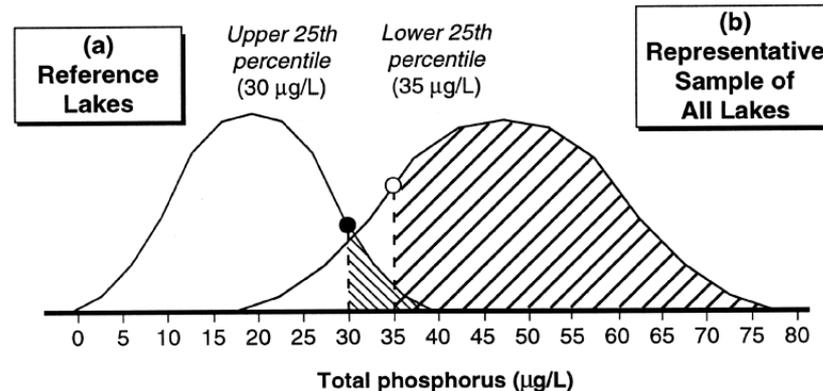
- Search and Screening Strategy
- Approaches
  - Reference
  - Empirical Stressor-Response Models
  - Mechanistic Stressor-Response Models
  - Scientific Literature
- State Plans for NNC Development
- References

# Reference

- State of water body in the absence of, or under minimal, anthropogenic influence
- 3 approaches
  - Direct observation of sites and estimation or inference
  - Paleolimnological reconstruction of past conditions
  - Model-based prediction or extrapolation

# Direct Observation of Sites and Estimation or Inference

- Collection of reference lakes or entire population of lakes



- Often used as one of multiple lines of evidence
- Example papers
  - Ohio EPA 2010: Technical Support Document, Nutrient Criteria for Inland Lakes in Ohio
  - Dodds et al. 2006: Determining Eco-regional Reference Conditions for Nutrients, Secchi Depth and Chlorophyll a in Kansas Lakes and Reservoirs

# Paleolimnological Reconstruction of Past Conditions

- Remains of organisms preserved in lake sediments—look for relationship between water quality endpoints and biota to infer past lake water quality conditions
- Example papers
  - Spring Lake, MN (MPCA 2015)
  - Diatoms from MN lakes (Heiskary and Wilson 2005, 2008)

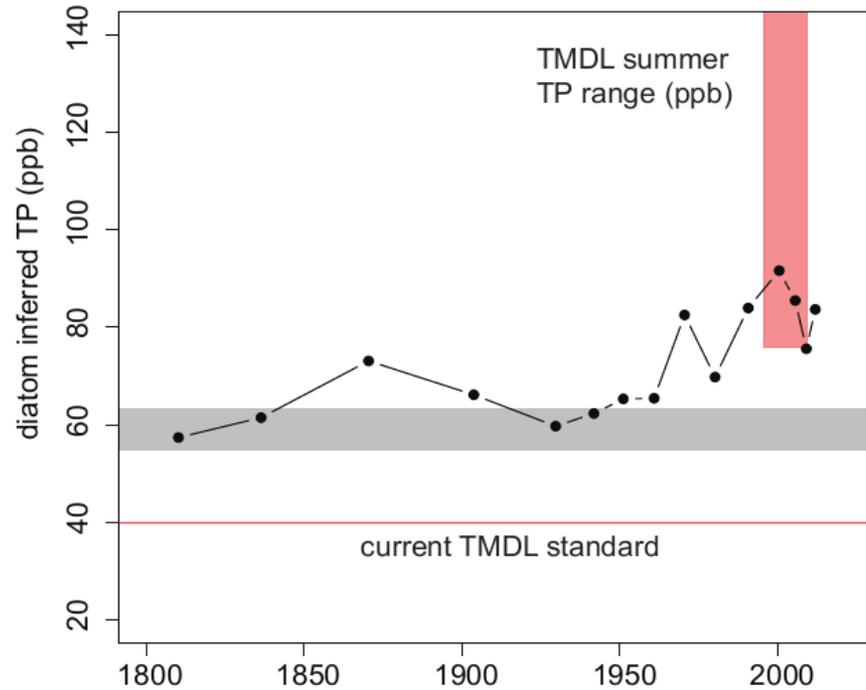


Figure 6: The diatom-inferred total phosphorus reconstruction. The grey bar is the approximate historical background for Spring Lake prior to settlement. The red line is the current background or TMDL standard set for Spring Lake and the red shaded area represents the measured summer TP range over the last 10-15 years (Wenck, 2011).

# Model-Based Prediction or Extrapolation of Reference

- Predict reference condition with empirical or mechanistic models
- MI lakes (Soranno et al. 2008): Stepwise multiple regression, set human factors to zero
- Lake Alma and Searcy TMDLs, FL (Rhew 2018): HSPF, EFDC, WASP models

## 1. Predict lake-specific expected TP

- (a) Model lake TP as a function of HGM features and human LULC (hydrogeomorphic - land use model, HGM-LU).

e.g.

$$TP = a + b(\text{lake morph}) + c(\text{geol}) + d(\text{LULC})$$

- (b) Predict expected TP for all lakes at zero level of human LULC ( $EXP_0$ ) using the HGM-LU model; add allowance to  $EXP_0$  to estimate  $EXP_A$ .

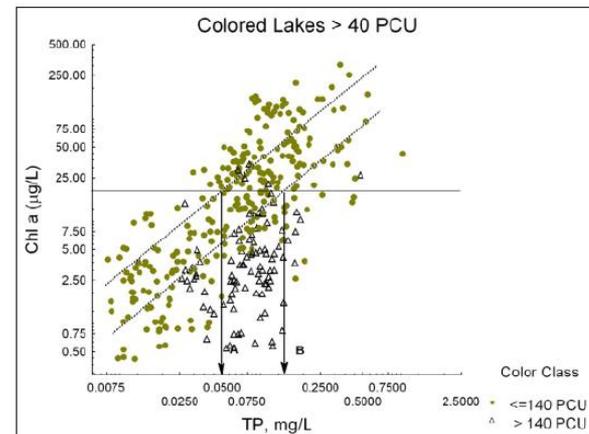
e.g.

$$EXP_0 = a + b(\text{lake morph}) + c(\text{geol}) + d(0)$$

$$EXP_A = EXP_0 + \text{allowance}$$

# Empirical Stressor-Response Modeling

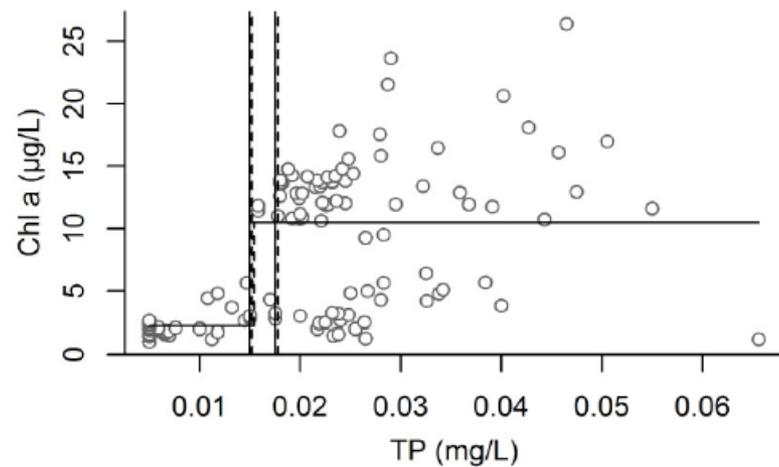
- Conceptual models
- Relationships between stressors (e.g., nutrients) and responses (e.g., chlorophyll, DO, biota assemblages, use support)
- Examples:
  - Florida lakes (USEPA n.d.): linear regression with chl
  - Lake Champlain (Smeltzer 1999): User surveys



**Figure 2-29. Chl-a and TP in colored lakes, showing 50% prediction interval (dotted lines).** Note that symbols and data as in Figure 2-23. Horizontal line: chl-a criterion (20 µg/L). A indicates TN concentration corresponding to 25% probability of chl a exceeding 20 µg/L; B indicates concentration corresponding to 75% probability of exceedance.

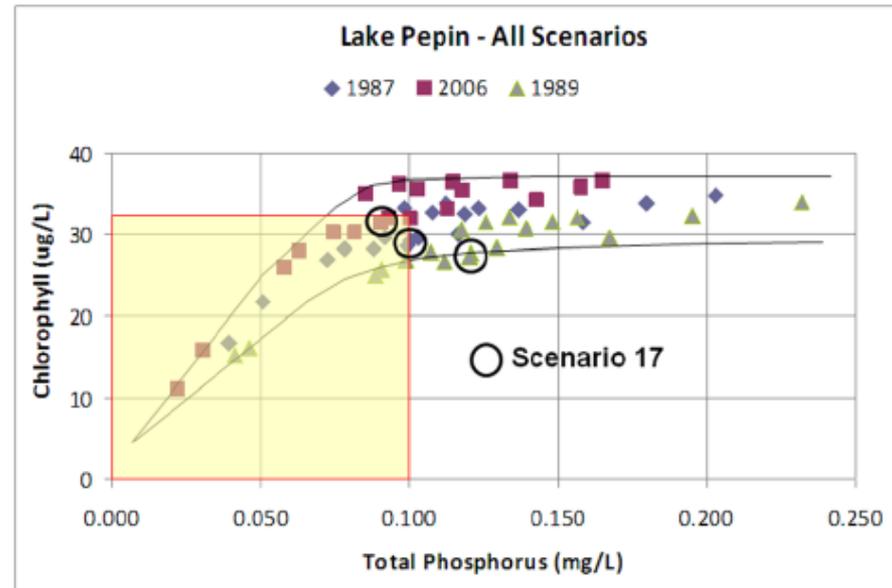
# Empirical Stressor-Response Modeling (continued)

- Biological thresholds—small increase in stressor lead to abrupt change in biological response
- Techniques:
  - Nonparametric changepoint analysis (Huo et al. 2015)
  - Threshold indicator taxa analysis (TITAN) (Cao et al. 2016 and 2017)
- Nutrient bioassays—relationship between nutrients and algal biomass (Kiesling et al. 2001)



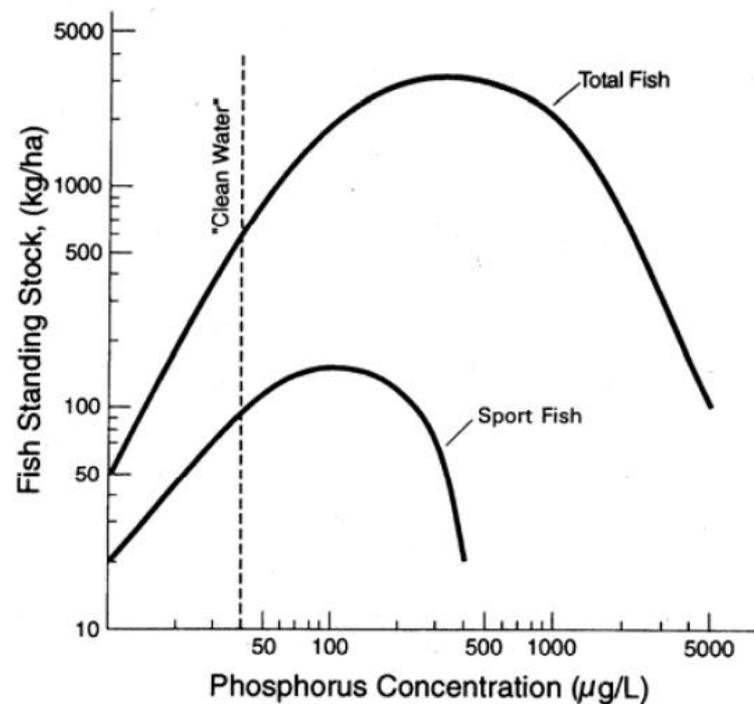
# Mechanistic Stressor-Response Modeling

- Lake Pepin (DePinto et al. 2009): Linked hydrodynamic water quality model, lake P target to minimize algal bloom frequency and % cyanobacteria
- Santa Margarita River Estuary (Sutula et al. 2016): HSPF, EFDC, WASP, evaluated nutrients and DO



# Literature

- When site-specific data are lacking
- Water body must have similar characteristics to systems used to derive published targets
- Examples
  - Lahontan Reservoir chl target (Pahl 2012), impaired beneficial uses
  - Virginia lakes (VWRRC 2007): relationships between fisheries health and P + chl concentrations in literature



# State Plans for NNC Development

- Submitted to USEPA for review and approval

<b>Mutually Agreed Upon State Plan</b>	<b>Empirical Stressor-Response Modeling</b>	<b>Mechanistic Stressor-Response Modeling</b>	<b>Reference Condition</b>	<b>Literature Values</b>
Arizona/Nevada/CA (Tetra Tech 2002)	x	x	x	
Colorado (Colorado Department of Public Health and Environment 2002)	x			
Idaho (IDEQ 2007)	x		x	x
Montana (Montana DEQ 2002)	x	x	x	x
Nevada (NDEP 2007)	x			
New Mexico (NMED 2006)			x	x
New Mexico (NMED 2014)	x			x
Utah (Utah DWQ 2005)	x		x	
Wyoming (Wyoming DEQ 2008)	x		x	x

# Next Steps

- Science Panel review
- Finalize

