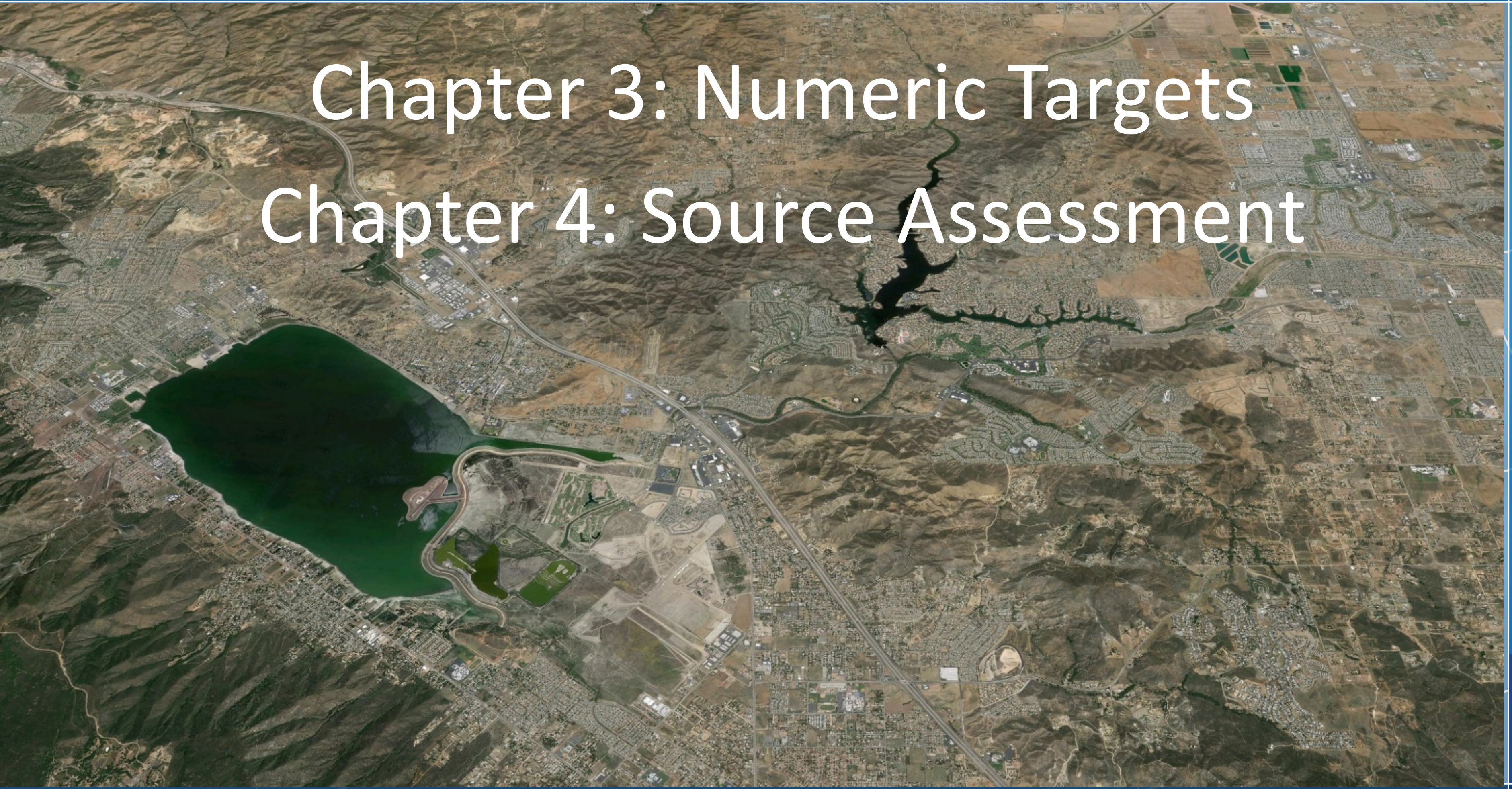
Revision of the Lake Elsinore & Canyon Lake Nutrient TMDL

CDM Smith Team
& Risk Sciences

Chapter 3: Numeric Targets

Chapter 4: Source Assessment



June 14, 2016

Lake Elsinore/Canyon Lake
Task Force Meeting

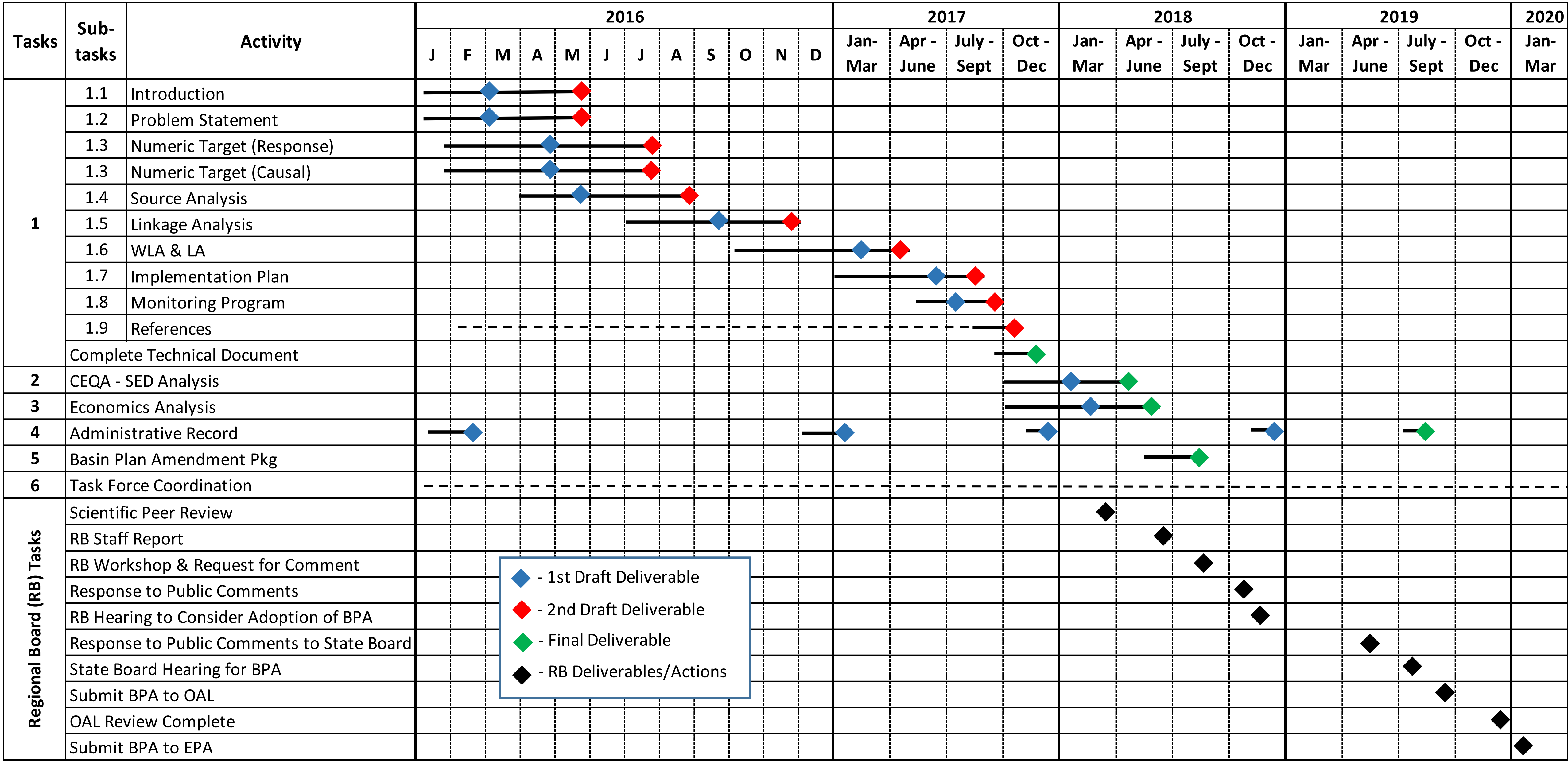
CDM Smith

RISK SCIENCES

Presentation Outline

- Project Progress/Status
- Estimation of Potential Lake Elsinore Numeric Targets
- Canyon Lake Model Results
- Paleolimnology Study
- Source Assessment

Project Schedule



Historical Records Search - Acquired

- Engineering Science, LEMA, Final Environmental Assessment: Proposed LEMP 11/1/1984
- Chambers Group, LEMA, Draft EIR: East Lake Specific Plan, 2/1/1993
- Engineering Science, LEMA, Final EIR/ Environmental Assessment: Proposed Lake Management 1/1/1988
- Army Corp of Engineers (ACOE), LEMA, Final Environmental Assessment Lake Elsinore Project , 6/1/1988
- Army Corp of Engineer (ACOE), LEMA, Lake Elsinore Small Flood Control Project Authority Definite Project Report, 4/1/1987
- Engineering Science, LEMA, Preliminary Proposed Mitigation Plan for the Elsinore Lake Management Plan, 5/1/1987
- SWRCB, Useful Waters for California, 11/31/1967
- SWRCB, California Publications, Elsinore Basin, 2/1/1953
- SWRCB, Bulletin No. 9, Elsinore Basin, 2/1/1953
- Glenn Lukos Association, LEMA, Army Corp of Engineers Permitting Requirements Behind Levee, 3/25/1993

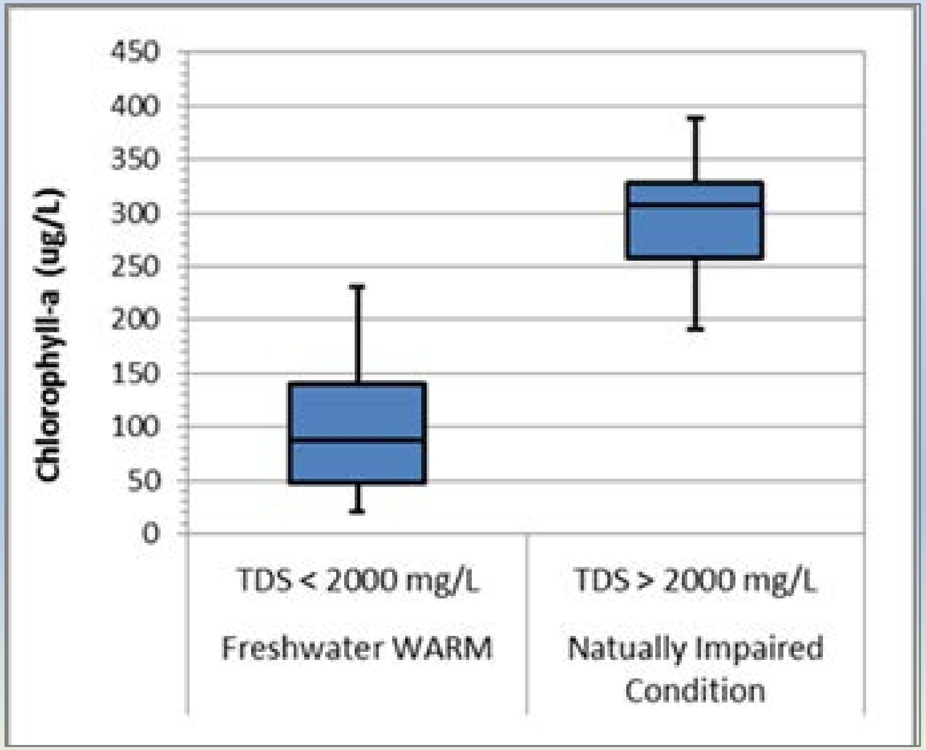
Historical Records Search – In Search Mode

- Army Corps of Engineers 404 Permit
- State 401 Certification
- Lake Alteration (1603) Permit from California Fish & Game

NUMERIC TARGETS FOR LAKE ELSINORE

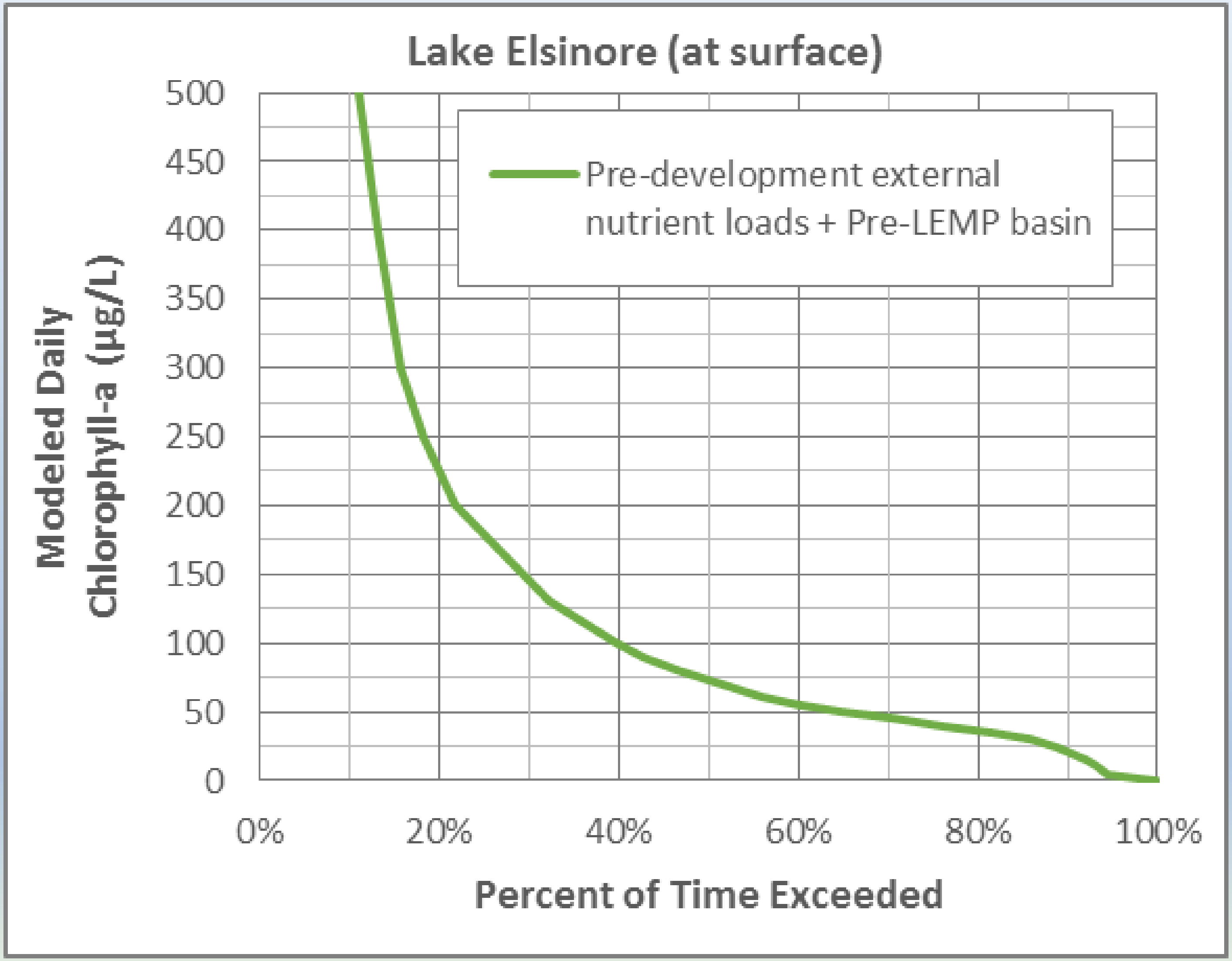
Lake Elsinore Chlorophyll-a Revisited

- Narrative water quality objective
  - *"Waste discharges shall not contribute to excessive algal growth in inland surface receiving waters"*
- Chlorophyll-a is a measure of algae
- What constitutes excessive is highly variable decadal hydrologic patterns
  - 10-yr averaging period may not be appropriate
- Consider other alternatives to setting numeric targets
  - Use of tiers based on TDS
  - Much longer averaging periods



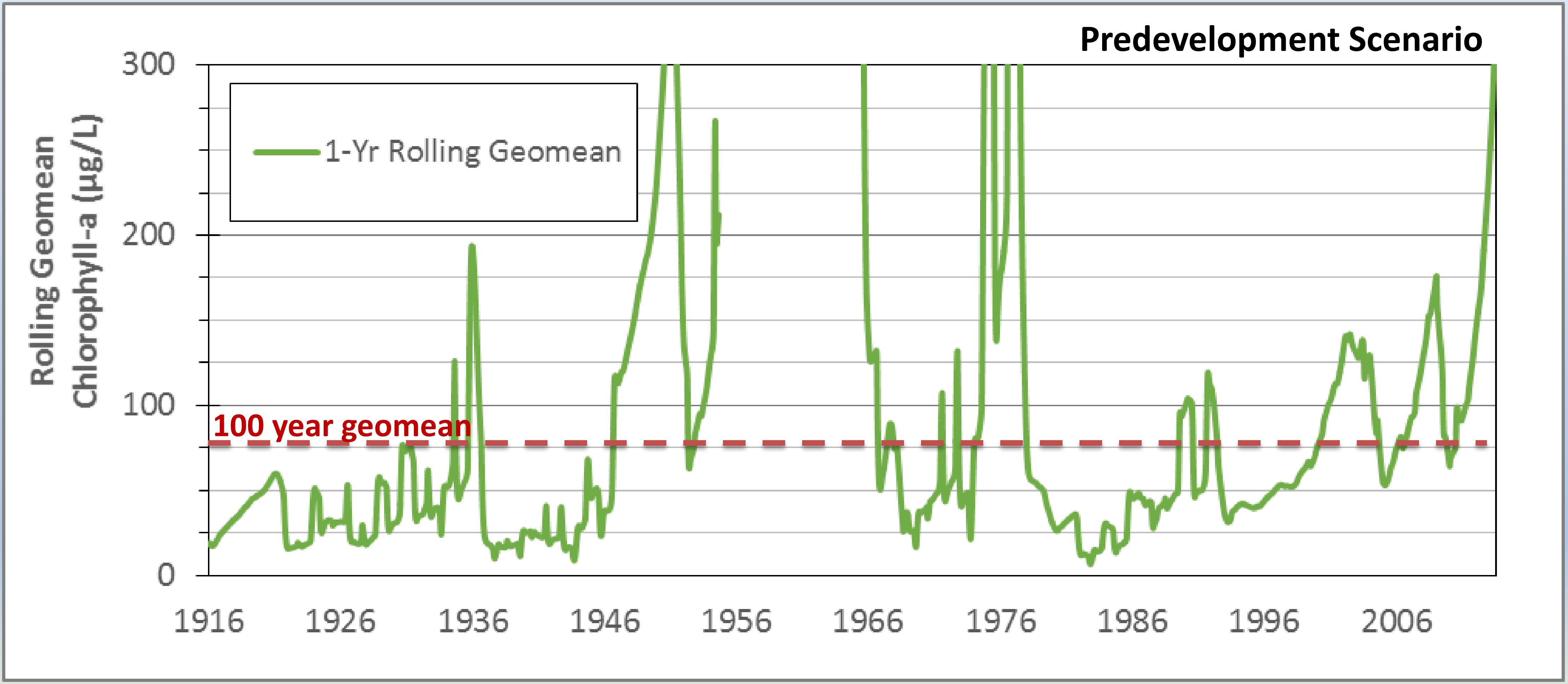
Lake Elsinore Chlorophyll-a Revisited

- Predevelopment scenario to set a reference watershed numeric target
- Median daily chlorophyll-a is 75 µg/L
- Averaging period to account for full range of hydrologies



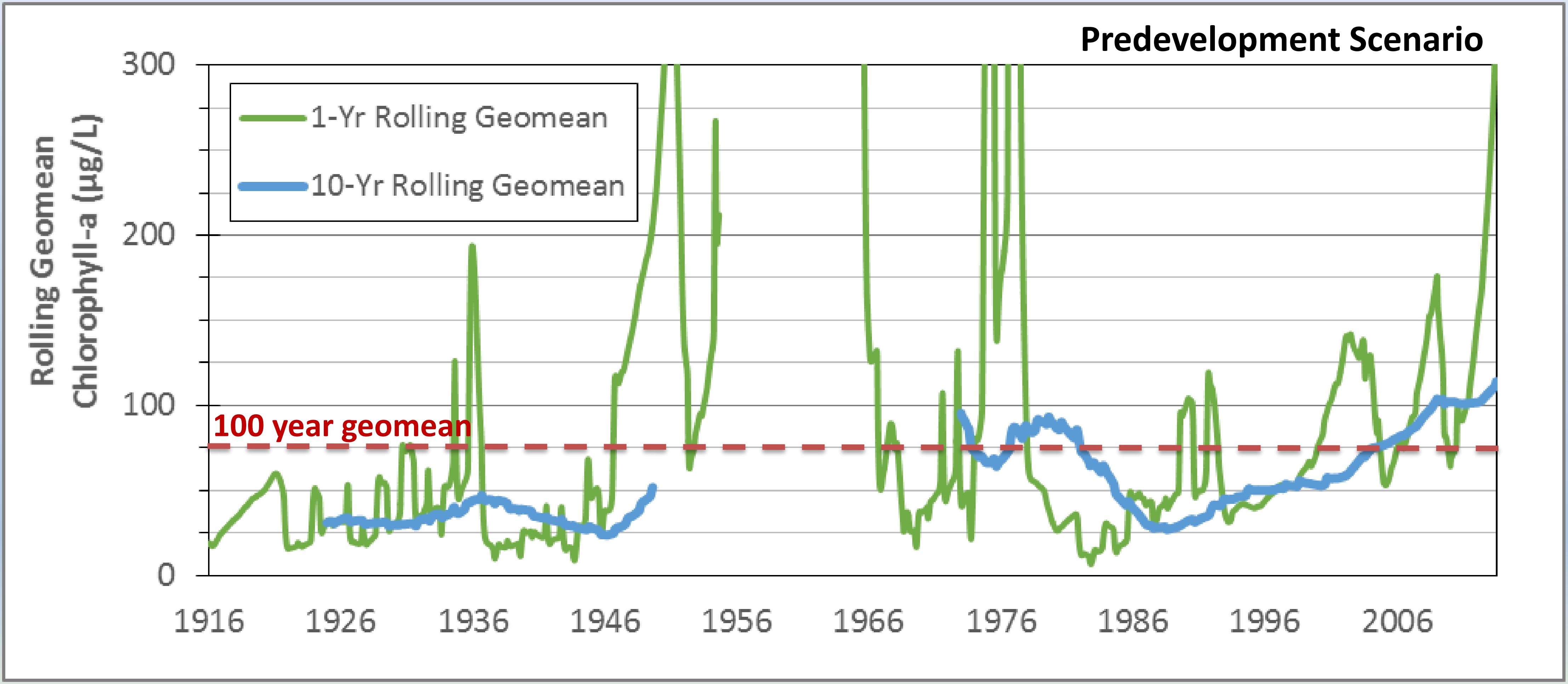
Lake Elsinore Chlorophyll-a Revisited

- Averaging period: 1-year rolling geomeans



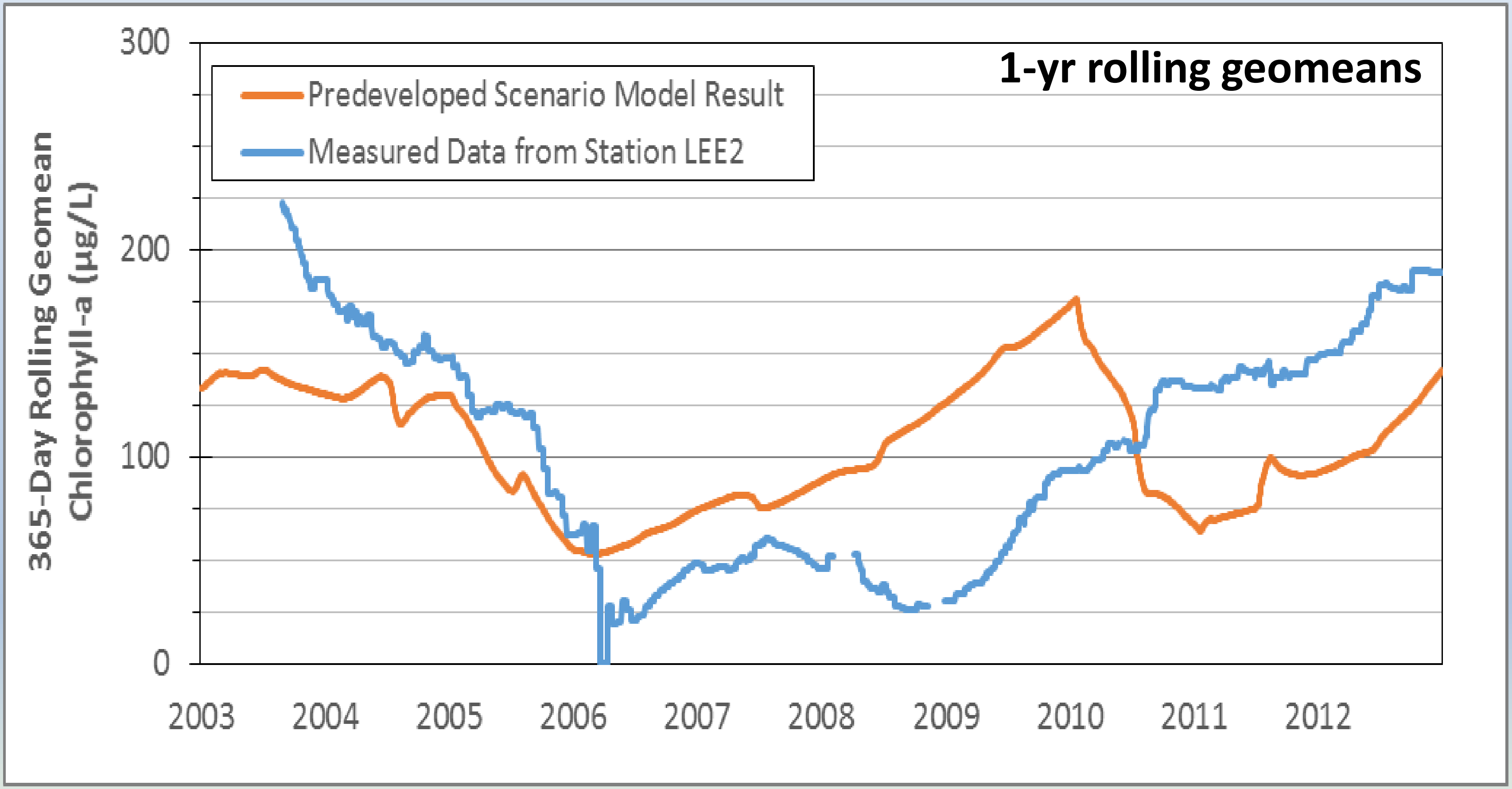
Lake Elsinore Chlorophyll-a Revisited

- Averaging period: 10-year rolling geomeans



Lake Elsinore Chlorophyll-a Revisited

- Existing BMPs are making progress toward natural condition
- 1-yr geomean comparison plot
- 10-yr geomean from 2003-12
  - Predeveloped model: 102 µg/L
  - Monitoring Data (n=177) at LEE2: 106 µg/L



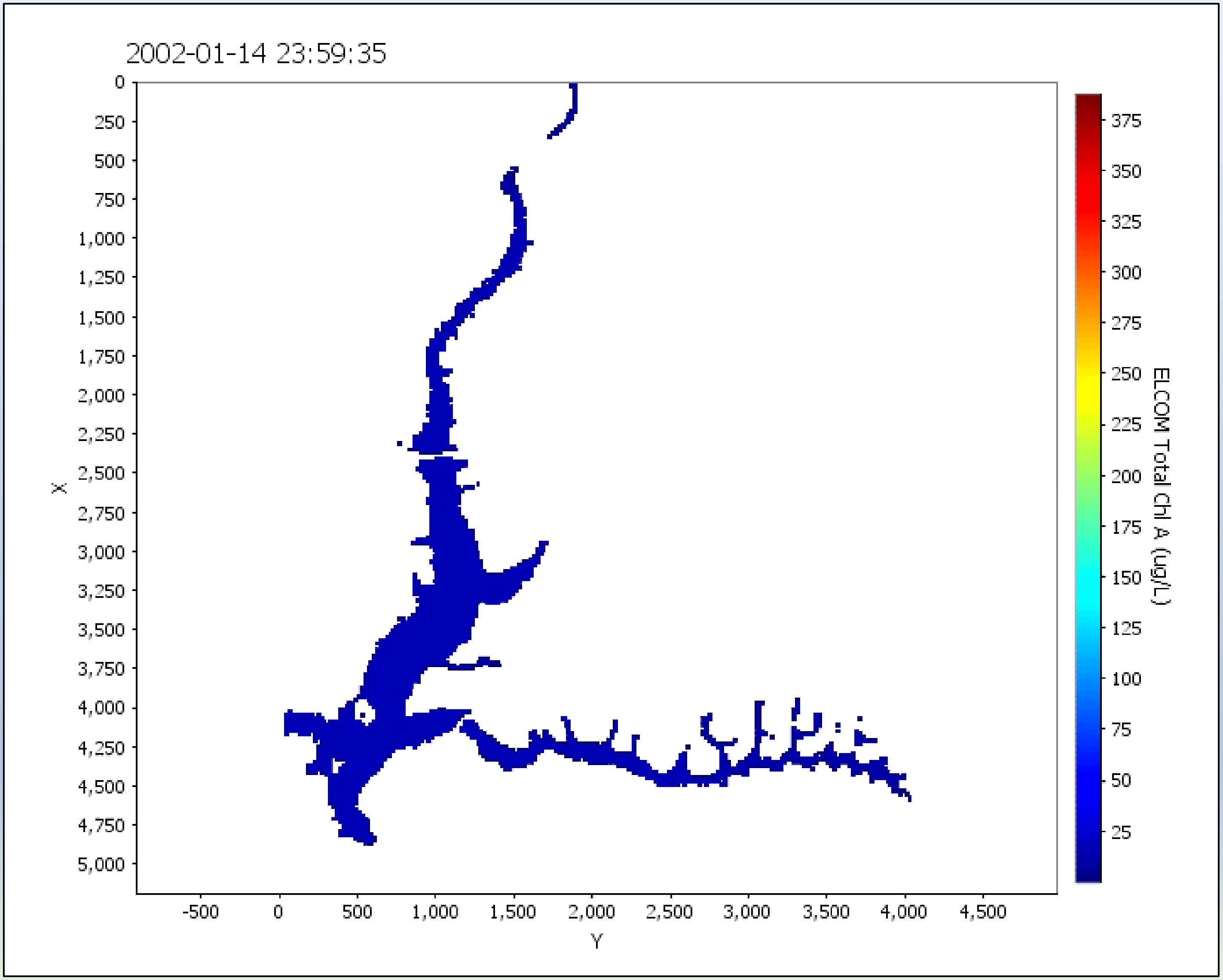
NUMERIC TARGETS FOR CANYON LAKE

Numeric Target Development

- Set numeric targets that represent a state that is equal to or better than that which occurs naturally
- Consideration of the entire hydrologic variability of external loads
- Water quality model (CAEDYM) to characterize long term dynamics of nutrients and biological communities
- Hydrodynamic model to separate lake distinct lake segments and to accurately represent exchanges between segments and overflows to Lake Elsinore

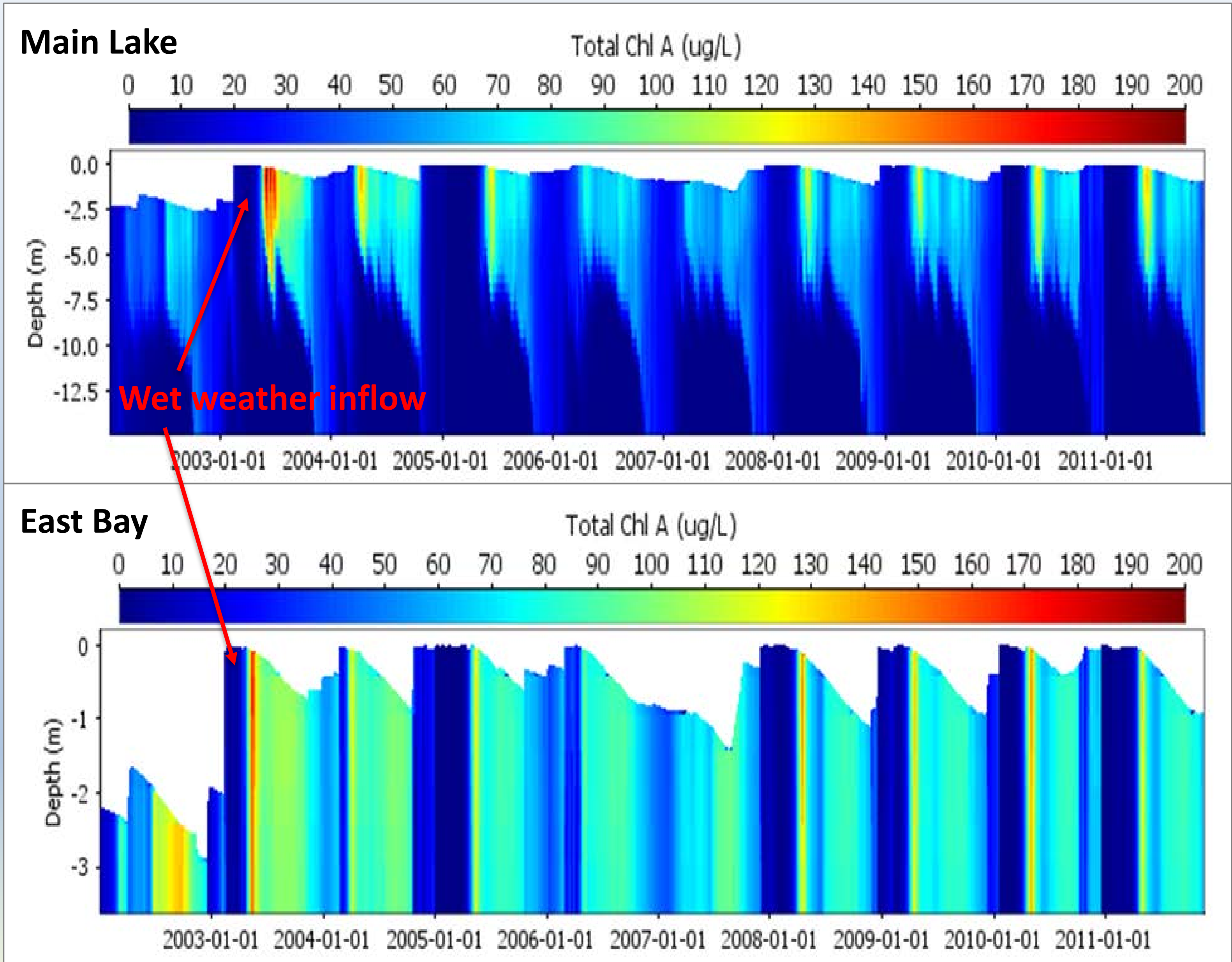
Canyon Lake Target Development

- ELCOM-CAEDYM model development ongoing
- Preliminary results for all constituents complete
- Simulation developed for a predeveloped nutrient loading scenario



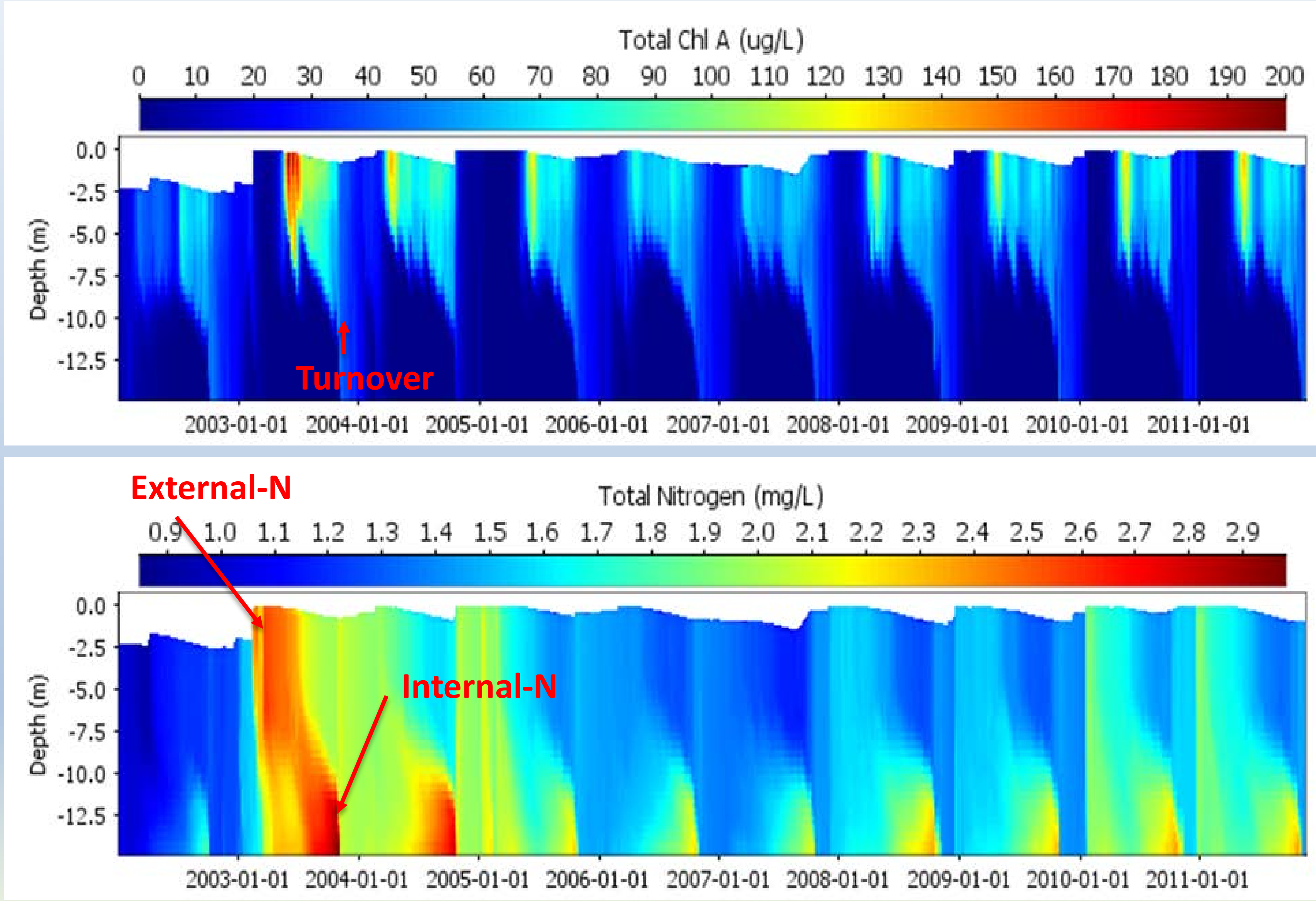
Canyon Lake Target Development

- Severe algae blooms occur in predeveloped scenario
- Greatest Chl-a immediately following wet season
- Maximum runoff volume retained within CL in 2003



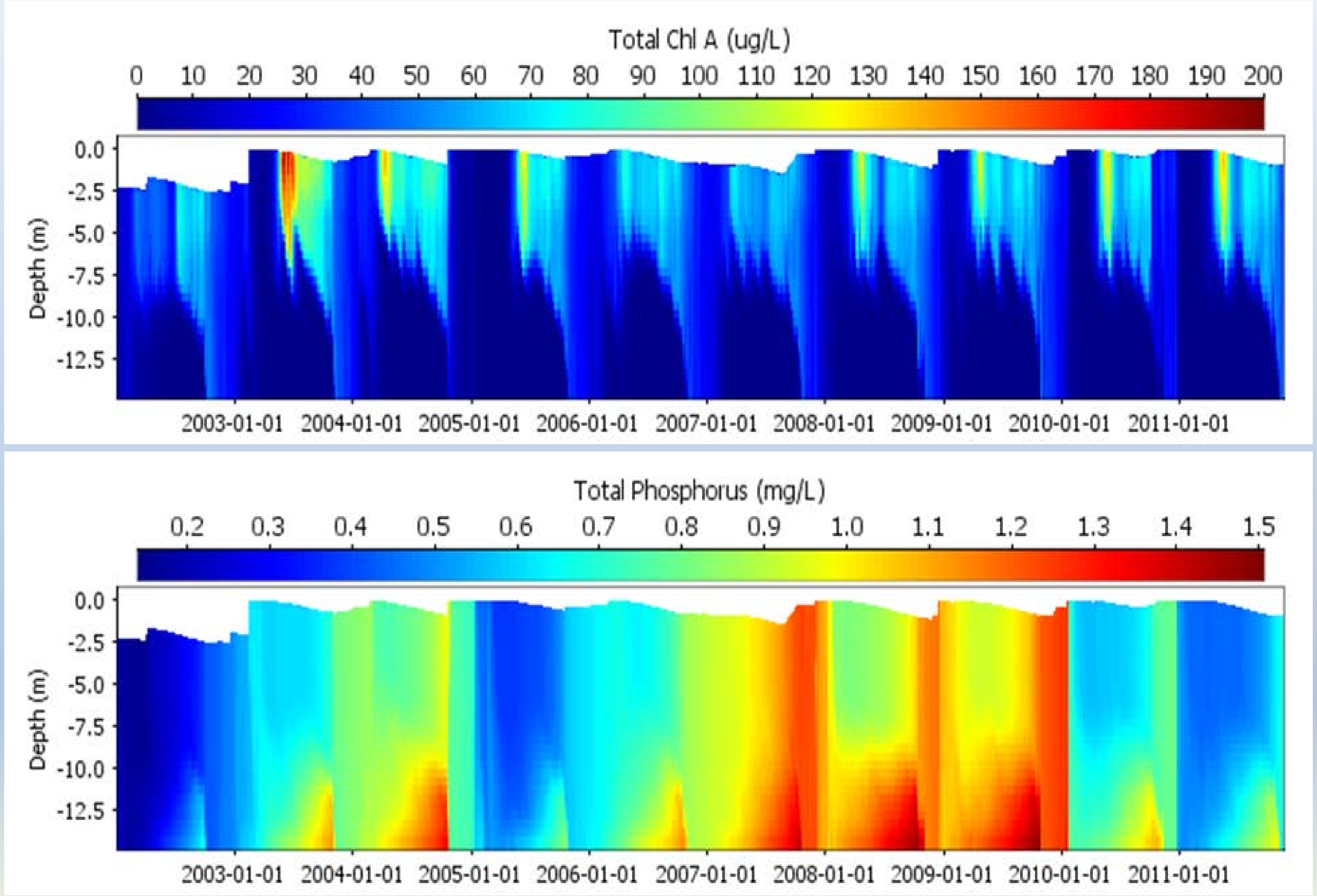
Canyon Lake Target Development

- Main Lake shows N-limitation
- External N inputs and retention are most important



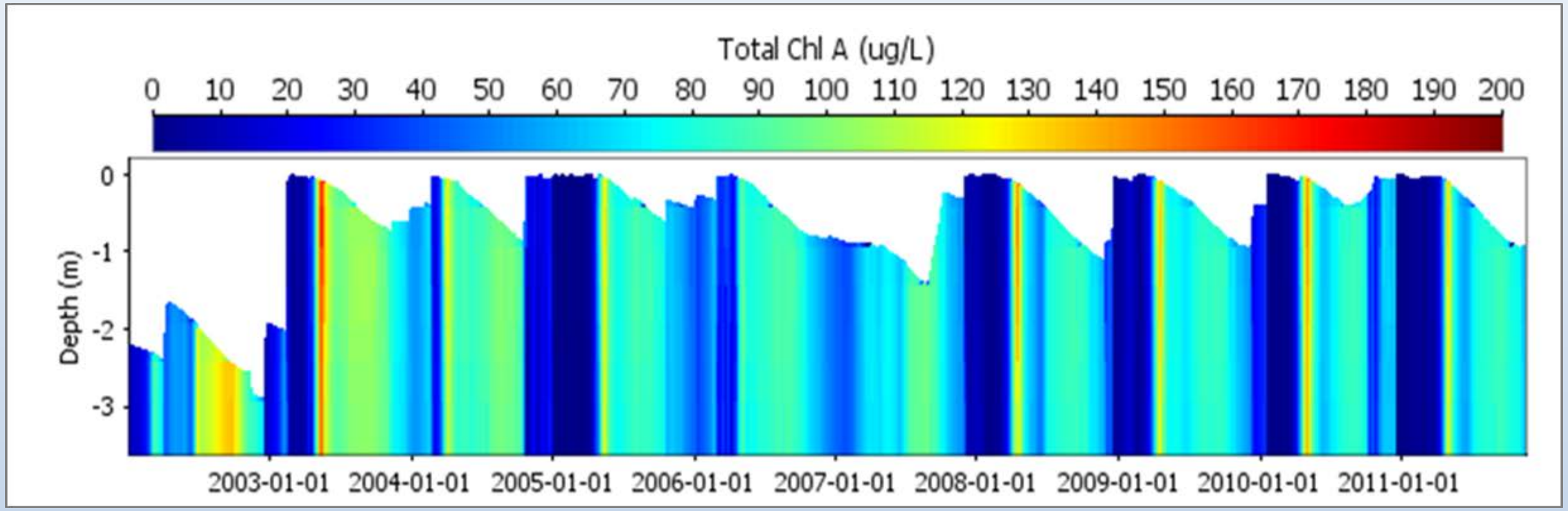
Canyon Lake Target Development

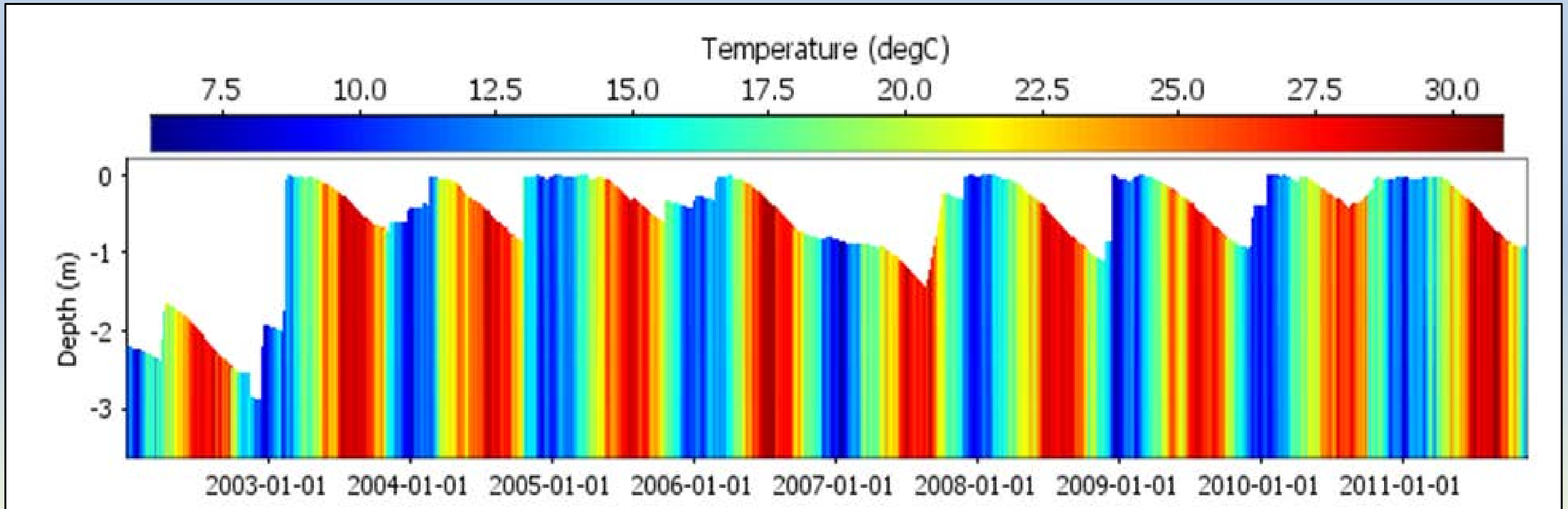
- Less evidence of P-limitation in Main Lake
- Phosphorus concentrations are persistently high
- No correlation with P and Chl-a



Canyon Lake Target Development

- East Bay has persistently high Chl-a following wet season in predevelopment scenario results
- Decline in wet season from flushing





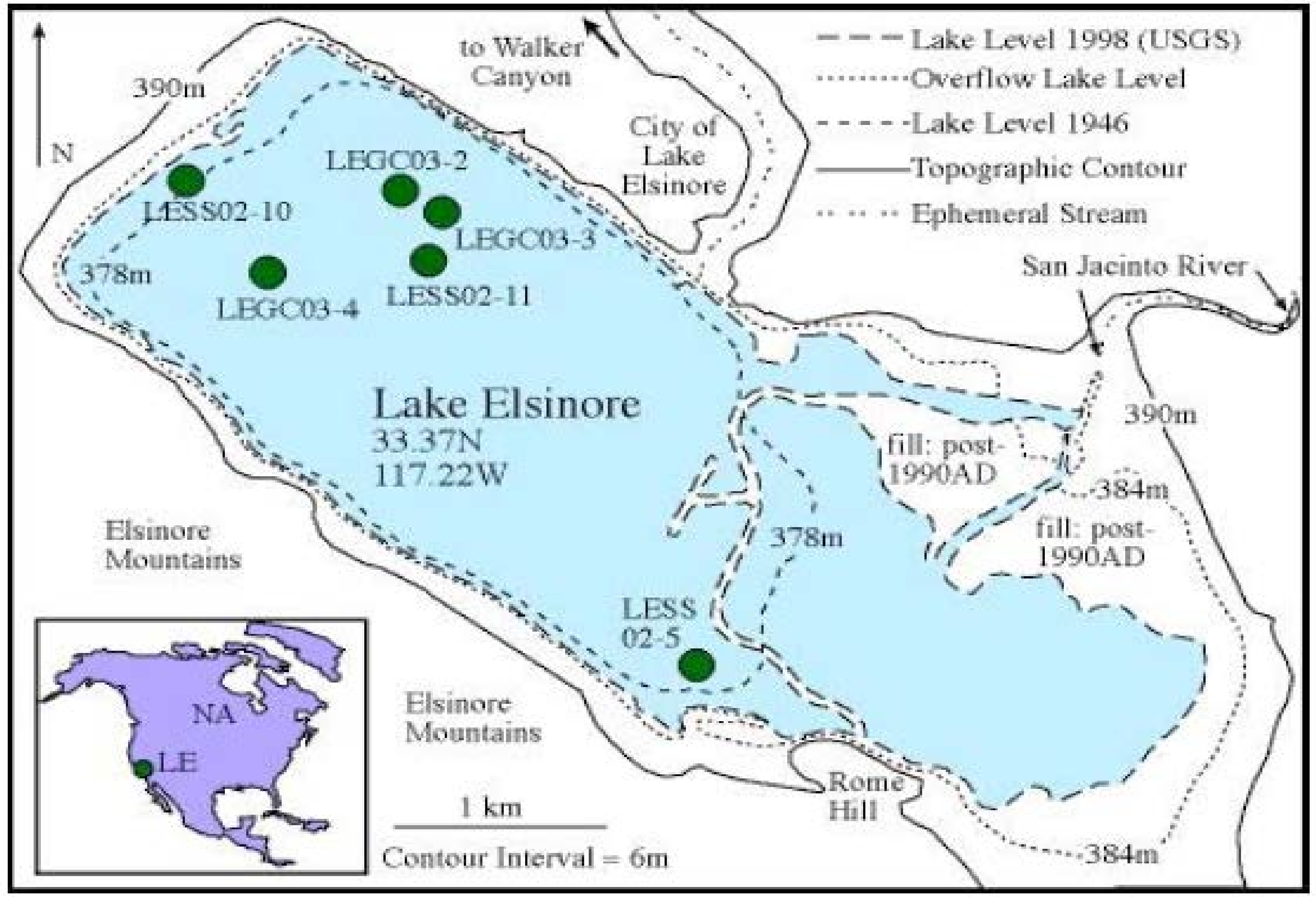
PALEOLIMNOLOGY STUDY

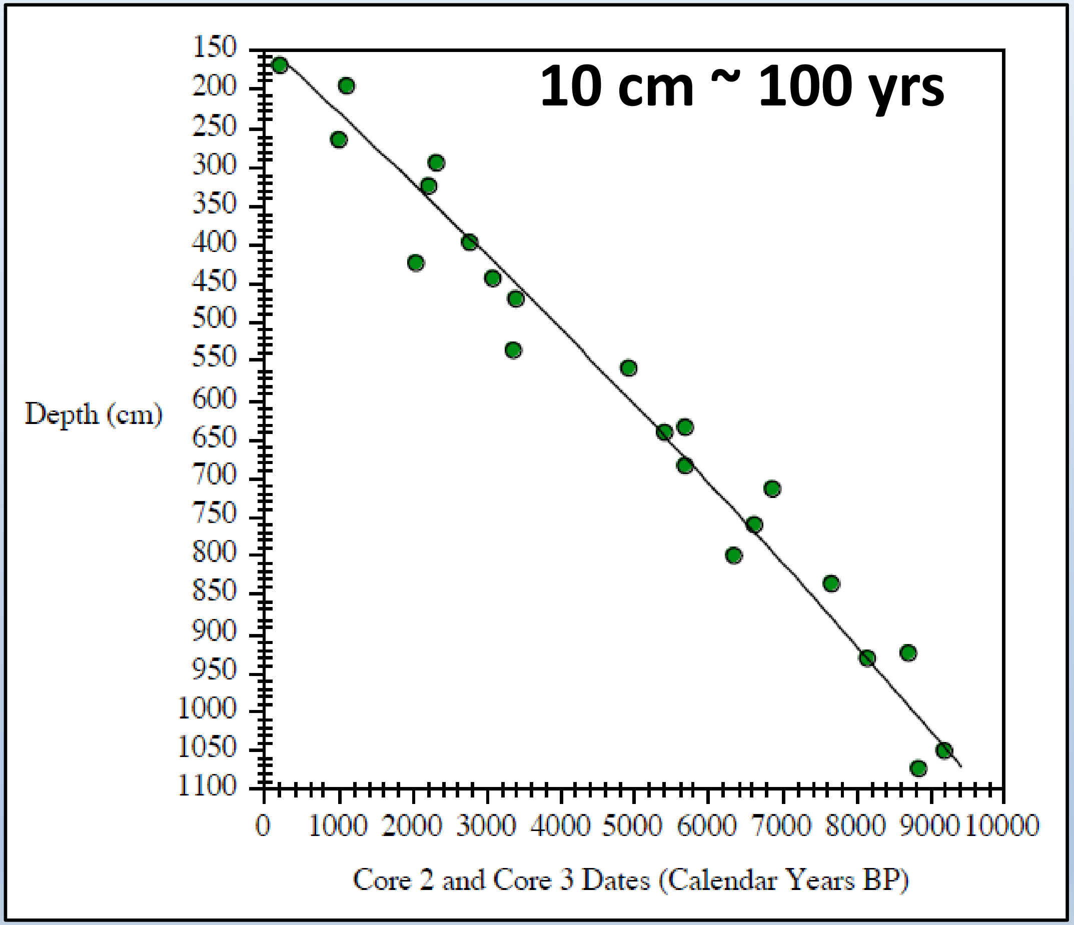
Paleolimnology Study

- Paleolimnology study results provide an additional line of evidence to describe naturally occurring water quality (basis for TMDL)
- *Developing a Baseline of Natural Lake Level / Hydrologic Variability and Understanding Past Versus Present Lake Productivity over the Late-Holocene: A Paleo-Perspective for Management of Modern Lake Elsinore* (Kirby et al., 2005)
- Task Force commissioned a study to collect sediment cores to assess cumulative benefits of in-lake nutrient management (Anderson, 2016)

Paleolimnology Studies

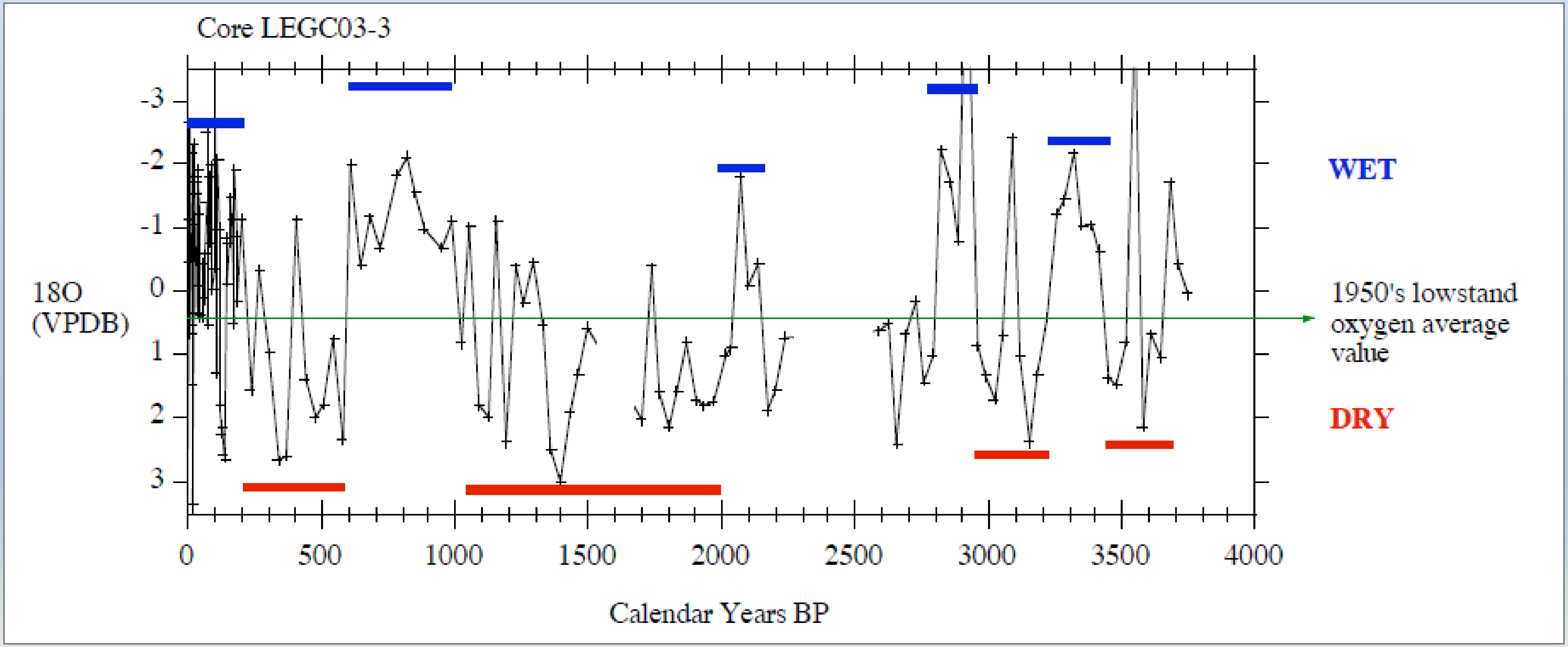
- Aging model based on carbon isotopes





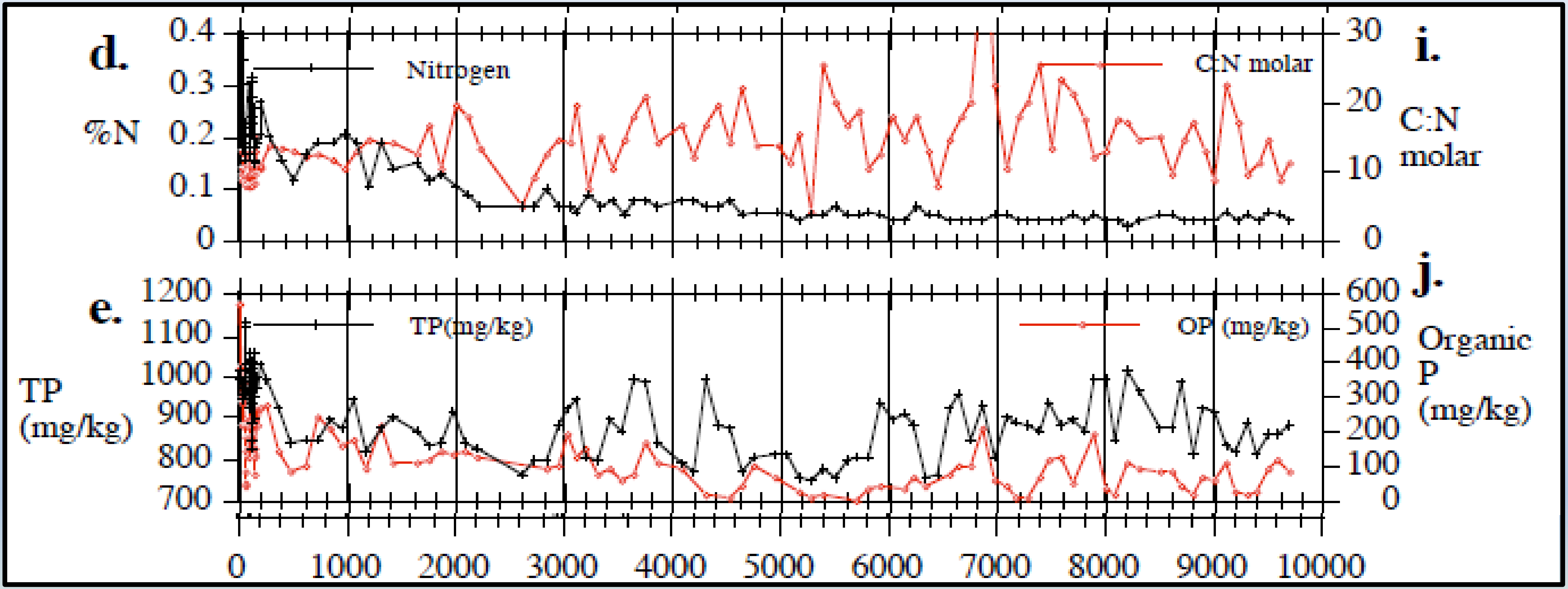
Key Findings

- Multi-decadal and centennial scale climate variability measured by oxygen isotopes (O-18 composition a function of Precip:Evap ratio)
- Currently in a wet cycle, which can include extended drought



Key Findings

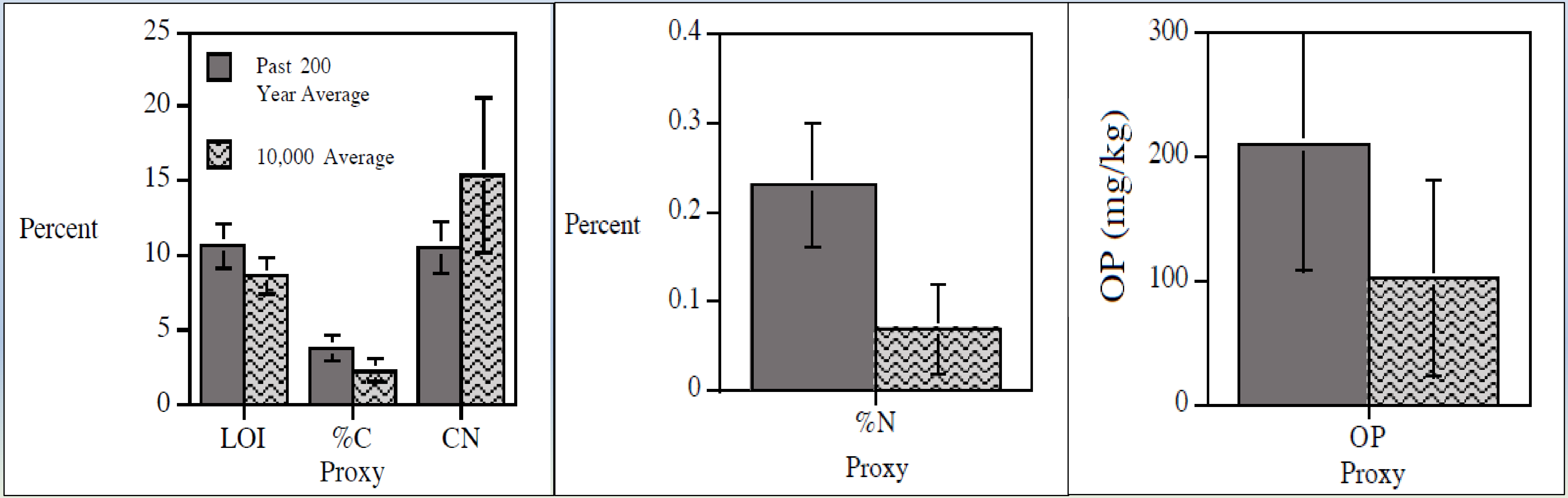
- Historical estimation of sediment nutrients in Lake Elsinore



Years Before Present Day

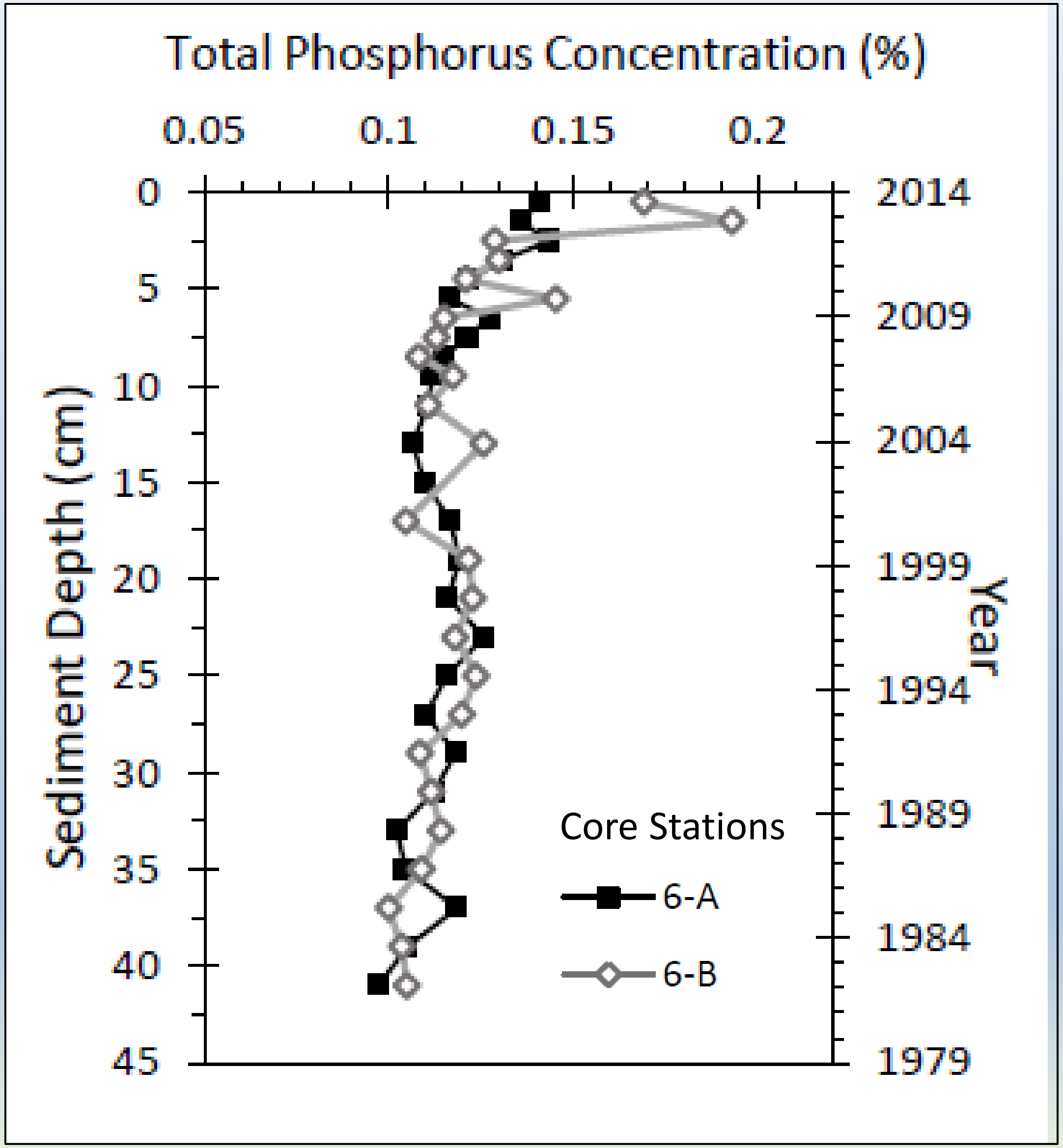
Key Findings

- Anthropogenic impacts have affected trophic status
- Change in nutrients supports assumptions for predevelopment model
  - Recent LE inflow monitoring 2-3 times greater nutrients than reference watershed



Key Findings

- TP in sediment cores collected in 2014 from top 50 cm
- Representative of modern developed watershed
- Sediment TP in 1,000 – 1,500 mg/kg range



SOURCE ASSESSMENT

Key Elements of Source Assessment

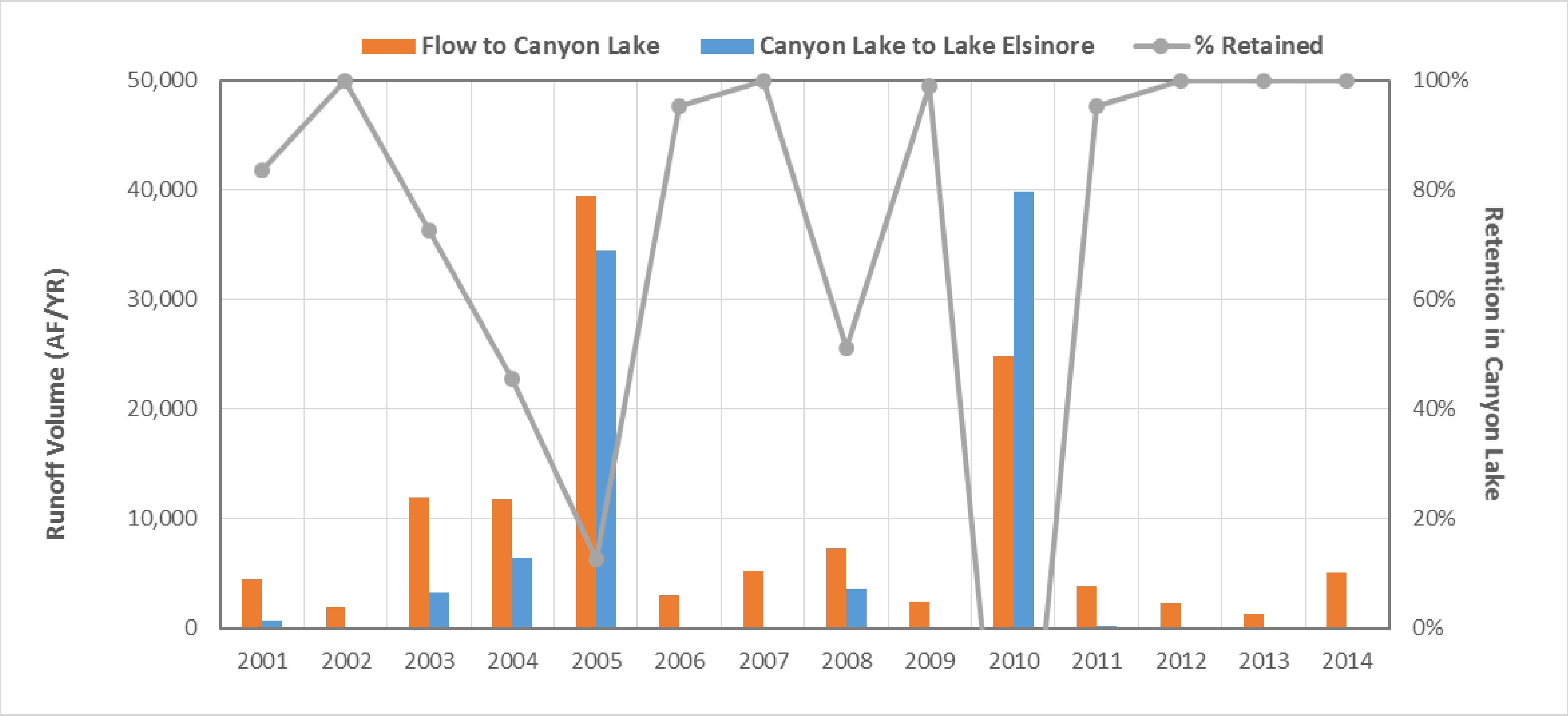
- External Sources
  - Watershed nutrient washoff
  - Overflows from Mystic Lake
  - Septic systems
  - Nutrient attenuation
  - Reclaimed water
- Internal Sources
  - Internal sediment nutrient flux
  - Resuspension
  - Atmospheric deposition
  - Nitrogen fixation
  - Evapo-concentration

Watershed Nutrient Washoff

- LSPC model used for TMDL and 2010 Update
  - Buildup / washoff of nutrients
  - Complex, costly to develop
  - Only as good as data and modeler
- TMDL revision to use a simplified approach
  - Data driven
  - Clearly defined and referenced unit area loading rates
  - Transparent and explicit quantifications of watershed specific conditions (e.g. nutrient attenuation, runoff retention)

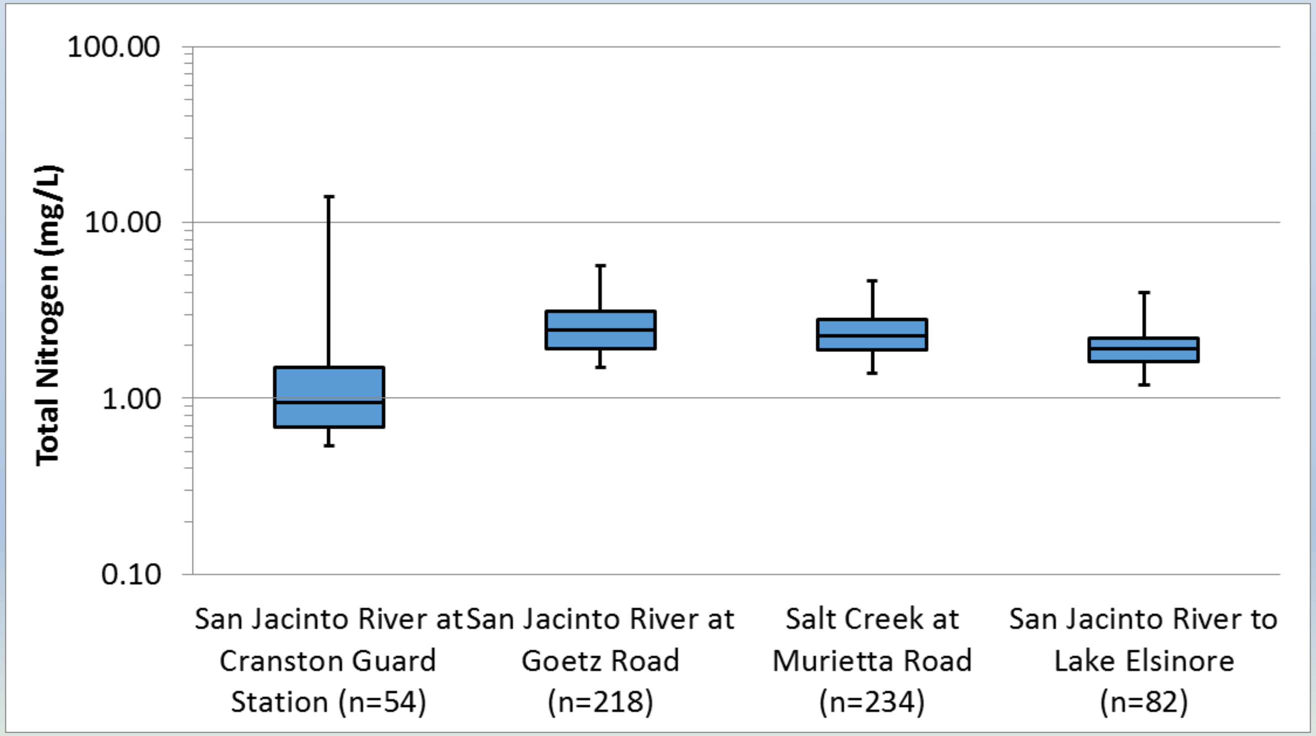
Simplified Approach

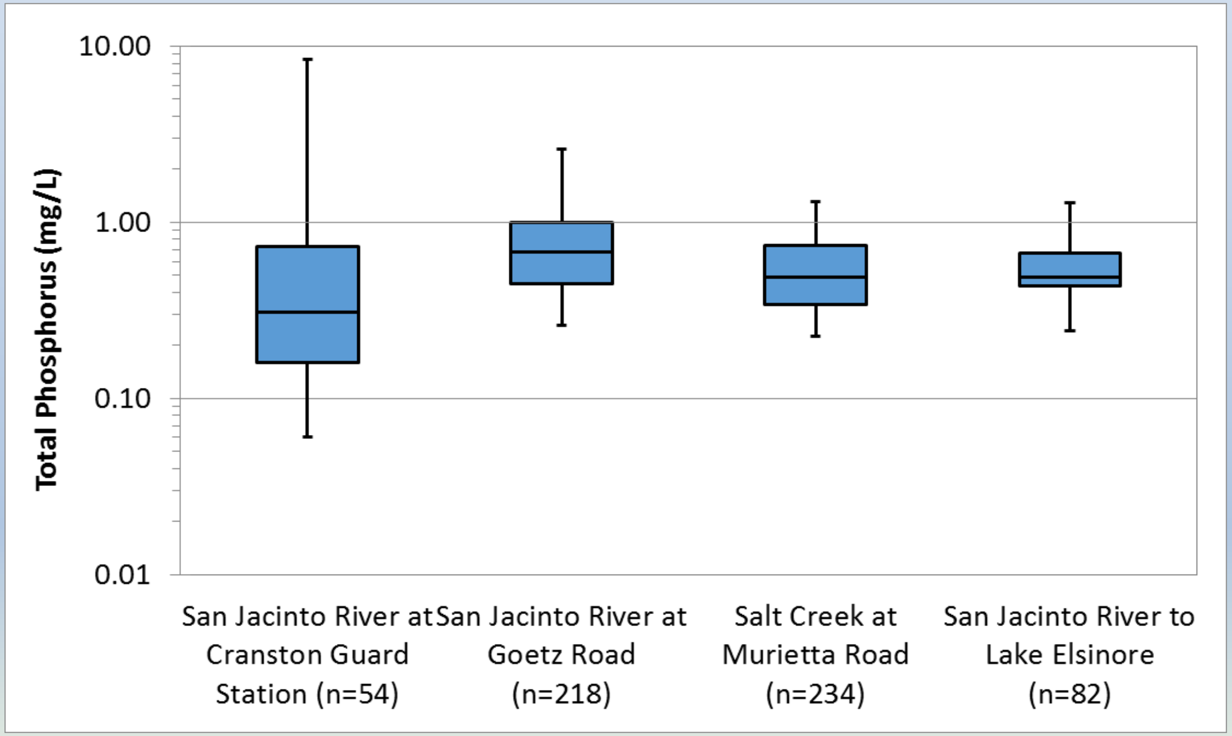
- Leverage continuous historical hydrologic data



Simplified Approach

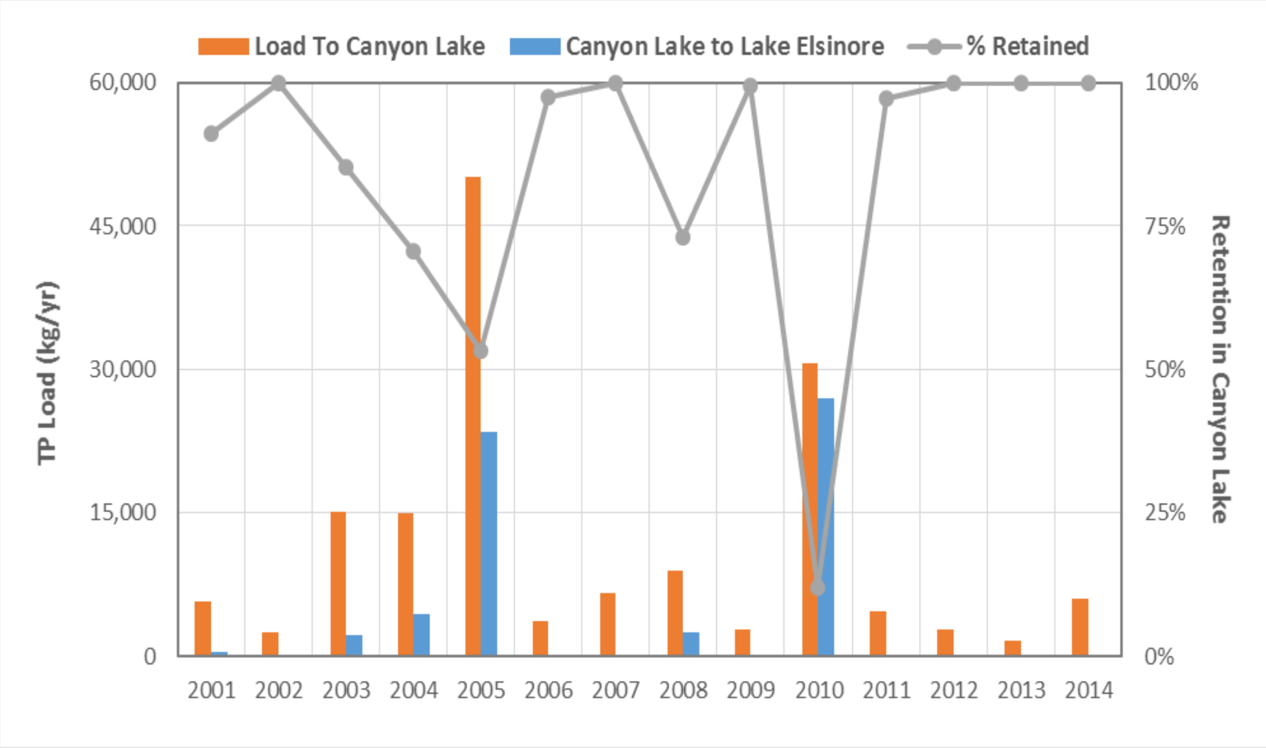
- Use extensive monitoring results from watershed monitoring program since 2007 (n=25 storm events)

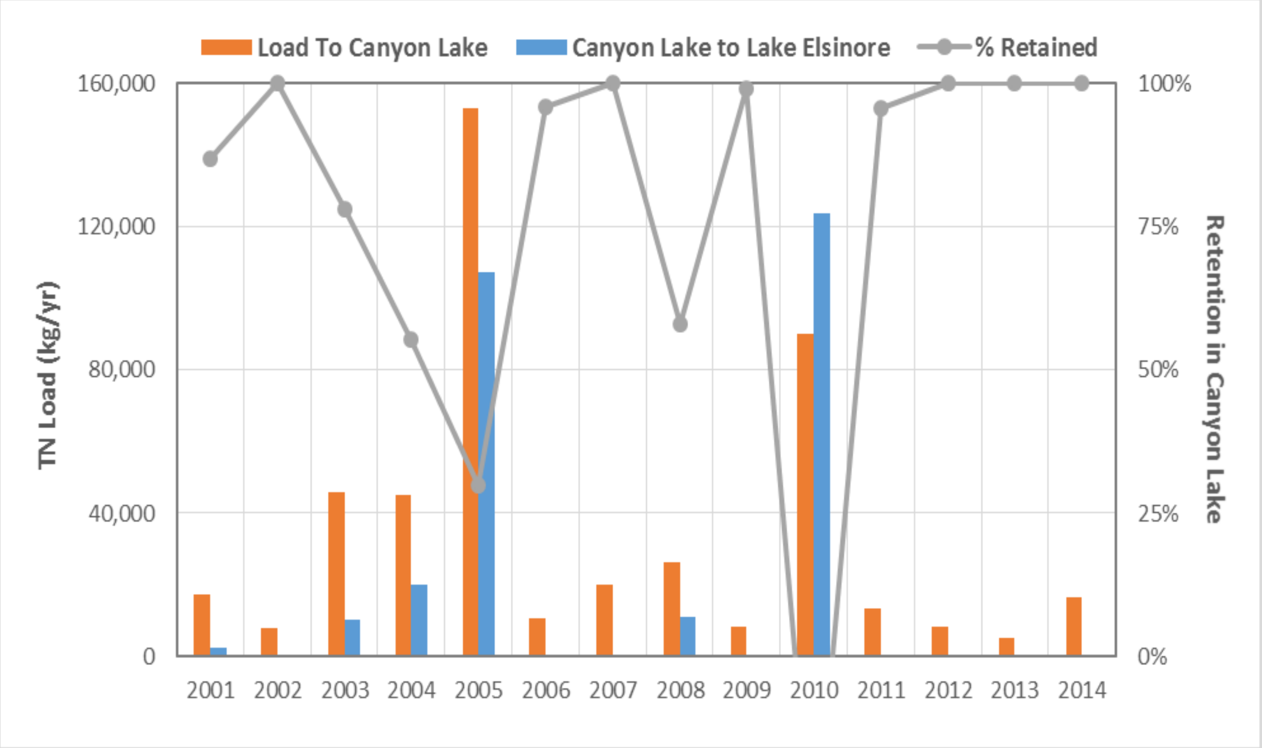




Simplified Approach

- Interpolation of nutrient concentrations to estimate annual loads

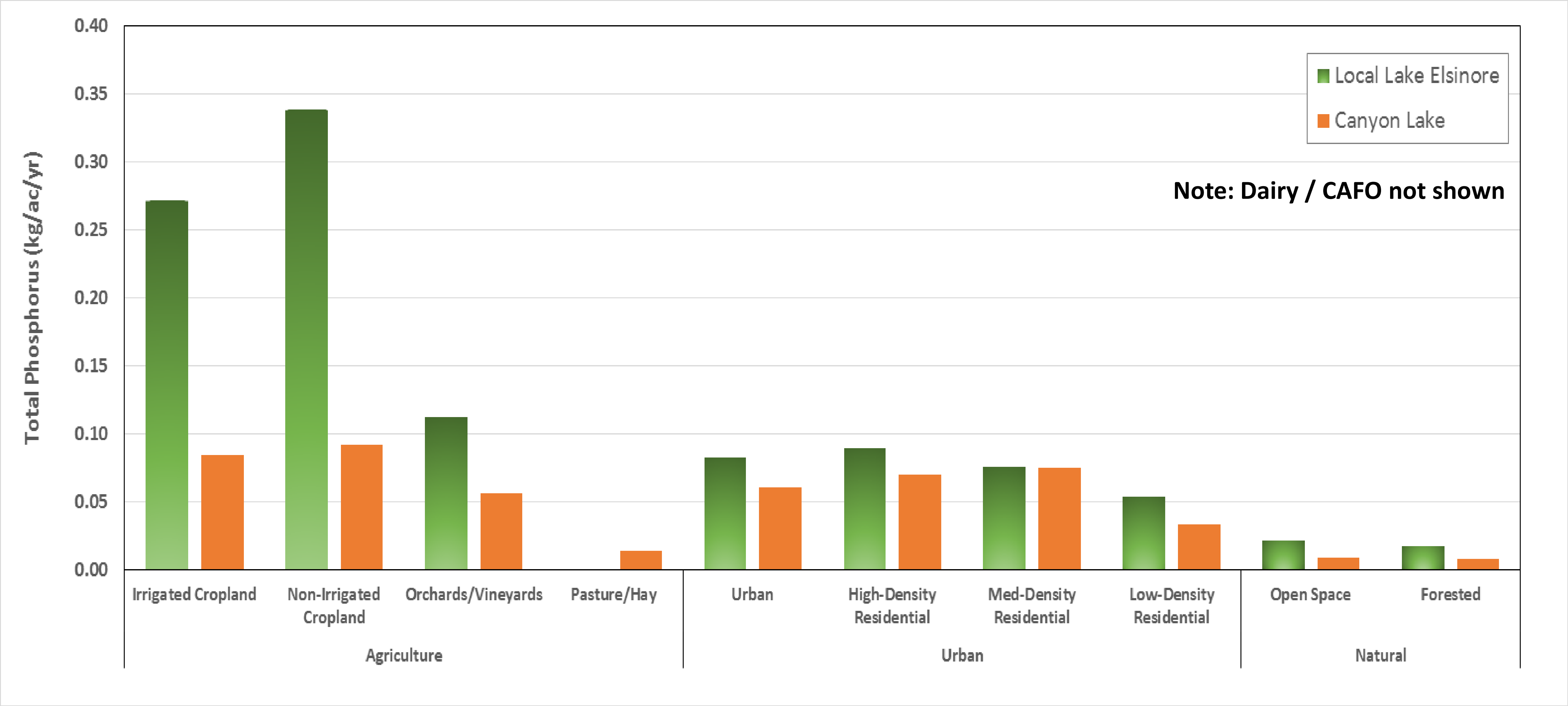




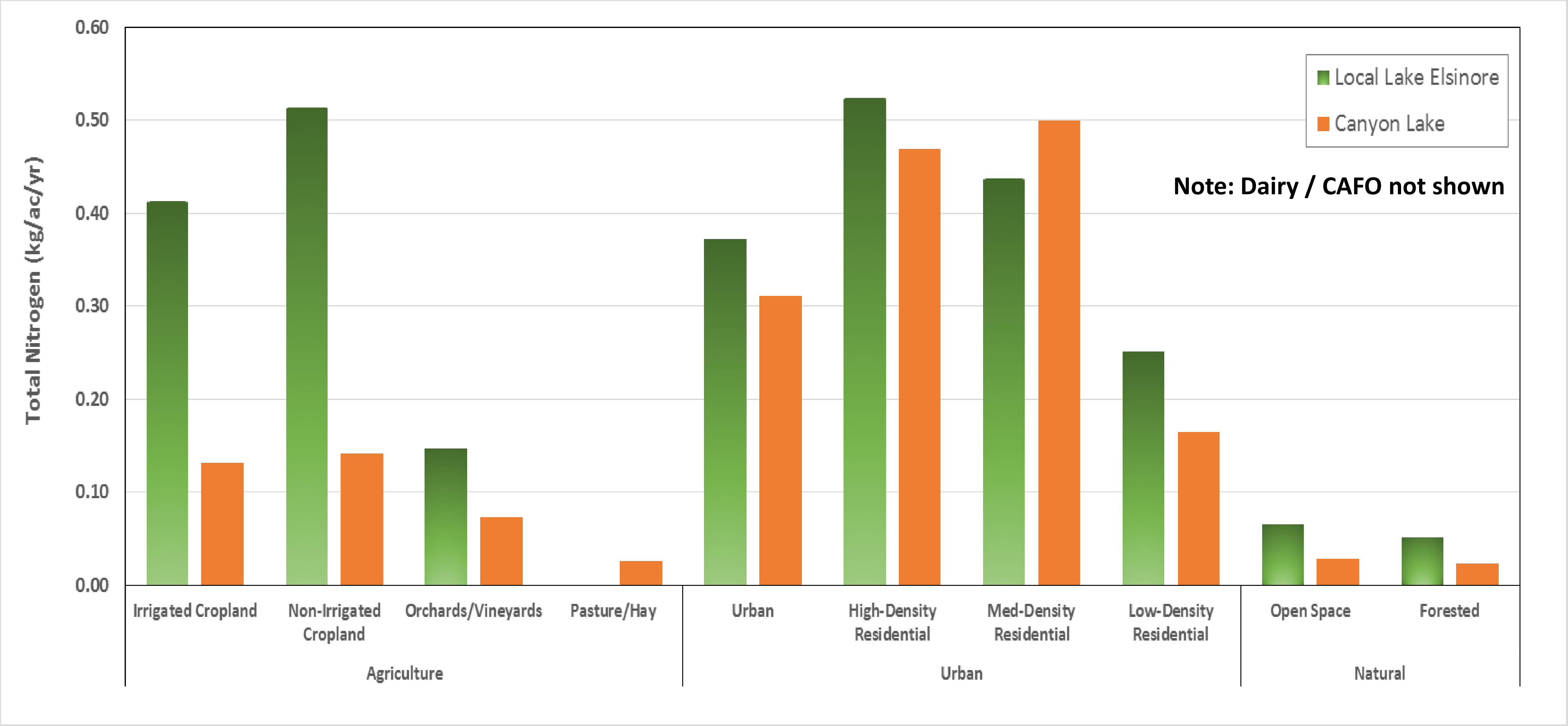
Washoff from Unique Land Cover Types

- Nutrient washoff from watershed lands is key for allocation of estimated downstream loads to upstream jurisdictions
- From Beaulac and Reckhow (1982):
  - *As watersheds shift from natural, undisturbed conditions to increasing levels of human disturbance, the ecological mechanisms controlling nutrient flux become more complex and less understood. Therefore, the ability to accurately quantify or predict interactions between land use and aquatic conditions or responses becomes less precise and more uncertain*
  - *For management of water resources, the use of nutrient loading coefficients for predicting changes in water quality conditions that follow changing land use is highly subjective. To reduce uncertainty in this use, the user of these coefficients must be familiar with the biogeochemical processes that influence nutrient fluxes*
- Simplified approach to focus on specific biogeochemical processes by leveraging current scientific understanding

Phosphorus Washoff Rates in 2010 LSPC Update



Nitrogen Washoff Rates in 2010 LSPC Update



Comparison with Literature Values

Land Use	CL / LE LSPC Model		Average reported in Reckhow et al., 1980	
	TP	TN	TP	TN
Irrigated Cropland	0.08	0.13	1.81	6.51
Non-Irrigated Cropland	0.08	0.13	0.44	2.10
Orchards/Vineyards	0.09	0.14	1.46	1.94
Pasture/Hay	0.06	0.07	0.61	3.50
Urban	0.01	0.03	0.77	4.04
High-Density Residential	0.06	0.31		
Med-Density Residential	0.07	0.47		
Low-Density Residential	0.08	0.50		
Open Space	0.03	0.17		
Forested	0.01	0.03	0.10	1.16

Washoff from Unique Land Cover Types

- LSPC calibration focused on adjustment to empirical buildup/washoff washoff coefficients
- Simplified approach based on nutrient balance with each source/sink developed independently
  - Update washoff rates based on higher reference values
  - Maintain single washoff rate for distinct land uses across all jurisdictions
  - Quantify in-stream nutrient attenuation and assign credit by jurisdiction based on travel time to lake inflow
  - Separate nutrient budgets for Salt Creek – East Bay and San Jacinto River – Main Lake