



MERCURY IN MOTION:
**An Examination of Mercury Mobilization and
Transformation Associated With Wetland Restoration in
South San Francisco Bay**

M. MARVIN-DIPASQUALE

B. JAFFE, J. ACKERMAN & G. SHELLNBARGER

U.S. GEOLOGICAL SURVEY

D. SLOTTON

UNIV. CALIFORNIA - DAVIS



USGS National Research Program

Biogeochemistry at Regional Scales



JENNIFER AGEE
Biologist
Lab Manager, Data Guru



LISAMARIE WINDHAM-MYERS
Wetland Ecologist; Ph.D.



EVANGELOS KAKOUROS
Chemist
ICP-MS Guru
Field & Lab technician



TRAVIS CONLEY
Student Intern
Field & Lab technician



LE KIEU
Biologist
Field & Lab
technician

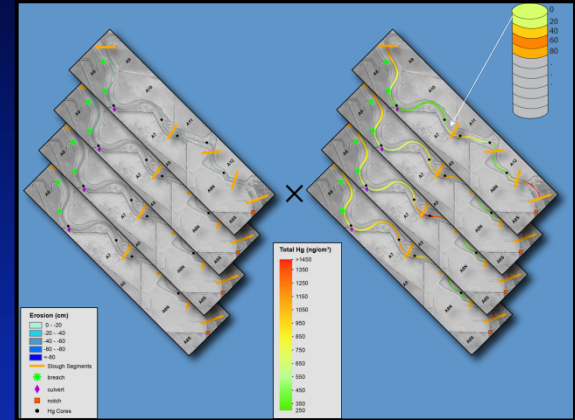


MICHELLE ARIAS
Physical Science
Field & Lab technician

Mercury in Motion – 3 Short Stories

(California)

I. 2006 & 2012 Deep Cores / Bed Sediment & Hg Mobilization

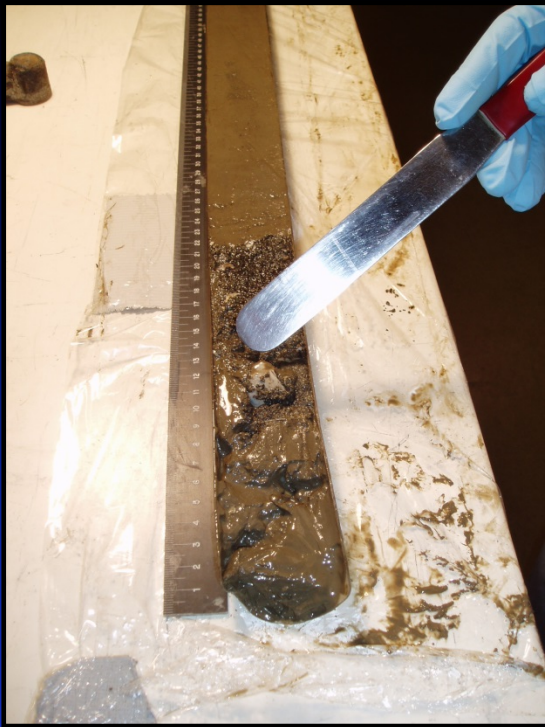


II. Pond A8 Notch Opening / 'Biosentinal Toolbox'



III. Water Column Hg Flux / 24-Hr Studies

I. 2006 & 2012 Deep Cores / Bed Sediment & Hg Mobilization

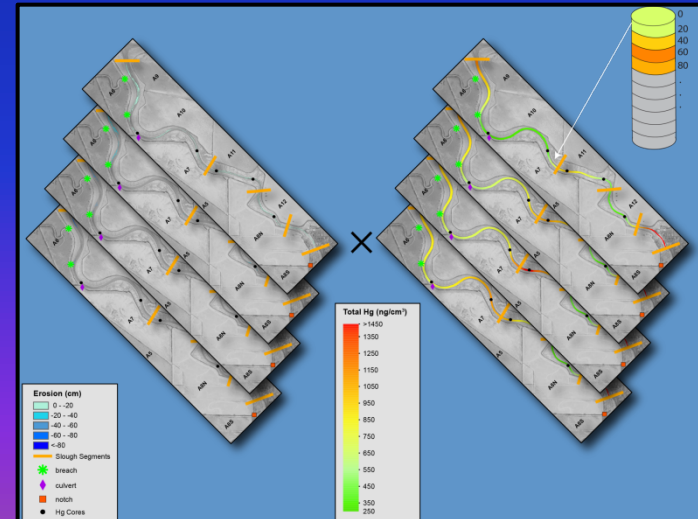


2006 Collaboration with SFEI & UC Berkeley

- Collect 15 deep (2 meter cores) in Alviso Sl.
- Main channel and fringing Marsh
- Quantify Hg species & potential mobilization
- Based on 20 ft. & 40 ft. A8-Notch scenario

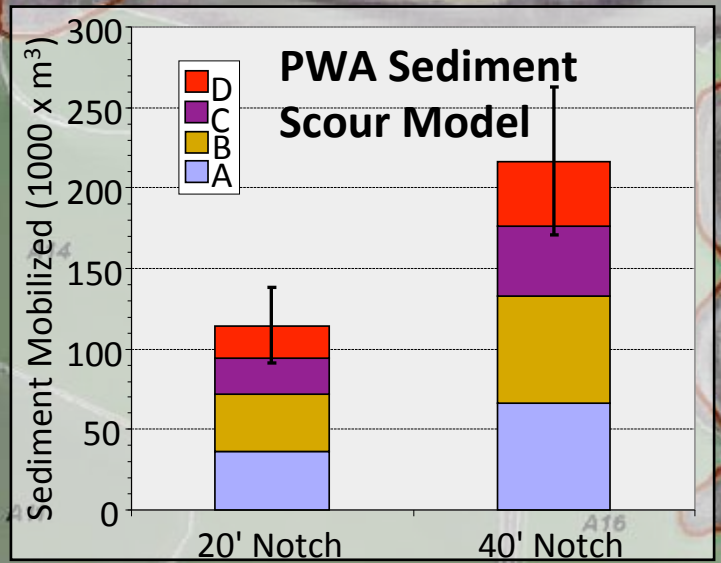
2012 Collaboration with B. Jaffe (USGS)

- Collect 4 additional deep (2 meter cores) in Alviso Sl.
- Main channel only
- Combine with 2006 data
- Use bathymetry models to quantify sediment & Hg mobilization since A8-Notch opening
- Compare to original predictions

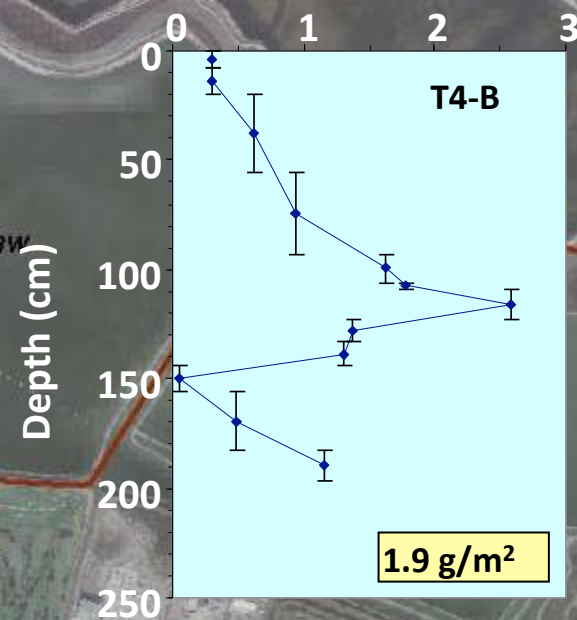


USGS & SFEI: 2006 Deep Cores

**Total Mercury
in Alviso Slough:
1,650 kg**



THg ($\mu\text{g}/\text{cm}^3$)



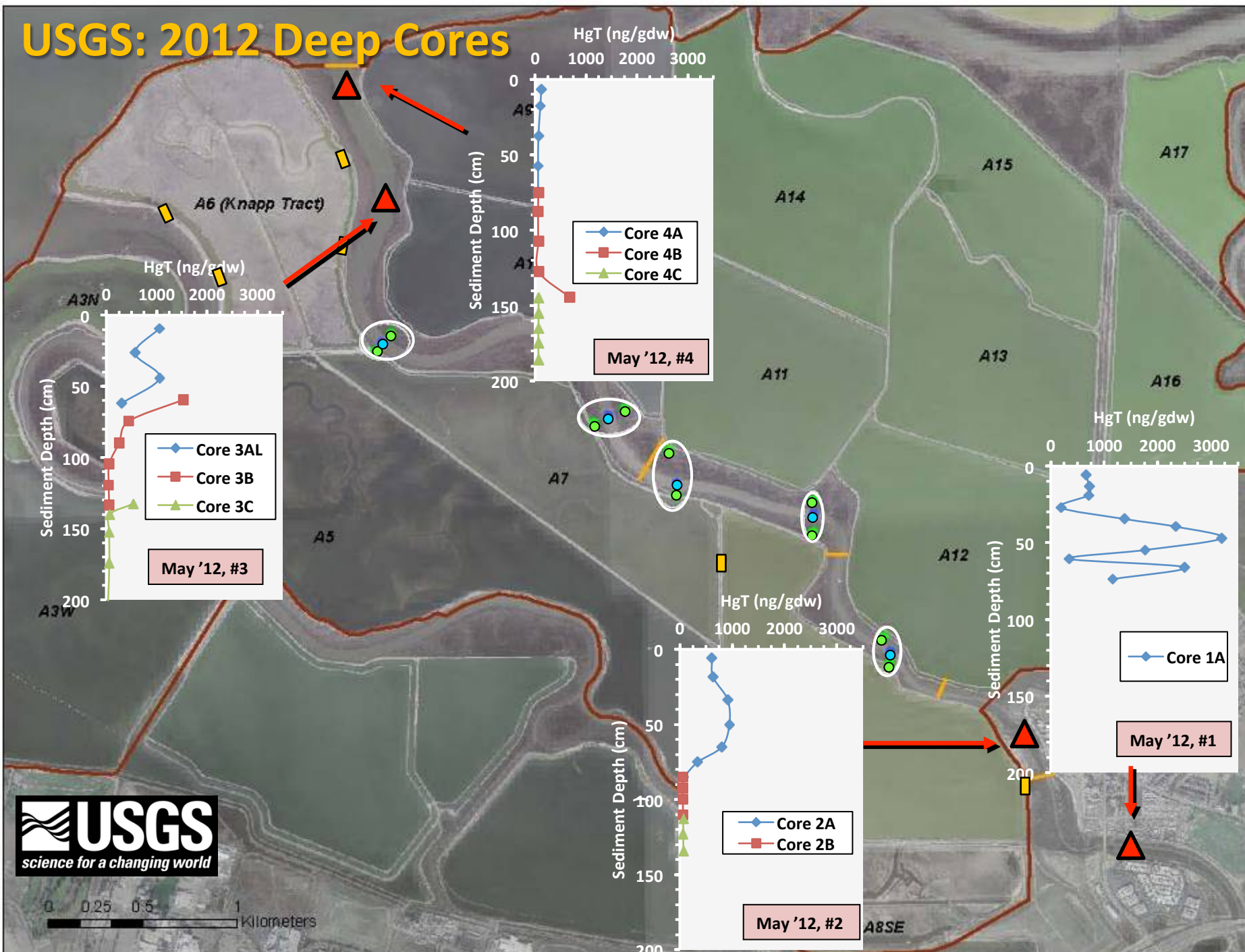
Mercury Mobilized

Scenario	THg
20 ft. Notch	66 kg
40 ft. Notch	125 kg

Proposed A8 notch location



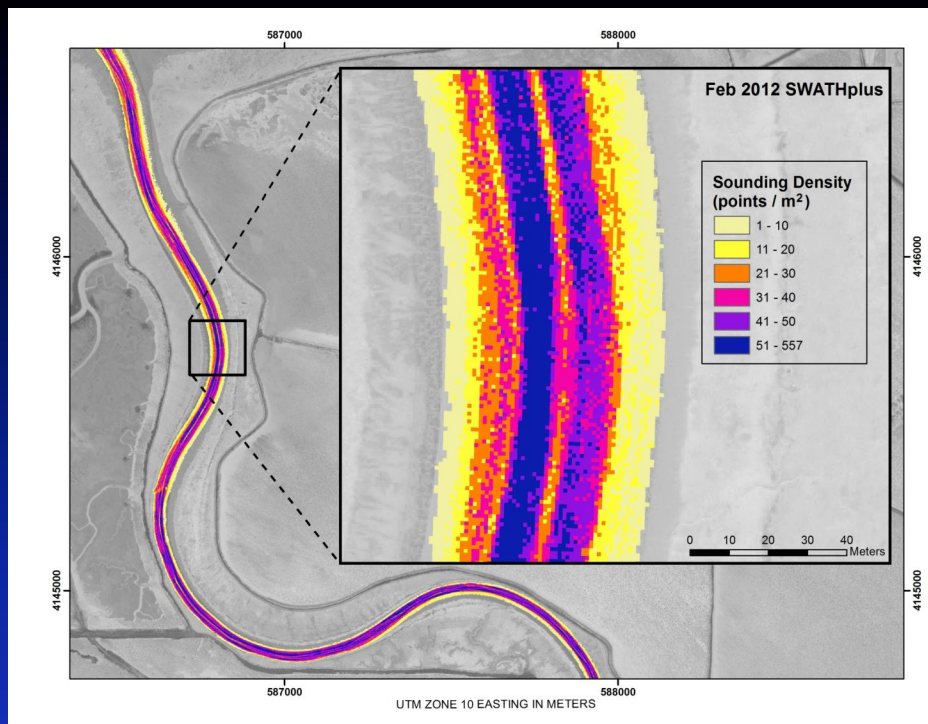
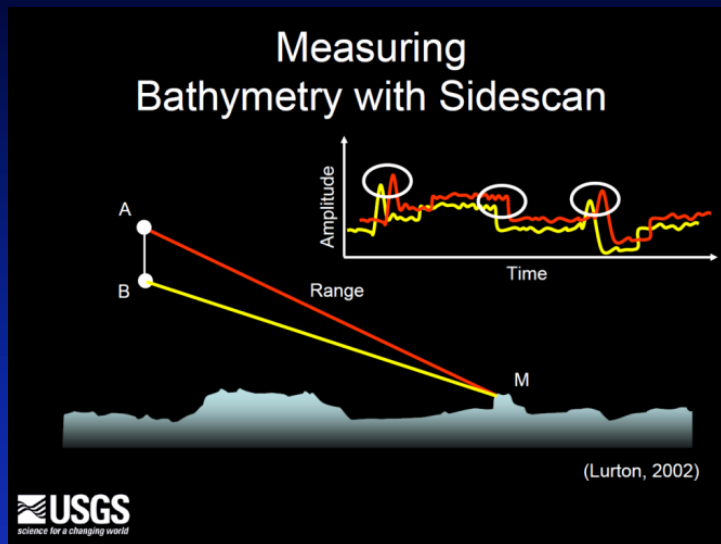
USGS: 2012 Deep Cores



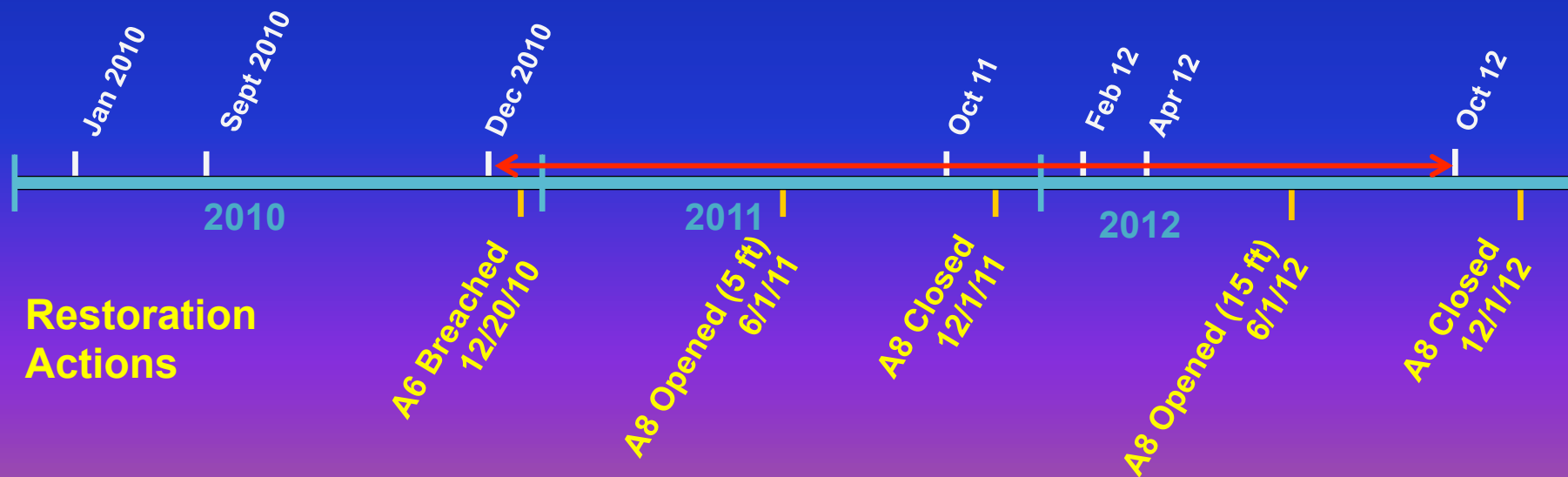
0 0.25 0.5 1 Kilometers

USGS Bathymetric Surveys

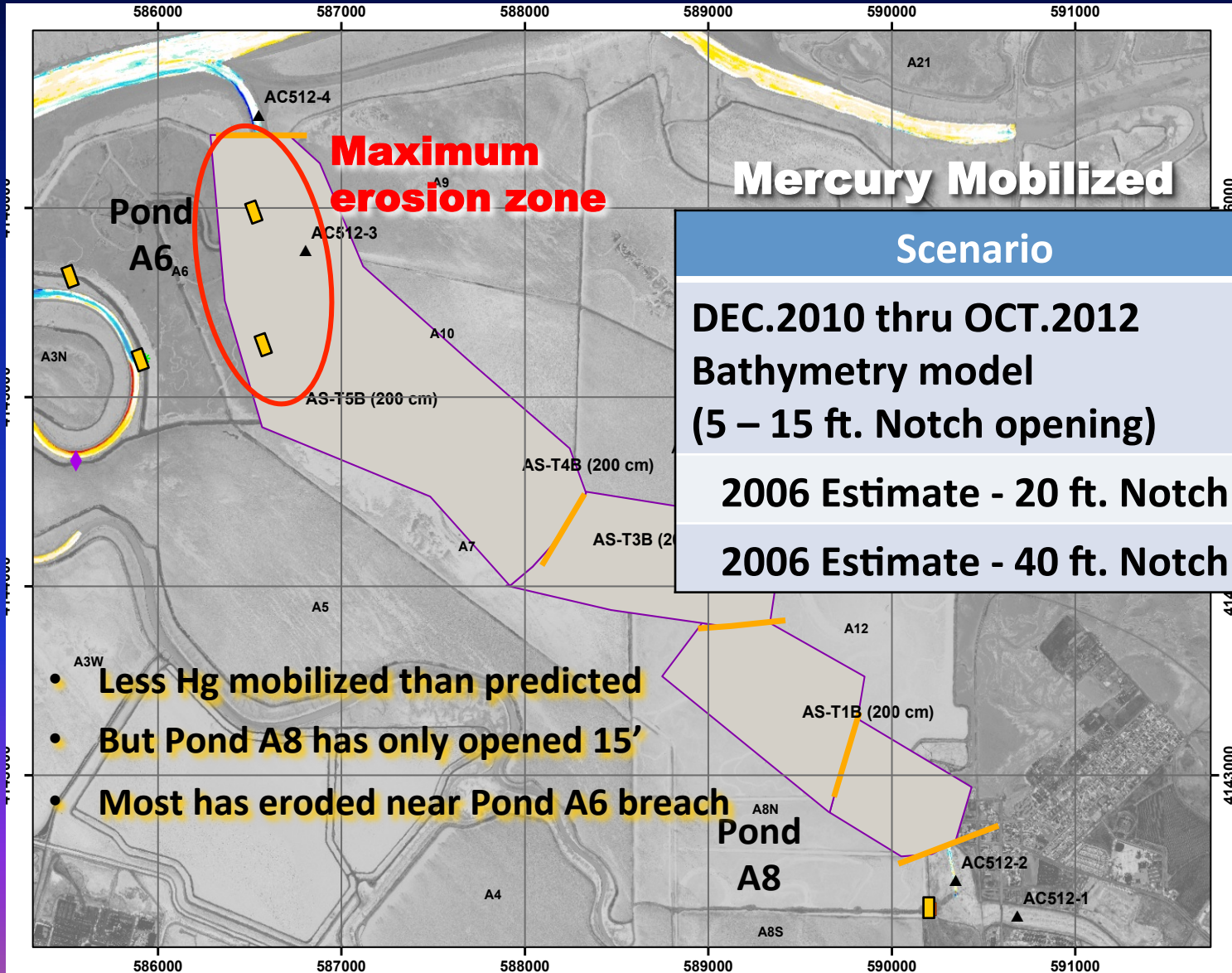
(B. Jaffe, A. Foxgrover, T. Fregoso)



Bathy Surveys



I. 2006 & 2012 Deep Cores / Bed Sediment & Hg Mobilization



Mercury Mobilized

Scenario	THg (kg)
DEC.2010 thru OCT.2012 Bathymetry model (5 – 15 ft. Notch opening)	10.6 – 14.4
2006 Estimate - 20 ft. Notch	66
2006 Estimate - 40 ft. Notch	125

- Less Hg mobilized than predicted
- But Pond A8 has only opened 15'
- Most has eroded near Pond A6 breach

II. Pond A8 Notch Opening / 'Biosentinal Toolbox'

USGS & UC-Davis collaboration

Document changes in Hg:

- Sediment and water
- Biosentinel fish
- Bird eggs

A8 Notch Construction



Where:

- Pond 'A5/A7/A8 Complex'
- Alviso Slough
- REFERENCE Ponds and Slough

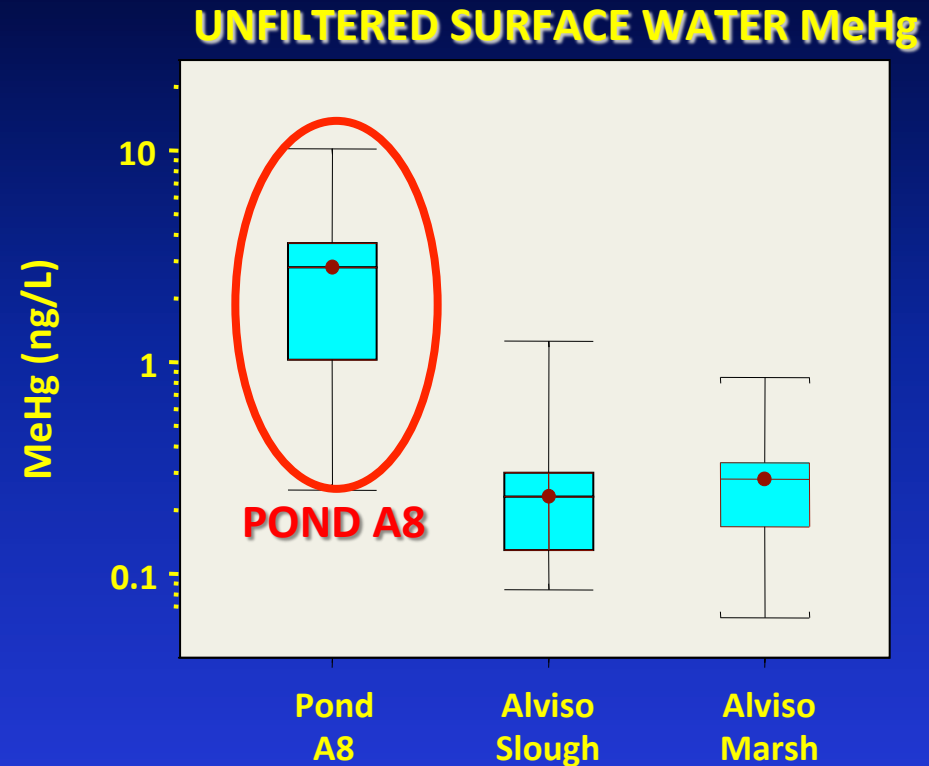
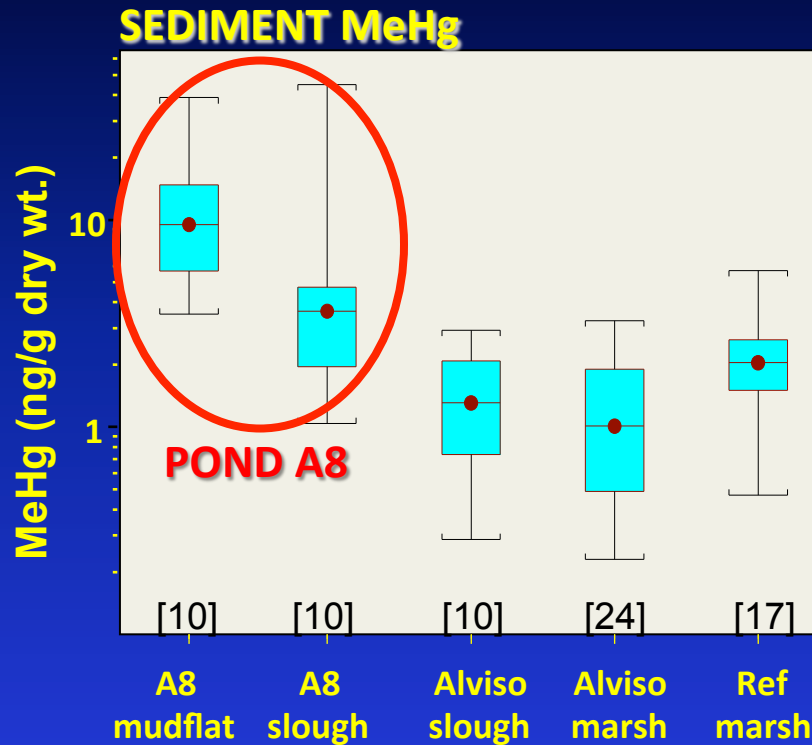
When:

- 2010 (Pre-Notch Opening)
- 2011 (Post-Notch Opening)
[JUNE 1, 2011; 5 ft]

A8 Notch Opening



Previous USGS & SFEI Study [2007-2008]

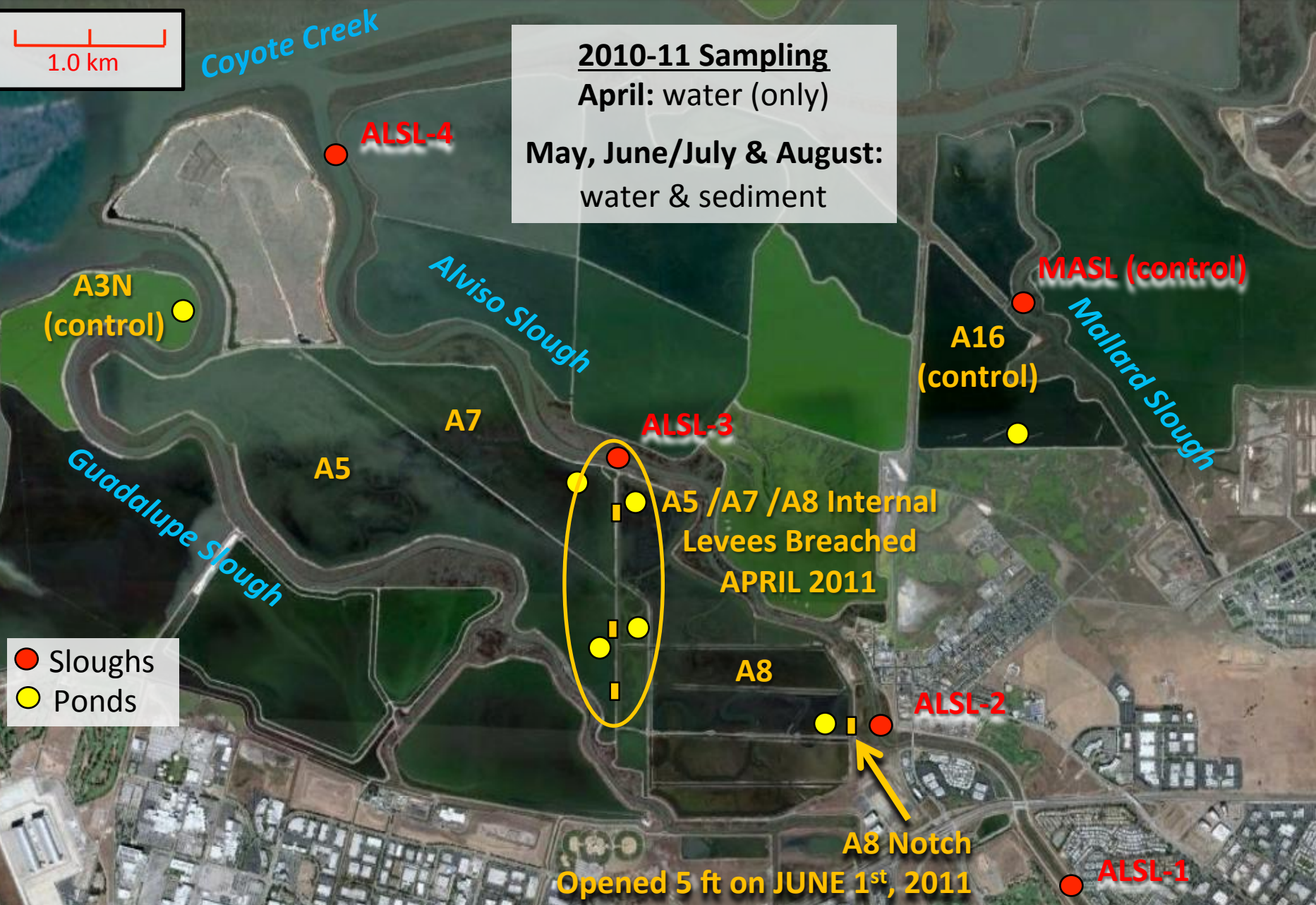


- Pond A8 very contaminated w/ MeHg (sediment & water)
- Predicted: this would improve if tidal flushing was restored

Study Design

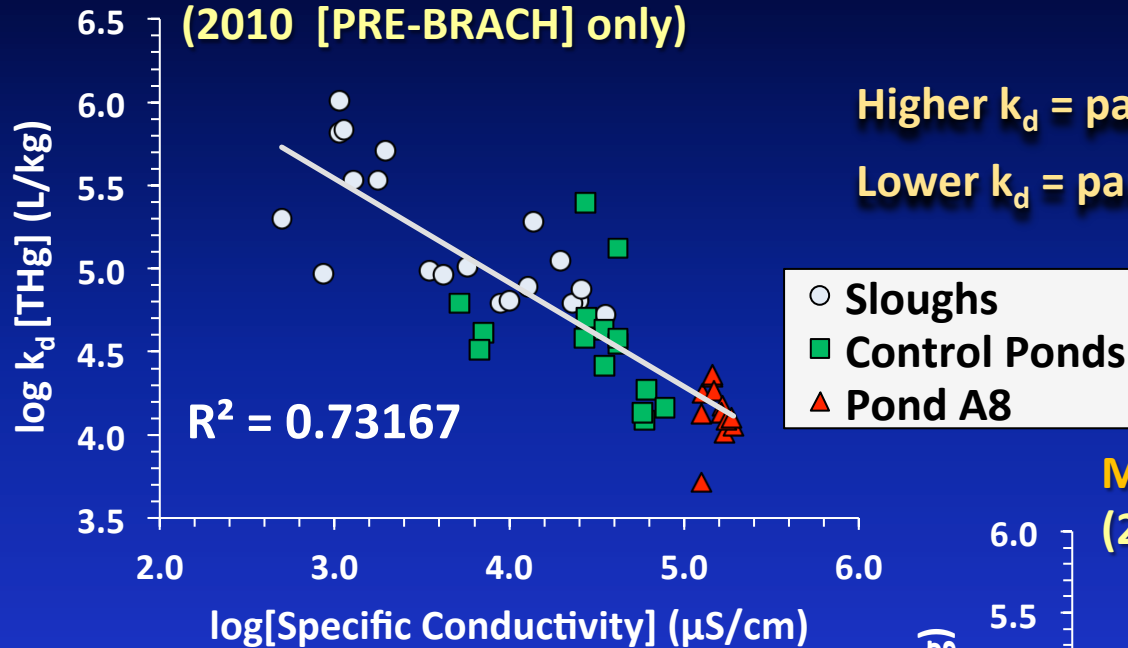


2010-11 Sampling
April: water (only)
May, June/July & August:
water & sediment

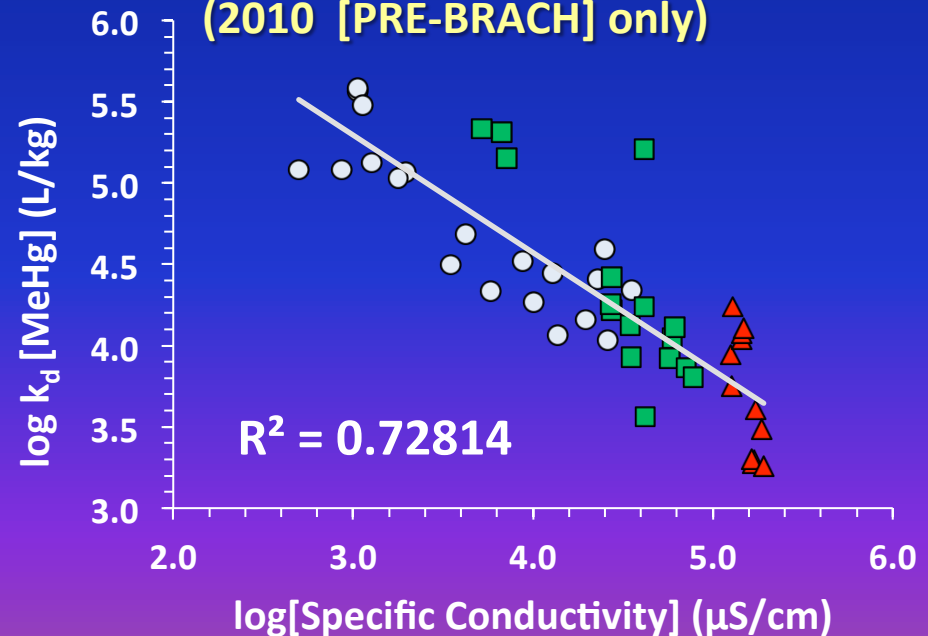


II. Pond A8 Notch Opening / 'Biosentinal Toolbox'

THg Partitioning vs Salinity
(2010 [PRE-BRACH] only)

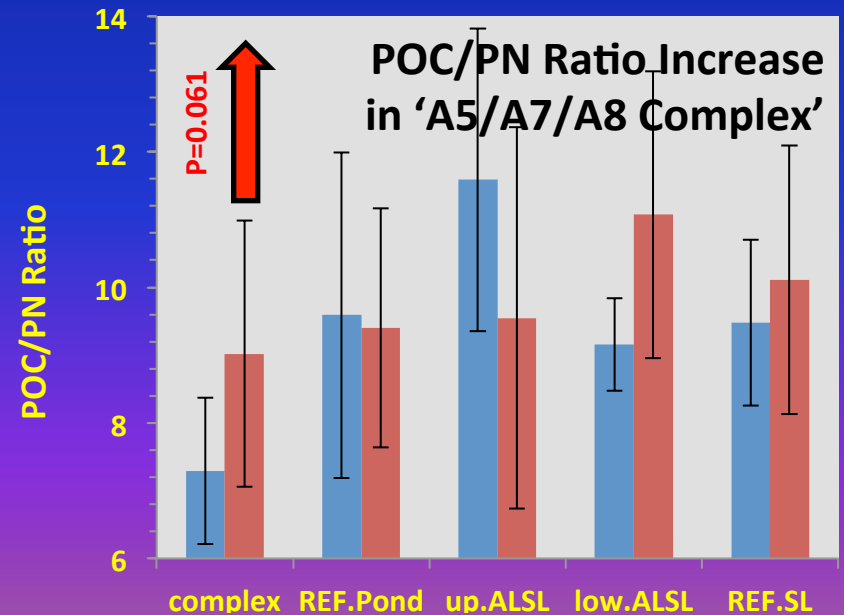
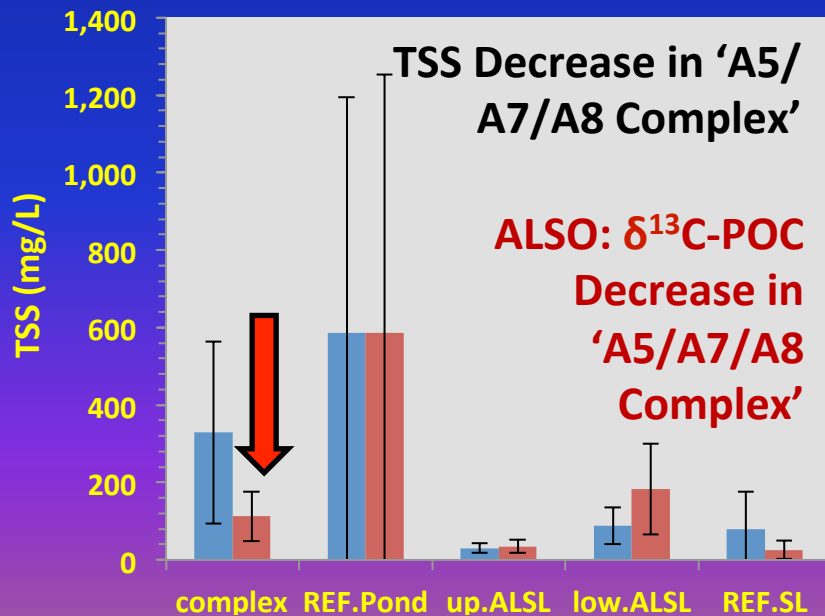
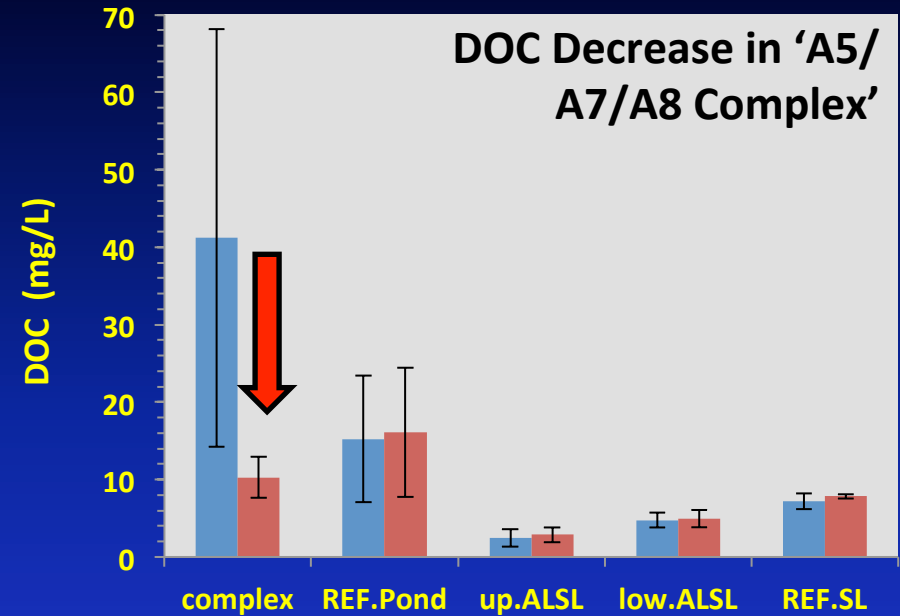
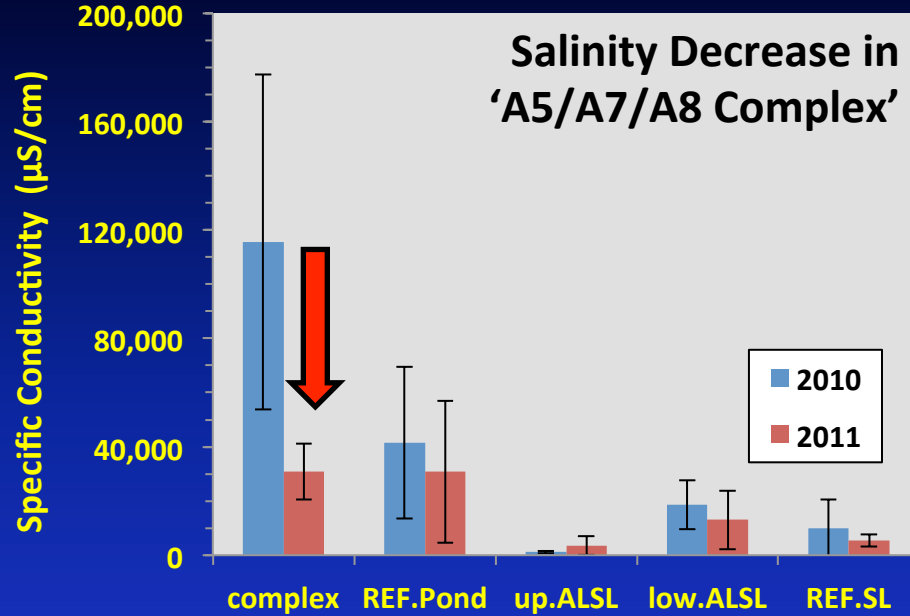


MeHg Partitioning vs Salinity
(2010 [PRE-BRACH] only)



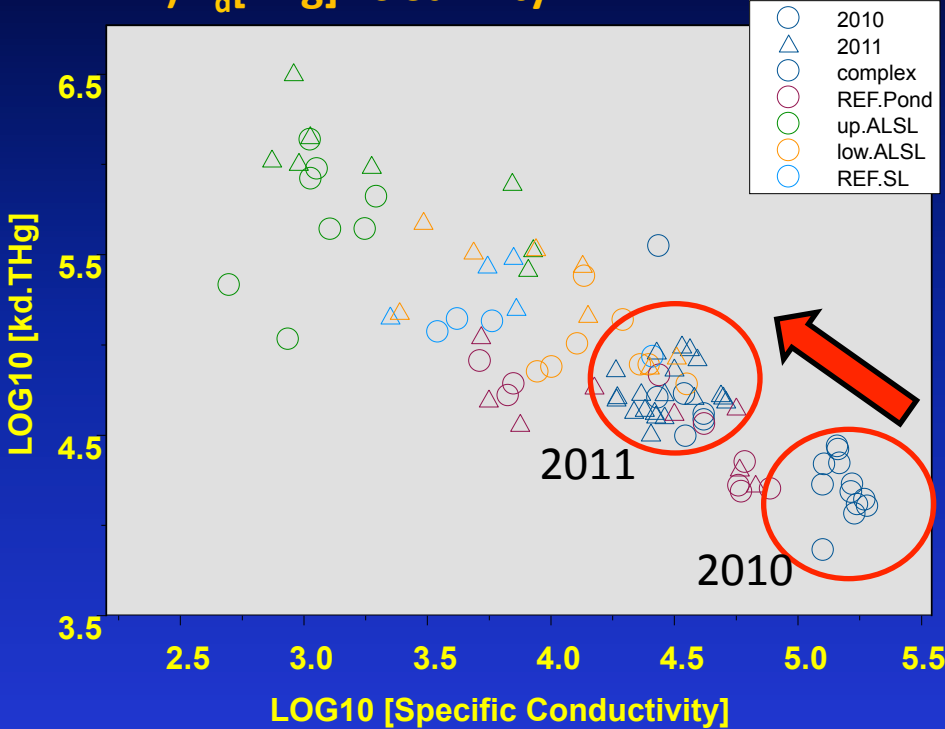
- Hg binding to particles is controlled by salinity, DOC & particle composition
- Has direct implications on Hg accumulation into biota

Changing Surface Water Chemistry (2010 to 2011)



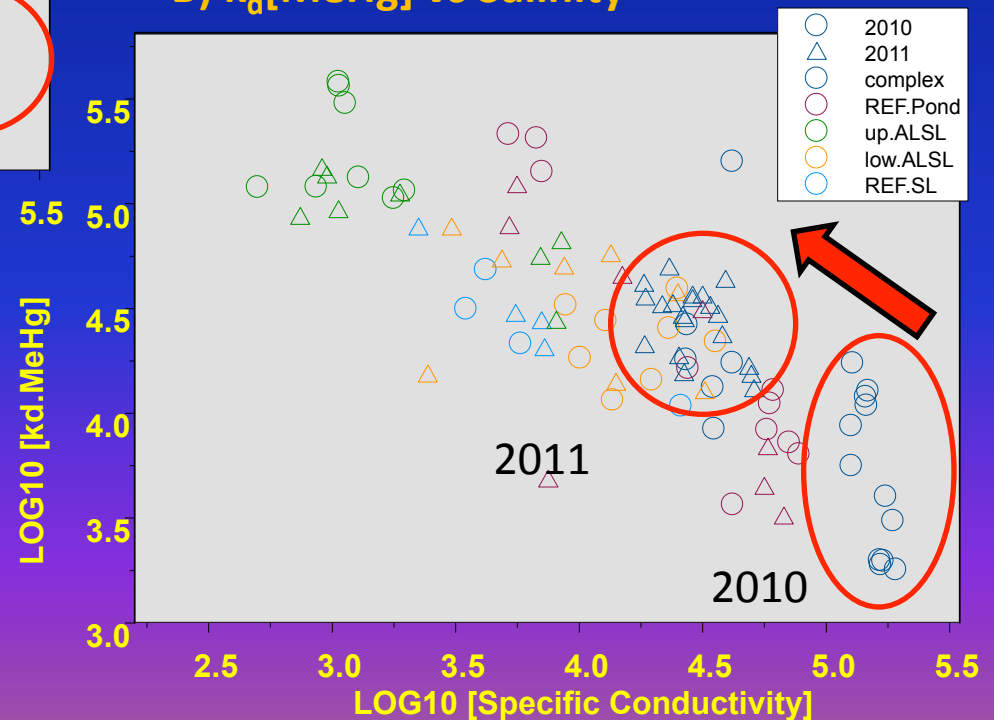
Surface Water Hg Partitioning vs Salinity (2010 & 2011)

A) k_d [THg] vs Salinity



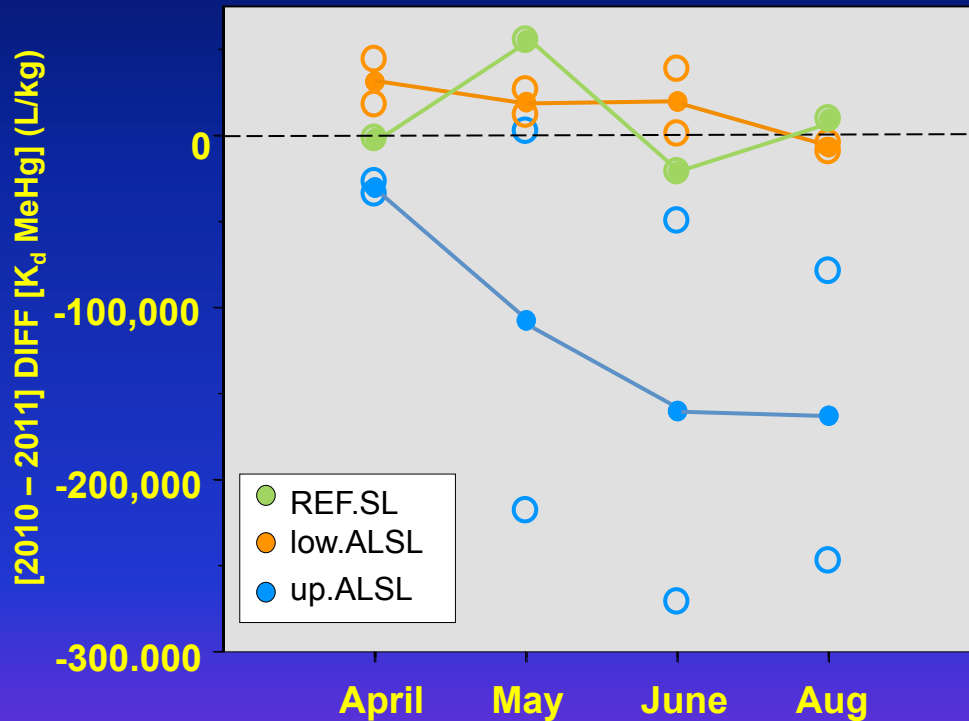
- Significant shift in THg & MeHg partitioning towards particles from 2010 to 2011 (A5/A7/A8 Complex)
- Due to decreased salinity & DOC, and changing particle character

B) k_d [MeHg] vs Salinity



II. Pond A8 Notch Opening / 'Biosentinal Toolbox'

SLOUGH Surface water MeHg partitioning coefficients



- 2010 to 2011 **DECREASE** in $k_d[\text{MeHg}]$ in up.ALSL (near Pond A8 Notch), compared to low.ALSL and REF.SL
- Shift towards dissolved phase
- Linked to high Salinity & DOC efflux from the A5/A7/A8 Complex?

II. Pond A8 Notch Opening / 'Biosentinal Toolbox'



Threespine Stickleback



Longjaw Mudsucker

A5/A7/A8 Complex

- Fish [Hg] decreased after opening of Pond A8 Notch (June 1, 2011)
- Coincident with an increase in THg and MeHg partitioning onto particles
- Suggesting less bioavailable Hg

Alviso Slough

- Fish [Hg] increased during 2011 (peak in July) relative to 2010 and Mallard Slough
- Coincident with a decrease in MeHg partitioning (off of particles) in upper Alviso Slough
- Suggesting more bioavailable Hg



Threespine Stickleback

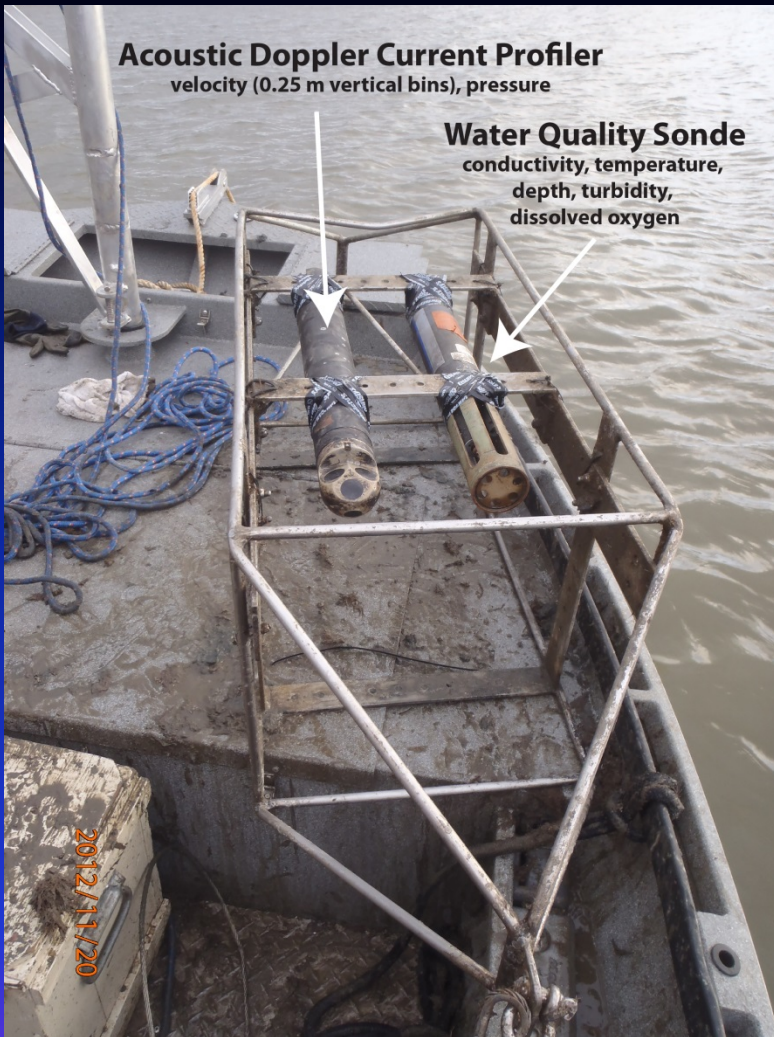


Mississippi Silverside

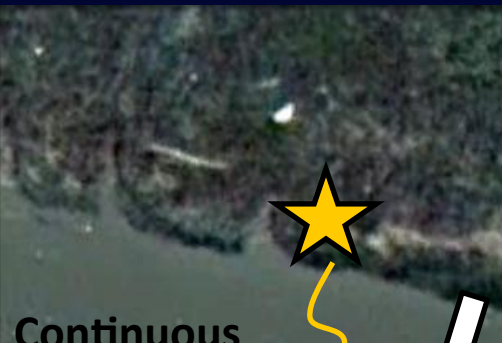
III. Water Column Hg Flux / 24-Hr 'Diel' Studies

**2012-2013 Collaboration with USGS CA-
Water Science Center, Sacramento, CA
(G. Shellenbarger & D. Schoellhamer)**

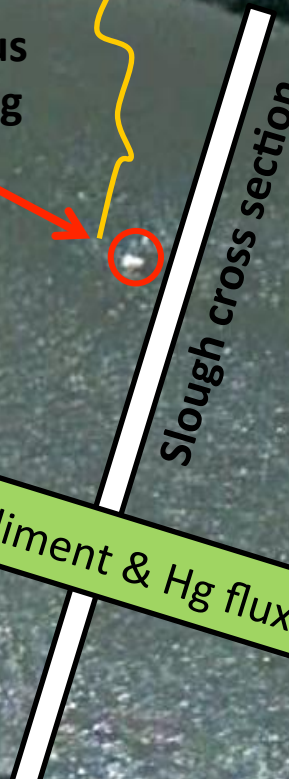
- Collect hourly surface water samples for Hg species over a full 'diel' 24-hr cycle (two tides)
- Co-locate sampling with USGS 'continuous monitoring' station (mid-Alviso Slough)
- Seasonal (spring, summer, winter, fall), PLUS the 1st big flush event
- Develop [Hg] & SSC relationships
- Use 'continuous monitoring' & 'SSC mass flux' data to integrate 24-hr results over longer time frames.



III. Water Column Hg Flux / 24-Hr 'Diel' Studies



Continuous monitoring buoy



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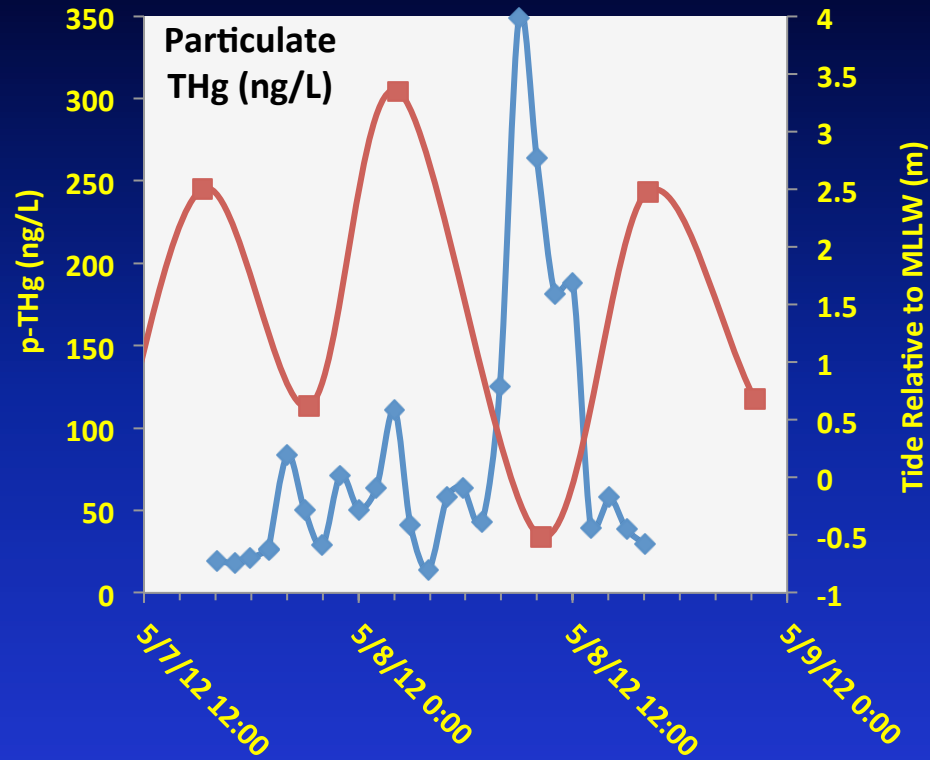
37° 26.390' N 121° 59.906' W elev 0 ft

©2010 Google

Eye all 297 ft

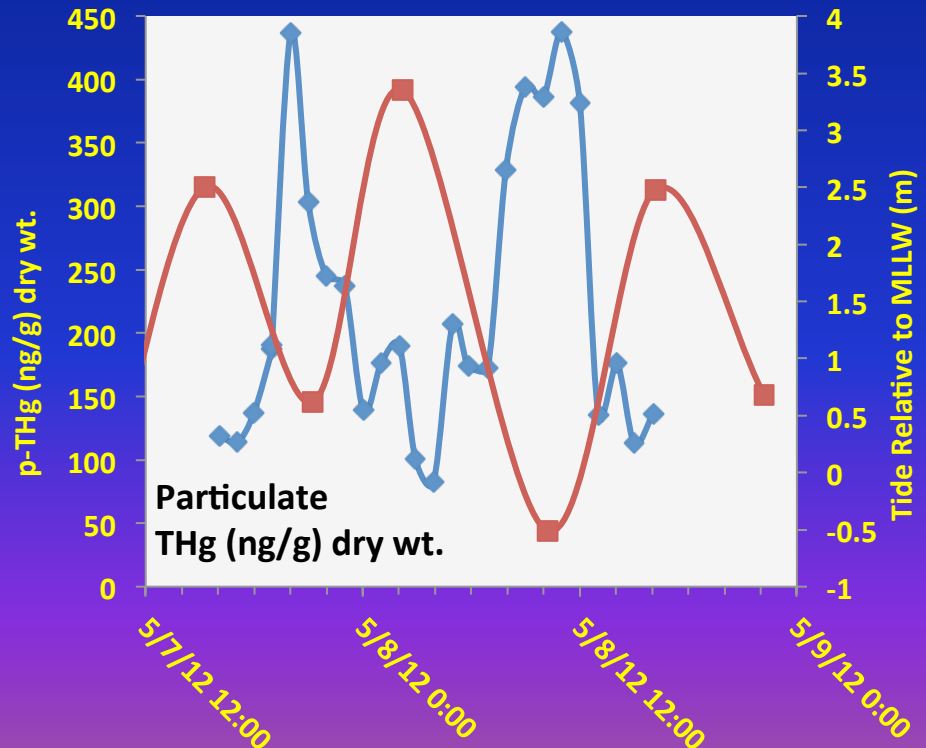
III. Water Column Hg Flux / 24-Hr 'Diel' Studies

Data for May 7-8, 2012

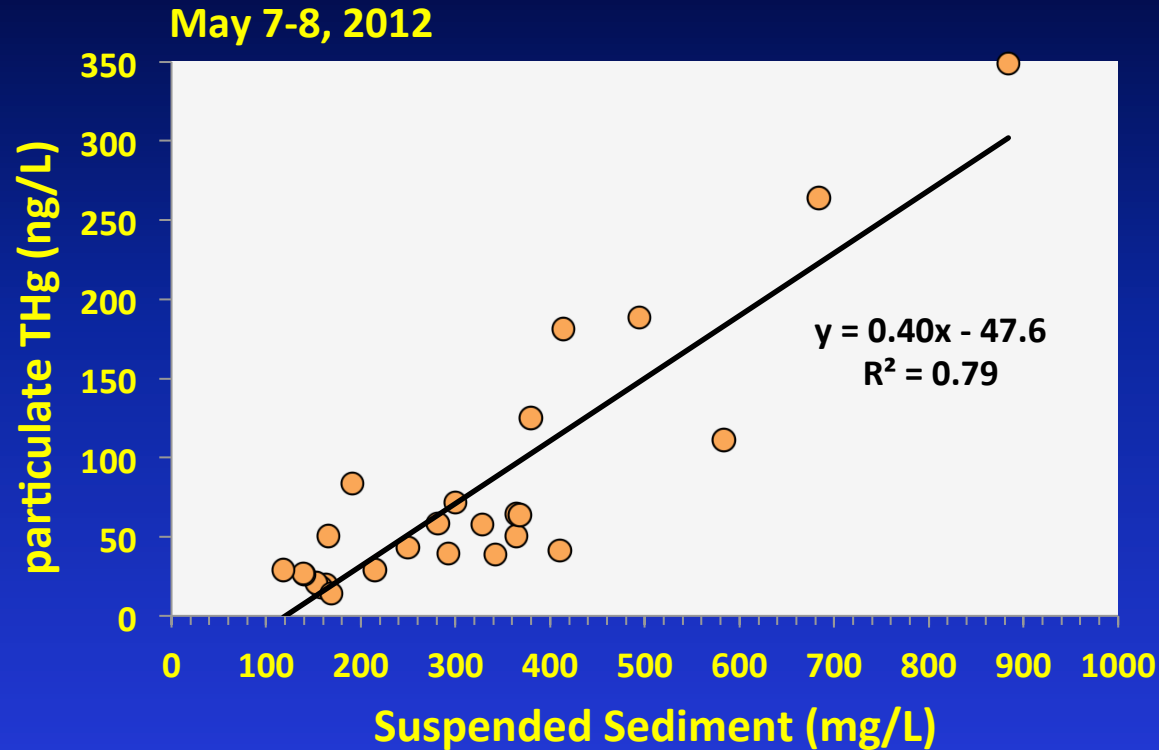


Also data for

- Dissolved THg
- Dissolved & Particulate MeHg
- TSS, Chl-a,
- Salinity, temperature, Dissolve O₂
- Carbon & Nitrogen (w/ isotopes)



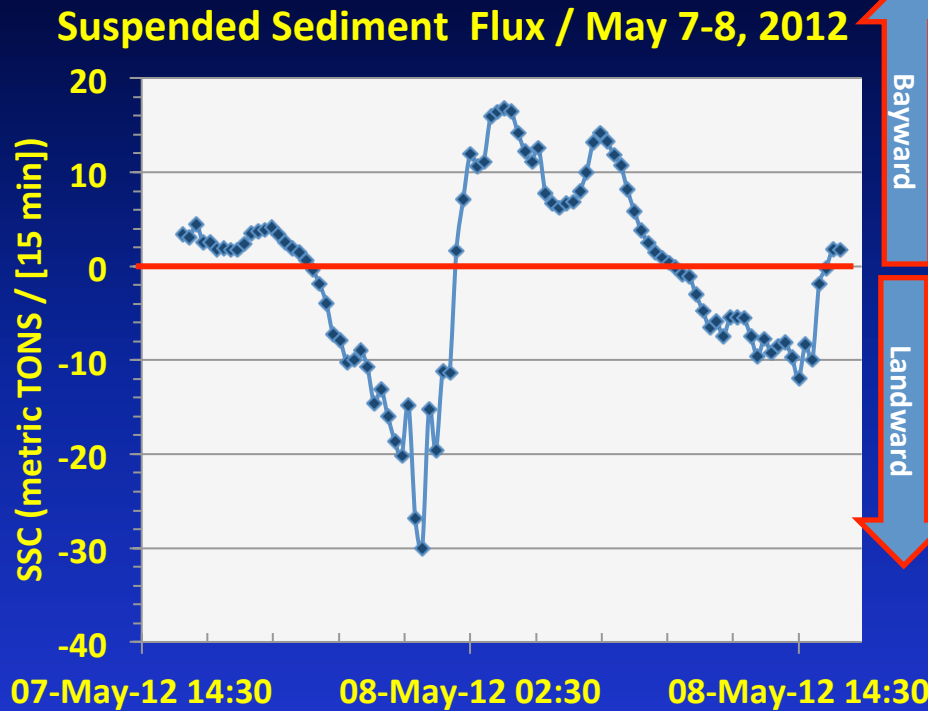
III. Water Column Hg Flux / 24-Hr 'Diel' Studies



- The SSC vs p.THg relationship is established for each sampling event
- The continuous (high resolution) SSC data is then used to calculate p.THg flux

III. Water Column Hg Flux / 24-Hr 'Diel' Studies

Initial Flux Calculations



- TONS of suspended sediment moving up/down Alviso Slough daily
- Net sediment & Hg flux can be either landward or bayward depending on season and tide
- THg flux \approx 10's g/day

Sampling Period	Sediment (TONS / day)	Total Hg (g / day)
May 7-8, 2012	-61.0 (landward)	-30.1 (landward)
Nov. 1-2, 2012	27.1 (bayward)	10.3 (bayward)
Dec. 1-2, 2012	15.7 (bayward)	-0.3 (landward)

Mercury in Motion – 3 Short Stories / TAKE HOME

(California)

I. 2006 & 2012 Deep Cores / Bed Sediment & Hg Mobilization

- Less Hg mobilized than originally predicted
- But Pond A8 has only opened 15' (out of 40' max)
- Most has eroded near Pond A6 breach

II. Pond A8 Notch Opening / 'Biosentinal Toolbox'

- The opening of A8 notch affected the partitioning of THg and MeHg on/off particles in the 'Complex' and Upper Alviso Slough
- This affected Hg availability into biota

III. Water Column Hg Flux / 24-Hr Studies

- TONS of suspended sediment moving up/down Alviso Slough daily
- Daily Net sediment flux can be either landward or bayward
- THg flux \approx 10's g/day