Lake Elsinore and Canyon Lake Nutrient TMDL Revision

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Project Kick-Off and General Approach

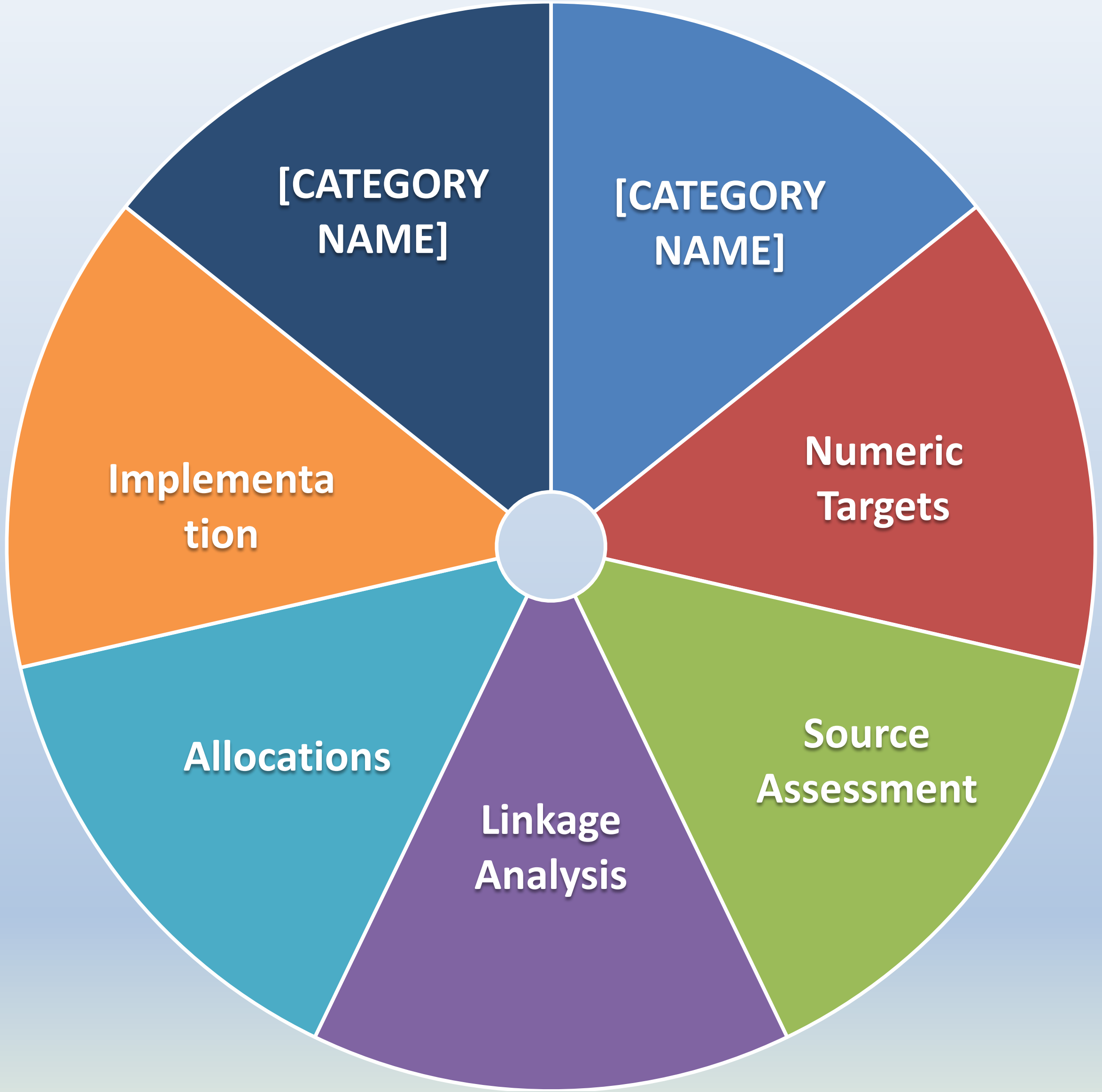
January 13, 2016

LE/CL Nutrient TMDL Task Force Meeting

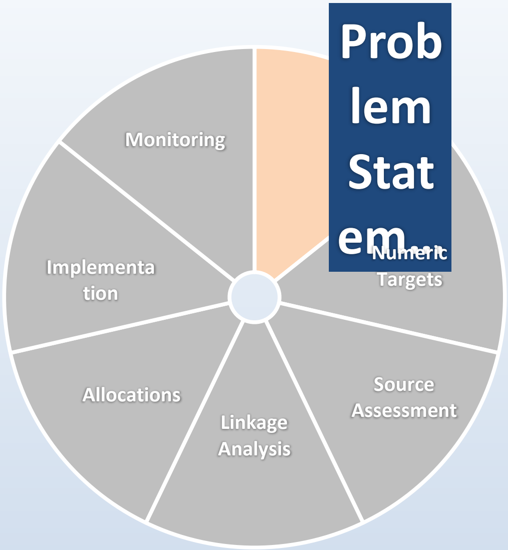
CDM Smith

Elements of TMDL Revision

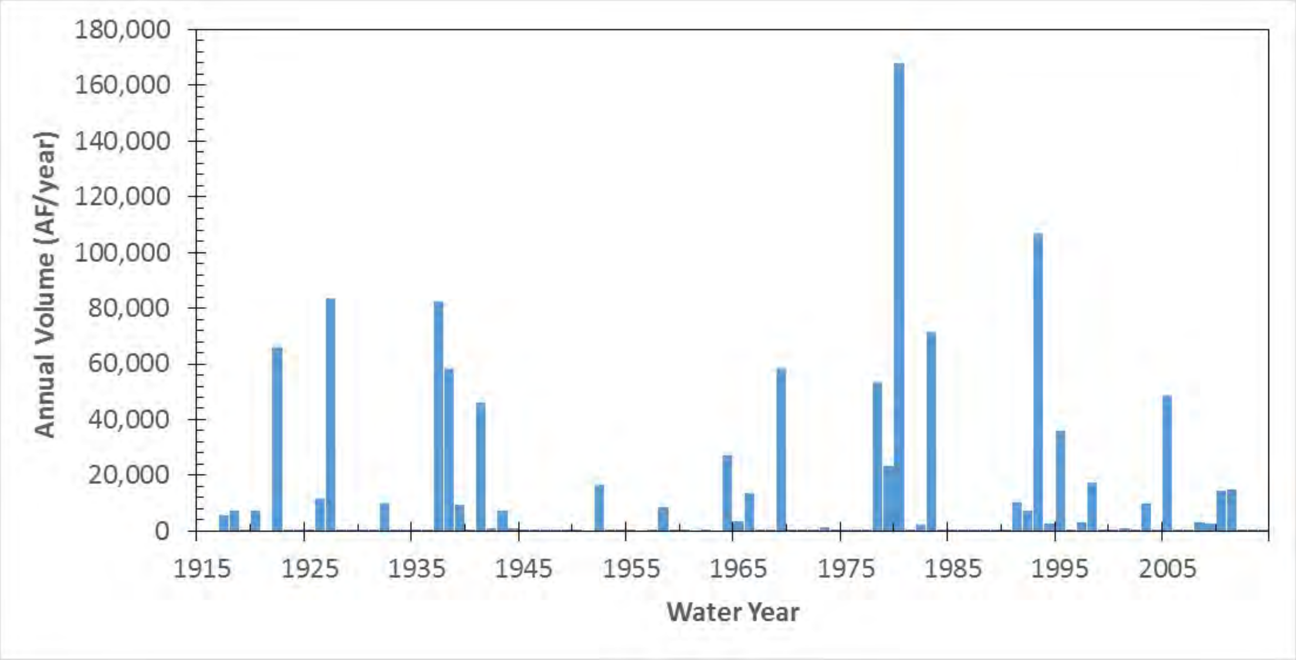
- EPA guidance on TMDL development
- TMDL chapter aligned to seven key elements
- Tasks in revision organized by element



Problem Statement

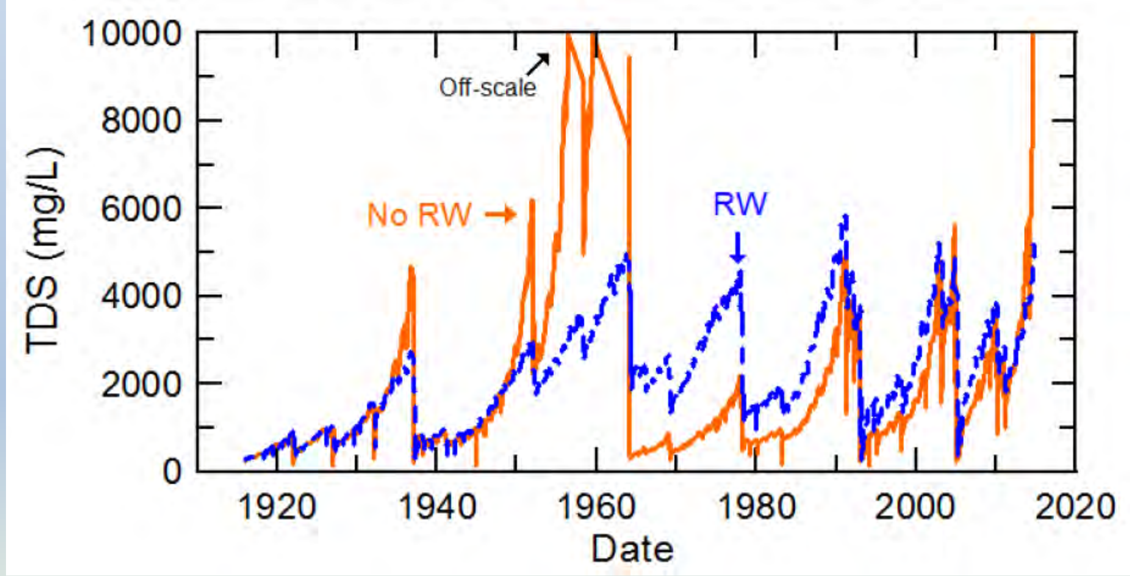


- **Hydrologic trends that have variability over decadal timescales**

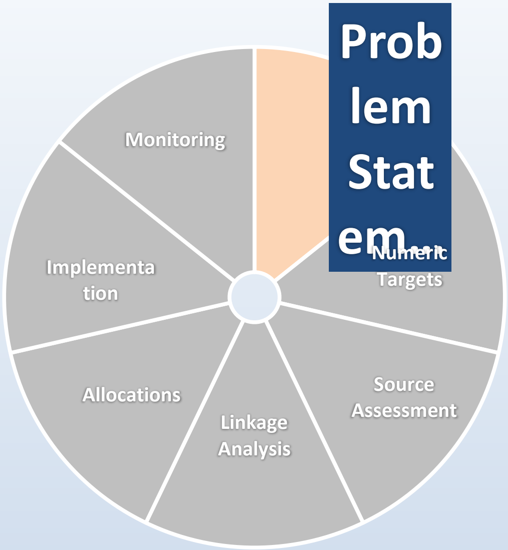


Annual runoff volume in San Jacinto River near Elsinore

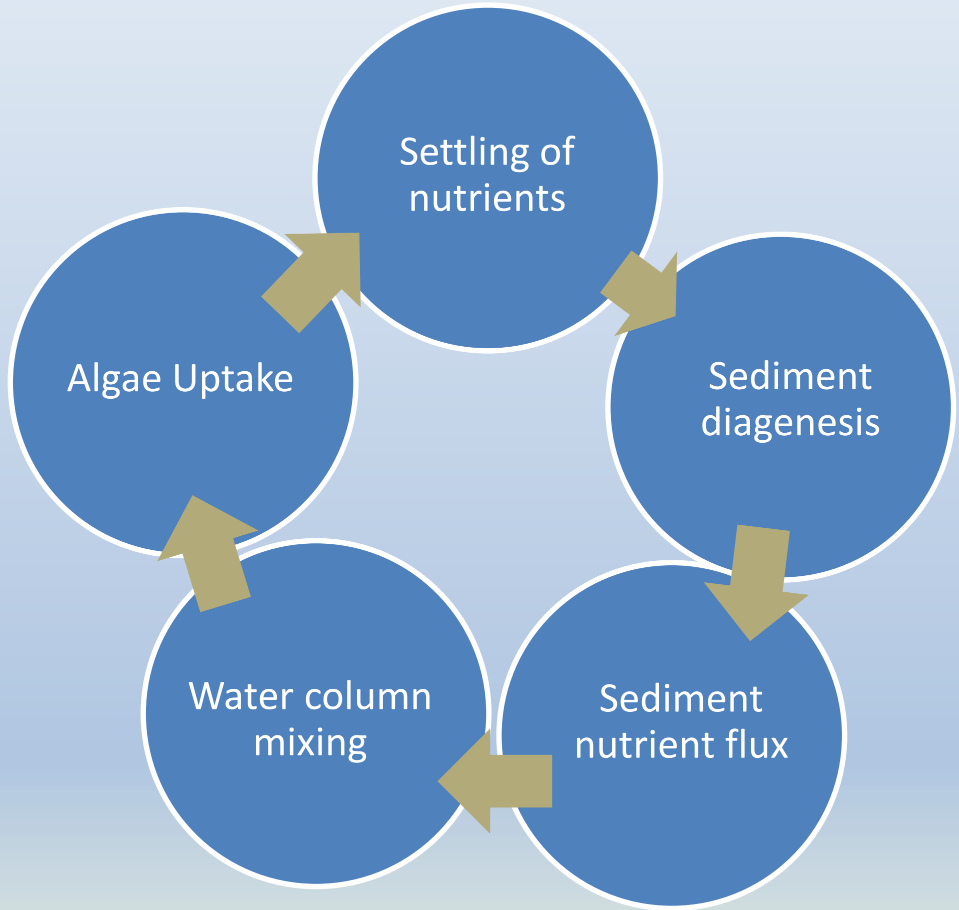
TDS in Lake Elsinore from DYRESM-CAEDYM

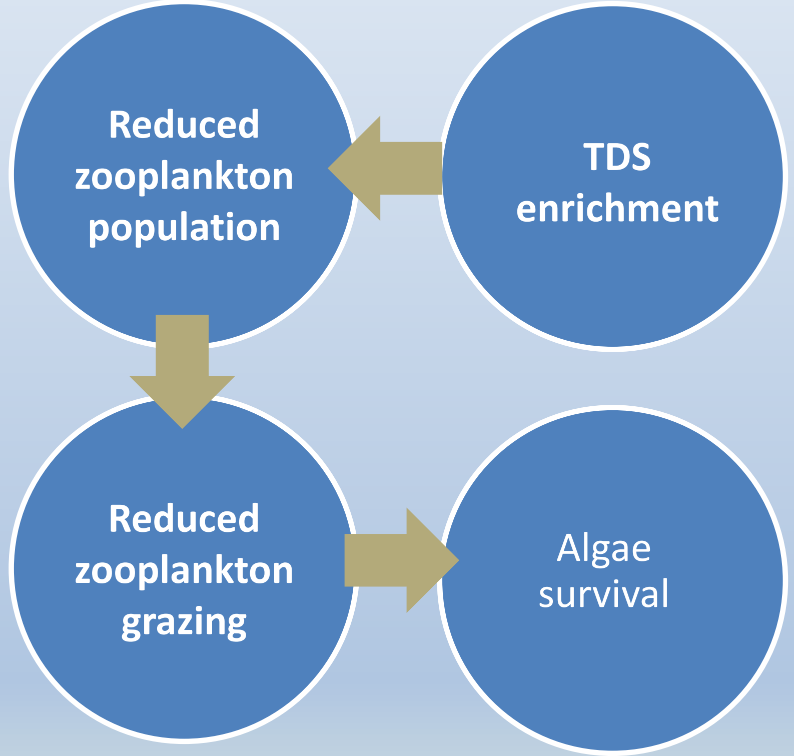


Problem Statement



- **Bottom up and top down controls on bioavailable nutrients**

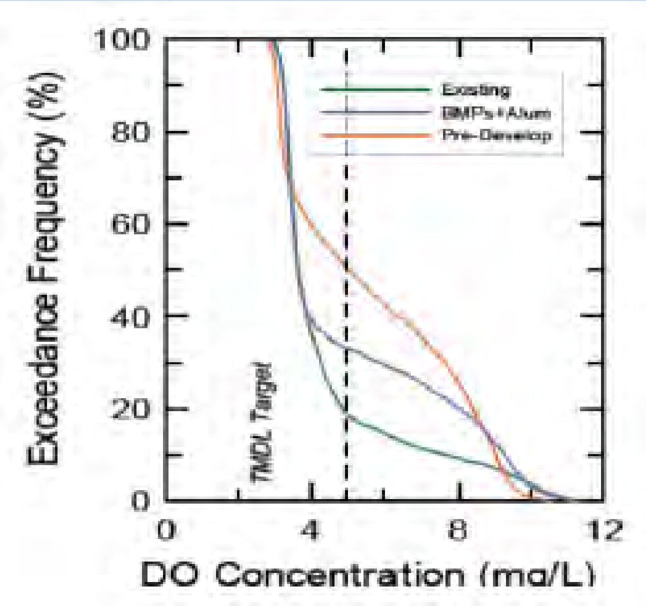




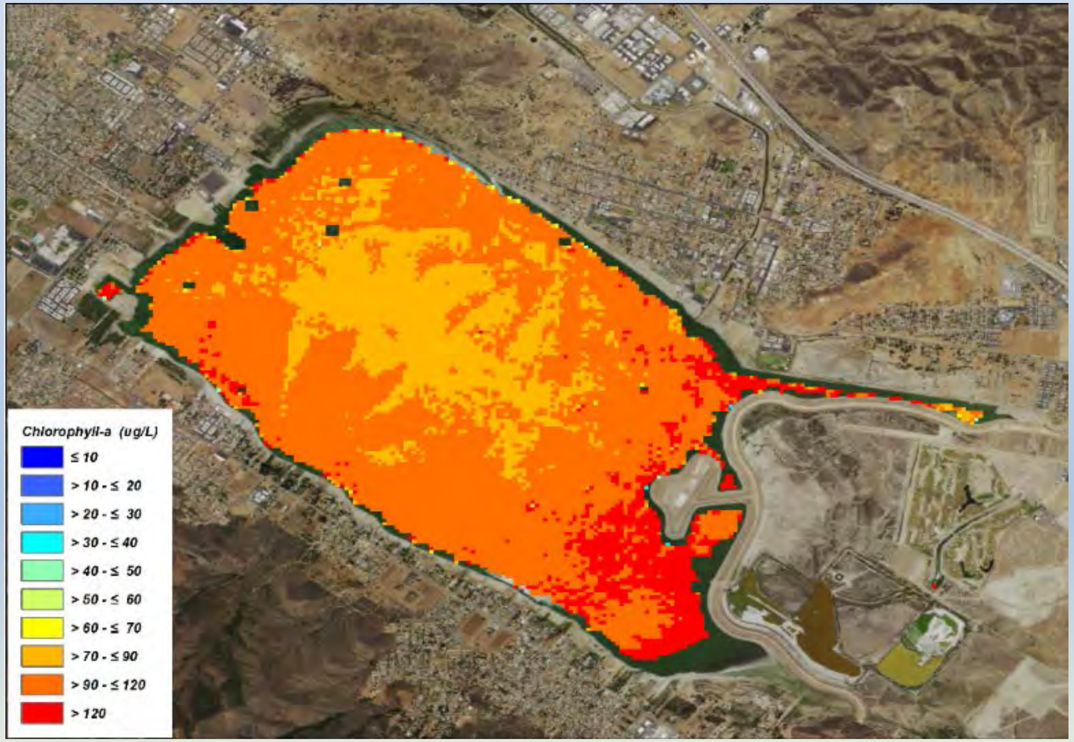
Element of TMDL Revision

- **Prescriptive methods to compute response targets for Chl-a, DO, and ammonia toxicity that consider natural variability**
  - **Spatially (laterally and vertically)**
  - **Temporal (daily, seasonal, annual, decadal)**

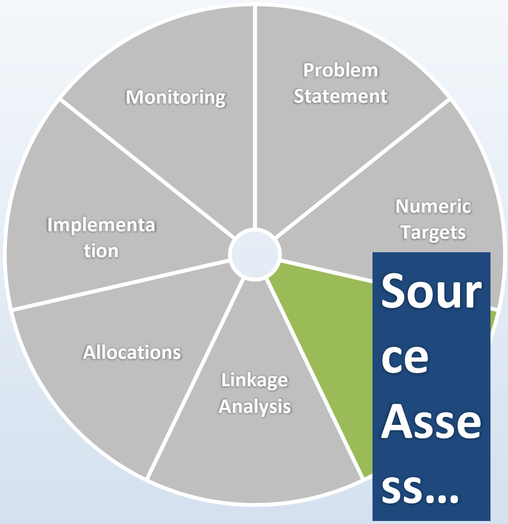
Fish-eye perspective



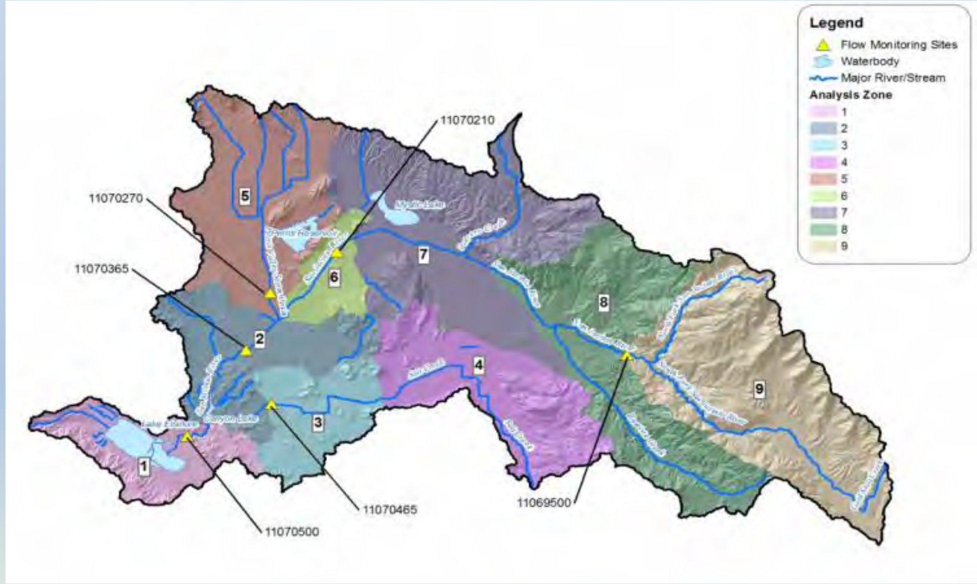
Frequency based temporal metrics



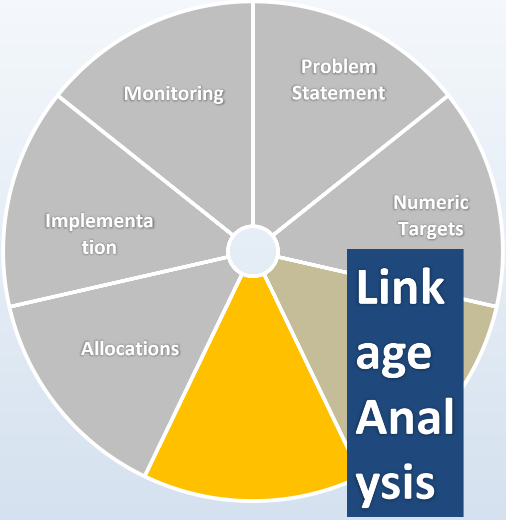
Source Assessment



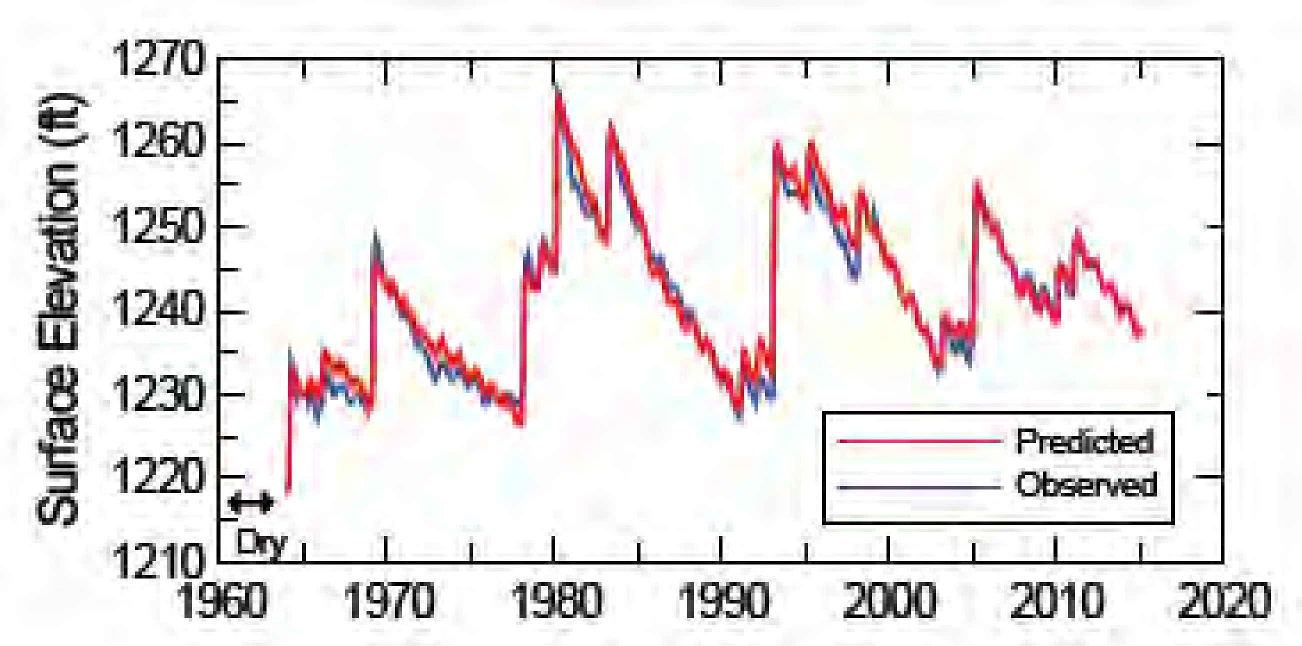
- Watershed model update
  - 2014 land use data
  - Self-retaining areas
  - Nutrient attenuation between sources and lakes
  - Undeveloped land soil erosion



Linkage Analysis

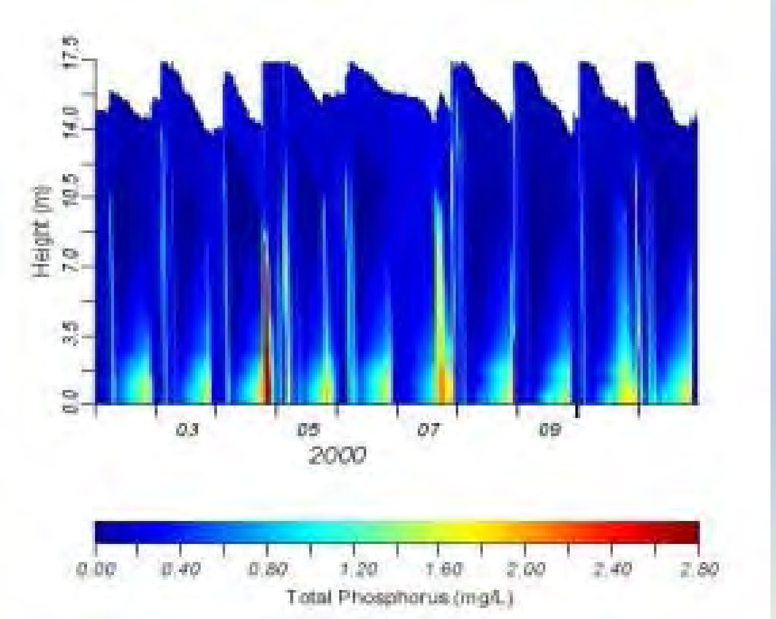


- Existing CAEDYM model developed by UC Riverside
  - Recent study data to parameterize internal loading
  - Updated watershed loading inputs
  - Separate East Bay and Main Lake of Canyon Lake

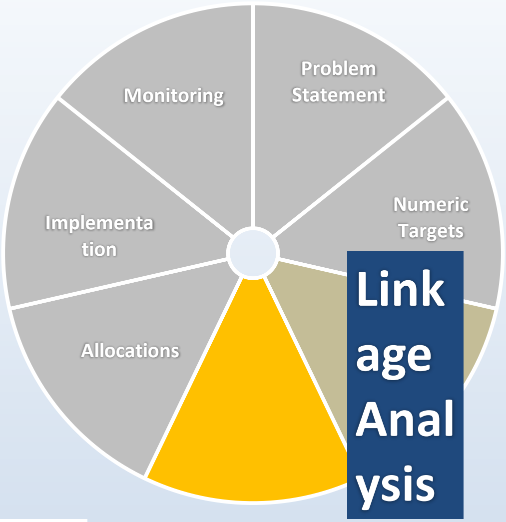


Lake Elsinore water level calibration

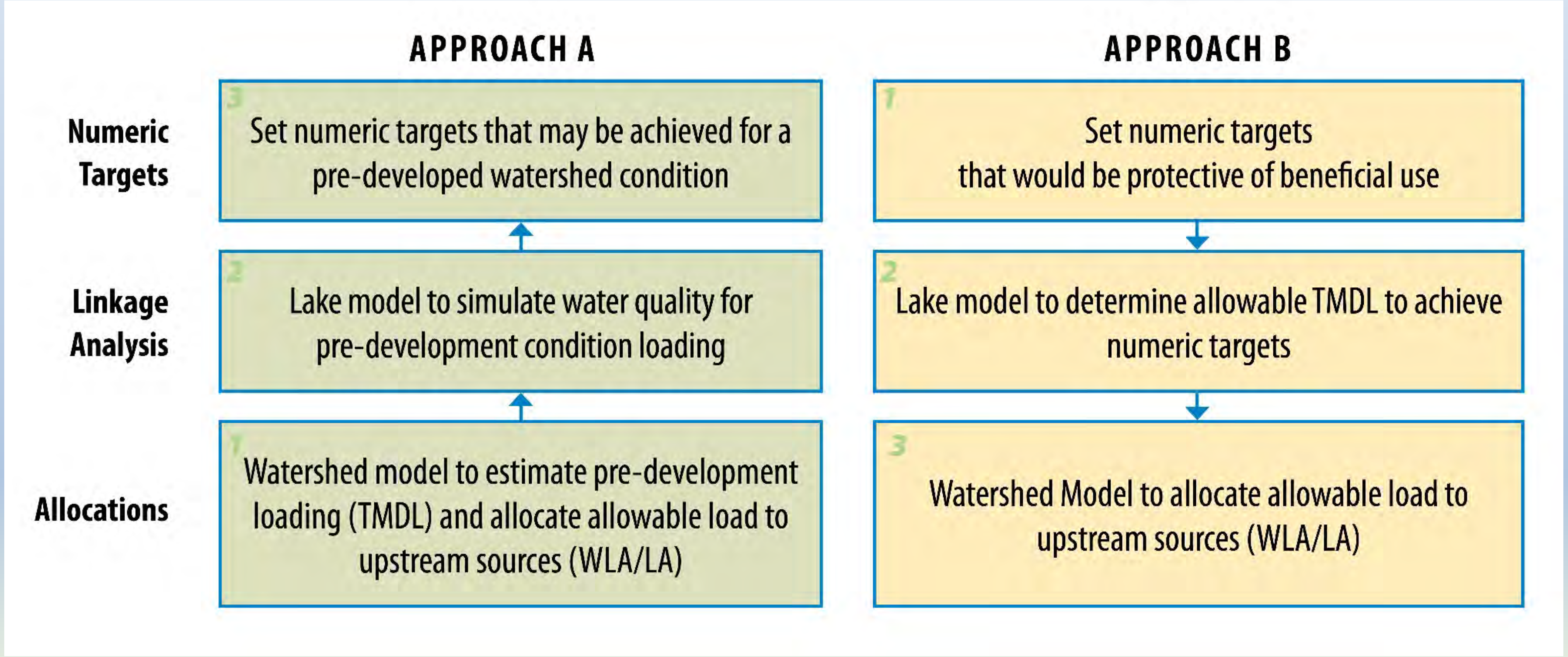
Canyon Lake
Depth Integrated TP



Linkage Analysis



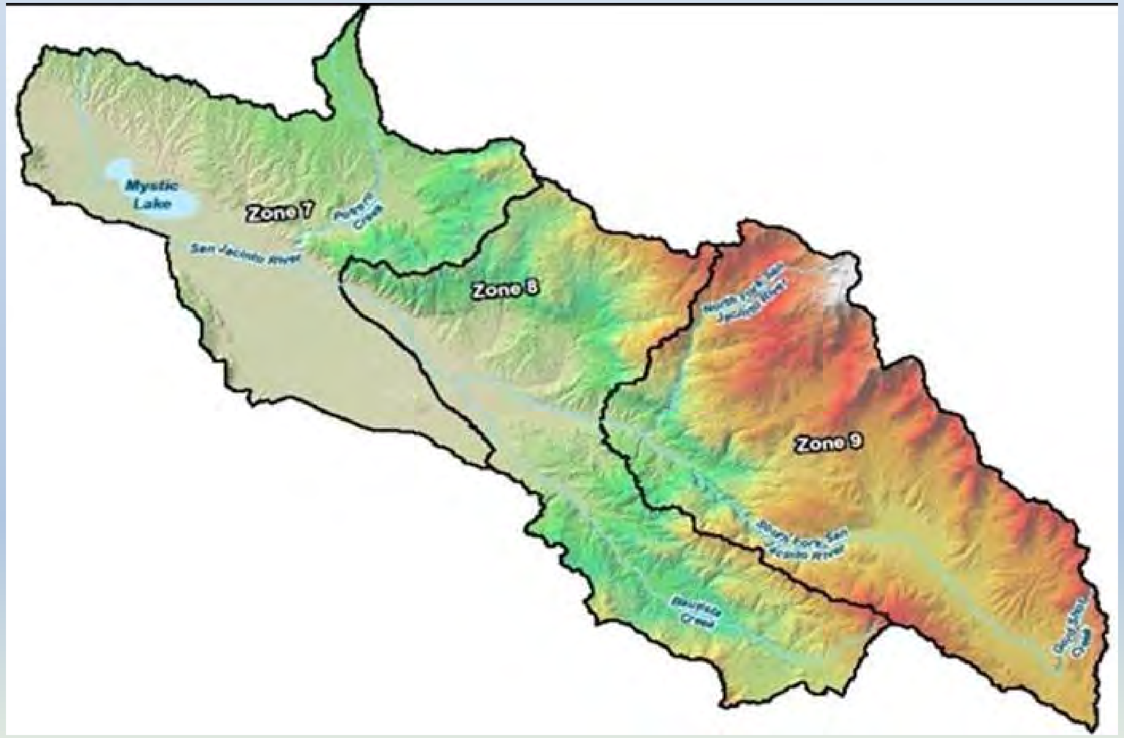
- **Two approaches for numeric target that affect linkage analysis**



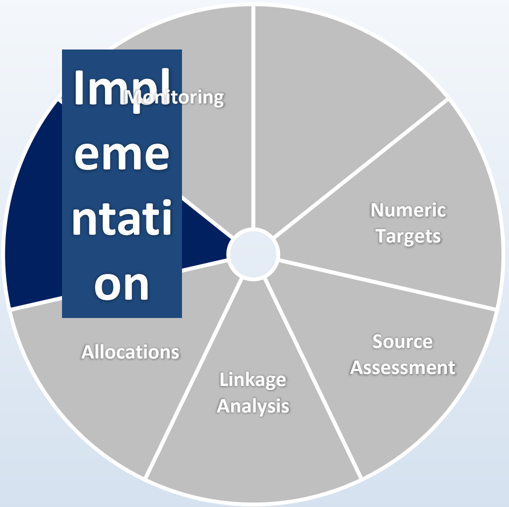
Allocations

- **Watershed model to allocate allowable external loads to sources**
  - **Lake Elsinore**
  - **Canyon Lake East Bay (Salt Creek)**
  - **Canyon Lake Main Lake (San Jacinto River)**
- **Jurisdictional loads reaching lakes for use in estimating offset demands**

Distinct approach to develop allocations for lands upstream of Mystic Lake

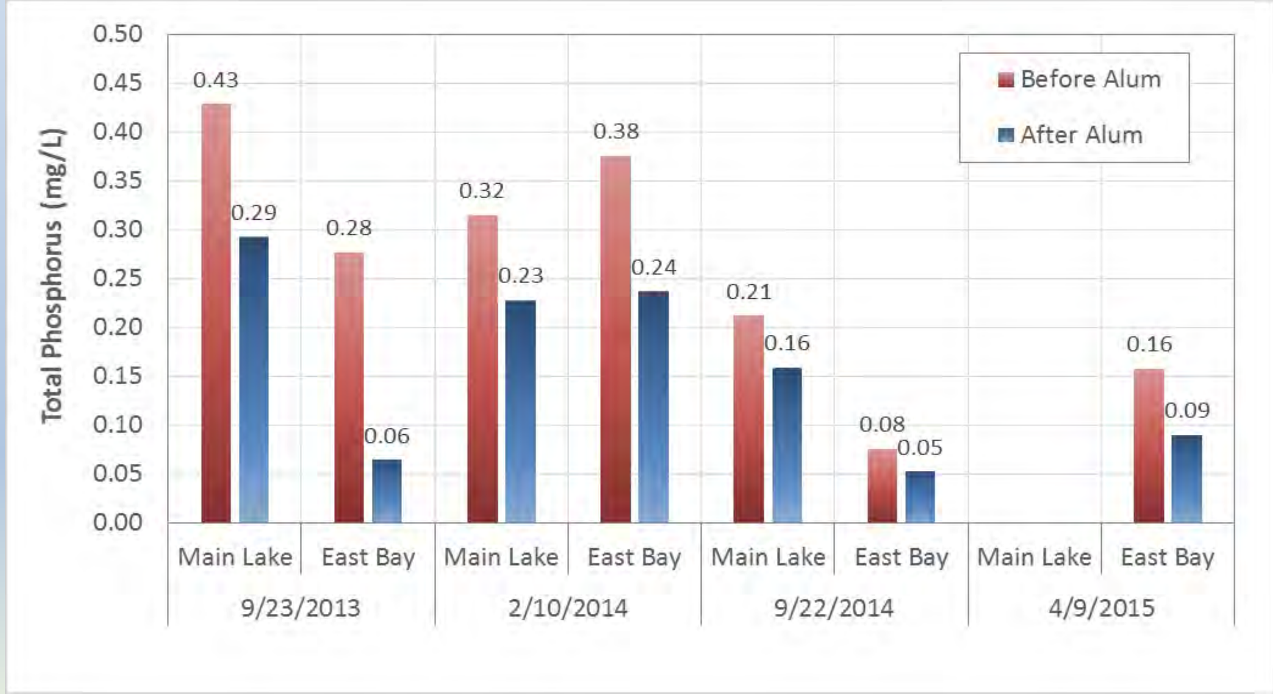


Implementation

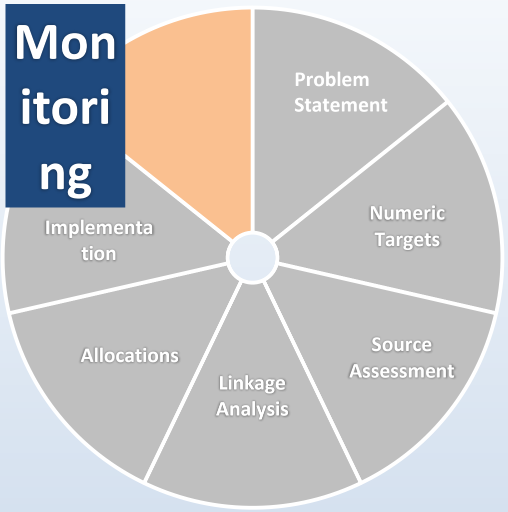


- **Modeling to assess need for existing BMP modification or supplemental projects**
- **Offset programs for multi- stakeholder participation in regional BMPs**
- **Develop supporting documentation**
  - **CEQA checklist / SED**
  - **Economic Analysis**
  - **Administrative Record**

Review effectiveness of existing watershed and in-lake BMPs



Monitoring



- Compliance assessment for a revised TMDL may require changes to the existing monitoring program
- Special studies to assess implementation effectiveness
  - Control of watershed sources
  - Lake bottom sediment nutrients
  - Biomanipulation

Coordinate TMDL monitoring recommendations with current program

Questions

Long-Term Water Quality Simulations for Lake Elsinore: Pre-Development Condition and Effects of Supplementation with Recycled Water (v.3)

Michael Anderson

UC Riverside

Objectives

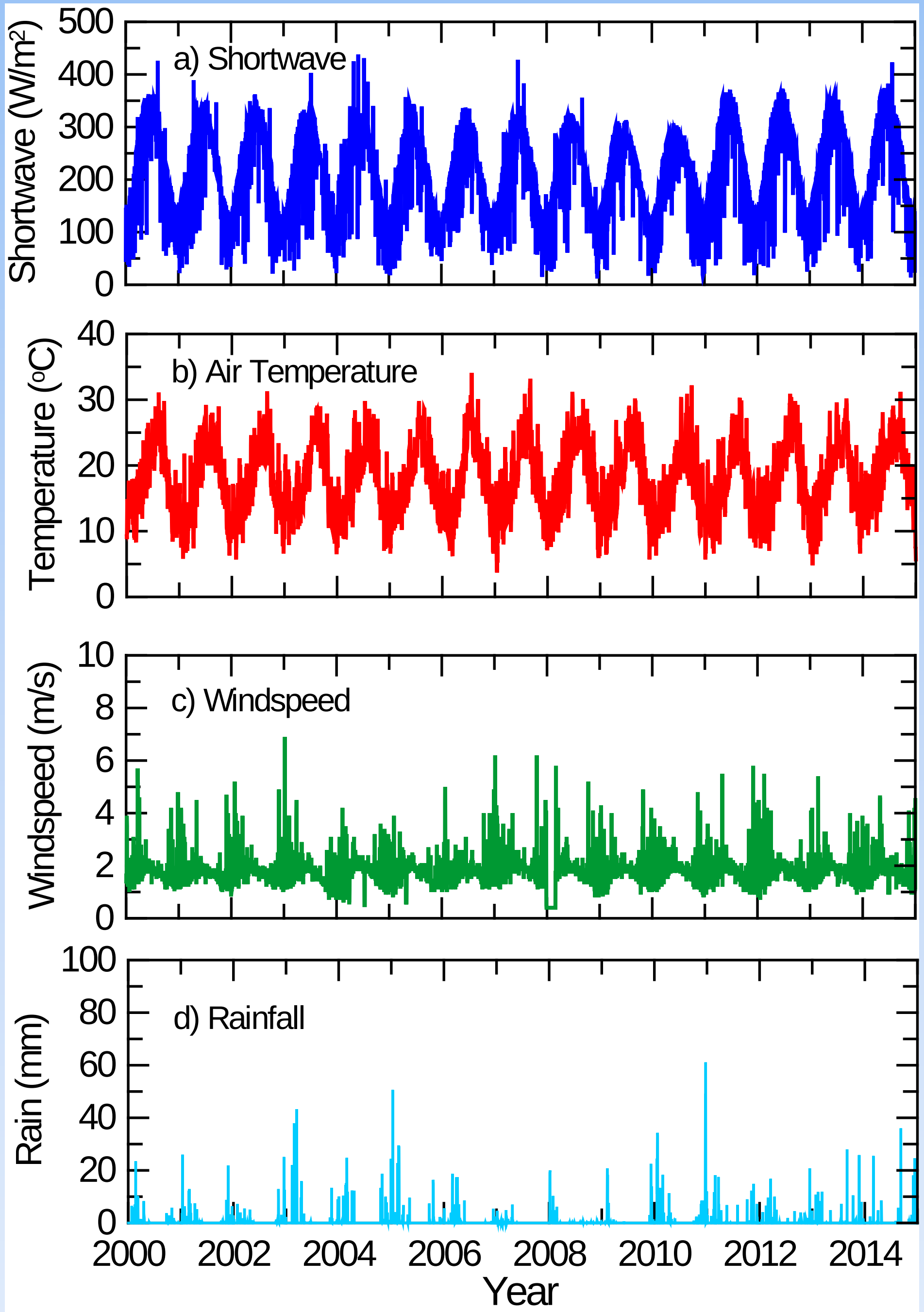
- Evaluate water quality under pre-development and selected management conditions

Approach

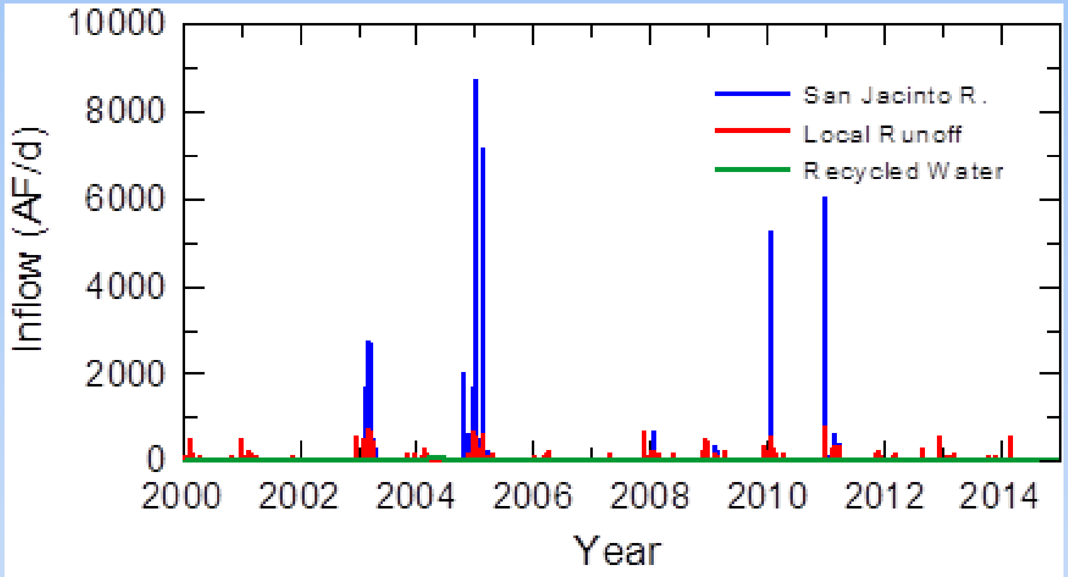
- Extend previously developed DYRESM (Dynamic Reservoir Simulation Model) that quantified water budget and provides 1-D hydrodynamic/thermodynamic/salinity predictions
- CAEDYM (Computational Aquatic Ecosystem Dynamics Model) was linked to DYRESM model to predict water quality and ecological properties of lake
- Model was calibrated for 2000-2014 period
- Simulations were conducted for 1916-2014 using LEMP basin and available meteorological and runoff data for this time period

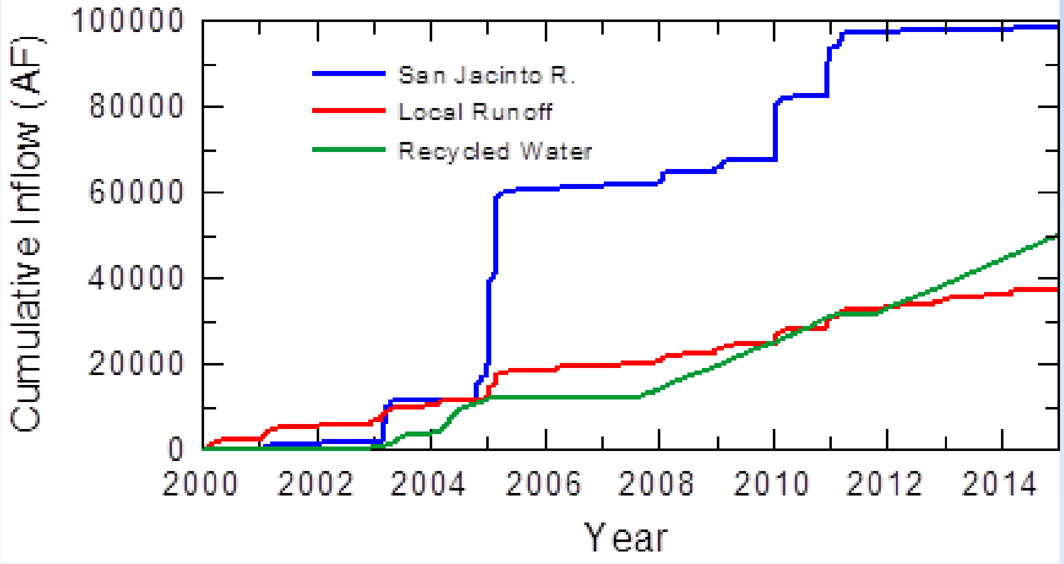
Calibration (2000-2014)

- Meteorological demonstrated predictable seasonal trends
- Daily average shortwave (300-3000 nm) radiation ranged from ~50 W/m^2 in winter to 350 W/m^2 in summer
- Daily average air temperature varied from 10°C in winter to 30° C in summer
- Average windspeeds were typically 2-4 m/s
- Daily rainfall was highly variable, from 0 – 60 mm/d



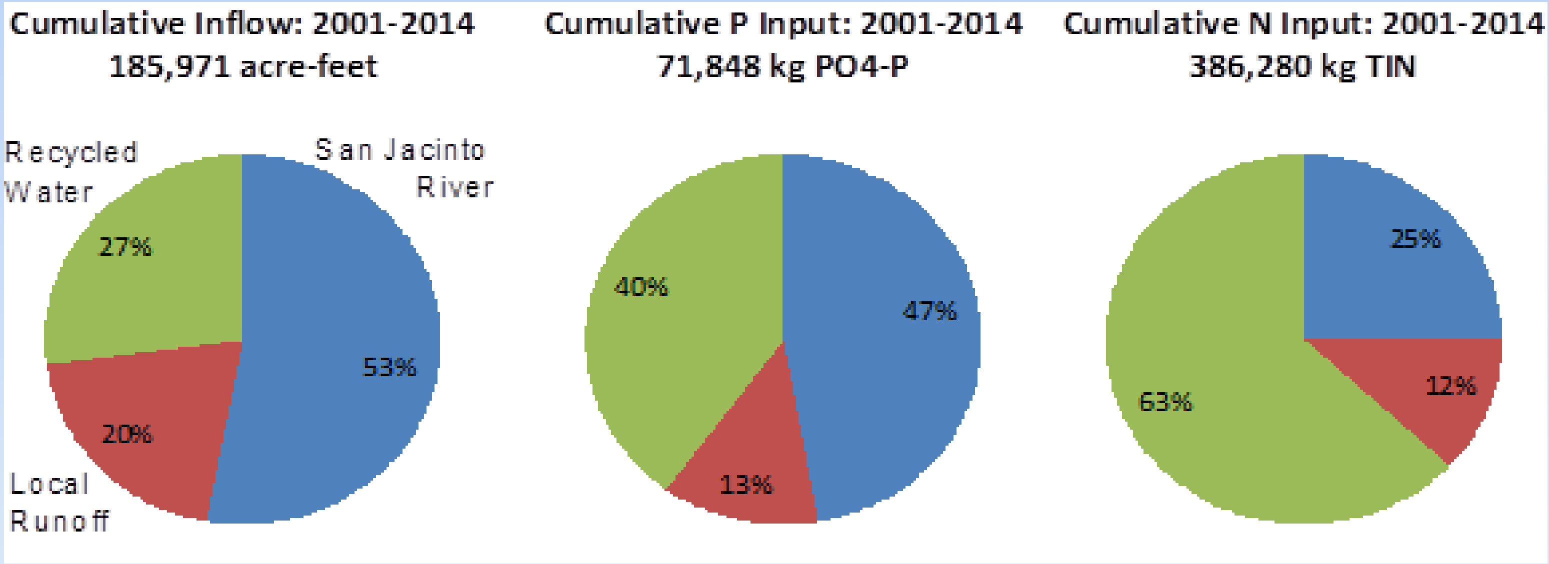
- Inflows to Lake Elsinore included San Jacinto River flows, local runoff and recycled water





- Average mutrient concentrations in inflows taken from available data

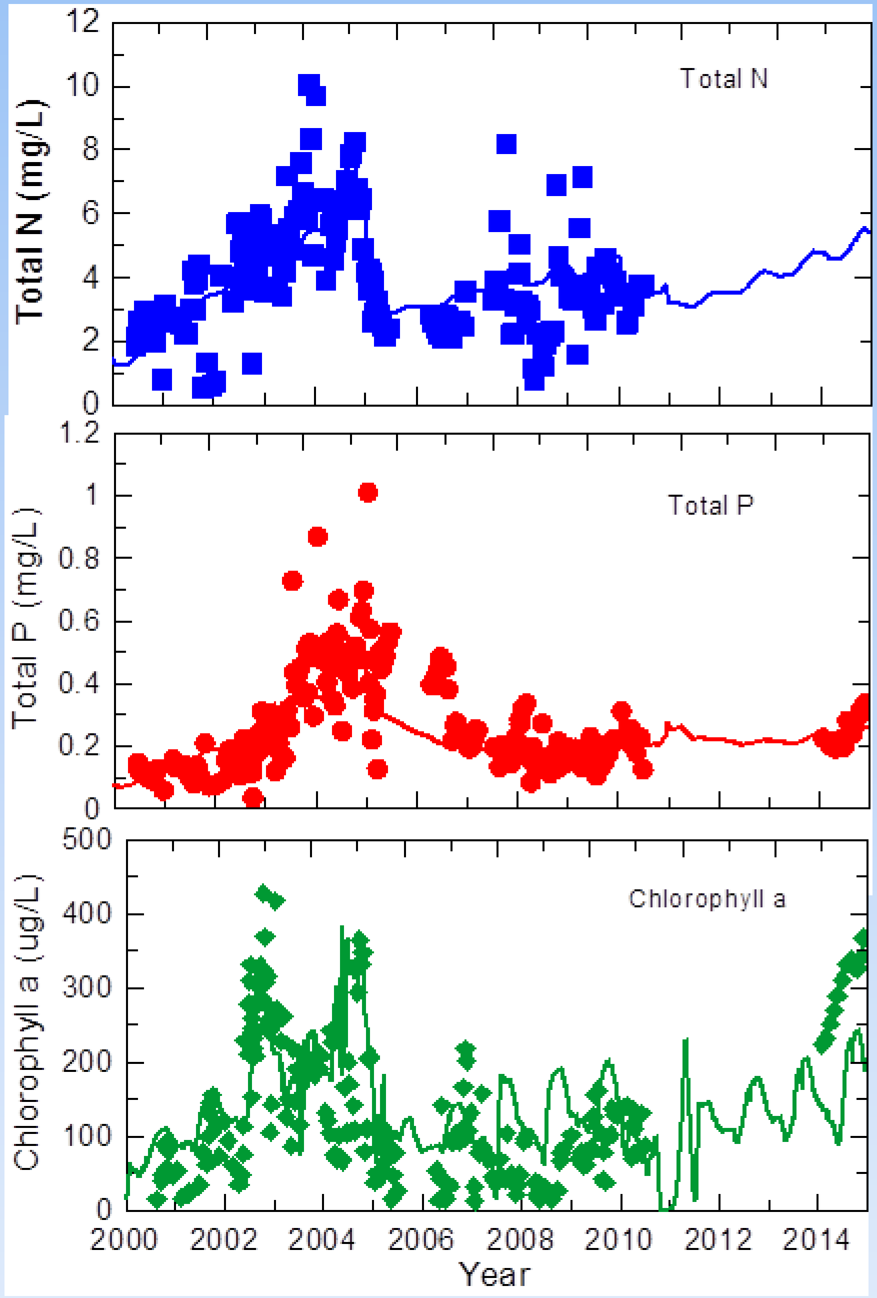
Source	TDS (mg/L)	PO_4-P (mg/L)	Total P (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)	Total N (mg/L)
San Jacinto R	310	0.28	0.50	0.22	0.57	1.62
Local Runoff	150	0.20	0.48	0.22	0.80	1.82
Recycled H_2O	705	0.32	0.41	0.36	1.62	2.87



High fraction of TN due in part to high concs in EMWD flows added in 2003

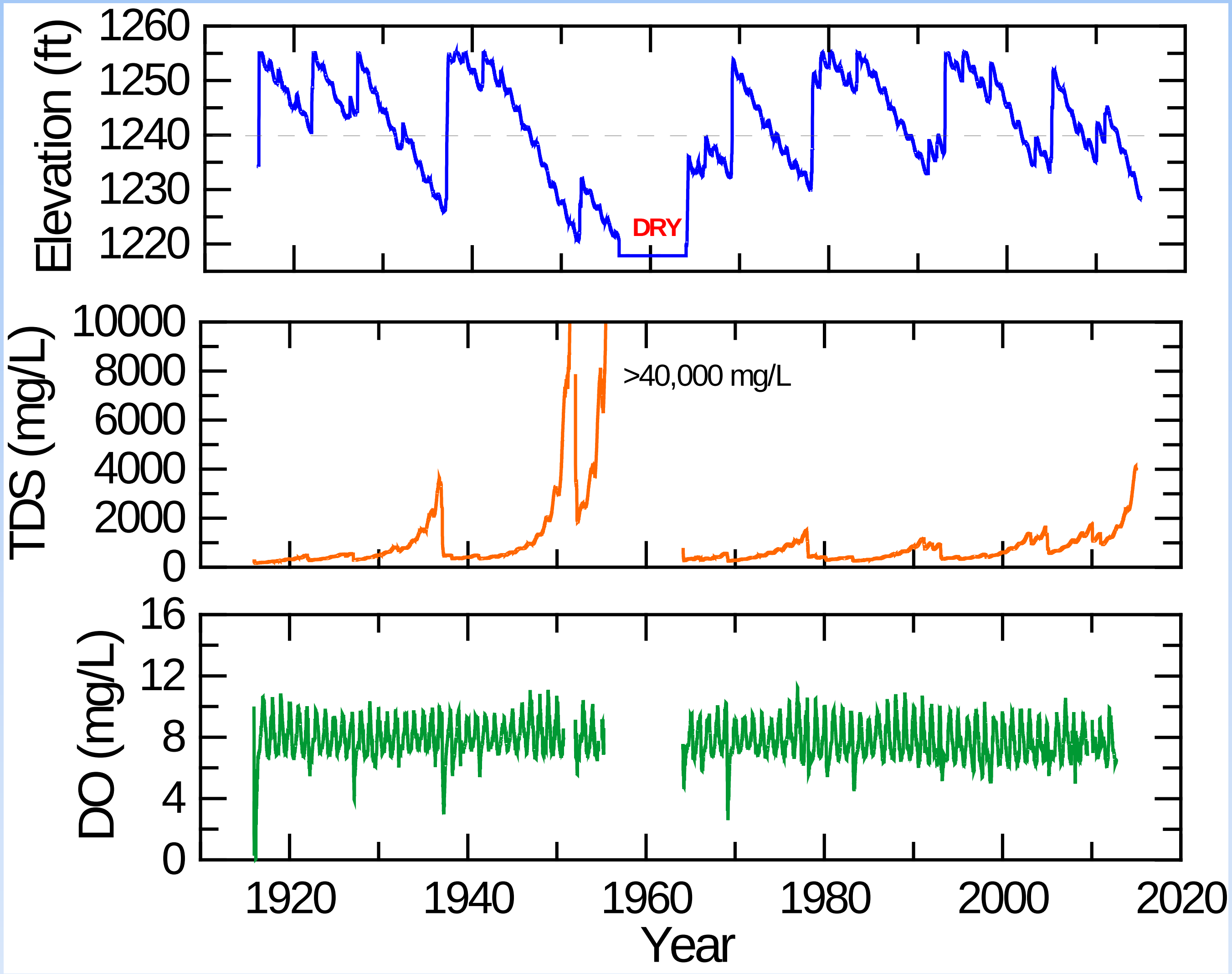
- The model reproduced general observed trends in total N concentrations
  - Increased concentration from 2000-2004
  - Marked reduction in 2005
  - Subsequent increase in 2008-2010
- Model reasonably reproduced most features in total P concentrations
  - Predicted peak concentration of 0.6 mg/L in late 2004 before declining to values of 0.2-0.3 mg/L later
- Model also better captured seasonal and interannual variation in chlorophyll a concentrations
  - Increase from 2000 to 2004 followed by subsequent decline
  - peaks in chlorophyll in late 2002, 2004

Mean predicted and observed values			
	Observed	Predicted	% Error
Total N	3.98	3.88	-2.5
Total P	0.265	0.235	-11.3
Chl a	130	137	+5.4



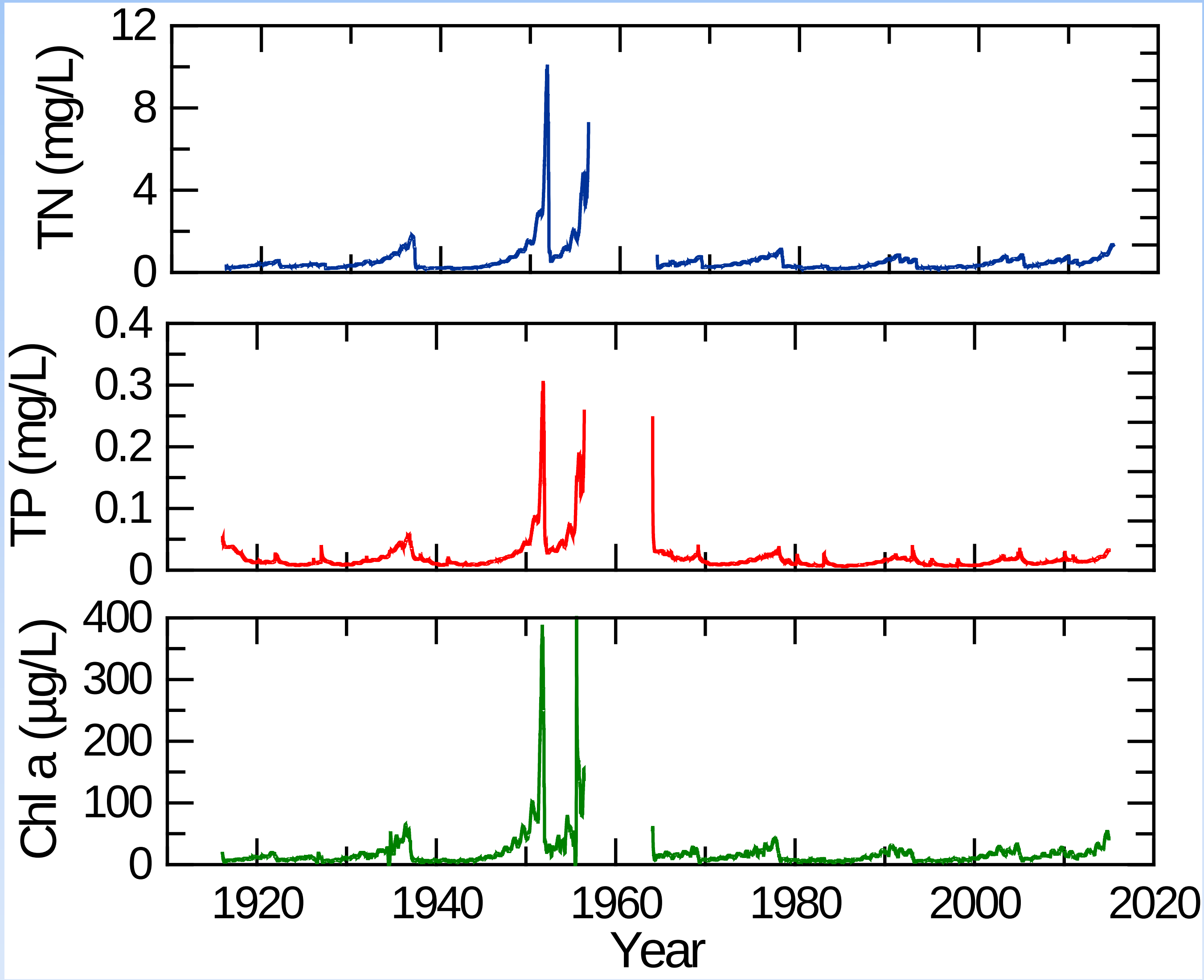
RESULTS
Pre-Development

- Lake goes dry
- Salinity reaches brine levels (assuming 50% reduction in salt load to current)
- DO concs follow Henry's Law, with little biological inputs or losses



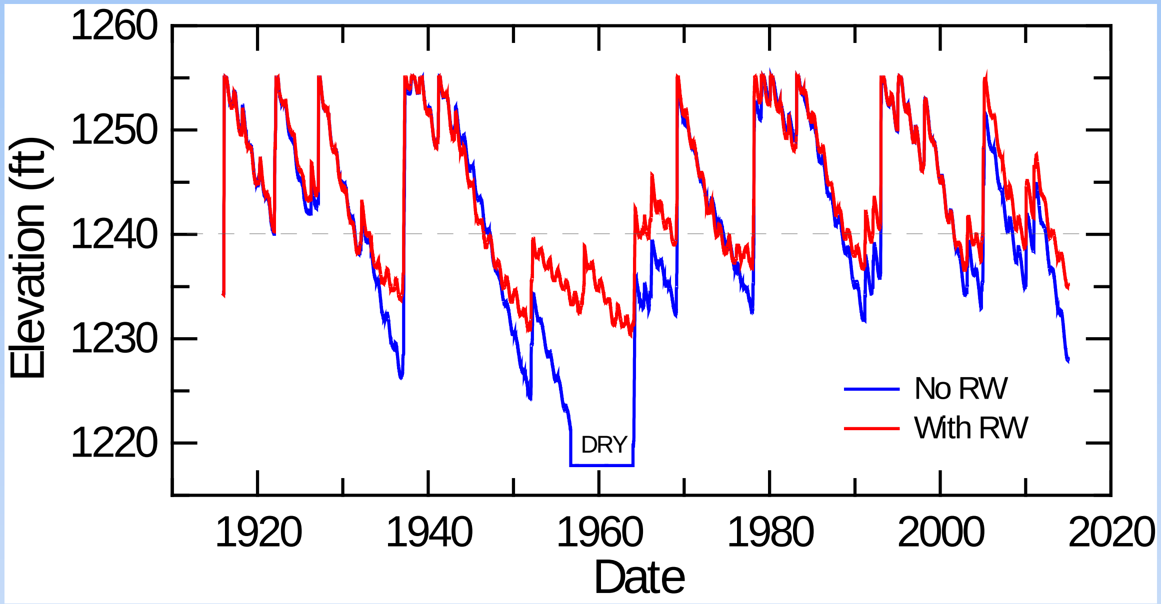
Pre-Development (cont'd)

- Median TN is 0.4 mg/L; reaches >10 mg/L in 1950s
- Median TP is 0.014 mg/L; reaches >0.3 mg/L in 1950s
- Median chl a is 12 µg/L; reaches 400 µg/L in 1950s



Current Conditions & Recycled Water Supplementation

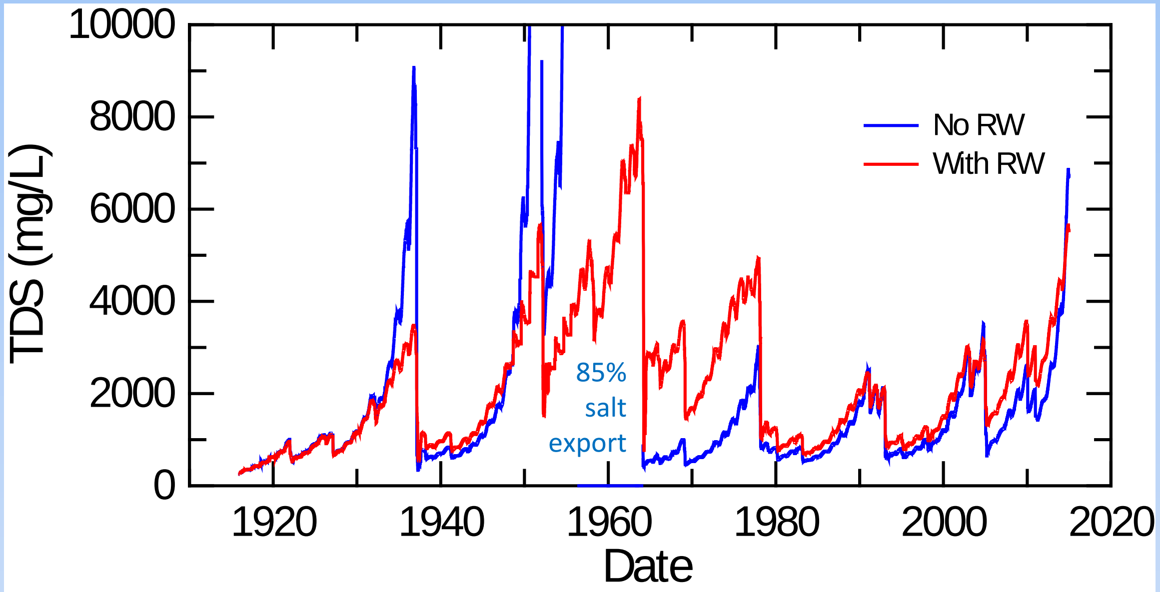
Lake Level



- Lake level varied strongly in response to rainfall and runoff
- As previously noted, lake goes dry for a number of years in late 1950s - early 1960s without recycled water supplementation
- Recycled water additions maintain lake level above ~1232’ in this simulation

Current Conditions & Recycled Water Supplementation (cont'd)

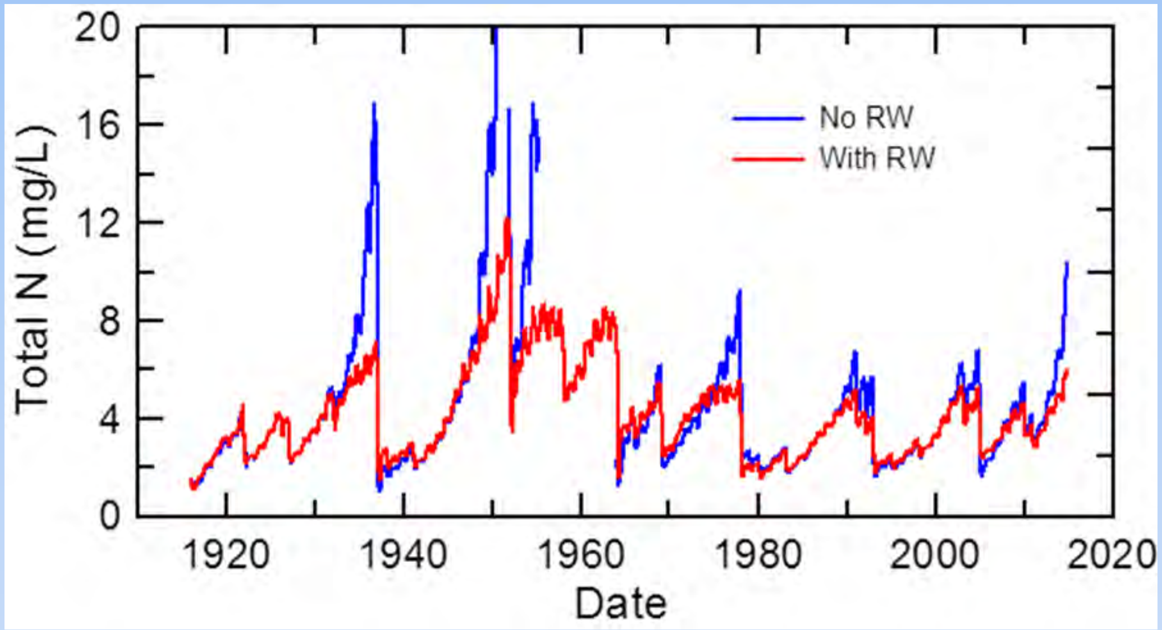
Salinity



- Salinity concentrations without RW inputs varied in response to watershed inputs and evapoconcentration
- Input of RW maintains water in lake and prevents extreme TDS levels from developing (e.g, late 1930s and early 1950s)
- Flushing of salt out of lake during extreme runoff in 1978-79 normalized lake TDS levels with and without recycled water

Current Conditions & Recycled Water Supplementation (cont'd)

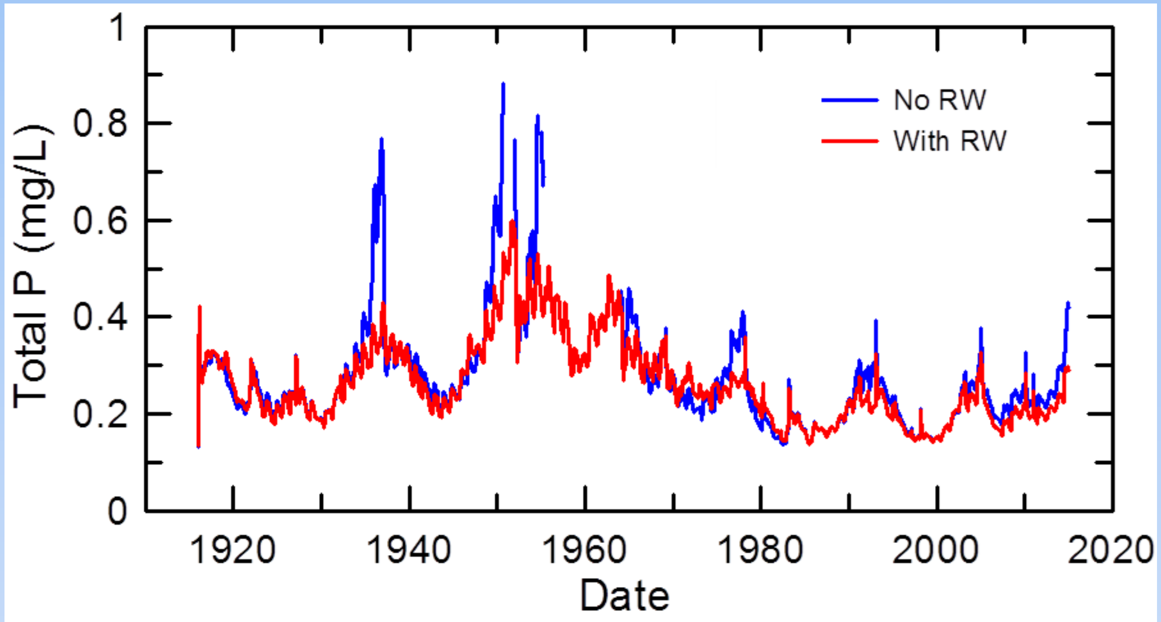
Total N



- Total N concentrations without RW inputs varied in response to watershed inputs and evapoconcentration
- Inputs of RW not predicted to markedly increase total N concentration in the lake, and in fact lowered concentration when lake level very low (and evapoconcentration high)

Current Conditions & Recycled Water Supplementation (cont'd)

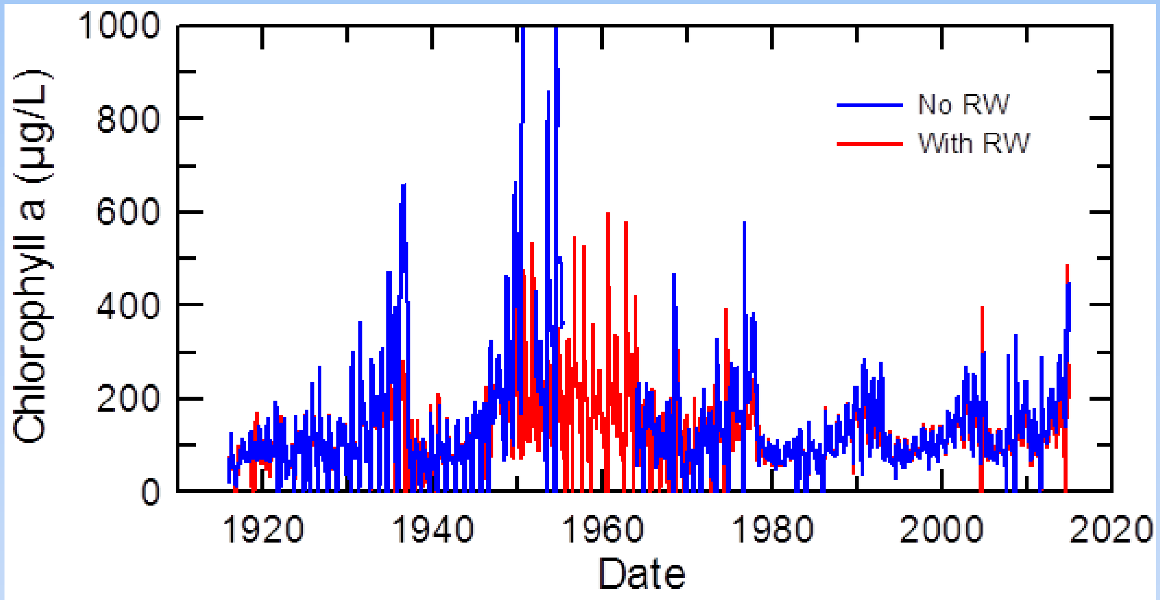
Total P



- Similar to total N, recycled water supplementation did not substantially alter predicted concentrations, and was predicted to *decrease* P concentrations relative to no RW inputs at low lake levels due to:
  - Dilution during periods of otherwise strong evapoconcentration
  - Evidence for incorporation into food web and subsequent settling
  - System predicted to return to values of 0.2-0.25 mg/L

Current Conditions & Recycled Water Supplementation (cont'd)

Chlorophyll a



- Predicted daily chlorophyll a concentrations varied dramatically over simulation period, with levels reaching 1000 μg/L during periods of very low lake levels
- Recycled water additions had little effect on chlorophyll a concentrations owing to similar nutrient levels as natural runoff

Mean Predicted Values: 1916-2014				
	Mean Concentration (mg/L or µg/L)			
	DO	Total N	Total P	Chl a
Pre-Development	7.77	0.59	0.02	19.0
Current/no RW	8.85	4.27	0.27	140
With RW	8.30	4.20	0.26	125
With RW+Aeration	9.03	4.01	0.24	125
With RW(0.1 PO_4)+Aer	9.02	4.01	0.23	125

- Pre-development conditions predicted to be mesotrophic
- Recycled water inputs *lowered* slightly the average DO, TN, TP and chlorophyll a concentrations in lake relative to no recycled water inputs
- Supplementation with recycled water coupled with aeration
  - increased mean DO level
  - decreased slightly TN and TP concentrations
  - did not affect average chlorophyll a levels
- Reduction of PO_4-P in recycled water to 0.1 mg/L was not predicted to alter (99-yr) average values; median and shorter intervals differ more

Conclusions

- Simulations provide improved insights into trophic state of lake prior to development and in response of lake to long-term recycled water inputs
- Supplementation with recycled water:
  - Had limited effect on mean DO concentration in lake, but increased range of average water column DO concentrations, with both increased supersaturation and greater episodes of anoxia
  - Had negligible effects on average total N and total P concentrations
  - Predicted to lower slightly chlorophyll a concentrations
- Overall, model predictions do not indicate marked effects on water quality resulting from periodic inputs of recycled water to help maintain lake level
- Wrapping up simulations to assess effects of lowered runoff nutrient concentrations on water quality
- Development full statistical representation of results (e.g., as cdfs)