UTAH LAKE C, N, AND P PROJECT UPDATE

ULWQS Science Panel Meeting

2021-05-13

Presented by Kateri Salk, Tetra Tech

TOPICS: EXTERNAL MASS BALANCE MODELING

1. Nutrient and flow monitoring protocols
2. Preliminary water budget results
3. Flow and loading from unmonitored watersheds
4. Defining lake elevation

NUTRIENT AND FLOW PROTOCOL FOLLOW-UPS

- WFWQC TN protocol: designed for TKN, but calculates:

  $TN - (NO_3^- + NO_2^-) = TKN$

→Will move forward with using these values

- Streamflow methodology: WFWQC
  - Raw data from 2018 indicates 5 or fewer cross-sections used to generate discharge
  - USGS methodology: "Space the partial sections so that no partial section has more than 10 percent of the total discharge in it." → minimum of 10 cross-sections needed
  - Do Theron or others have other documentation to share or any insights?
  - Would like advice on how to move forward

NUTRIENT PROTOCOLS

Constituent	UDWQ	WFWQC
TP & TDP Lower reporting limit	3 µg/L	21 µg/L
TP & TDP Minimum detection limit	2.8 µg/L	1 µg/L
TN & TDN Lower reporting limit	200 µg/L	700 µg/L
TN & TDN Minimum detection limit	185 µg/L	317 µg/L

- Values < detection limit → set at ½ MDL
- Values > detection limit and < reporting limit → retained as-is
- Watersheds w/ values < WFWQC detection limit → only DWQ samples used:
  - Lehi Spring Creek (P)
  - American Fork River (P and N)
  - Provo River (P and N)
  - Hobble Creek (P)
  - Spanish Fork (N)

HYDROLOGIC BUDGET

Inputs

- Streamflow (monitored watersheds) → direct measurements
- Streamflow & runoff (unmonitored watersheds) → Model My Watershed (GWLF-E)
- Groundwater → EFDC estimates, 4 zones (N, S, Provo Bay, Goshen Bay)
- Precipitation → EFDC estimates

Outputs

- Jordan River → direct measurements
- Evaporation → EFDC estimates

HYDROLOGIC BUDGET: INFLOW

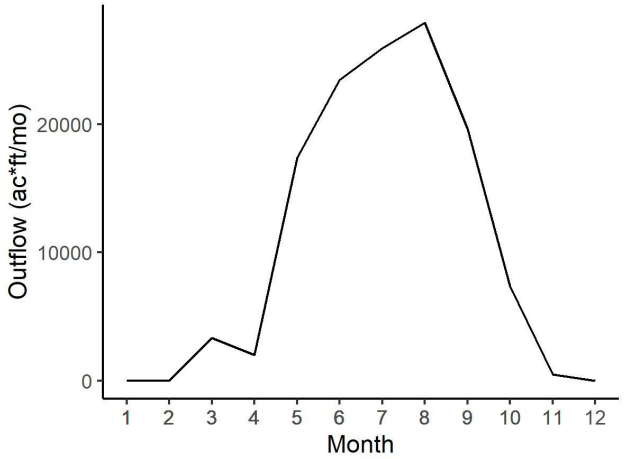
Study	Years	Streamflow (ac*ft/yr)
This study	**2015-2020**	**411,257**
Su and von Stackelberg (2020)	2006-2018	356,742
Merritt and Miller (2016)	2009-2013	495,092
PSOMAS and SWCA (2007)	1980-2003	421,600
Merritt (unpublished LKSIM)	2015-2020	395,397

Inflow estimates fall in the middle of previous estimates

→ suggests monitored flow is not over- or under-predicted compared to other approaches

HYDROLOGIC BUDGET: JORDAN RIVER OUTFLOW

Study	Years	Streamflow (ac*ft/yr)
This study	**2015-2020**	**127,610**
Su and von Stackelberg (2020)	2006-2018	260,695
Merritt and Miller (2016)	2009-2013	336,045
PSOMAS and SWCA (2007)	1980-2003	428,200

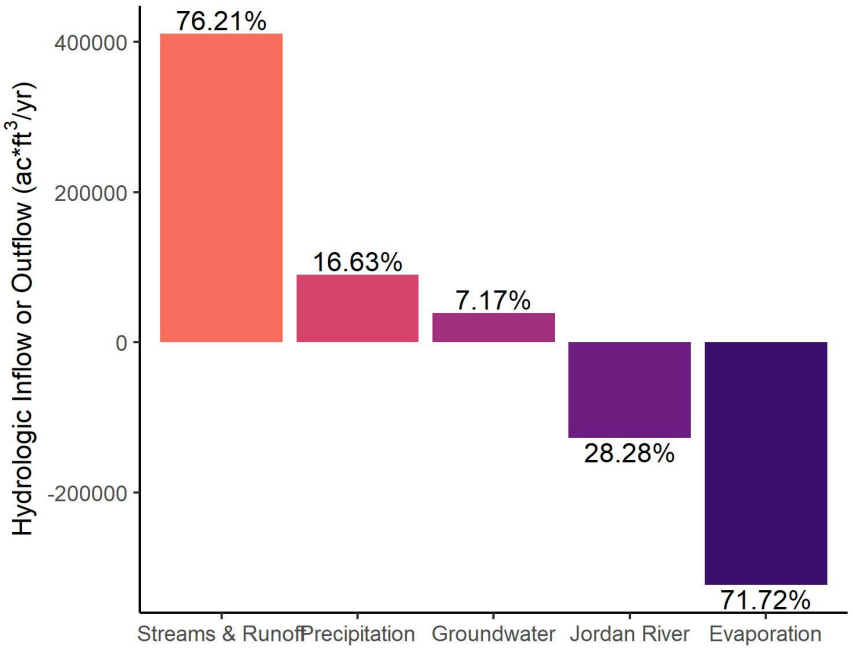


Outflow estimates are lower than previous studies

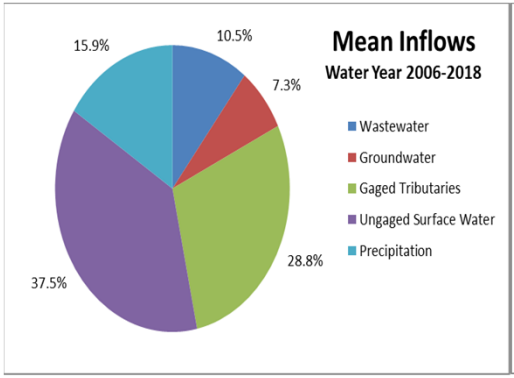
- Daily outflow values @ Narrows paired with nutrients @ outflow
- December-February: observed flows of zero at outflow → replace non-zero Narrows values

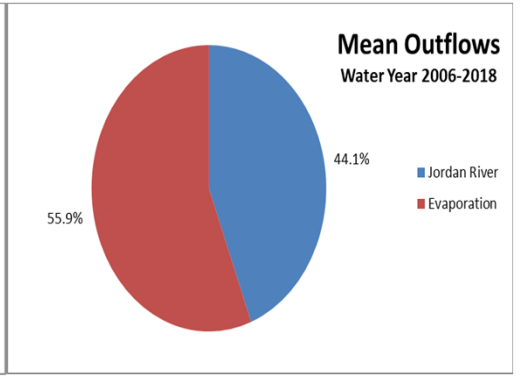
HYDROLOGIC BUDGET

This Study

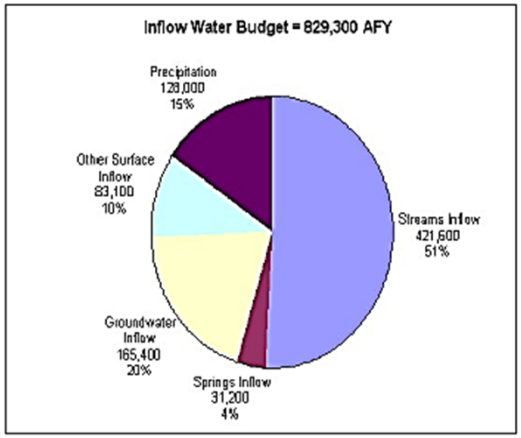


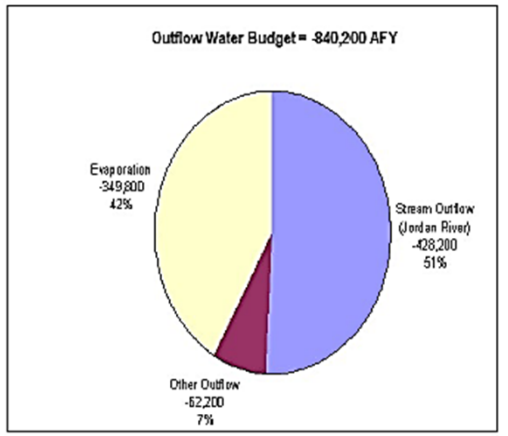
Su and von Stackelberg (2020) – EFDC/WASP





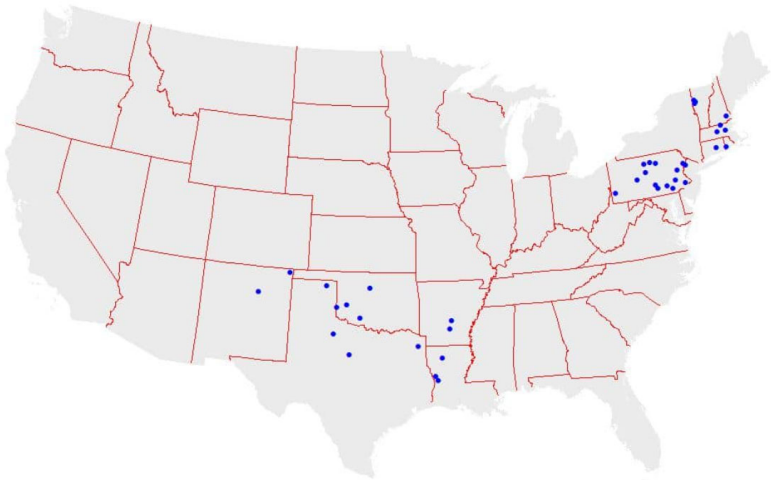
PSOMAS and SWCA (2007) – LKSIM





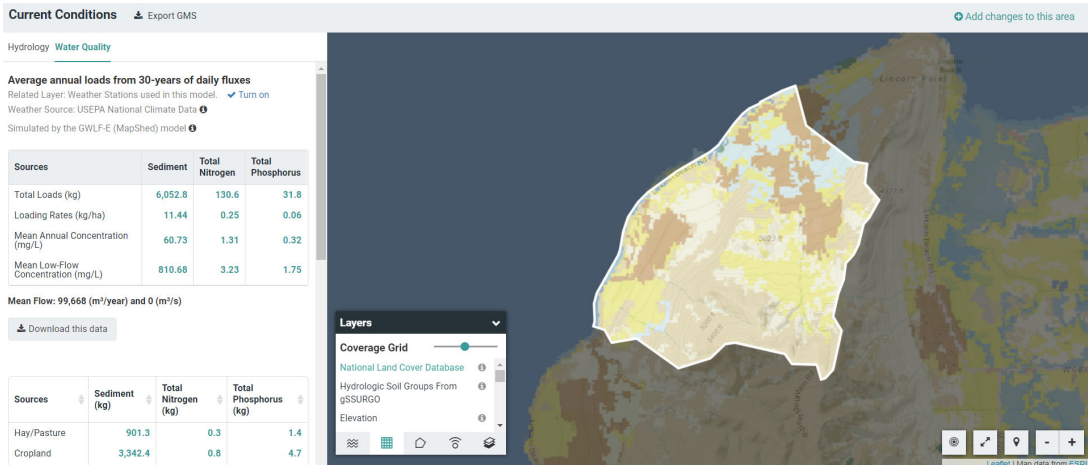
UNMONITORED WATERSHED MODELING

- Original plan: paired watershed approach
- Issue: several watersheds have ephemeral flow w/ no monitored counterpart
- Revised plan: simple model to estimate flows and nutrient loads
- Model My Watershed
  - **Watershed Multi-Year Model**: simulates 30 years of daily data w/ Generalized Watershed Loading Function Enhanced (GWLF-E) model
  - **Hydrology**: NHDplus v2 medium resolution (1:100,000-scale) flow lines (includes ephemeral flow)
  - **Nutrient loading**: farm animal populations, point sources, land cover, soil N and P
  - Calibration of multi-year model conducted for some western watersheds, but none in Utah

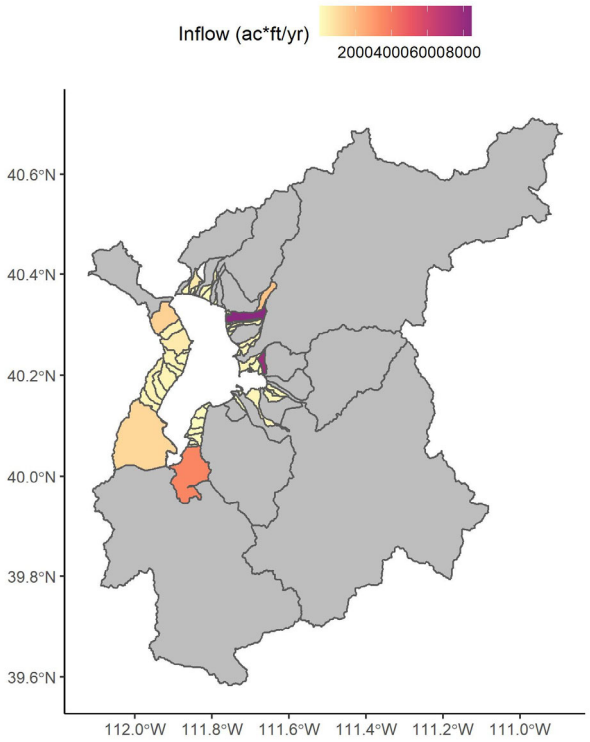


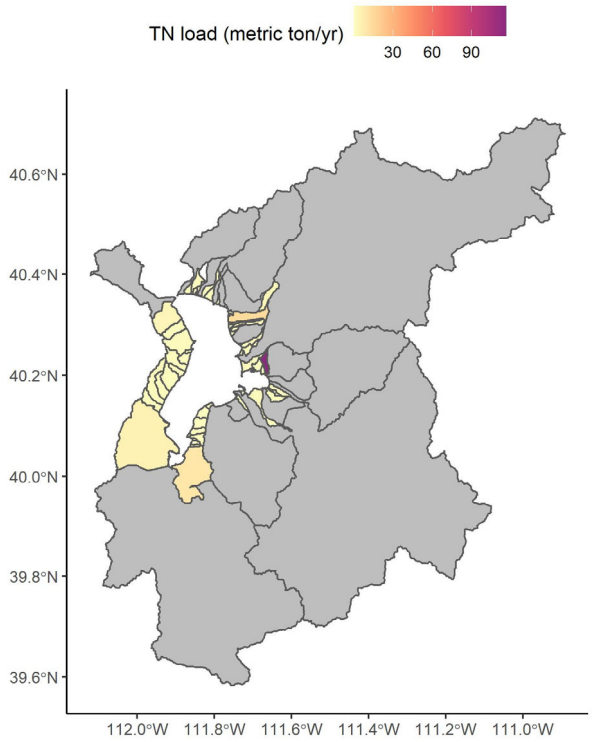
UNMONITORED WATERSHED MODELING

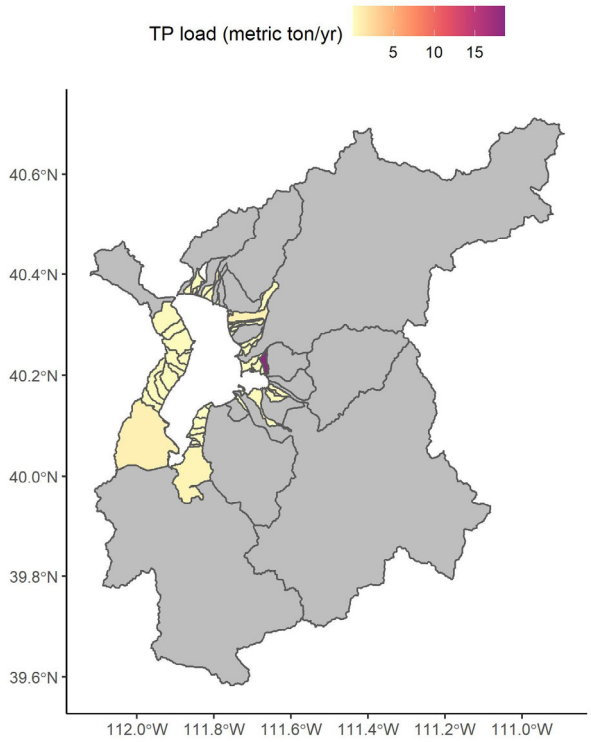
- Ran Watershed Multi-Year Model for 54 unmonitored watersheds
- Output: monthly hydrology, annual nutrient and sediment loads
  - Hydrology: **overland flow, streamflow,** subsurface flow, point source flow, ET, precip
  - Nutrients: **TN and TP** parsed into land use, farm animals, stream bank erosion, subsurface flow, point sources, septic systems



UNMONITORED WATERSHED BUDGETS







EXTERNAL MASS BALANCE: DECISION POINTS

Focus today: changing lake level and tributary vs. DMR loads

2 Decision points:

1. Address changing lake level: assign lake boundary
2. For watersheds with WWTP, how to address DMR loads vs. tributary data?

PURPOSE OF EXTERNAL LOADING CALCULATIONS

- Loading estimates do not account for in-lake processes that impact the transformation of nutrients
  - Sediment uptake and release
  - Macrophyte uptake and senescence
  - Nitrification, denitrification, P binding
  - Biogeochemical impacts of wetting/drying
- Other studies & RFPs document the importance of changing lake level & sediments on nutrient conditions in Utah Lake

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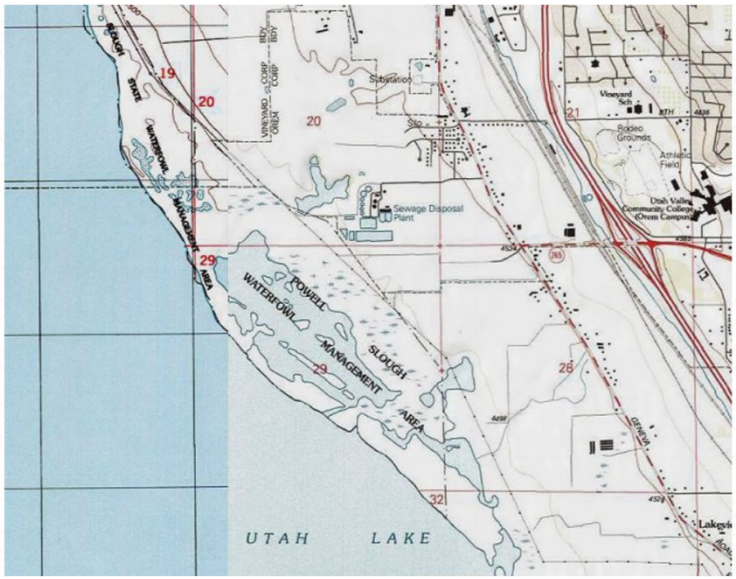
Scope of Work: Utah Lake Littoral Sediment Study

UTAH DEPARTMENT of ENVIRONMENTAL QUALITY
WATER QUALITY

Scope of Work: Utah Lake Sediment–Water Nutrient Interactions

ACCOUNTING FOR CHANGING LAKE LEVEL

- Utah Lake experiences substantial changes in elevation (2010-2020: 10 ft)
- Several wetlands around the lake have capacity to take up, release, and/or transform nutrients
- BUT how do we account for these areas if they are sometimes inundated with lake water?
- *Central question: What defines the lake boundary?*



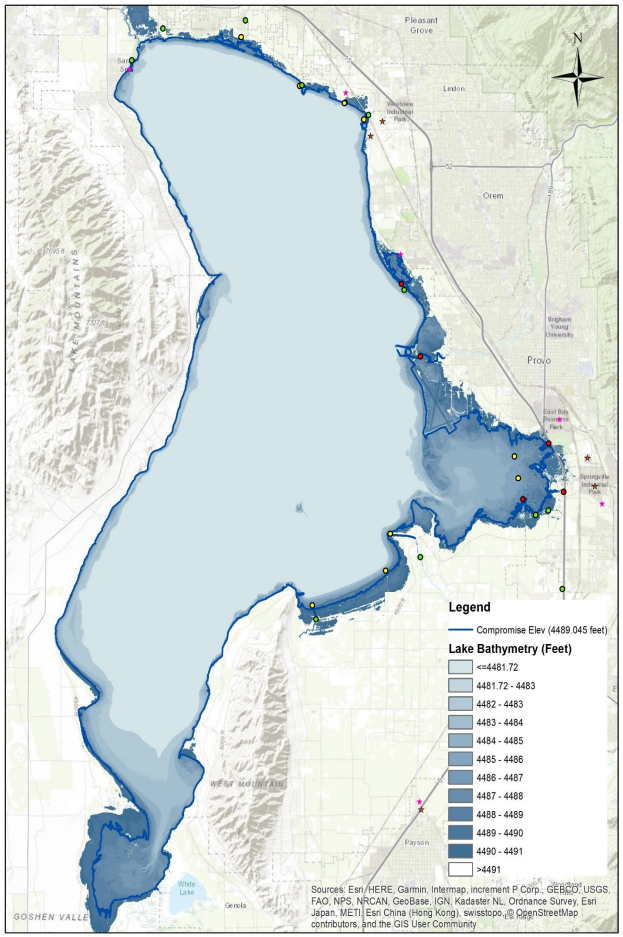
ACCOUNTING FOR CHANGING LAKE LEVEL

Study will generate average monthly loading from 2015-2020
→ need to designate a lake level across the period of record

Compromise elevation: 4489.045 ft

Year	Min Elevation (ft)	Max Elevation (ft)
2010	4,486.80	4,489.07
2011	4,488.15	**4,491.30**
2012	4,485.98	4,489.45
2013	4,485.16	4,488.11
2014	4,484.34	4,487.20
2015	4,483.12	4,485.81
2016	4,481.93	4,484.94
2017	4,482.77	4,486.71
2018	4,483.64	4,486.72
2019	4,484.50	4,488.66
2020	4,485.90	**4,489.05**
2010-2021	4,481.93	4,491.30

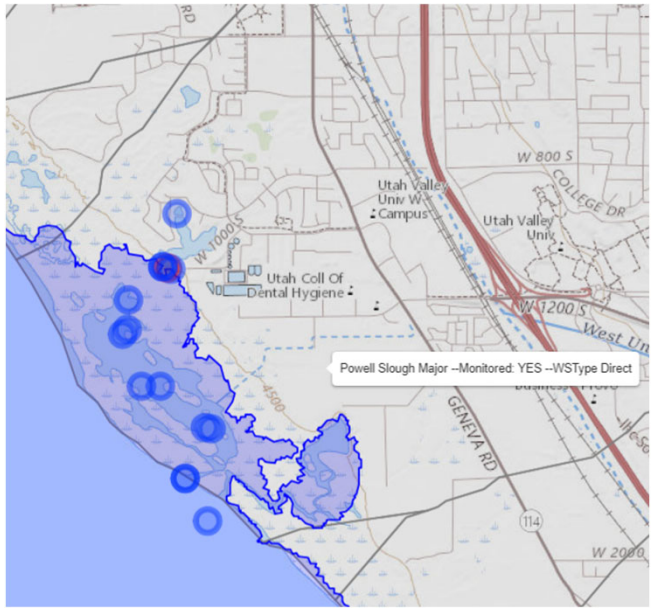
	Daily Exceedance Probability	
Lake Stage (ft)	2010 to 2020	2015 to 2020
4481	100.0%	100.0%
4482	99.7%	99.4%
4483	96.0%	92.7%
4484	89.0%	79.8%
4485	74.6%	60.2%
4486	57.0%	37.1%
4487	39.4%	21.1%
4488	26.5%	12.3%
4489	11.9%	0.4%
4489.045	9.3%	0.0%
4490	2.8%	0.0%

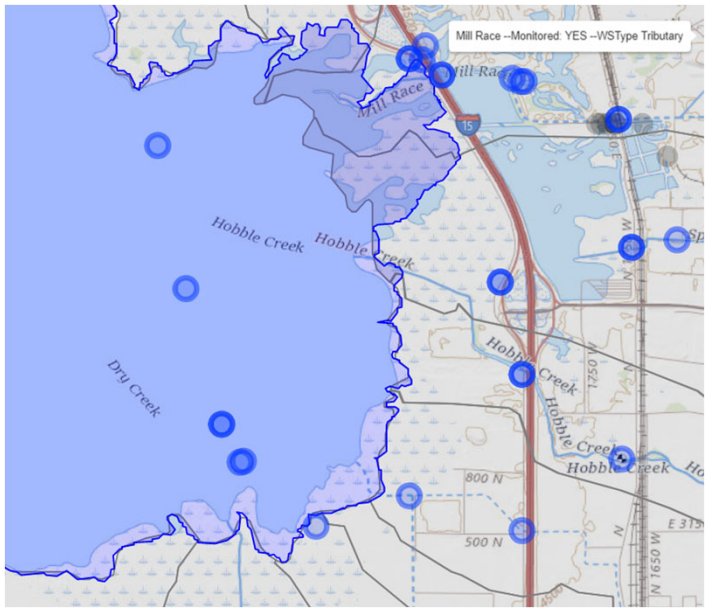


WATERSHEDS OF INTEREST

Powell Slough (left) and Mill Race (right)

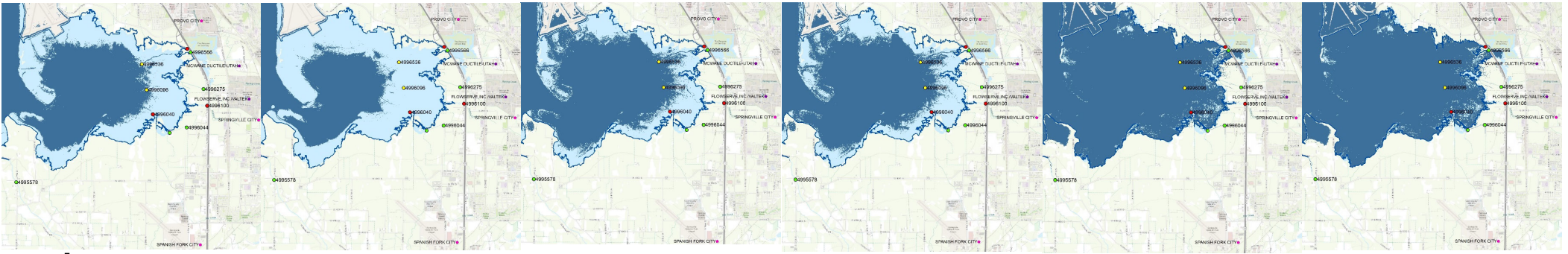
Downstream monitoring sites are below compromise elevation → limited data



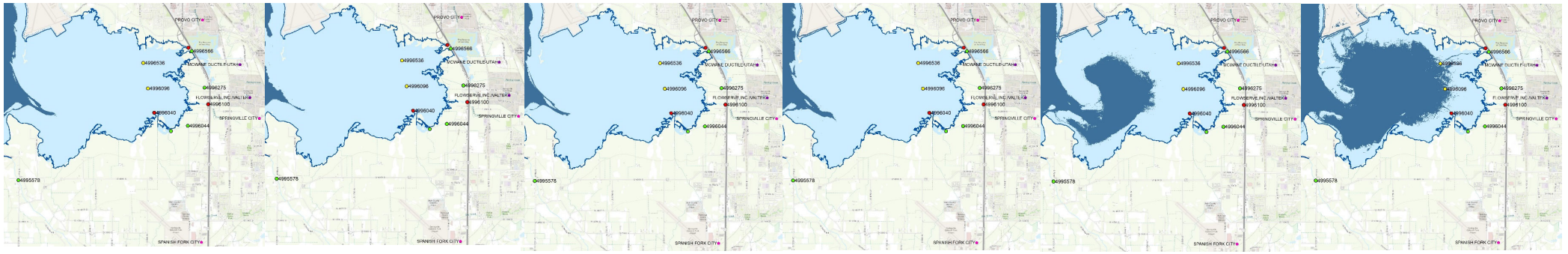


PROVO BAY: VARIATION IN ELEVATION

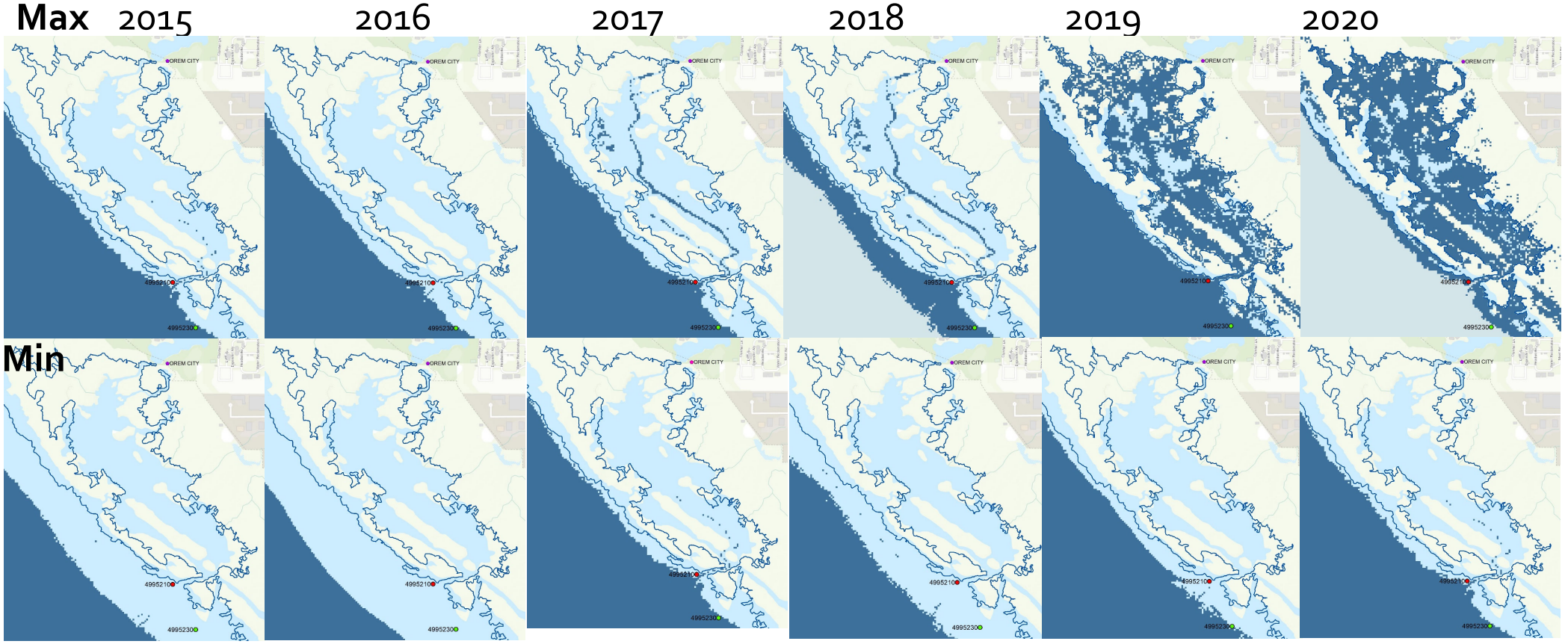
Max 2015 2016 2017 2018 2019 2020



Min



POWELL SLOUGH: VARIATION IN ELEVATION



Option A: compromise (high) elevation

"Any nutrients reaching sometimes inundated locations are considered load to the lake, regardless of processing that may happen at low lake level"

- Calculate load at a point directly upstream of compromise
- Would need to eliminate downstream sampling sites (DWQ & WFWQC)
- Would not account for any nutrient transformation occurring during non-inundated periods

Option B: low elevation

"Nutrients are only considered load to the lake if they reach an inundated location at the time of loading"

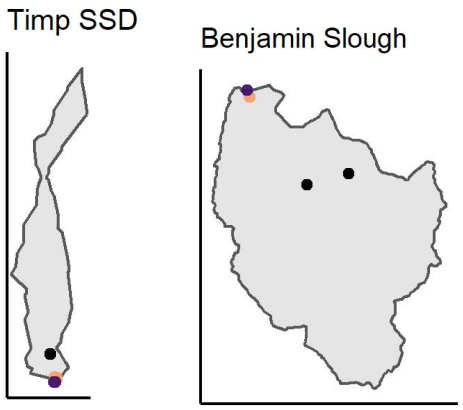
- Calculate loading at the most downstream location
- Limited data (sites not sampled when inundated)
- Loading would be biased toward times when lake is at low level

DECISION POINT: DMR AND TRIBUTARY MONITORING DATA

- WWTPs report outflow volume and nutrient loading (DMR) → can generate end-of-pipe load from WWTP
- Need to decide whether to generate loads from:
  - DMR reports
  - Tributary monitoring data
  - Mix of both

COMPARISONS OF FLOW: MONITORED SITES AND DMR REPORTS

Monitored flows > DMR flows when WWTP is farther from the lake monitoring site



Watershed	Annual Flow – Monitored (ac*ft/yr)	Annual Flow – DMR (ac*ft/yr)	Percent
Timp SSD (*Timpanogos*)	21,658	20,939	96.7%
Powell Slough Major (*Orem*)	19,538*	9,404	48.1%*
Mill Race (*Provo*)	15,240	12,690	83.3%
Spring Creek – Springville (*Springville*)	7,259	3,977	54.7%
Dry Creek – Spanish Fork (*Spanish Fork*)	15,790	4,603	29.2%
Benjamin Slough (*Payson, Salem*)	15,007	5,155	34.3%

* Generated from limited downstream data

Option A: tributary data

Incorporates both wastewater and natural loads

Estimated loads lower than or equivalent to option B

Option B: DMR data

Incorporates only wastewater loads

Upstream tributary monitoring data is limited → natural loads difficult to quantify

Estimated loads higher than or equivalent to option A

Option C: mix of tributary and DMR data

Use DMR data when WWTP is near tributary outflow

- Timp SSD
- Powell Slough
- Mill Race

Use tributary data when WWTP is far from tributary outflow

- Spring Creek – Springville
- Dry Creek – Spanish Fork
- Benjamin Slough