Bathymetric Survey and Sediment Hydroacoustic Study of Canyon Lake

Michael Anderson
UC Riverside

Introduction

- Canyon Lake was constructed in 1928 as the Railroad Canyon Reservoir as a result of the impoundment of the San Jacinto River
- The reservoir thus receives runoff from a very large (>1900 km^2) watershed
- Canyon Lake receives very large total suspended solids loads during strong runoff events
- As a result, the lake has a high sedimentation rate (about 2.4 cm/yr based upon a core collected by USGS in 1998)

- Sedimentation in East Bay has also been identified as a significant concern for residents
- The accumulation of sediment lowers the storage capacity of the reservoir
- The distribution of sediments and the properties of those sediments also affects water quality and efforts to improve it
- Sediment properties directly influence rates of:
  - internal recycling of nutrients
  - sediment oxygen demand

Objective

- Overall objective of the study was to better understand Canyon Lake from bottom up
- Specific objectives were to:
  - Develop up-to-date bathymetric map
  - Derive up-to-date storage curve for the reservoir (elevation-area-volume)
  - Estimate volume of sediment deposited and where
  - Characterize distribution of sediment types across basin
  - Develop estimate of fish abundance by size class

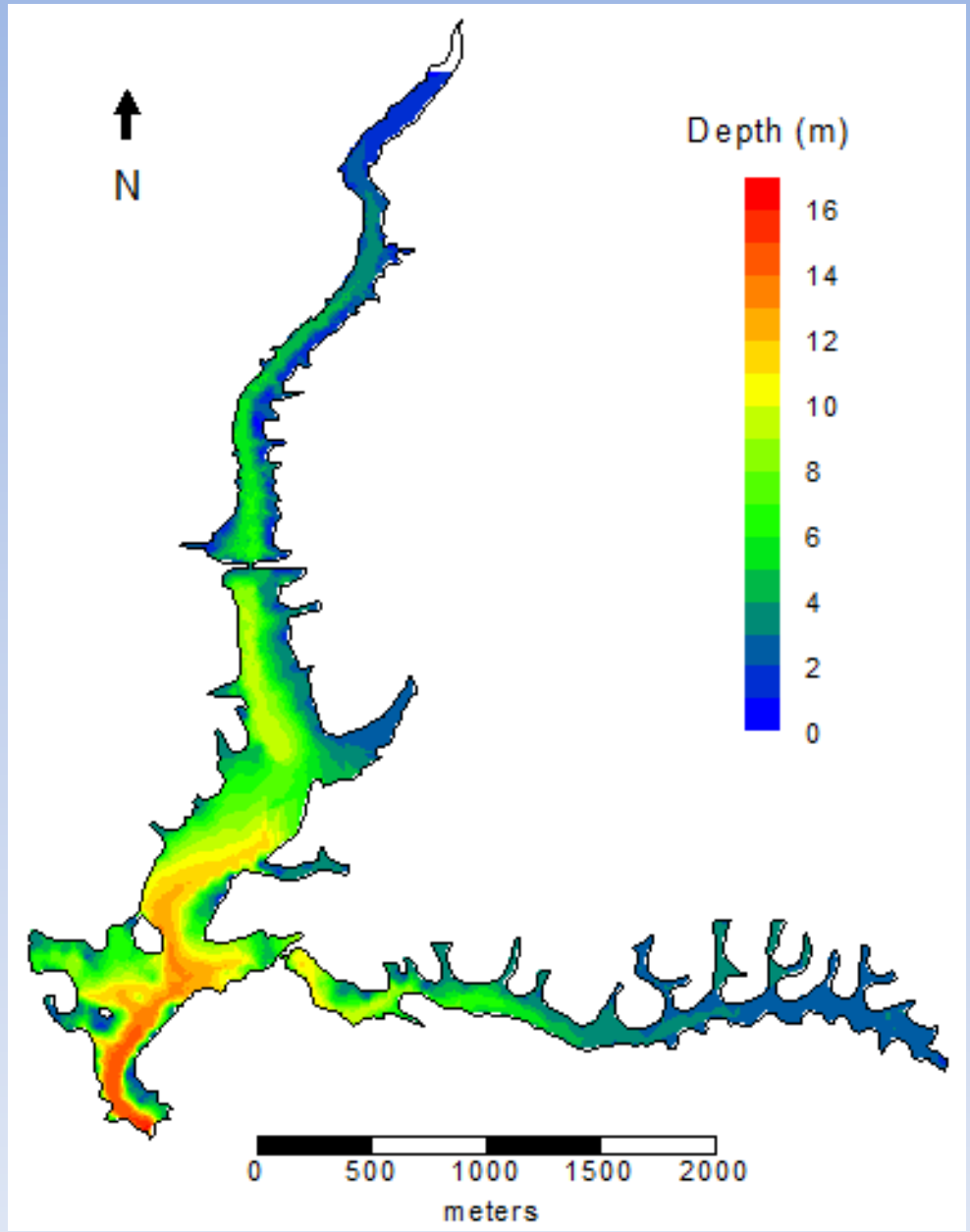
Approach

- Hydroacoustic survey was conducted over 2-days on December 16-17, 2014
- Survey conducted using a BioSonics DTX echosounder with multiplexed transducers:
  - 430-kHz single beam with pitch-roll sensor
  - 201-kHz split beam
  - 38-kHz single beam with pitch-roll sensor
- Transducers operated at 5 pps on each frequency, with 0.4 m pulse duration
- Position recorded each second using a JRC 202W realtime DGPS
- Data acquired using BioSonics VisualAcquisition v.6.0 software on a Dell ATG laptop

Results

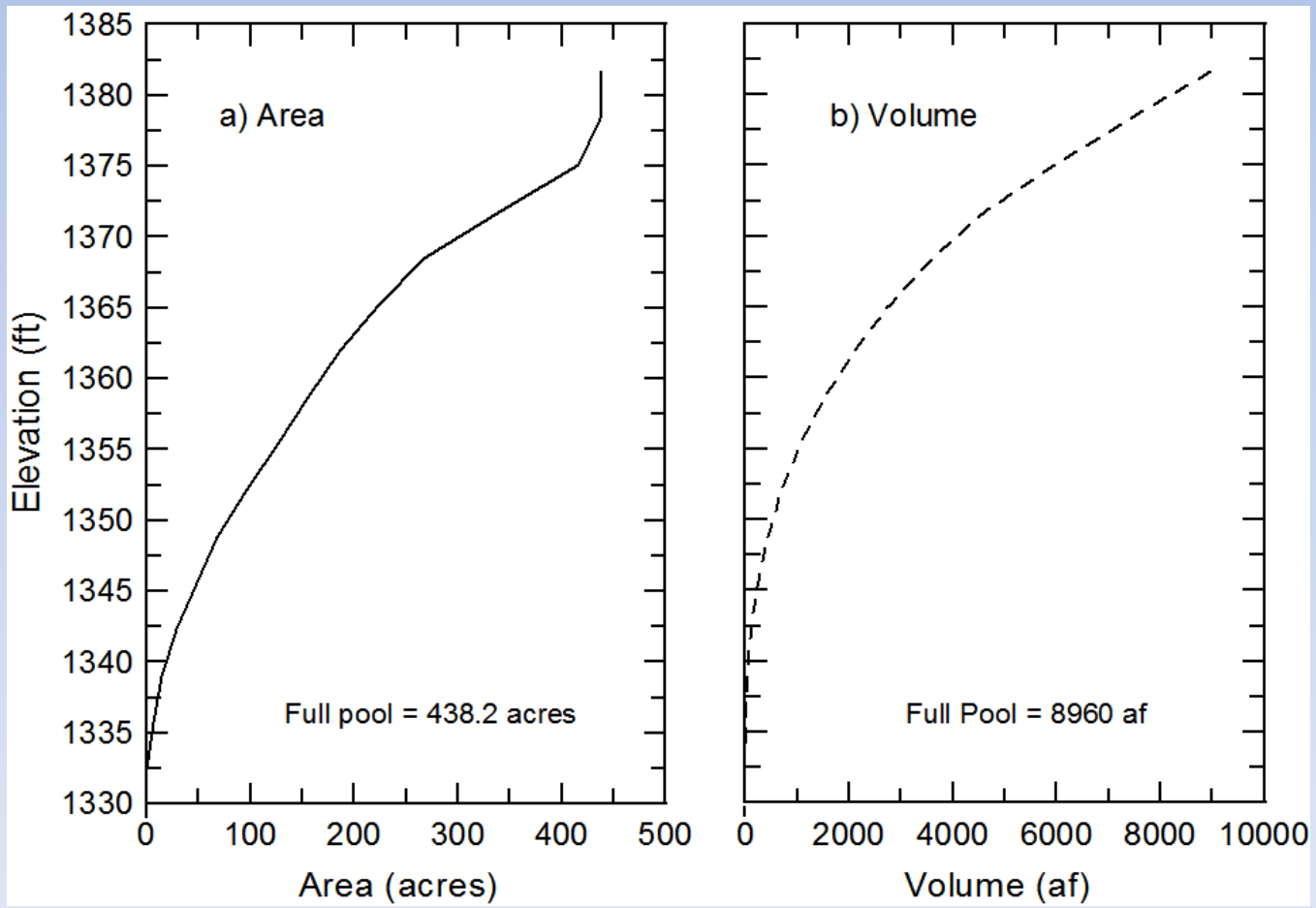
Depth

- Depths ranged from <1 m at lake margin and 16 m near dam
- Depths increased with distance from inflows
- Original river channel evident



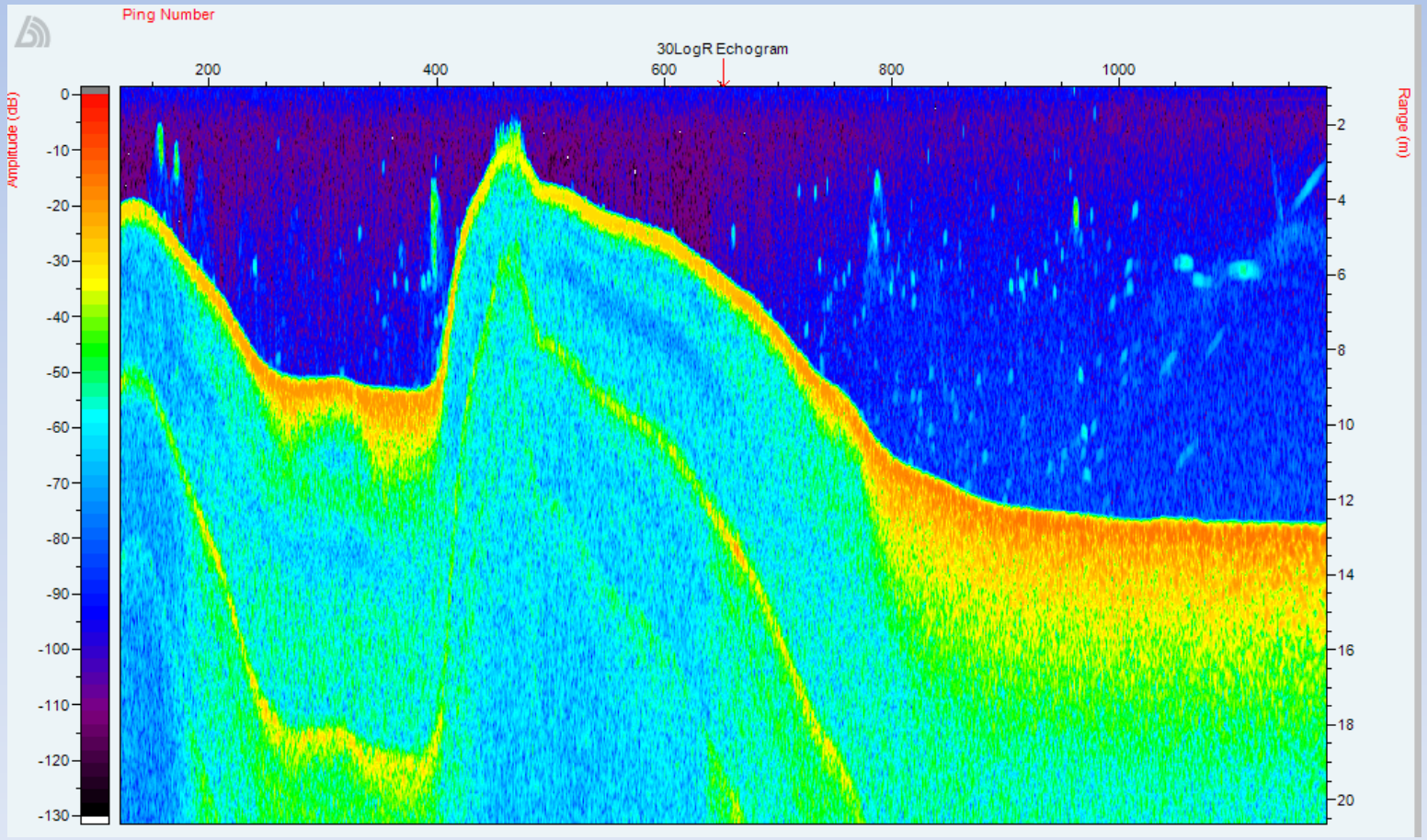
Elevation-Area-Volume

- Bathymetric data used to develop elevation-area-volume curves

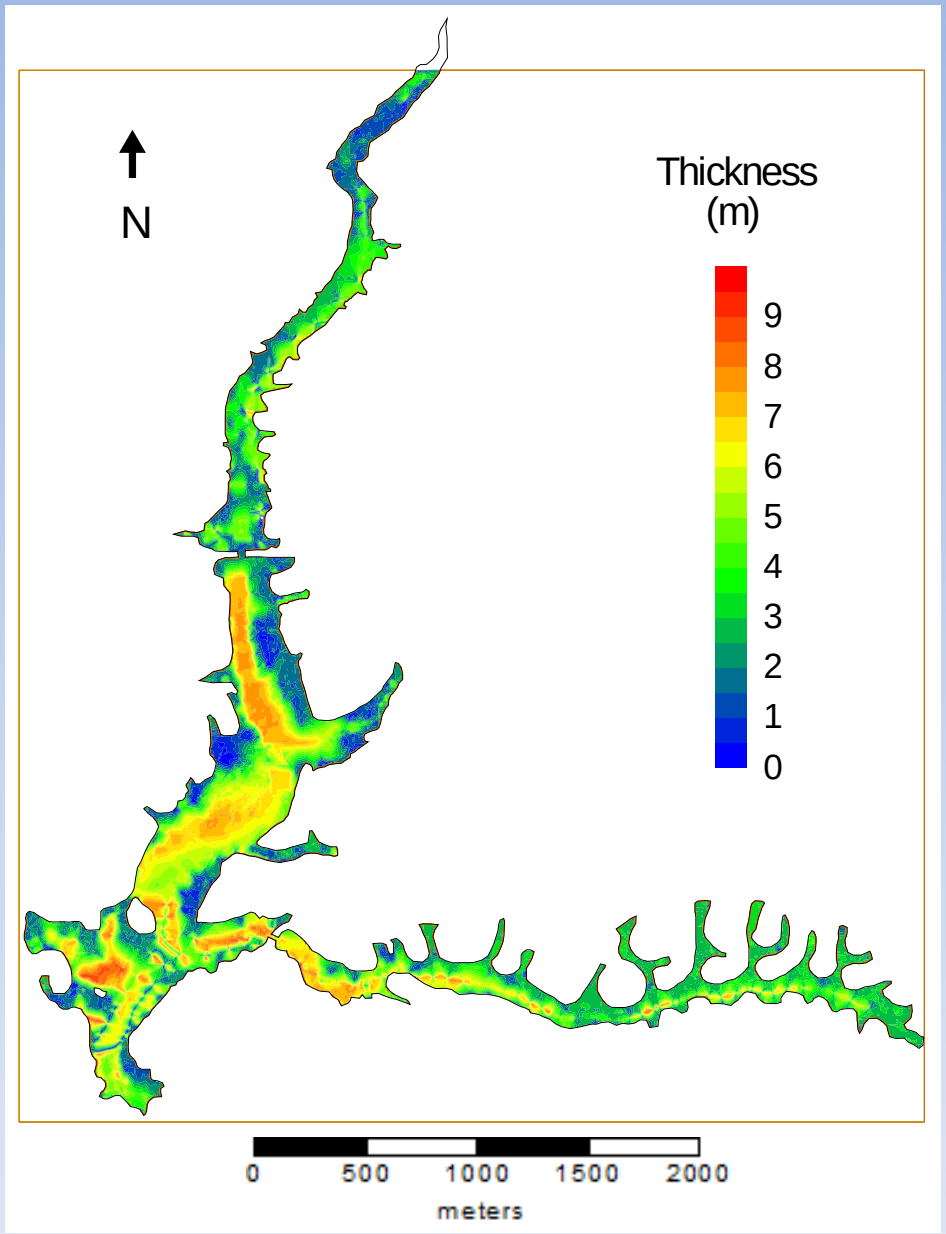


Sediment Thickness

- Echograms at 38-kHz provide information about sediment thickness

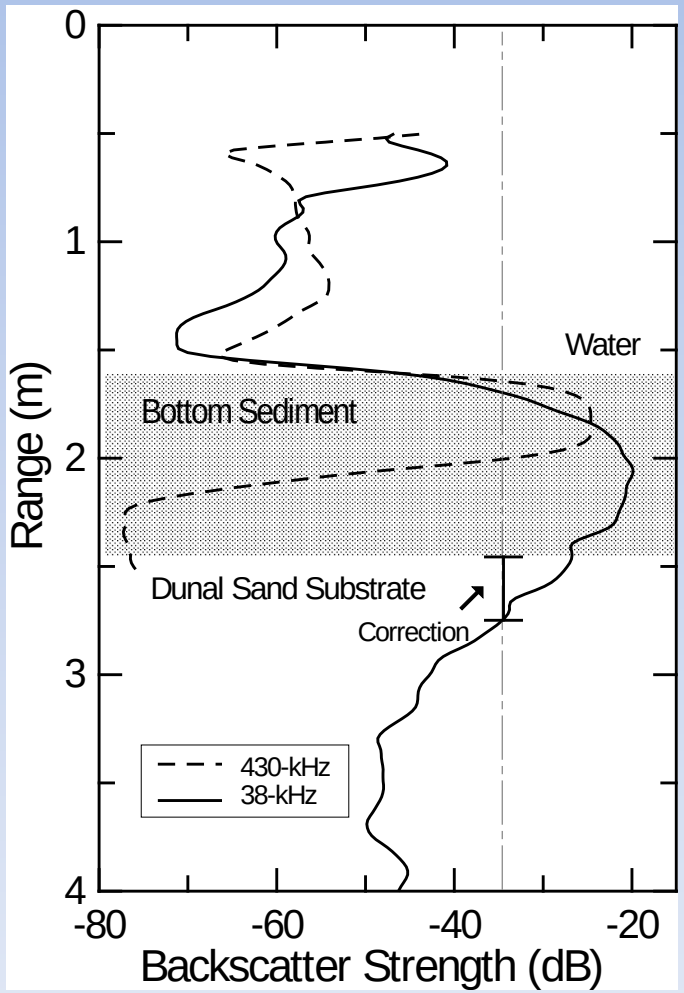


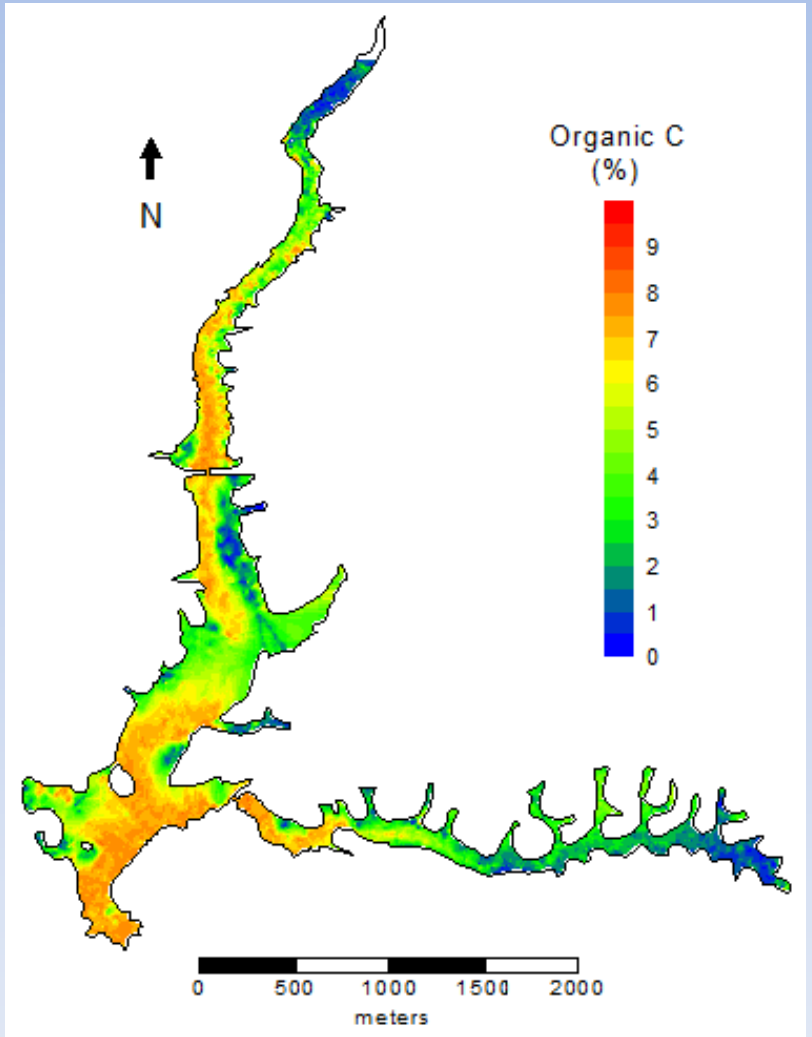
- Thickness of sediment ranged from 0 to 8 m
- Thickness varied in complex way across basin
- Sediment deposited in river channel & deeper areas of basin
- Sedimentation has reduced capacity by >4000 af



Sediment Properties

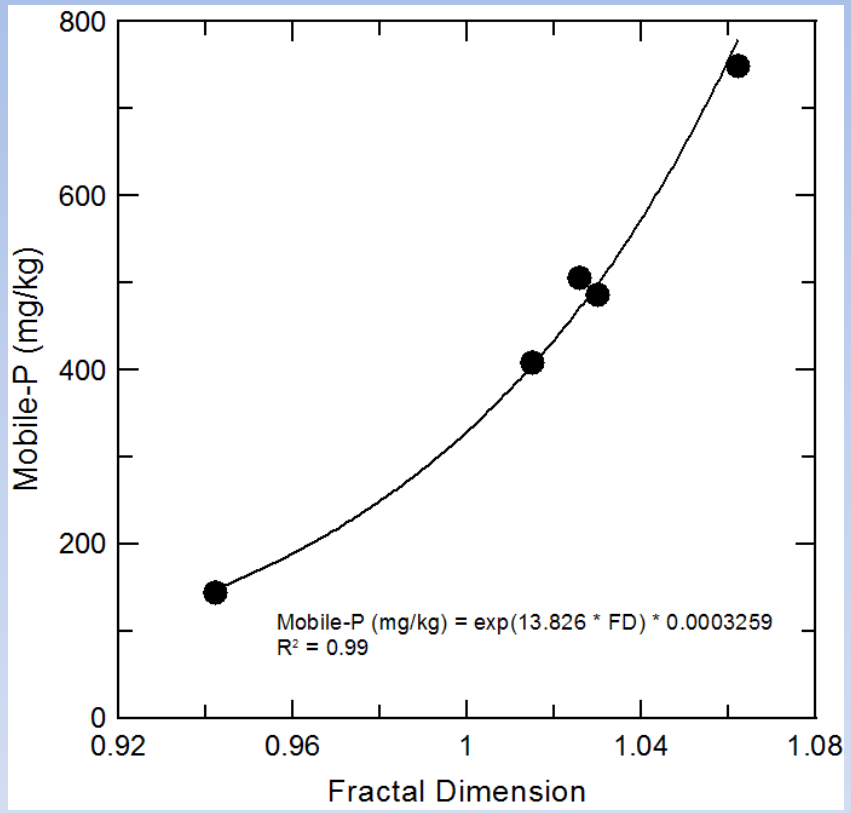
- Attributes of bottom echo correlated with properties
- Fractal dimension strongly correlated with organic C %





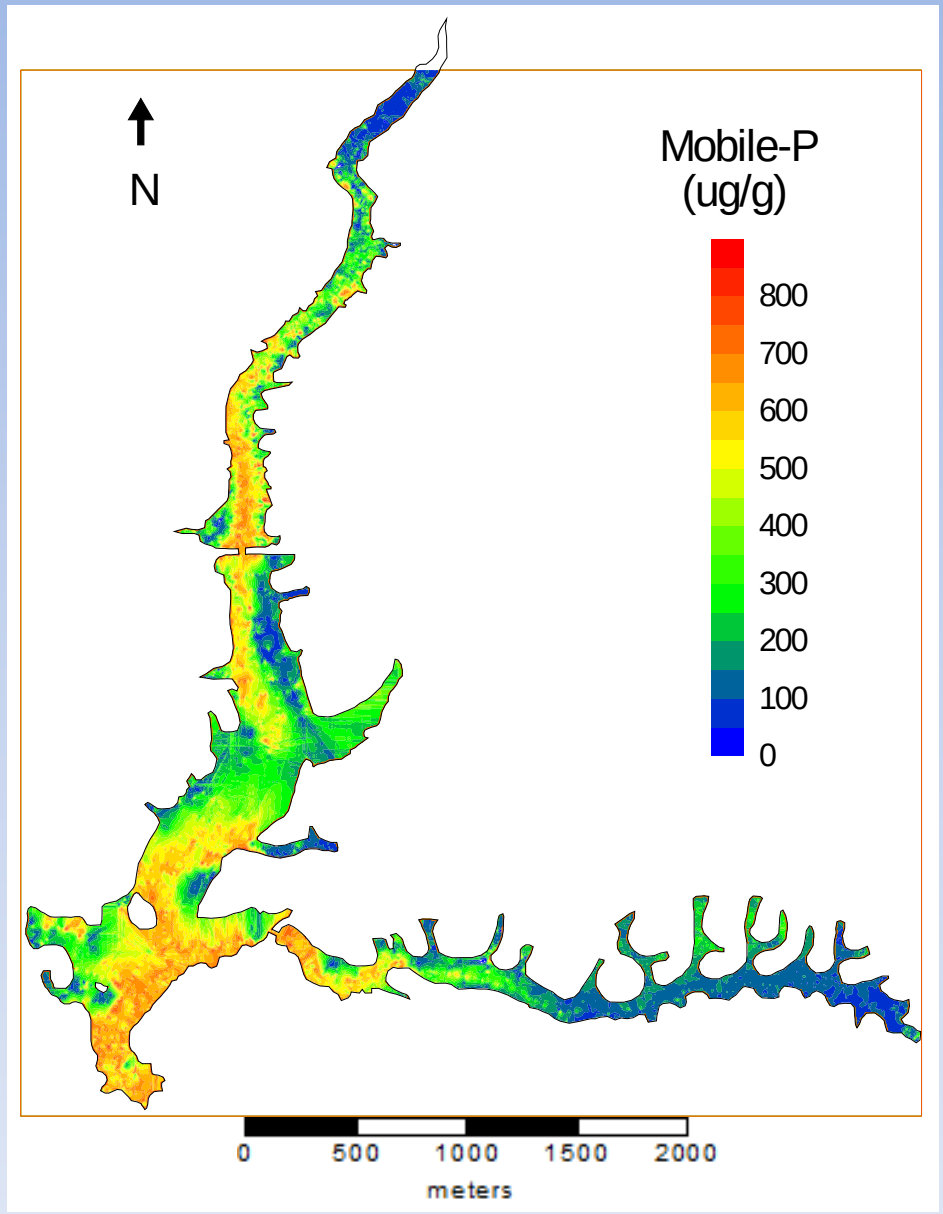
Mobile-P

- Fractal dimension also correlated with mobile-P content of sediments
- Equation used to estimate mobile-P across basin



Mobile-P

- Mobile-P content of surficial sediments enriched in original river channel north of Causeway
- Mobile-P also elevated in deeper sediments near closer to dam
- This distribution can help guide alum treatment for sediment inactivation



Conclusions

- Survey provide up to date bathymetry and elevation-area-volume relations for Canyon Lake
- Measurements also provide new insights into the distribution, thickness and properties of sediment within the lake
- Sedimentation projected to have reduced storage capacity by >4000 af
- Sediments enriched in mobile-P and organic matter deposited in deeper regions of lake, and represent regions of greater nutrient flux and oxygen demand

Lake Elsinore & Canyon Lake Nutrient TMDLs
Draft Phase 2 Monitoring Plan

Nancy Gardiner
January 13, 2015

amec foster wheeler

HALEY & ALDRICH

Phase 2 Monitoring: Focus on Two Objectives

- Evaluate status and trends towards achieving response targets and determine how to quantify the amount of influence natural background has on the status and trend (highest priority/easiest)
- Quantify the external pollutant loading originating in the upstream watershed above the lakes

Additional Objectives

- Support stormwater compliance activities by stakeholders in the watershed (MS4 permit)
- Support land use monitoring requirements related to the Conditional Waiver for Agricultural Dischargers (CWAD)

Watershed-Wide Monitoring

- Monitor during storm events (3/year) and monthly during dry weather (when conditions allow):
  - San Jacinto River @ Goetz Road
  - Salt Creek @ Murrieta Road
  - San Jacinto River below Railroad Canyon (Canyon Lake) Dam (when dam is spilling)
  - San Jacinto River @ Ramona Expressway (not expected to flow except under extremely high rainfall conditions)

Watershed-Wide Monitoring

- Sample at one or more additional “contingency” sites that may change from year to year
- Collect data from a new area or to help answer a technical study question

  Examples:

  - Background station
  - Agricultural land use station
  - Site impacted by wildfire
  - Other examples?

Watershed-Wide Monitoring

- Sample same constituents that historically have been measured

Turbidity	Nitrate Nitrogen	Total Suspended Solids
Water Temperature	Ammonia Nitrogen	Chemical Oxygen Demand
pH	Total Kjeldahl Nitrogen	Biochemical Oxygen Demand
Total Organic Nitrogen	Total Phosphorous	Total Dissolved Solids
Nitrite Nitrogen	Soluble Reactive Phosphorous	Total Hardness

In-Lake Monitoring Study Questions

- What is the status and trend of each lake towards achieving TMDL response targets?
- Are prior monitoring methods providing sufficiently representative values for TMDL compliance assessment over time?
- What is the extent of influence of in-lake aeration at Lake Elsinore?
- How are plankton communities responding to in-lake management strategies in both Lake Elsinore and Canyon Lake?

In-Lake Core Monitoring

- Sample historical locations to maintain consistency and facilitate assessment of trends
- Lake Elsinore
  - 3 lake monitoring sites, monthly/bi-weekly sample collection (e.g., at historical sampling locations)
  - Depth-integrated sampling and in-situ field monitoring
- Canyon Lake
  - 3 locations, monthly sample collection (two in main body, one in East Bay)
  - Same sampling approach as in Lake Elsinore

Candidate Special Studies

- Two categories of special studies
  - Water quality
  - Biological
- Conduct in near term (~ next 1-2 years)
- Gain a better representation of water quality in Lake Elsinore and Canyon Lake for assessment of TMDL compliance

WQ Special Study 1 – Existing Data Assessment & Enhance Monitoring in LE

- Gather more accurate measurements of DO
  - Mine and analyze existing data collected by EVMWD's two sondes used for monitoring the aeration system
  - Install additional sondes at the TMDL monitoring stations to collect data further away from the aeration system and compare results with field collected data

WQ Special Study 2 – Enhanced In Situ Sonde Monitoring in CL

- No existing sondes present in Canyon Lake
- Install sondes at the 3 TMDL monitoring locations and one additional location in the East Bay

WQ Special Study 3 – Comparison of Depth-Integrated and Discrete Sampling in CL

- Collect both depth-integrated and discrete samples at the 2 TMDL stations in the main body
- Further investigate existing historical data from 2007-2012 to explore potential differences related to sampling techniques and calculation methods

WQ Special Study 4 – Satellite Imagery Measurements for Chlorophyll-a

- Conduct monthly satellite mapping of chlorophyll-a in both lakes (summer months only in LE)
- Consider reducing the resolution (pixels per acre) to optimize costs versus resolution

Biological Monitoring Special Study in LE

Zooplankton

- Monthly sampling for zooplankton at one location (TMDL Site 2)
- Conduct using same methods as in 2004 and 2011 (composite from 3 replicate vertical tows using a Wisconsin plankton net)
- Identify and enumerate zooplankton and assess reproductive index

Biological Monitoring Special Study in LE

Phytoplankton

- Conduct using same methods as in 2003 and 2011 (depth-integrated 0-2m samples using polycarbonate tube sampler)
- Quantify major algal groups and assess primary productivity

Biological Monitoring Special Studies in CL

- Limited data on plankton are available for Canyon Lake
- Recommend conducting similar studies described for Lake Elsinore at the 3 TMDL monitoring locations at a minimum of 4 months

Special Studies to Assess Daphnia Species Potential as Phytoplankton Grazers

- Healthy zooplankton population (Daphnia) is important to keep lake in balance
- Threats to populations of Daphnia species:
  - Predation by threadfin shad
  - Lack of vegetation habitat
  - Elevated conductivity/TDS
  - Food quality
- Recommendation: conduct additional special studies to build on past/current efforts by others

Zooplankton Special Study 1: Ion Concentration Evaluation

- Measure natural ion concentrations over 1 year
  - Monthly at central lake location in LE and CL
  - Quarterly in major source waters (reclaimed water and in-lake groundwater wells)
  - Composite stormwater samples during 3 storms at the 3 historical monitoring sites
- Evaluate relative change in ion concentrations and ratios throughout the year and compare to published information regarding toxicity to Daphnia

Zooplankton Special Study 2: Daphnia Food Quality and Algae Toxicity Evaluation

- Subsample phytoplankton populations from LE and CL monthly or quarterly and provide as food source to Daphnia under controlled laboratory conditions
- Assess food quality and potential toxic effects

Other Potential Special Studies

- Evaluate Wildfires as a Source of Nutrients
  - Monitor water quality immediately downstream of the burn area and compare results with historical data
- Evaluate Use of Satellite Imagery for Phosphorous and Other Constituents
  - Conduct a pilot study using this new technology

Other Ideas/Suggestions

- Determining the capacity of Mystic Lake
- Sampling at a location above Mystic Lake
- Developing a documentation and reporting dashboard

Discussion/Comments/Next Steps