ULWQS Project Update

May 30th, 2019

Why are we all here again?

WOTUS Assessments

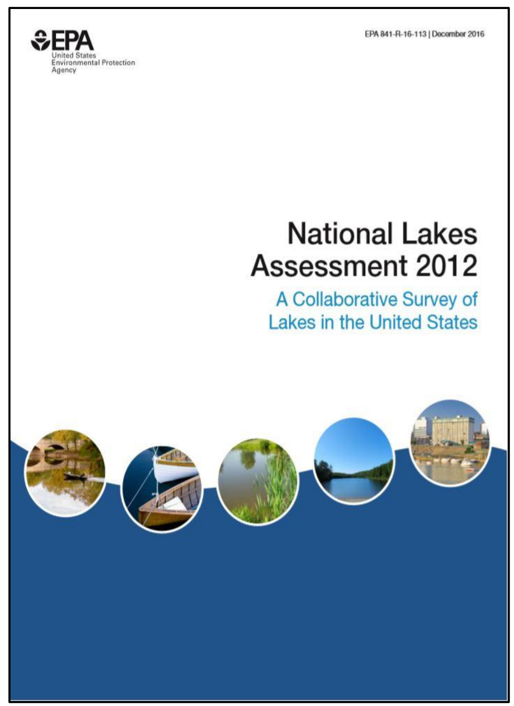
Recent Surveys and Environmental Studies

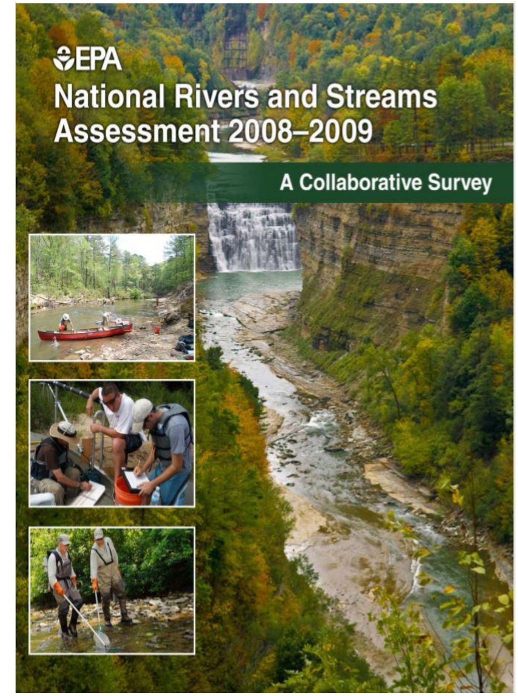
Rivers

- National Rivers and Streams Assessment
- 2008-2009

Lakes

- National Lakes Assessment
- 2012

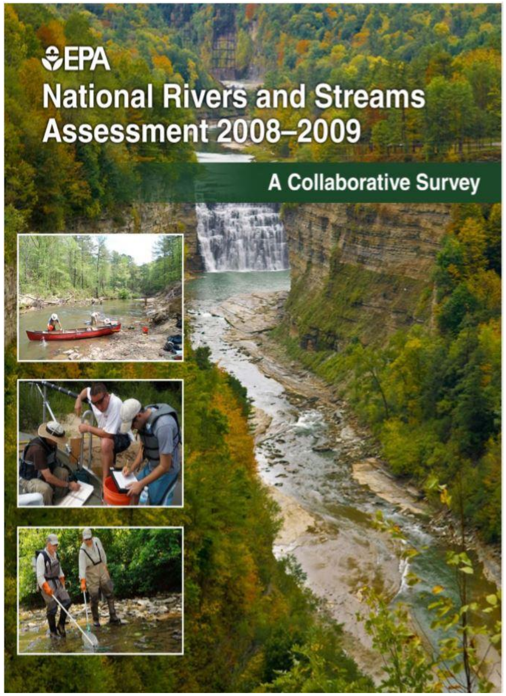




NR&SA 2008-2009

1.2 million miles of rivers, streams, and creeks surveyed

- Biological condition
    - 46% Poor
    - 24% Fair
    - 28% Good
- Key Stressor
    - >40% Nutrient Pollution



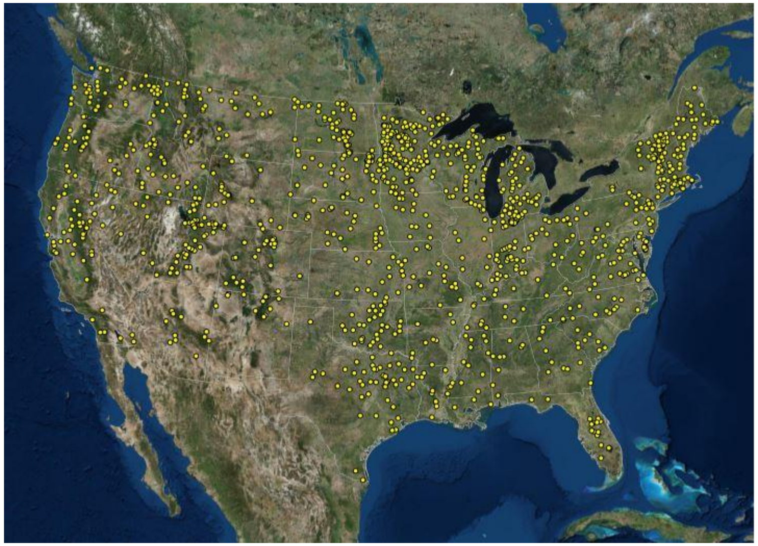
NLA 2012

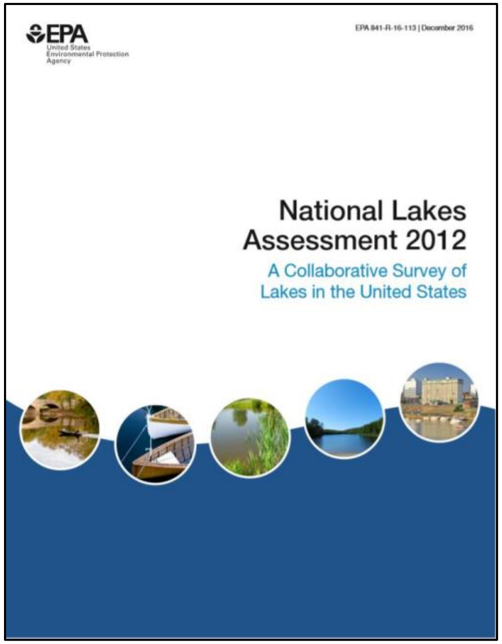
1,308 lakes surveyed

- Lake condition
  - 40% Phosphorus pollution
    - 18.2% increase since 2007
  - 35% Nitrogen pollution

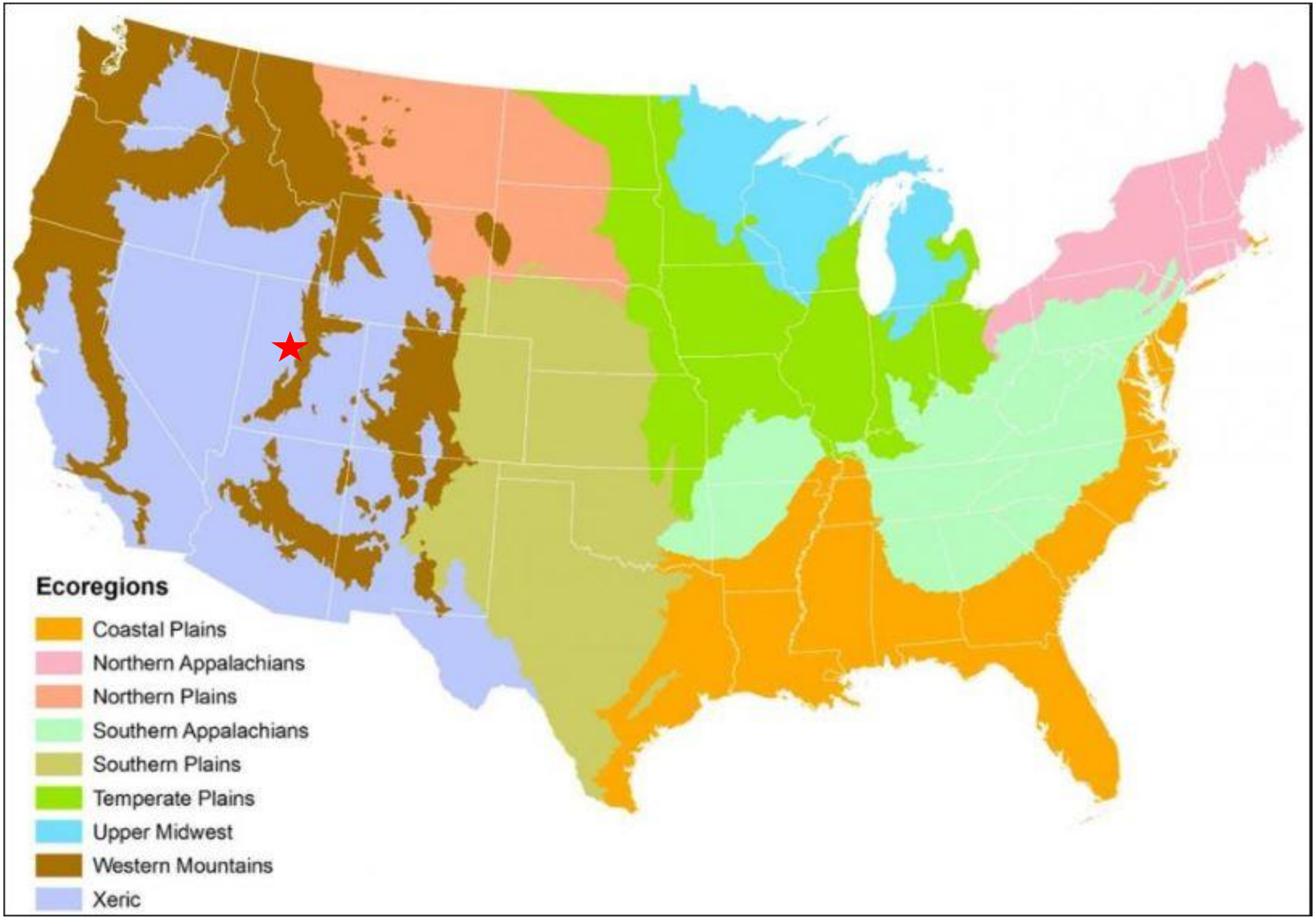
  - 31% Poor biological condition
    - Benthos
      - >P results in 220% worse
      - >N results in 160% worse

  - <1% Microcystin (cyano toxin)
    - 39% had measurable concentrations
      - 9.5% more than in 2007





US Lakes (NLA 2012)



US Lakes (NLA 2012)

	Key Stressors			
	Phosphorus	Nitrogen	Drawdown	Habitat
Western Mtns	17%	20%	10%	0%
Xeric	**39%**	31%		32%
Coastal Plains	**50%**	33%		**70%**
N Appalachians	**31%**	22%		21%
N Plains	**80%**	70%		69%
S Appalachians	**67%**	63%		52%
S Plains	58%	61%		31%
Temperate Plains	**46%**	34%		30%
Upper Midwest		27%		52%

Note: Habitat includes riparian zone, complexity, and shoreline disturbance

US Lakes (NLA 2012)

Western Mountain Lakes

8,112 lakes

- 73% natural
- 27% man made

Key Stressors

- 20% Nitrogen
- 17% Phosphorus
- 10% Drawdown

<1% of lakes have high risk of cyanotoxin exposure

Xeric Lakes

2,180 lakes

- 11% natural
- 89% man made

Key Stressors

- 39% Phosphorus
- 32% Lack of Riparian Cover
- 31% Nitrogen

16% of lakes have high risk of cyanotoxin exposure

US Lakes (NLA 2012)

Trophic State		
	Western Mtns	Xeric
# of Lakes	8,112	**2,180**
% Man made	27%	**89%**
Most Disturbed	2%	**20%**
Eutrophic	7%	30%
Mesotrophic	31%	27%
Oligotrophic	**59%**	22%
Cyano Risk	1%	**16%**

Headwaters have better water quality compared to desert surface waters

- Natural process (eutrophication)
- Human activity (enhanced eutrophication)

And back to the task at hand…..

Update on Science Panel Activities

Overview of SP Efforts

Review Tetra Tech progress

1. Approach framework document
2. Conceptual models
3. Data characterization
4. Uncertainty guidance document
5. Data gaps analysis
6. Strategic research plan

Discuss upcoming technical consultant and science panel activities

Discuss progress made on University of Utah model

Questions and Discussion

Overview of Science Panel Efforts

Overview of SP Efforts

1. 2019 Research Development
2. Technical Consultant
    1. Interstate knowledge discussions
    2. Data analyses
    3. Nutrient criteria reviews
3. University of Utah Model Review
    1. Mass balance(s)
    2. Storm water
4. Outreach
    1. WEAU
    2. Great Salt Lake Alliance
5. Atmospheric deposition whitepaper

Review Tetra Tech Progress

1. Approach framework document
    - 3.1 Reference
        - Utah's historic preference
            - Direct observation & Reference conditions
                - Reference = 'natural' in this context
                - 2019 Priority
            - Paleolimnological reconstruction
                - 2019 Priority
            - Model-based prediction based on 'natural' conditions

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

March 29, 2019

PRESENTED TO

Utah Department of Environmental Quality
Division of Water Quality
PO Box 144870
Salt Lake City, UT 84114

PREPARED BY

Tetra Tech
1468 West Ninth Street, Suite 620
Cleveland, OH 44113

Please read this document, this will shape the Study

Review Tetra Tech Progress

1. Approach framework document
   3.2 Empirical Stressor-Response Modeling
   Utah's historic preference
   USEPA method
   4-steps
   Conceptual models
   Exploratory data analysis
   Stressor-response relationships
   N &P
   Model accuracy and precision

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1. Approach framework document
    - 3.3 Mechanistic Modeling
        - Use models to predict future conditions
            - Pick an endpoint

All models are wrong, but some are more useful

Good data informs useful models!!!

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1. Approach framework document
   - 3.4 Literature
     - If not enough data, then compare to others
     - Many assumptions = uncertainty

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1. Approach framework document

Table 2. Approaches to numeric nutrient criteria derivation in state mutually agreed upon development plans

Mutually Agreed Upon State Plan	Empirical Stressor-Response Modeling	Mechanistic Stressor-Response Modeling	Reference Condition	Literature Values
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

Conceptual Models

Approach 3.2

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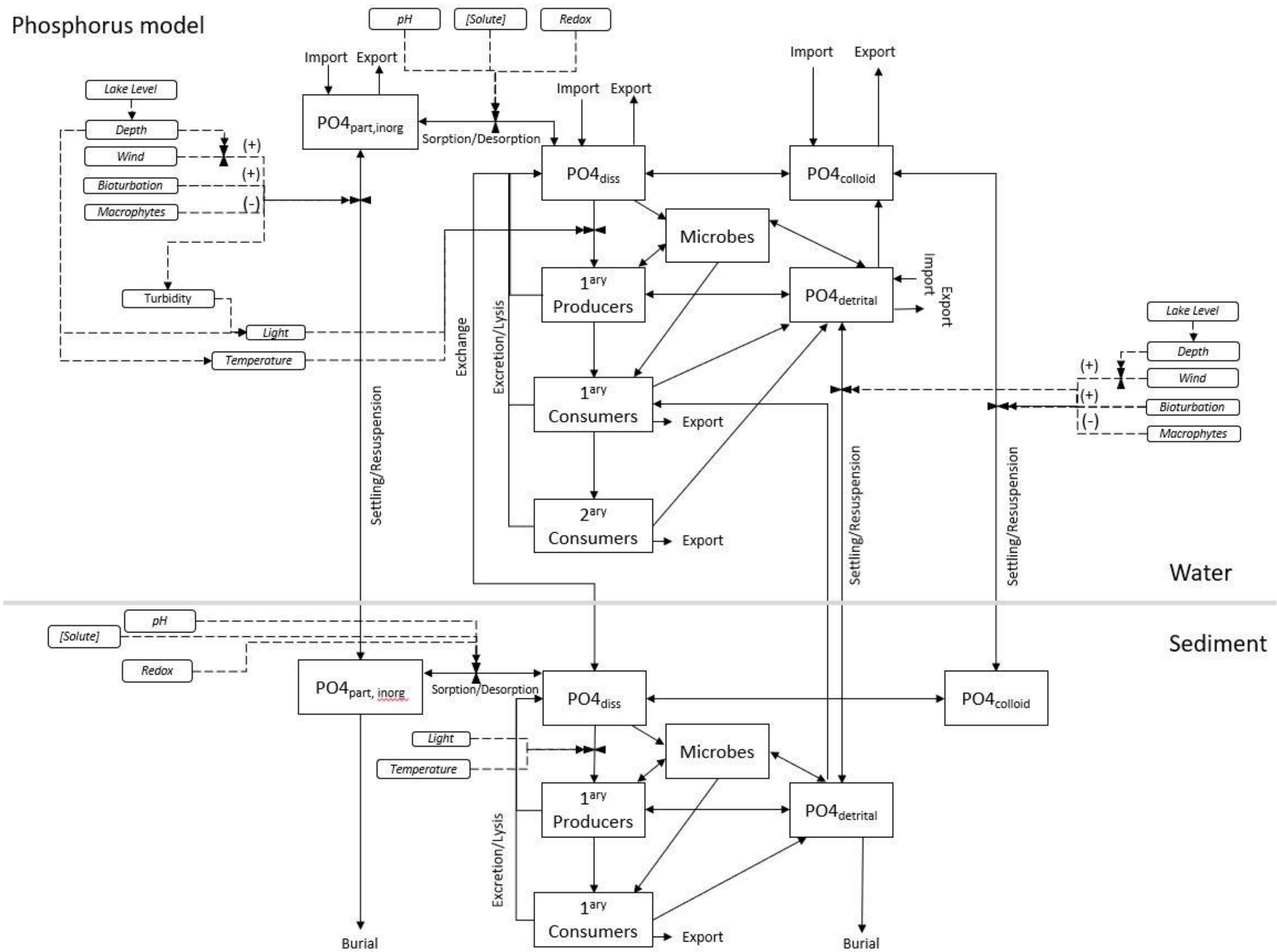
2. Conceptual models
    - Phosphorus



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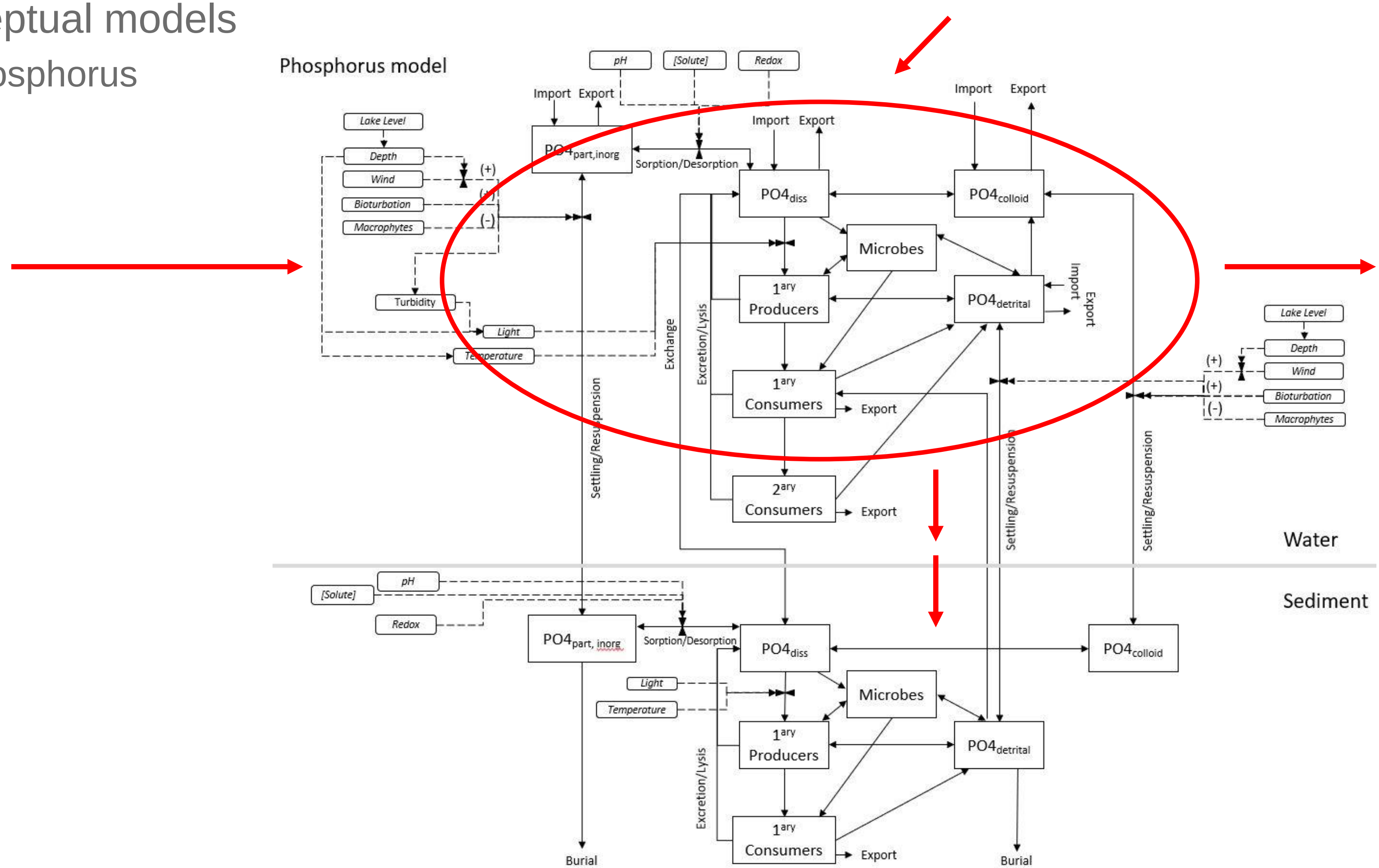
2. Conceptual models
   - Phosphorus



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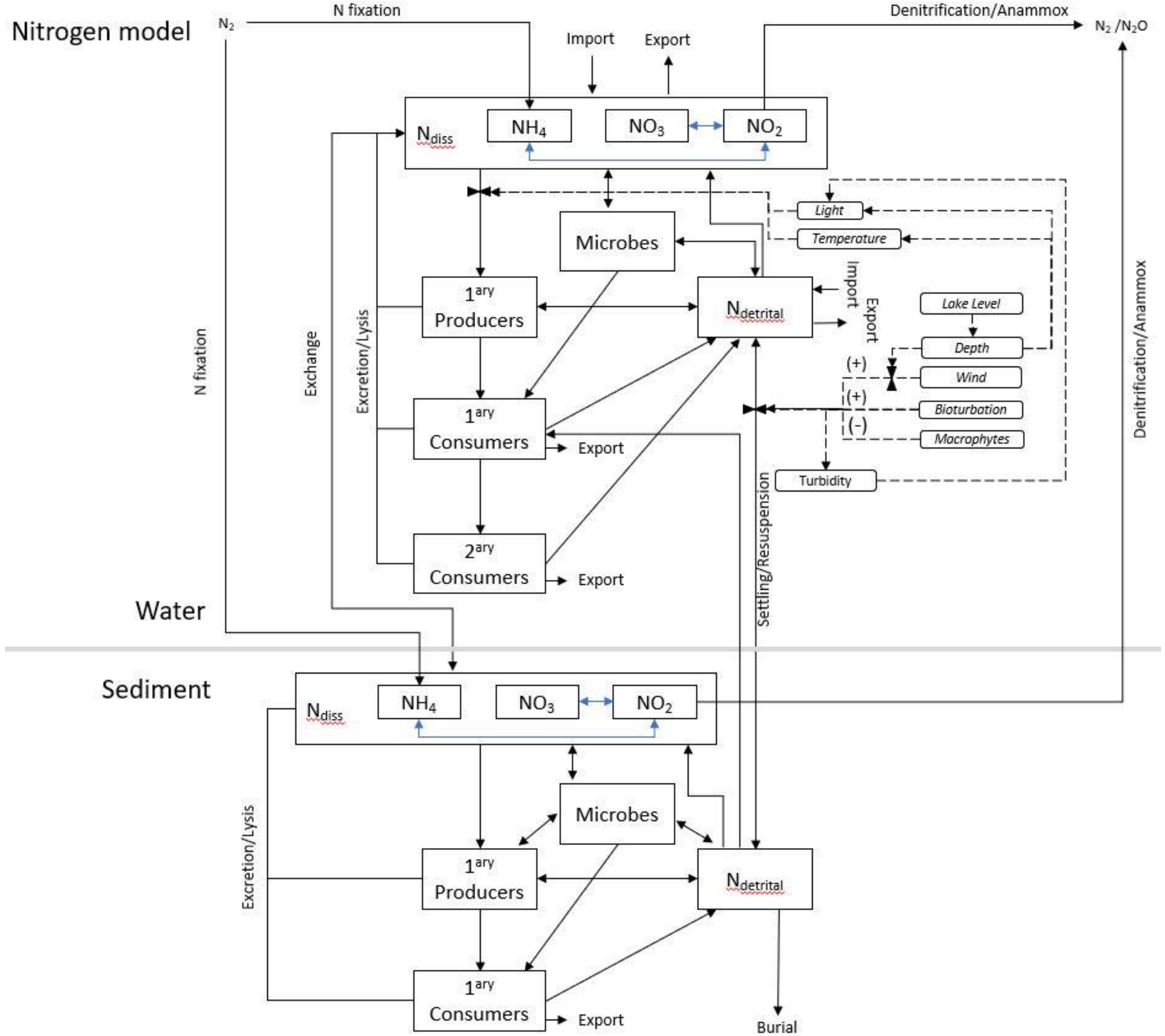
2. Conceptual models
   - Nitrogen



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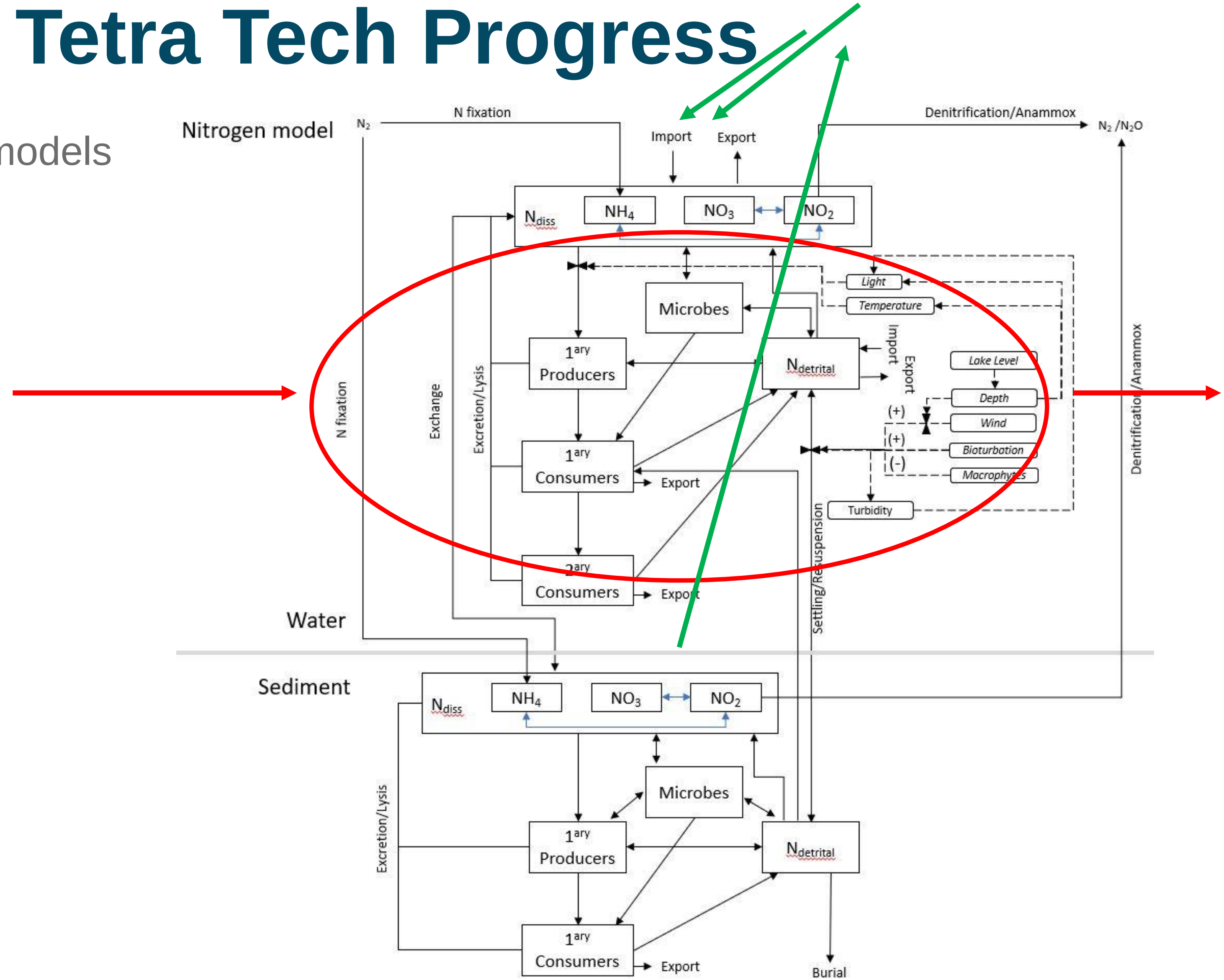
2. Conceptual models
   - Nitrogen



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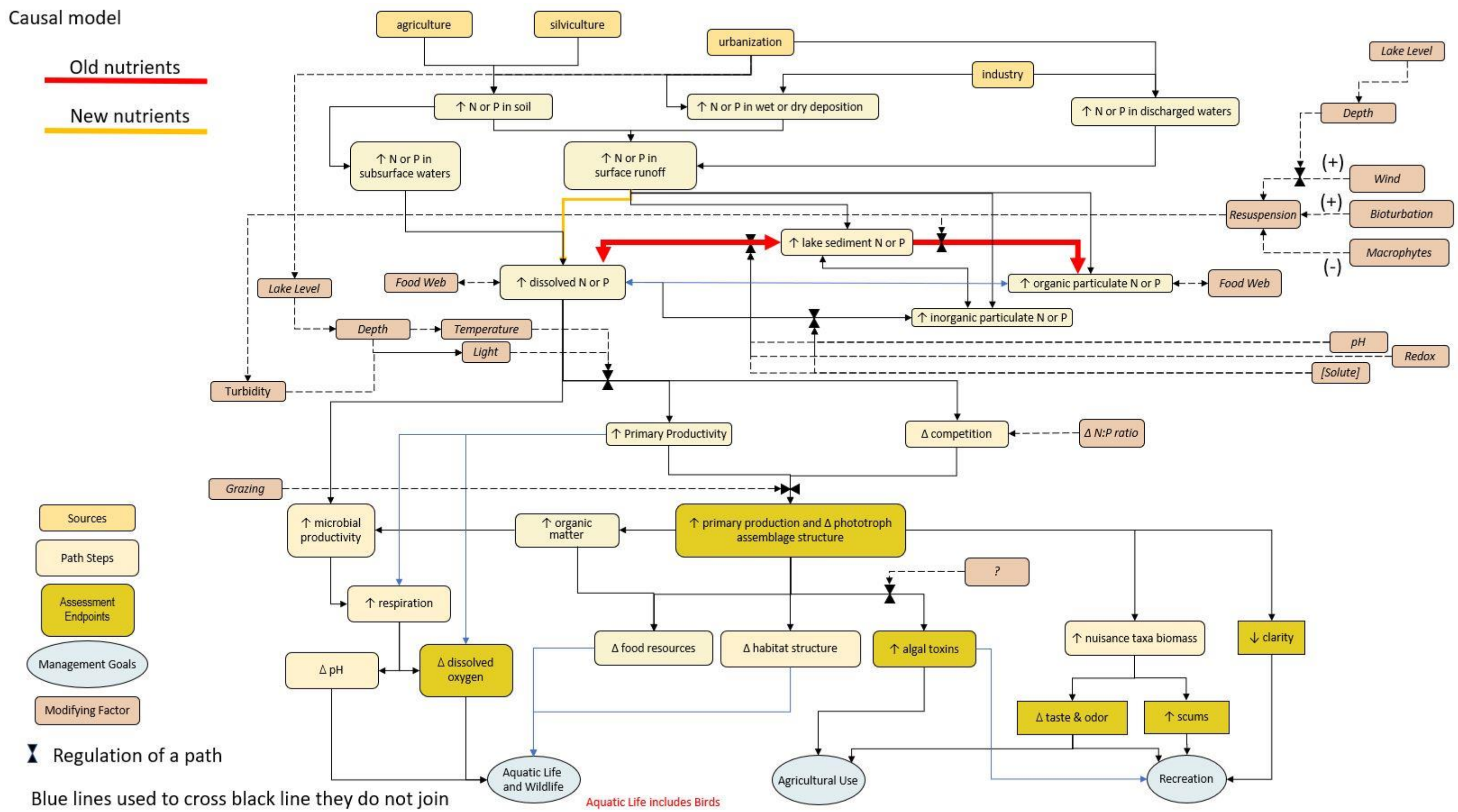
2. Conceptual models
   - Causal



Data Characterization

Approach 3.1

Review Tetra Tech Progress

3. Data characterization

   2.1 Carp excretion rates

   - Charge Question 2.1
   - Nutrient cycling mass balance

   2.2 Algal cell count and pigment relationships

   - Use existing data (Phase I and II)

   2.3 Sonde Data Analysis

   - Use existing UDWQ buoy data
   - General statistics
   - Net Daily Metabolism (Dr. Soren Brothers)

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3. Data characterization

    2.4 Plankton Spatial Analysis

        2.4.1 Phytoplankton and Zooplankton Temporal Dynamics
        - Charge Question 2.3.i
        - Phase I and II data, CYAN (satellite imagery)

        2.4.2 Phytoplankton and Zooplankton Spatial Dynamics
        - Charge Question 2.3.i
        - Phase I and II data, CYAN (satellite imagery)

        2.4.3 Dynamics in Plankton Pattern Related to Nutrients
        - Charge Question 2.3.ii and 2.3.iii
        - Relate nutrient data to tasks 2.4.1 and 2.4.2

        2.4.4 Dynamics in Plankton Pattern Related to Lake Level
        - Charge Question 2.3.iii
        - Relate lake elevation data to tasks 2.4.1, 2.4.2 and 2.4.3

        2.4.5 Dynamics in Plankton Pattern Related to Other Factors
        - Charge Question 2.3.iv
        - Relate to temperature and HABs

        2.4.6 Dynamics in Plankton Pattern Related to Climate
        - Relate HABs and precipitation

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3. Data characterization

   2.5 Environmental Requirements of Diatoms and Macrophytes

   - Charge Question 2.2 and 2.2.i
   - Review existing biological data and research environmental requirements

   2.6 Wind and Turbidity

   - Charge Question 2.2.ii
   - Relate historical wind data and theoretical sediment properties to model sediment resuspension and compare to buoy turbidity data

   2.7 Turbidity and Macrophytes

   - Charge Question 2.2.ii
   - Investigate macrophyte sediment stabilization and relate to historical and/or current standing stocks

   2.8 Light Extinction

   - Charge Question 2.3.vi
   - Relate TSS, turbidity and chlorophyll a data to secchi depth

Review Tetra Tech Progress

Review Tetra Tech progress

4. Uncertainty guidance document
   - Building off of chosen ‘nutrient criteria’ strategy(s) and strength of dataset
     - In progress

Review Tetra Tech Progress

Review Tetra Tech progress

5. Data gaps analysis
    - Ongoing
        - Existing data
        - 2019 research
        - Answer Initial Charge Questions
            - Answer as many questions as possible with existing data

Update on Science Panel Activities

Overview of SP Efforts

6. Strategic research plan

- SP priority voting
- 2019 research will direct future research

Charge Question	Subquestions	Prioritization	Potential Near-Term Research Topic/Question
1: Historical condition of Utah Lake	1.1. What does the diatom community and macrophyte community in the paleo record tell us about the historical trophic state and nutrient regime of the lake?		i. Can diatom (benthic and planktonic) and/or macrophyte extent or presence be detected in sediment cores? And if so, what are they?
			ii. What were the environmental requirements for diatoms and extant macrophyte species?
			iii. How have environmental conditions changed over time?
			1.2. What were the historic phosphorus, nitrogen, and silicon concentrations as depicted by sediment cores? (add calcium, iron, and potentially N and P isotopes)
			1.4. What do photopigments and DNA in the paleo record tell us about the historical water quality, trophic state, and nutrient regime of the lake?
2: Current condition of Utah Lake	2.1. What are the impacts of carp on the biology/ecology and nutrient cycling of the lake and how are those impacts changing with ongoing carp removal efforts?		i. What contribution do carp make to the total nutrient budget of the lake via excretion rates and bioturbation? How much nutrient cycling can be attributed to carp?
			ii. What is the effect of carp removal efforts on macrophytes, nutrients, secchi depth, turbidity, and primary productivity?
			iii. How much non-algal turbidity and nutrient cycling is due to wind action versus carp foraging? How much does sediment resuspension contribute to light limitation, and does wind resuspension contribute substantially in the absence of carp?
	2.3. What are the linkages between changes in nutrient regime and HABs? (recommendation to move sub-items v and vi to 2.4)		ii. Which nutrients are actually controlling primary production and HABs and when?
			v. What is the role of calcite "scavenging" in the phosphorus cycle?
			vi. What is the relationship between light extinction and other factors (e.g., algae, TSS, turbidity)?
			vii. (added by one of the break-out groups) What is the contribution of nitrogen fixation to water column nitrogen concentration?
	2.4. How do sediments affect nutrient cycling in Utah Lake?		i. What are current sediment equilibrium P concentrations (EPC) throughout the lake? What effect will reducing inputs have on water column concentrations? If so, what is the expected lag time for lake recovery after nutrient inputs have been reduced?
			ii. What is the sediment oxygen demand of, and nutrient releases from, sediments in Utah Lake under current conditions?
			iii. Does lake stratification [weather patterns] play a result in anoxia and phosphorus release into the water column? Can this be tied to HAB formation?
3: Additional information			3.2. For primary contact recreation: Utah Lake recreation survey
			3.3. For agricultural uses including irrigation of crops and stock watering: explore toxins and irrigation risk for crops and livestock

Tech. Consultant and SP Discussion

Discuss upcoming technical consultant and science panel activities

- Call #8
  - June 13th
- Two day meeting
  - July 10-11th
- Utah Lake Festival
- Coordinate and negotiate with 2019 researchers
- U of Utah modeling review
- Mass balance calculations and review
- Atmospheric deposition whitepaper
  - Review existing data
  - Better understand different forms of phosphorus

U of Utah Model Discussion

Discuss progress made on University of Utah model

- Review and address questions regarding how the ULWQS will utilize the models
  - The ULWQS will need additional models to answer ‘Initial Charge Questions’
  - Working with U of Utah regarding additional sampling to support models
- Focus on transferring model from University to UDWQ
  - 1-day conference to learn model(s)

General Discussion and Questions

Questions and Discussion

Utah Lake Near-Term Research RFPs

2019 Research (ULWQS)

2019 Contracted Research

1. Bioassays to investigate nutrient limitation in Utah Lake
2. Historic trophic state and nutrient concentrations in the paleo record of Utah Lake
3. Utah Lake sediment-water nutrient interactions

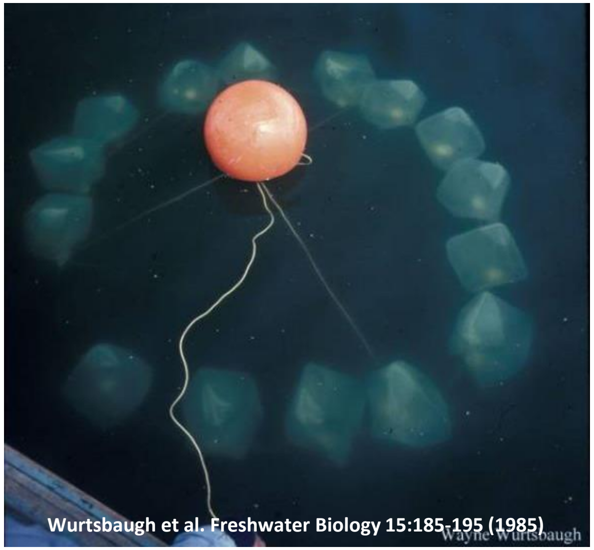
Bioassays

Objectives

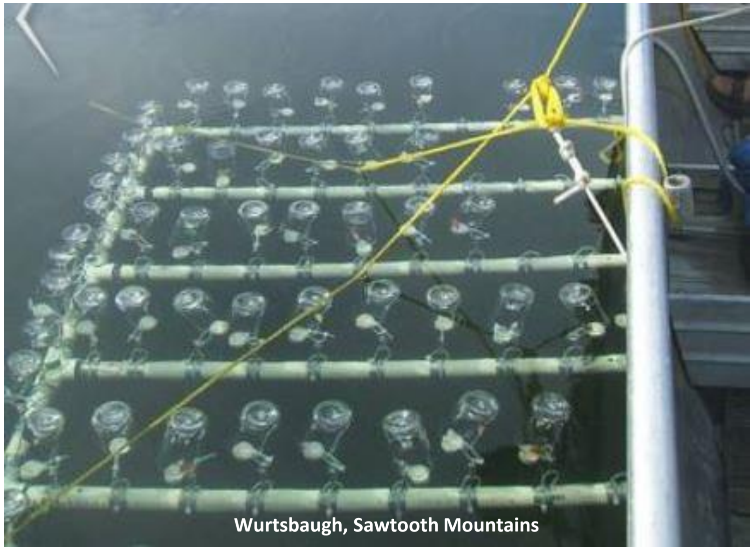
1. Determine if P, N, or N & P limited

2. Determine if there is a seasonal nutrient limitation

3. Determine if there is a spatial dynamic to nutrient limitation



Wurtsbaugh et al. Freshwater Biology 15:185-195 (1985)


Wurtsbaugh, Sawtooth Mountains

UTAH LAKE COMMISSION

UTAH DEPARTMENT of ENVIRONMENTAL QUALITY
WATER QUALITY

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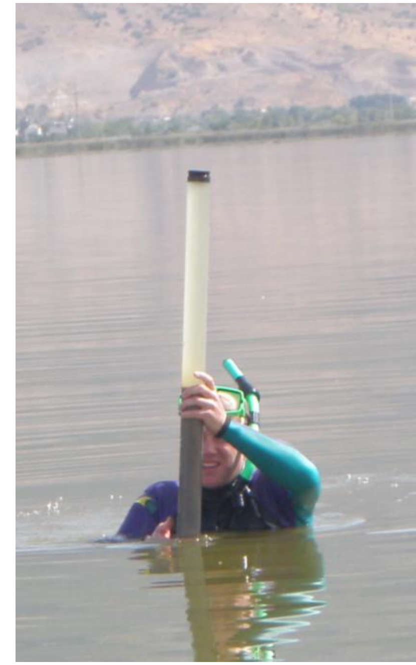
Paleo Record

Objectives

1. What were the historical phosphorus, nitrogen, and silicon concentrations as depicted by sediment cores?
   - Science Panel charge 1.2

2. What does the diatom community and macrophyte community in the paleo record tell us about the historical trophic state and nutrient regime of the lake?
   - Science Panel charge 1.1

3. What do photopigments and DNA in the paleo record tell us about the historical water quality, trophic state, and nutrient regime of the lake?
   - Science Panel charge 1.4



Utah Lake Commission · Utah Department of Environmental Quality Water Quality · UW · Baylor Bears · Mississippi State · Carolina Tar Heels · Utah State · BYU · WFWQC · Forsgren Associates Inc.

Sediment-Water Interactions

Objectives

1. What are current sediment equilibrium phosphorus concentrations (EPC) throughout the lake?
    - Science Panel charge 2.4.i

2. What is the role of anoxia in nutrient releases and sediment dynamics over a range of phosphorus concentrations?

3. What is the role of pH in water column–sediment interactions and nutrient releases? How does the equilibrium phosphorus concentration change over a range of water column pH?

4. What is the sediment oxygen demand of, and nutrient releases from, sediments in Utah Lake under current conditions?
    - Science Panel charge 2.4.ii

5. What is the role of calcite “scavenging” in the phosphorus cycle?
    - Science Panel charge 2.3.v

Sediment-Water Interactions

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Questions?

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