

Improving the Ecosystem Health and Water Quality of Clear Lake

Geoff Schladow, Alex Forrest and Steve Sadro
UC Davis Tahoe Environmental Research Center

gschladow@ucdavis.edu alforrest@ucdavis.edu ssadro@ucdavis.edu

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus

Data LDEO-Columbia, NSF, NOAA

Google Earth

OUTLINE

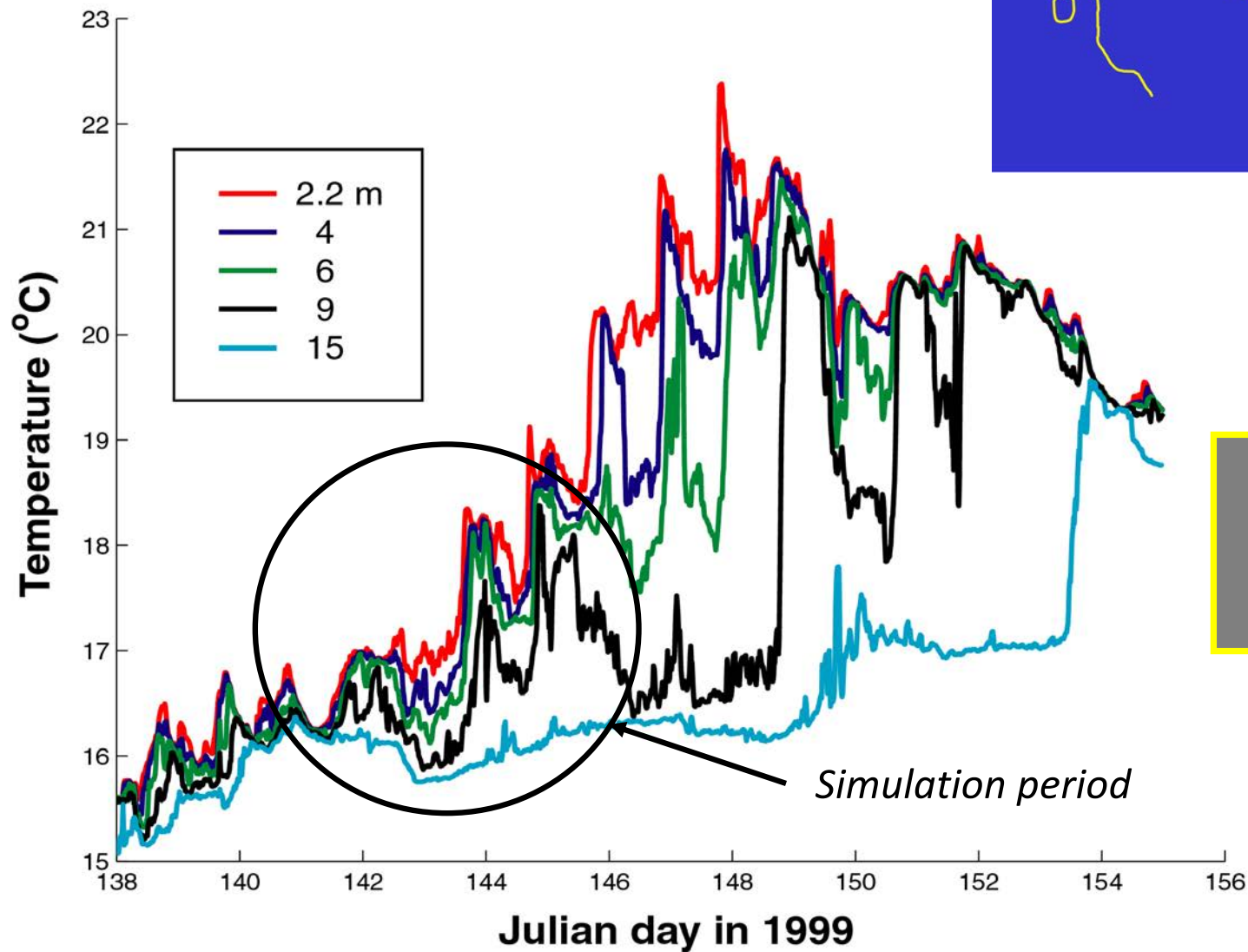
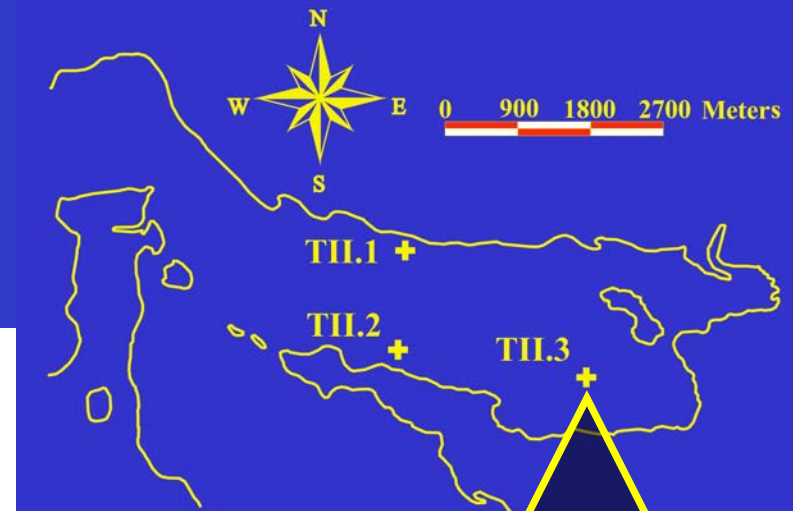
1. INTRODUCTION
2. A CONCEPTUAL MODEL OF HOW CLEAR LAKE “WORKS”
3. INTENDED WORK PLAN
 - MEASUREMENTS
 - MODELING
 - COLLABORATION
4. A FUTURE “VISION” TO CONSIDER

CLEAR LAKE IS THE MOST COMPLICATED LAKE IN CALIFORNIA

- LEGACY CONTAMINANTS
- HYPER-EUTROPHIC
- CYANOBACTERIA
- TWO EXISTING TMDLS
- THREATENED NATIVE FISH
- INVASIVE SPECIES
- THREE INTERCONNECTED BASINS
- WIND DOMINATED BY MAJOR OBSTRUCTION (MT. KONOCTI)
- LARGE ENOUGH TO BE IMPACTED BY EARTH'S ROTATION
- COMPLEX WATERSHED (WITH WILDFIRE IMPACTS – PAST AND FUTURE)
- SHALLOWNESS MEANS STRONG DOMINANCE BY SEDIMENTS
- **THERMAL STRATIFICATION VARIES DAILY-WEEKLY**

HOW CLEAR LAKE “WORKS”

Temperature stratification



IMPORTANCE OF THERMAL STRATIFICATION

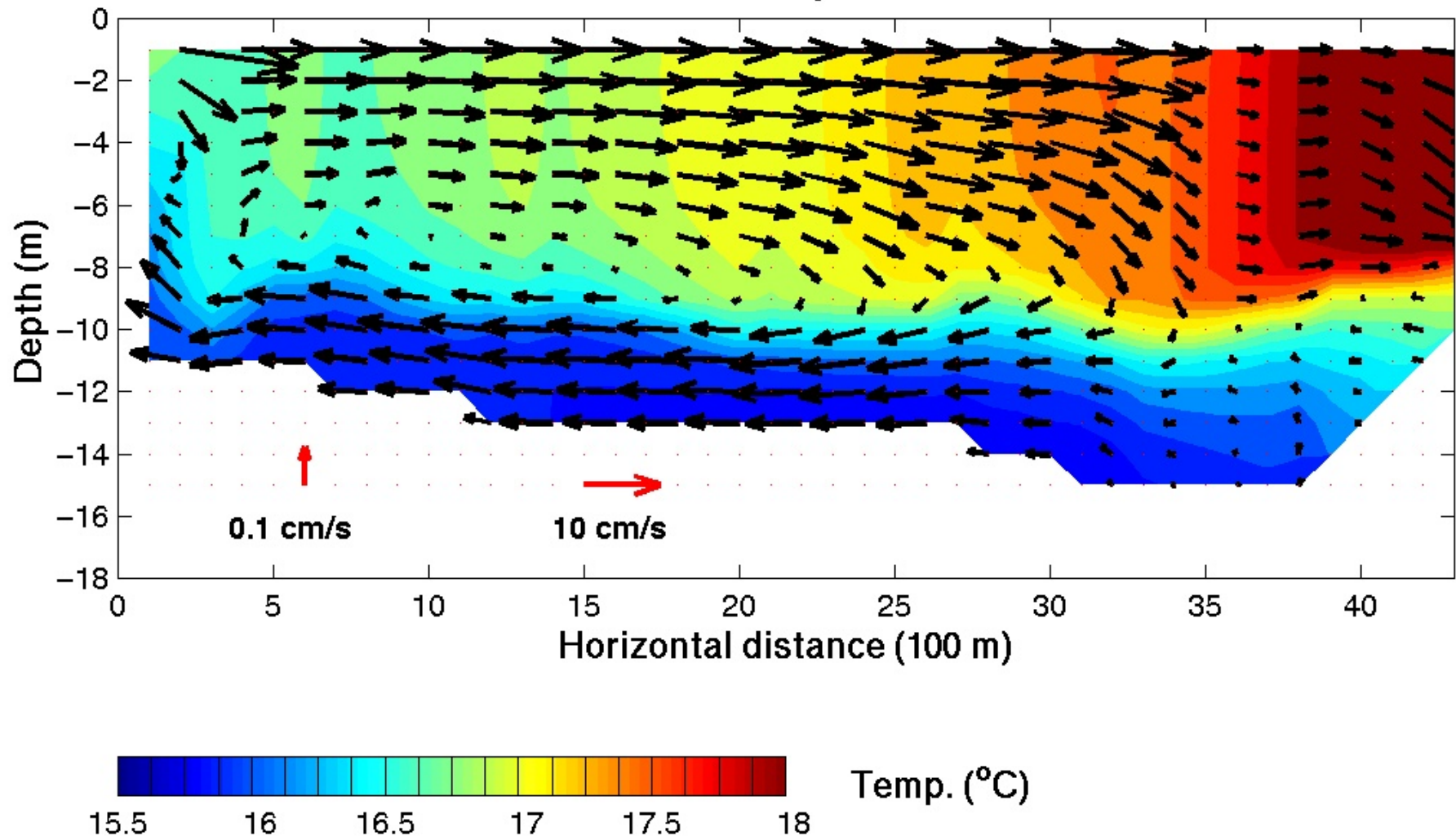
1. DISSOLVED OXYGEN (DO) IS REDUCED IN THE DEEP WATER

**2. ALLOWS FOR “INTERNAL NUTRIENT RELEASE”,
MERCURY METHYLATION, OTHER HEAVY METAL
RELEASE EPISODICALLY DURING THESE STRATIFIED
PERIODS**

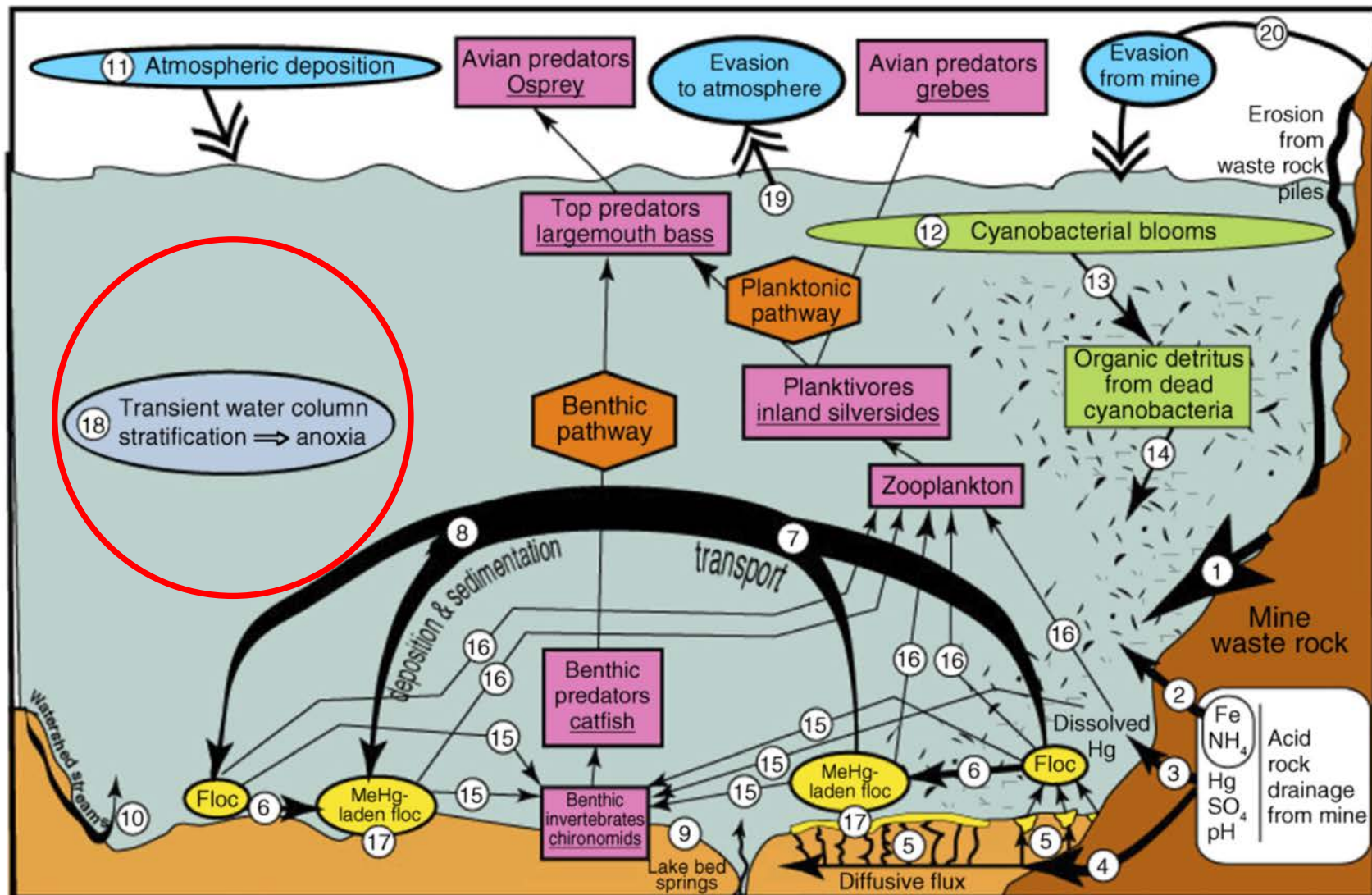
WHAT HAPPENS WHEN THE WIND BLOWS AND THE LAKE IS THERMALLY STRATIFIED?

TEMPERATURE AND CURRENTS IN THE OAKS ARM

Year=1999 Julian day=143 Hour=2000

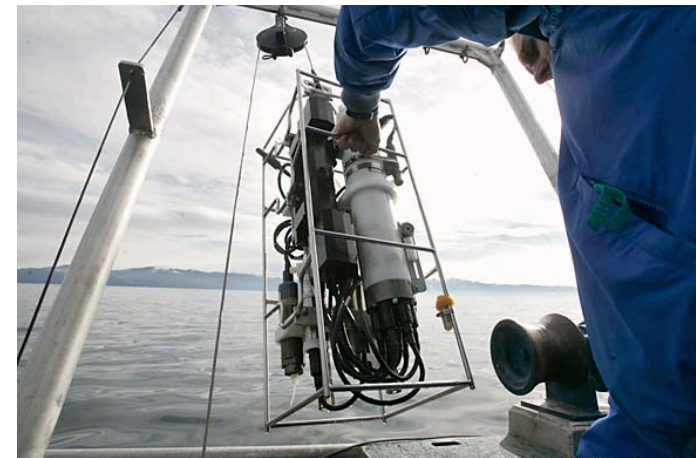


A COMPLEX CONCEPTUAL MODEL (e.g. Hg) IS MORE COMPLEX WITH MIXING AND EXCHANGE



LAKE MEASUREMENT WORK PLAN

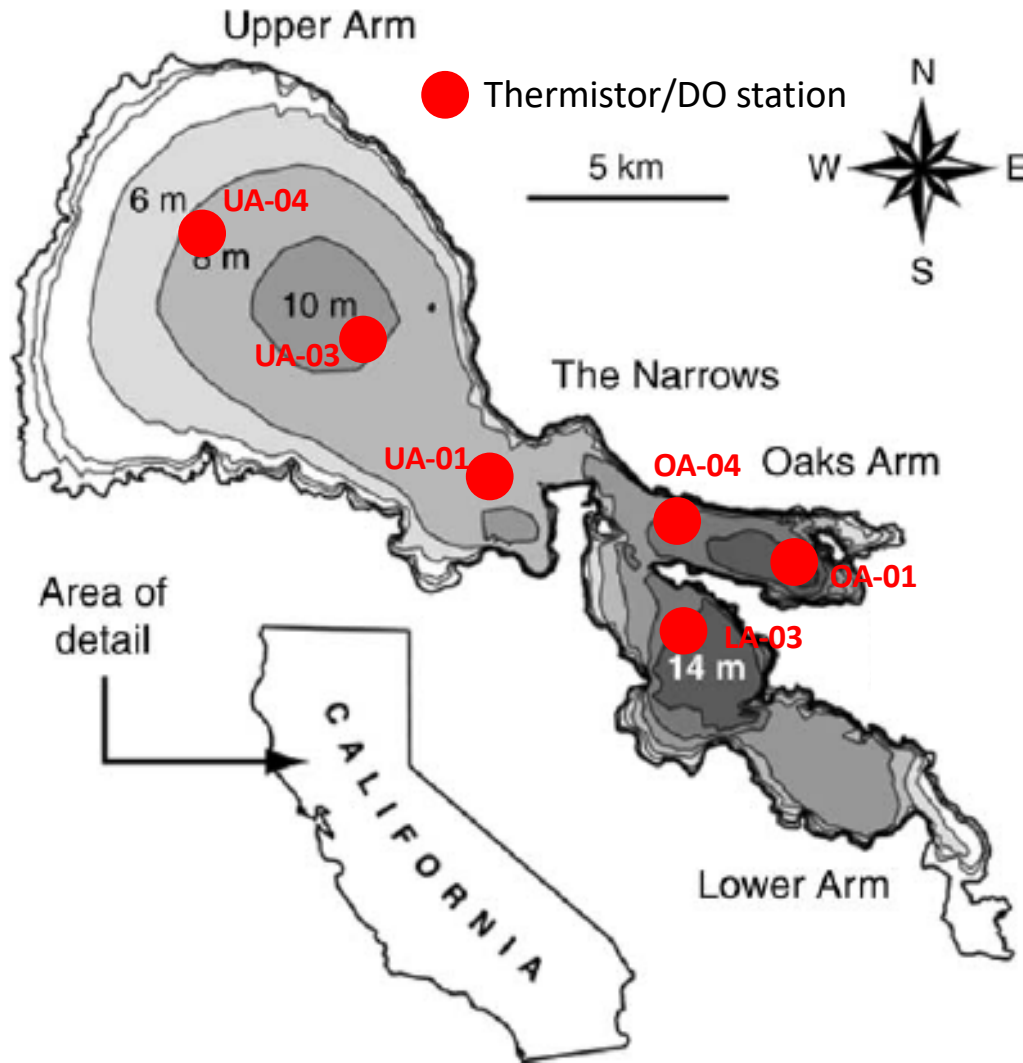
1. LAKE TEMP/DO MOORINGS PLUS ADCP (CURRENTS)
2. LAKE MONTHLY PROFILING AND SECCHI DEPTH
3. LAKE MONTHLY NUTRIENT, CHEMISTRY, PHYTOPLANKTON SAMPLING, PRIMARY PRODUCTIVITY (METABOLISM)
4. PHYTOPLANKTON BLOOM MONITORING WITH AUTONOMOUS ROBOTICS
5. *HIGH-RESOLUTION MAPPING OF LAKE BATHYMETRY BEFORE AND AFTER FIRE-RELATED SEDIMENT INFLUX TO QUANTIFY SEDIMENT FLUX AND DISTRIBUTION IN LAKE **



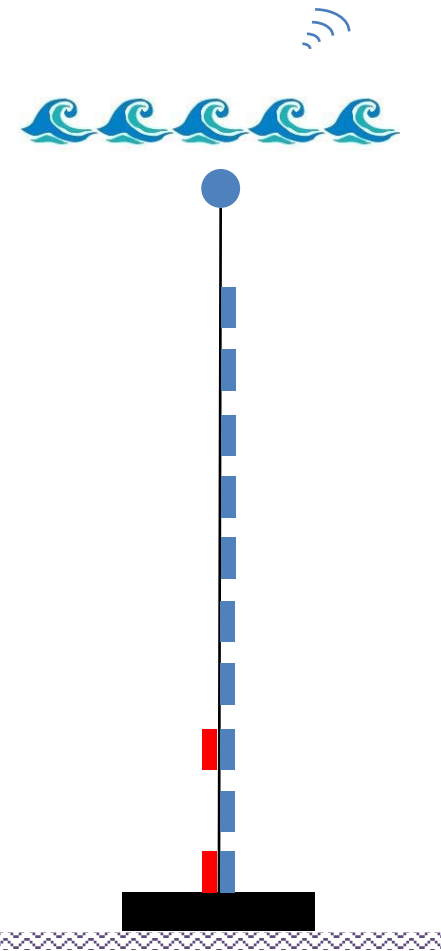
Chronicle / Eric Luse

*** UNFUNDED**

CLEAR LAKE WATER QUALITY MONITORING NETWORK

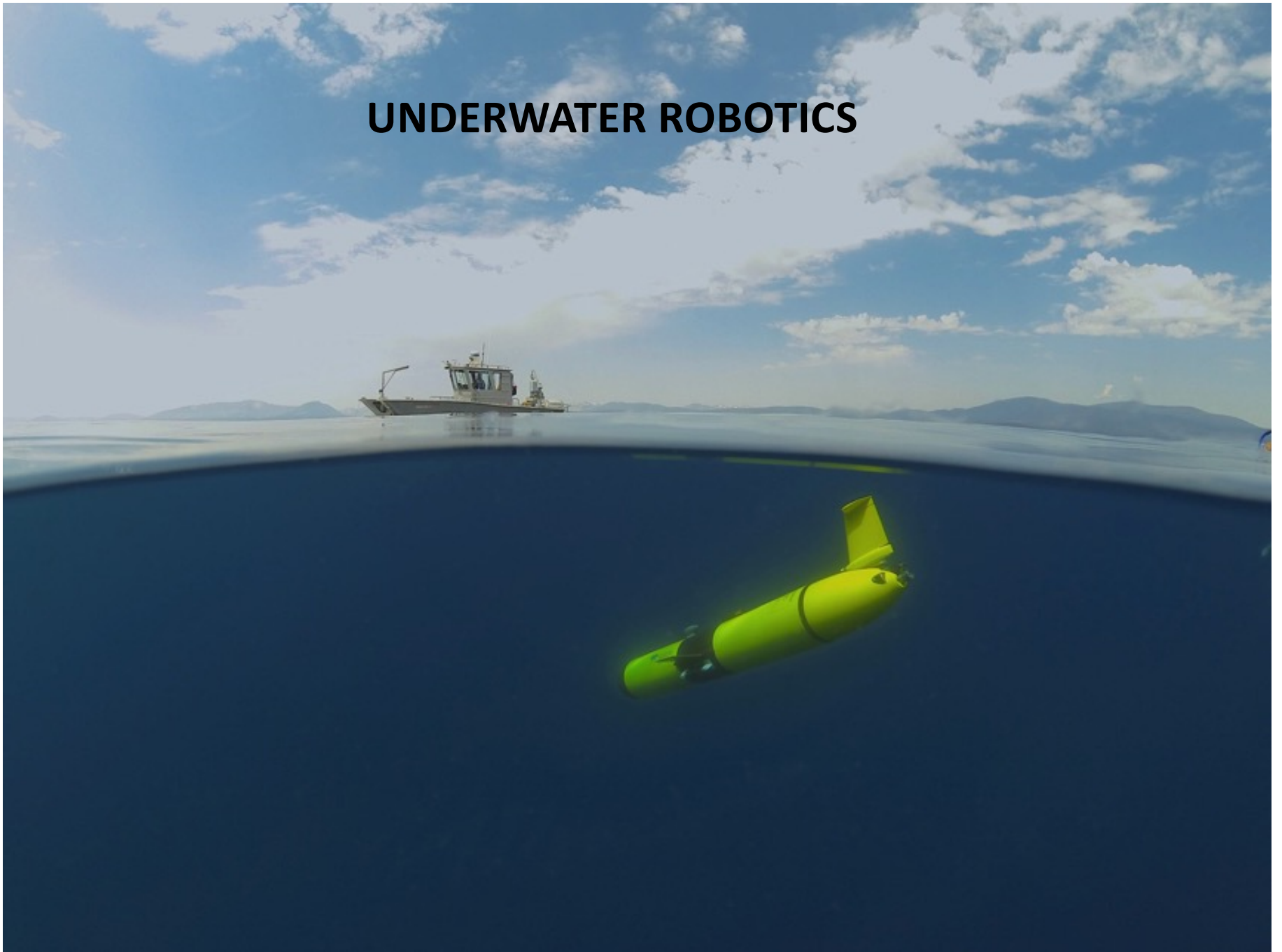


Data transfer to SQL database at UC Davis



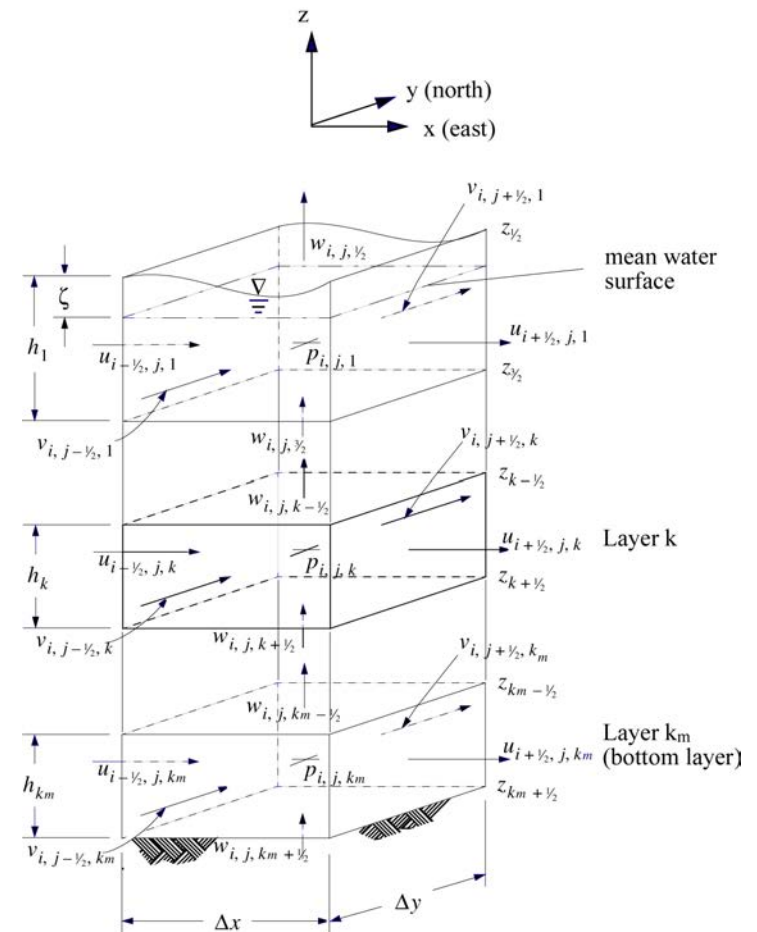
- Temperature sensor
- Dissolved oxygen sensor

UNDERWATER ROBOTICS



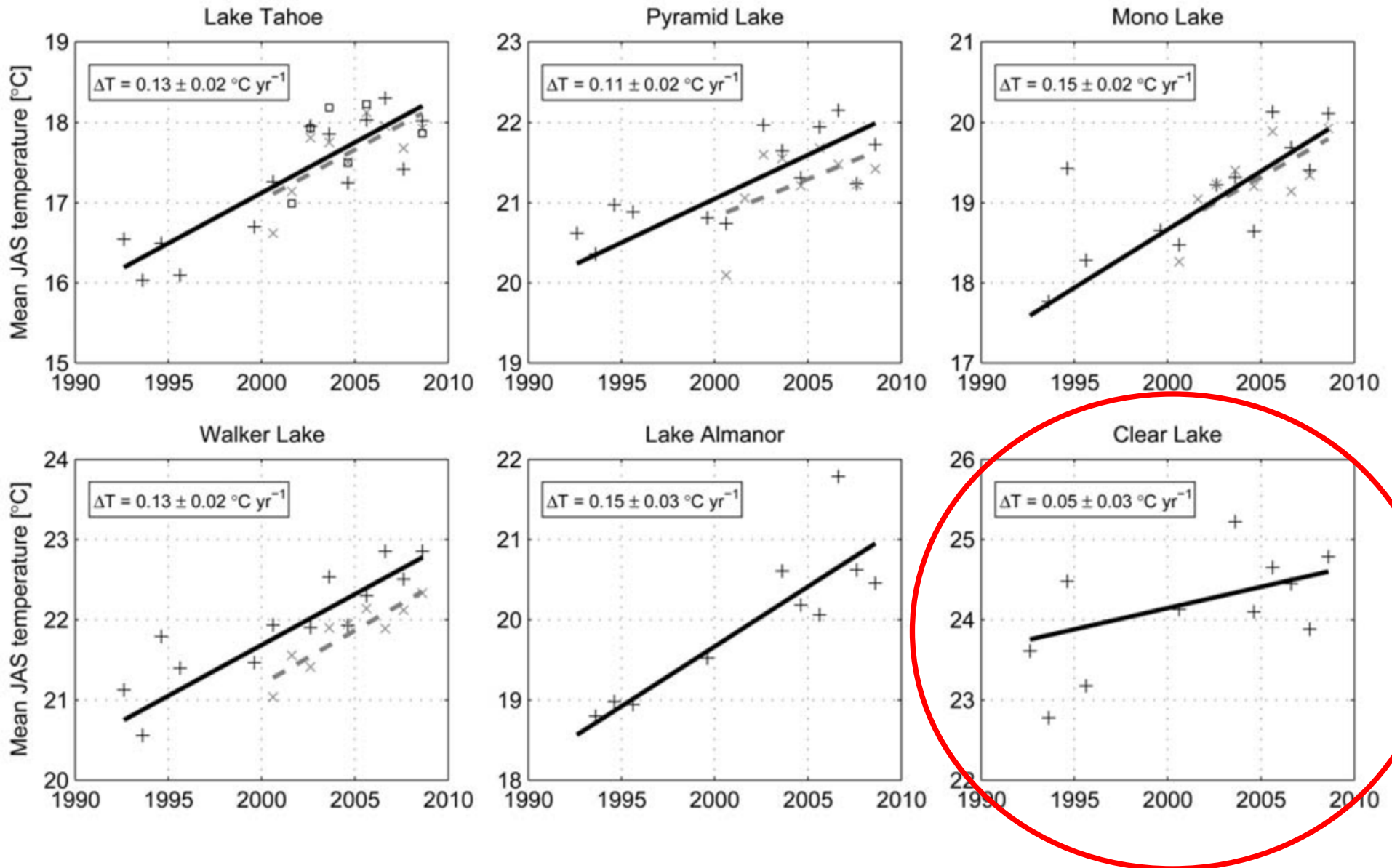
LAKE MODELING WORK PLAN

1. Si3D – peer-reviewed model that was initially developed at Clear Lake
2. Installation and maintenance of weather stations
3. *Accurate bathymetry* *
4. Impacts of climate change
5. External vs. Internal nutrients
6. Impacts of management actions – e.g. oxygen additions



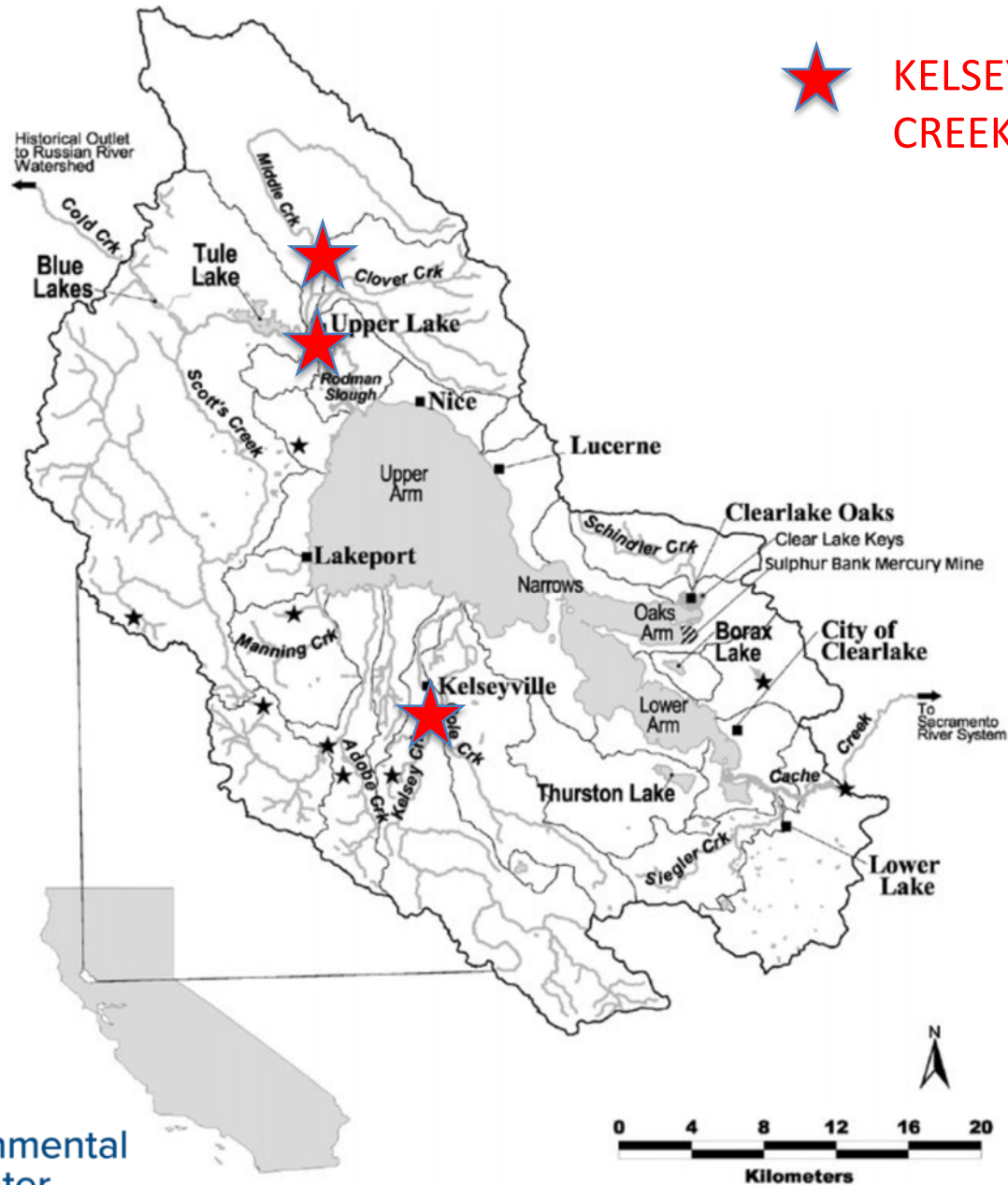
* UNFUNDED

CLIMATE CHANGE



P. Schneider, et al. 2009. Satellite observations indicate rapid warming trend for lakes in California and Nevada. *Journal, Geophysical Research Letters*, 36: L22402.

WATERSHED MEASUREMENT WORK PLAN



WATERSHED MEASUREMENT WORK PLAN

1. **THREE CONTINUOUS TURBIDITY/TEMPERATURE STATIONS**
2. **HYDROGRAPH-DRIVEN WATER SAMPLING FOR NUTRIENTS AND PARTICULATES (USING USGS SAMPLING PROTOCOLS)**
3. *CONTINUOUS NUTRIENT SAMPLING **



WATERSHED MODELING WORK PLAN

1. LSPC – used for TMDL watershed modeling at Lake Tahoe
2. 2016 Watershed LIDAR data set used for developing topography
3. Original plan to quantify stream water quality by land-use activities is on hold. Fire-related impacts will dominate for the next few years.
4. *2019 LIDAR data acquisition to quantify watershed erosion **



COLLABORATION

1. HAVE STARTED MEETING/WORKING WITH SOME STAKEHOLDERS (RCD, COUNTY, USGS, DWR...)
2. MEETINGS PLANNED WITH OTHER STAKEHOLDERS ON OCTOBER 24 (E-MAIL FROM CAROLYN ABRAMS)
3. COLLABORATIONS WILL LIKELY ALTER WORKPLAN AS A BROADER SET OF PERSPECTIVES AND EXPERTISE IS ENCOUNTERED
4. OUR TEAM CURRENTLY HAS OVER 10 FACULTY, STAFF AND GRAD STUDENTS



A FUTURE VISION TO CONSIDER

**CHANGING CLEAR LAKE WILL NEED MORE THAN MEASUREMENTS,
MODELING AND AN UNDERSTANDING OF HYDROLOGY AND LAKE
PROCESSES**

A TOTALLY NEW PARADIGM IS NEEDED



HERE IS ONE POSSIBLE PARADIGM

Hoover Dam has **2000 MW of Generating Capacity**



- **Clear Lake area = 43,500 acres**
- **1% of area = 435 acres**
 - **1,950 MW generating capacity with PVs**
- **World's largest floating PV system currently 1500MW**

- Clear Lake Is a center for clean, renewable energy
- Part of the energy used to prevent internal nutrient loading and mercury methylation.
- As a hyper-eutrophic lake, Clear Lake contributes GHG to the atmosphere. Restoring it would be a GHG reduction strategy
- Reduction of GHG and production of solar power eligible for Cap and Trade funding

NET RESULT

Clear Lake has no algal blooms, no mercury, no excessive nutrients. It is the largest solar producer in the country (maybe the world). It leverages that into building a national model for a zero-emission, organic, and sustainable community