

THE EFFECTS OF WETLAND RESTORATION ON MERCURY BIOACCUMULATION

Using the “Biosentinel Toolbox” to Monitor Changes Across Multiple Habitats and Spatial Scales

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Acknowledgements

Institutional Support

- Resources Legacy Fund
[Megan Moda and Aaron O'Callaghan]
- U.S. Environmental Protection Agency
- South Bay Salt Ponds Restoration Program
[Laura Valoppi and John Bourgeois]
- U.S. Fish & Wildlife Service
[Cheryl Strong & Eric Mruz]

UC – Davis Staff

- Shaun Ayers

USGS-WRD Staff

- Jennifer Agee
- Le Kieu
- Evangelos Kakouros
- Michelle Beyer

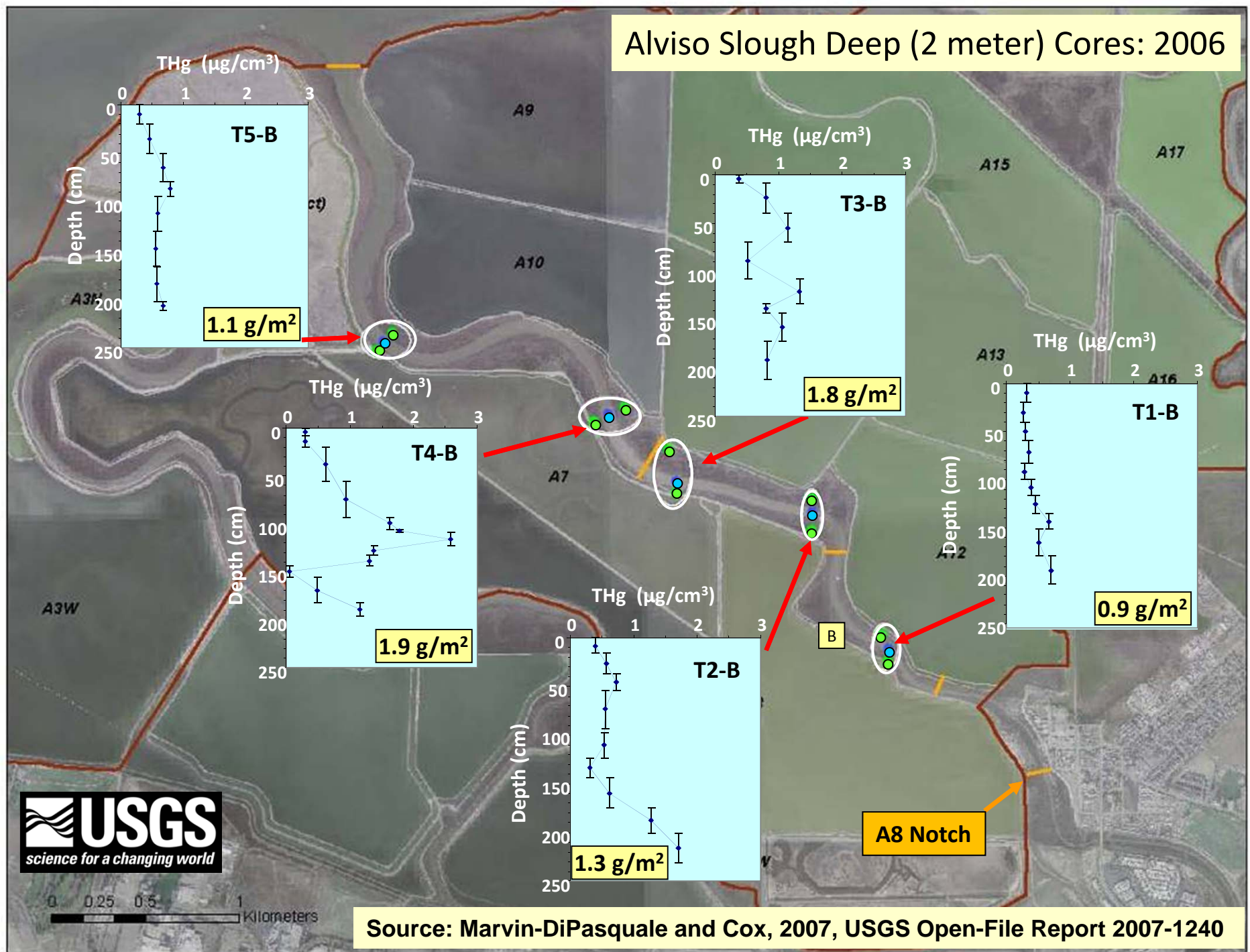
USGS-BRD Staff

- Garth Herring
- Jessica LaCoss
- Carley Schracter
- Kate Ruskin
- Dena Spatz
- Sarah Peterson
- Cara Thow

Background

- Restoration of (muted) tidal flow to Ponds A5/A7/A8
 - Goal: conversion to wetland habitat
 - Construction of tidal 'notch' in Pond A8 (completed fall 2010)
 - Large changes in hydrology and sediment dynamics in Alviso Slough
-
- Concerns about mercury (Hg)
 - Remobilization of 'buried' legacy Hg
 - Enhanced bioaccumulation?

Alviso Slough Deep (2 meter) Cores: 2006



Source: Marvin-DiPasquale and Cox, 2007, USGS Open-File Report 2007-1240

Total Mercury in Alviso Slough & Marsh in
the top 2 meters of sediment

THg

1,650 ± 310 kg

Total Mercury Mobilized

A8 Notch	THg
20 ft. Notch	66 ± 15 kg
40 ft. Notch	125 ± 30 kg

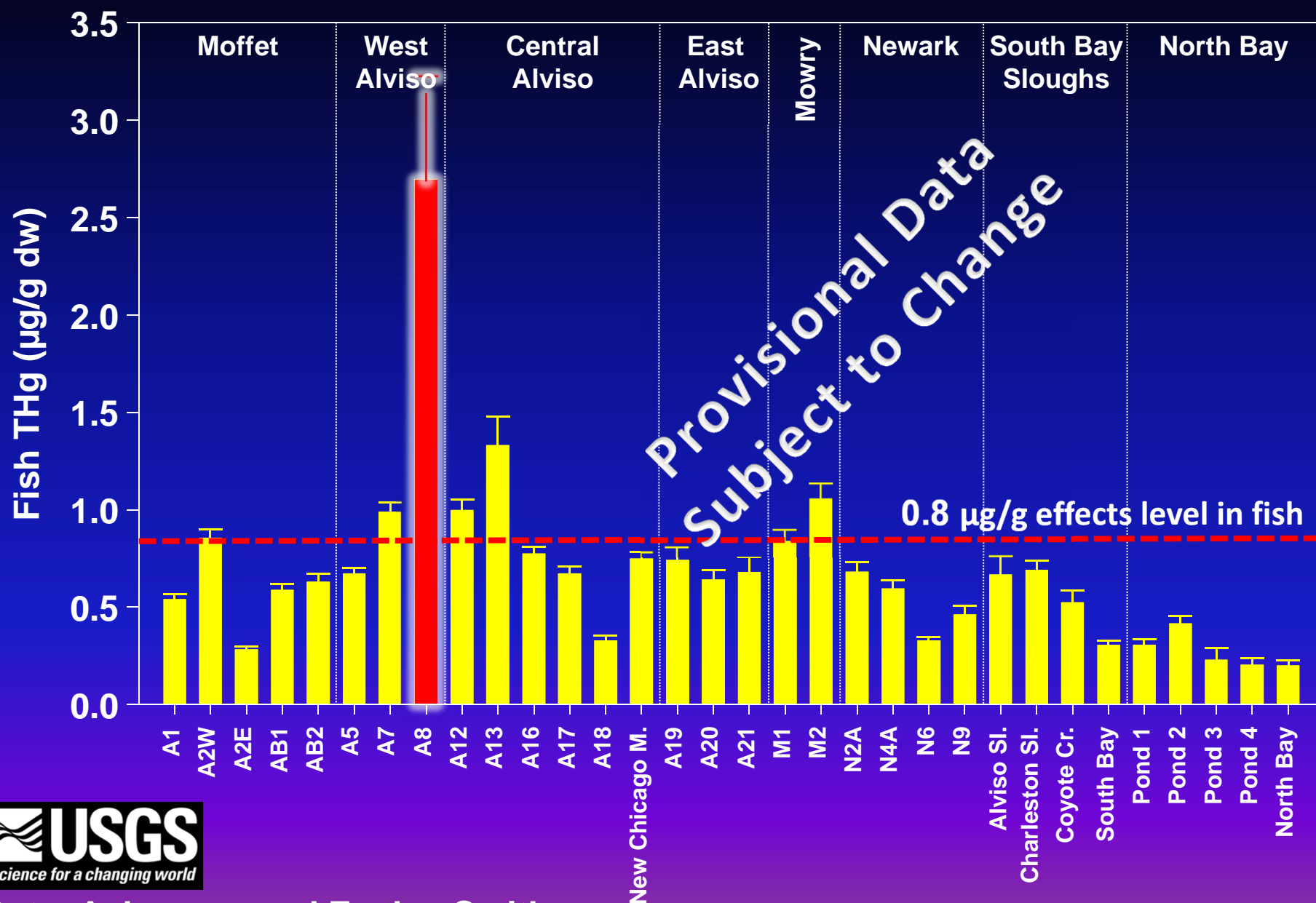


0 0.25 0.5 1
Kilometers

A8 Notch

Source: Marvin-DiPasquale and Cox, 2007, USGS Open-File Report 2007-1240

San Francisco Bay: Mercury Toxicity in Fish [Pre-Restoration]



Data: Ackerman and Eagles-Smith

San Francisco Bay: Mercury Toxicity in Fish [Pre-Restoration]

Silverside data (SFEI /UC-Davis)

- multi-individual composites
- Regional Monitoring Program (RMP) Small Fish Project

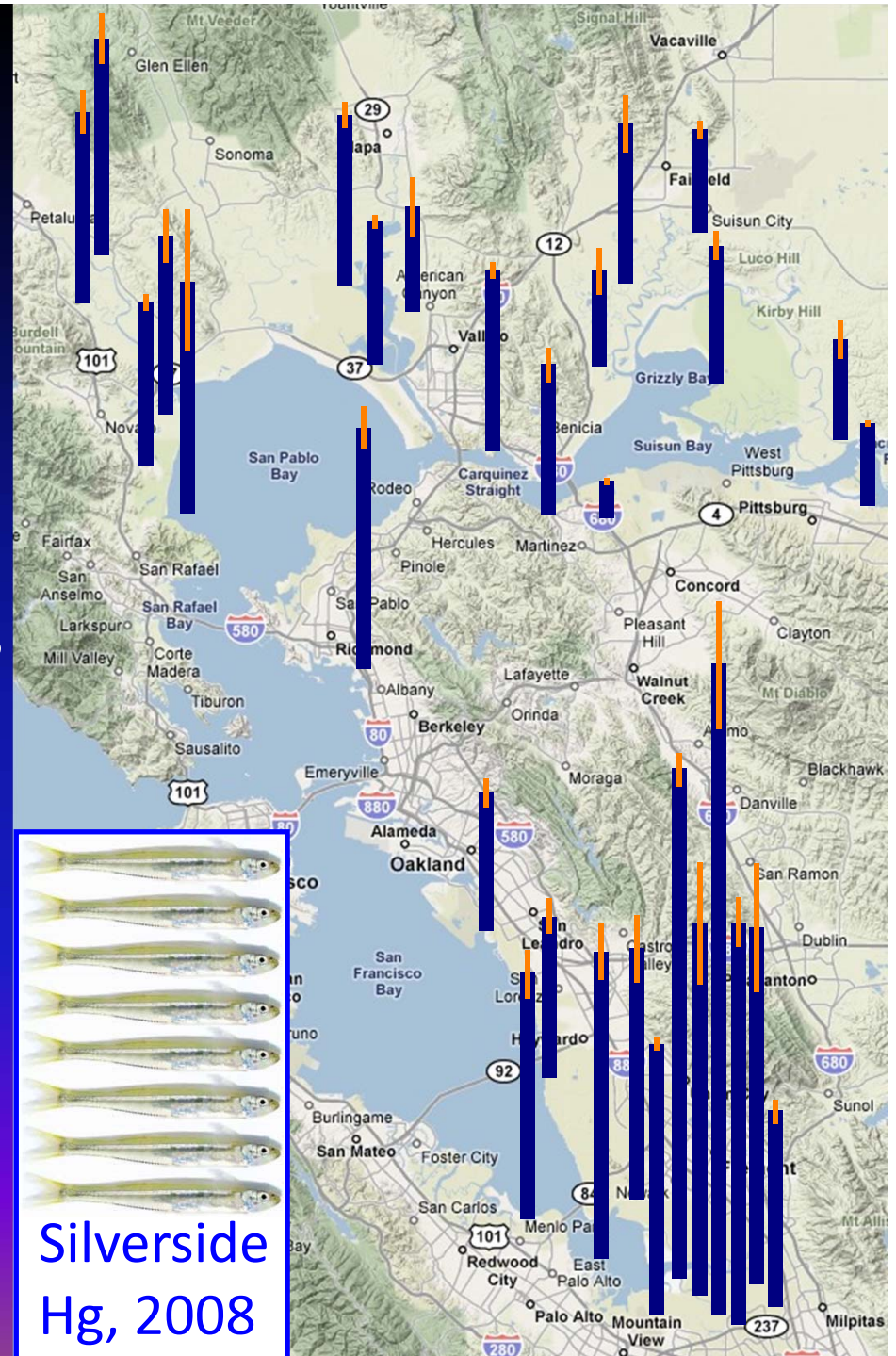


Data: Slotton and Ayers

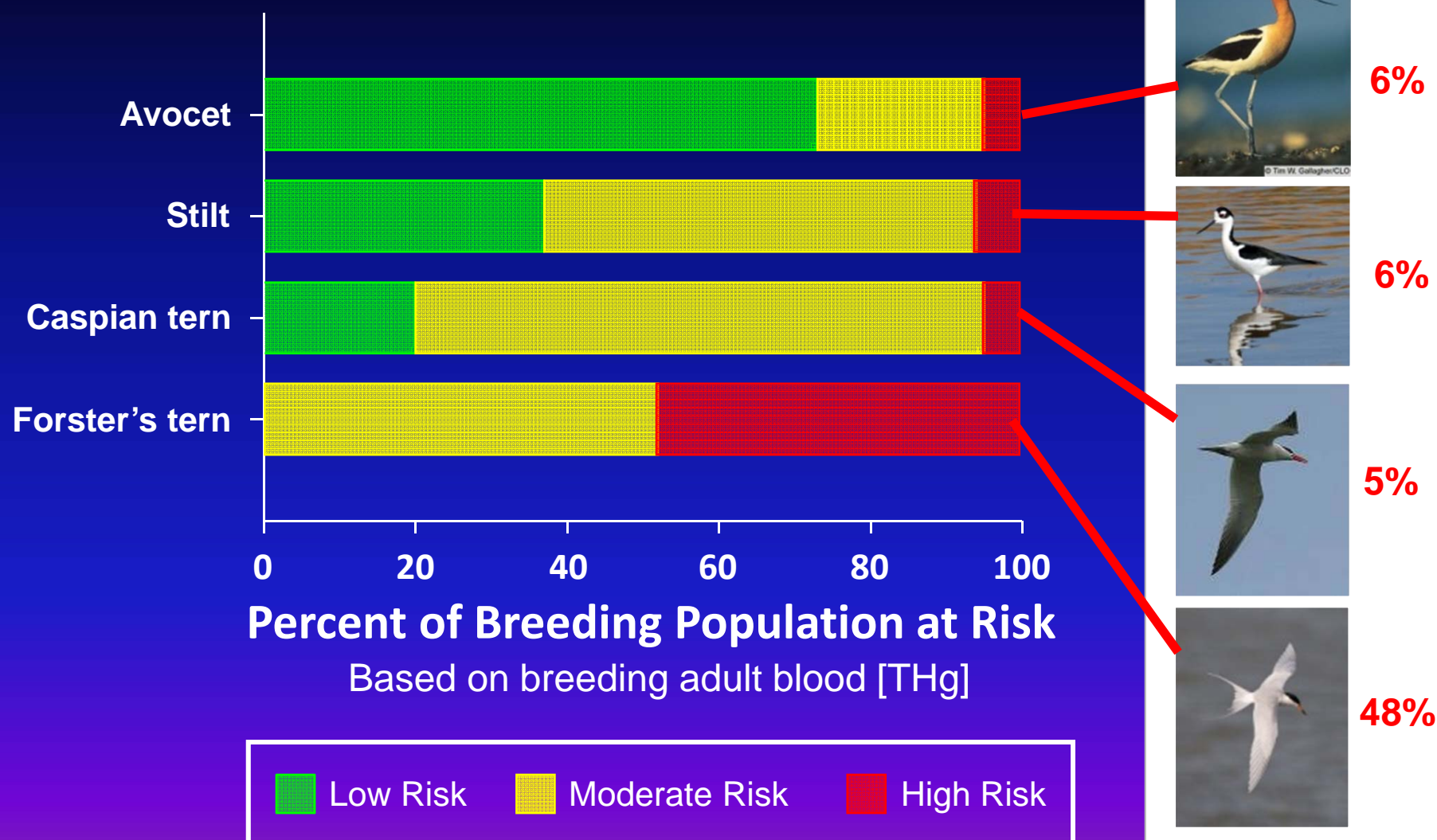
UCDAVIS



Silverside
Hg, 2008



San Francisco Bay: Mercury Toxicity in Birds [Pre-Restoration]



Source: Eagles-Smith and others, 2009, Environ. Pollut. 157:1993-2002

Project Goals

BEFORE (2010) and AFTER (2011) the initial opening of the Pond A8 Notch

Document changes in:

- Sediment and water Hg dynamics
- Biosentinel fish Hg concentrations (ponds vs sloughs)
- Avian risk



The Biosentinel Toolbox



Threespine stickleback

- Cross-habitat indicator
- Ponds (USGS-BRD) and Sloughs (UC-Davis)



Mississippi silverside

- Sloughs only (UC-Davis)
- Link to wider Bay study (RMP)



Forster's tern

- Fish-eating bird at highest Hg risk
- Monitor and sample nest eggs from ponds (USGS-BRD)



American avocet

- Invertebrate feeder; localized wildlife indicator
- Monitor and sample nest eggs from ponds (USGS-BRD)

Surface Water & Sediment Parameters



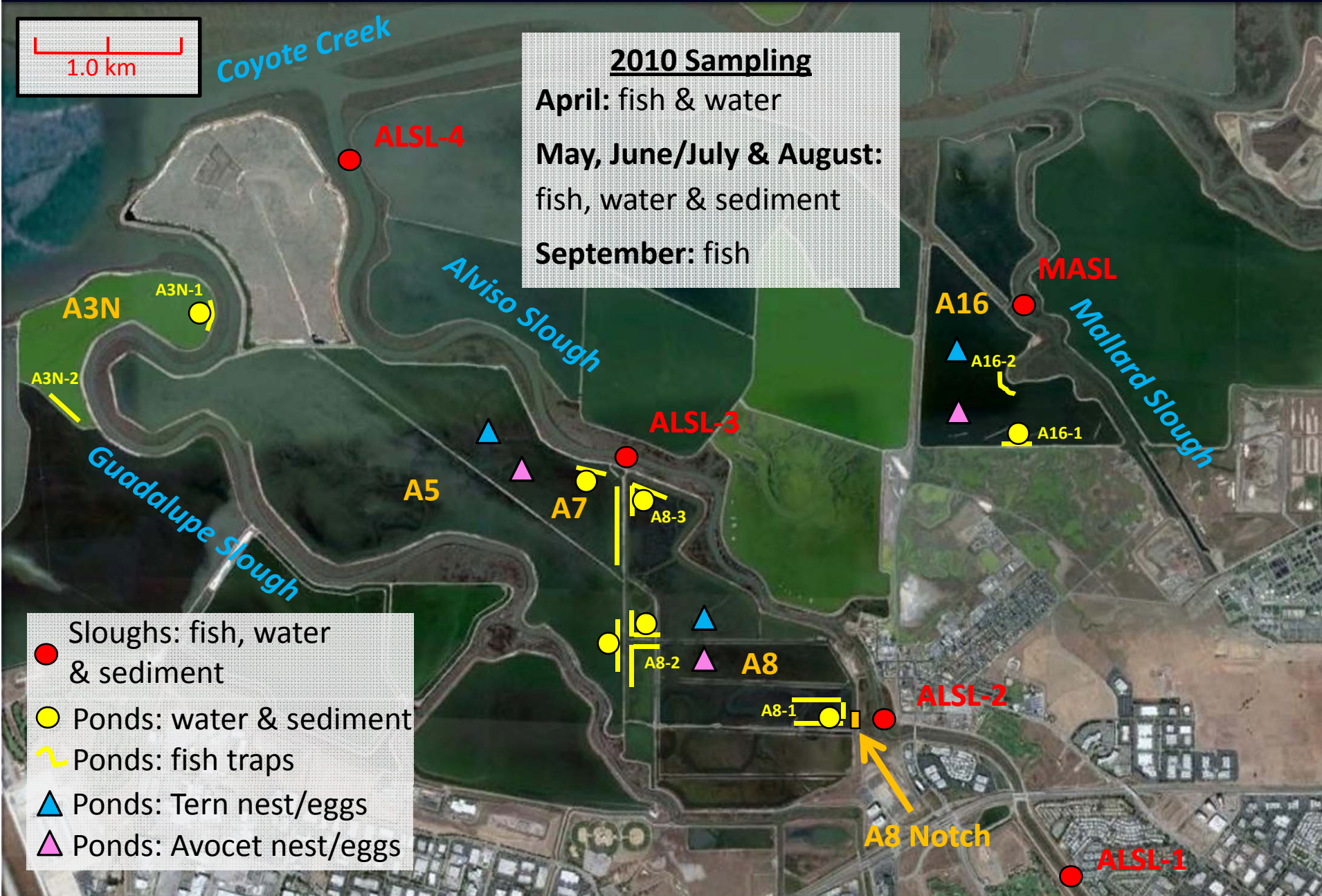
Surface Water

Particulate Hg (THg, MeHg)
Dissolved Hg (THg, MeHg)
Total Suspended Solids
Chlorophyll-a
Particulate C & N (w/ isotopes)
Dissolved nutrients (N & P)
Specific Conductivity
Dissolved O₂
pH and REDOX

Sediment (0-2 cm)

Hg Species (THg, MeHg, Hg(II)_R)
MeHg production rate (microbial)
Sulfate Reduction rate (microbial)
Iron speciation (Fe(II), Fe(III))
Total Reduced Sulfur
Organic content
Grain size
pH and REDOX
Pore water: H₂S, SO₄²⁻, Cl⁻, Fe(II)

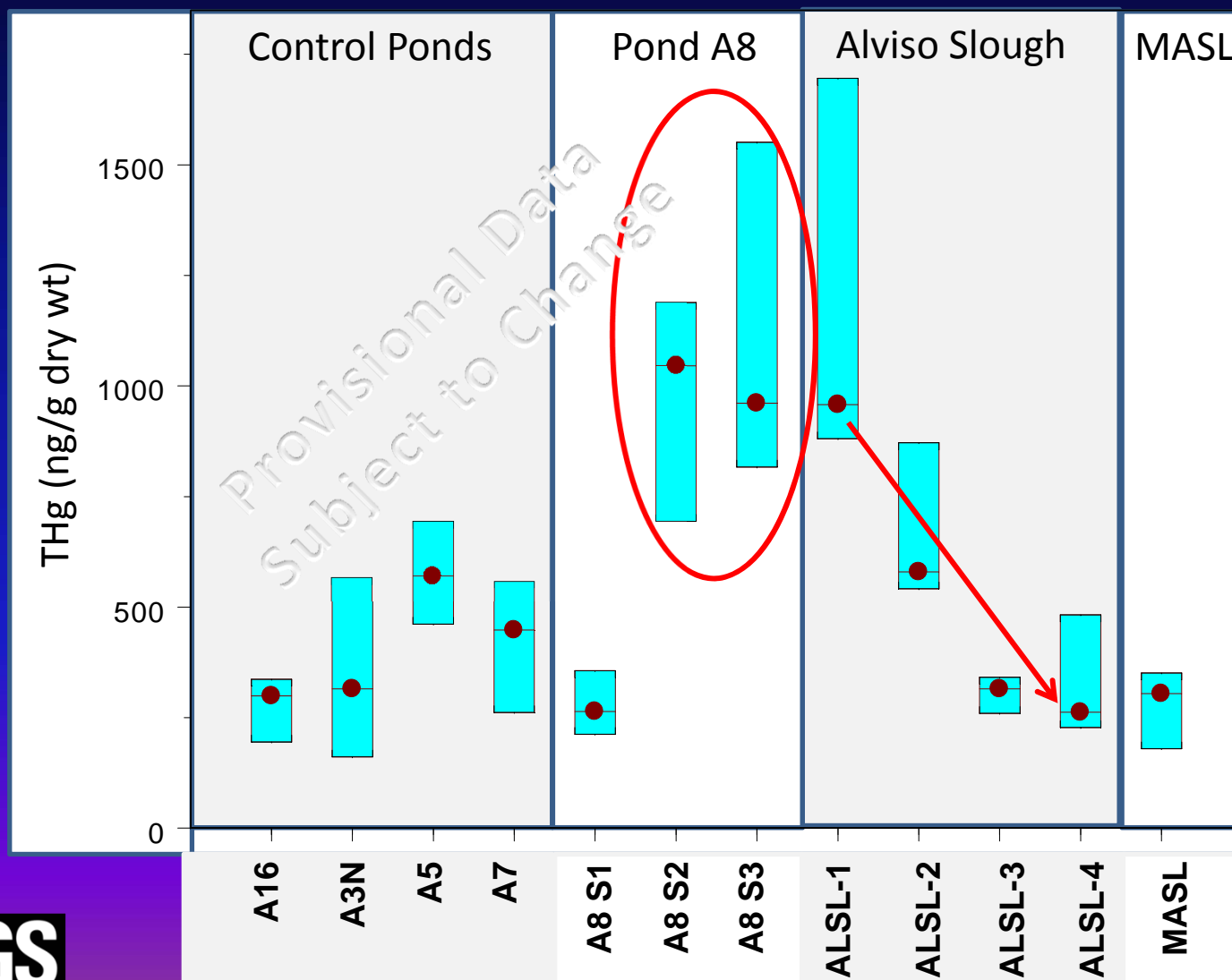
Study Design



Alviso Slough / Pond A8 Study: 2010 (pre-breach)

SEDIMENT (0-2 cm) / May-August

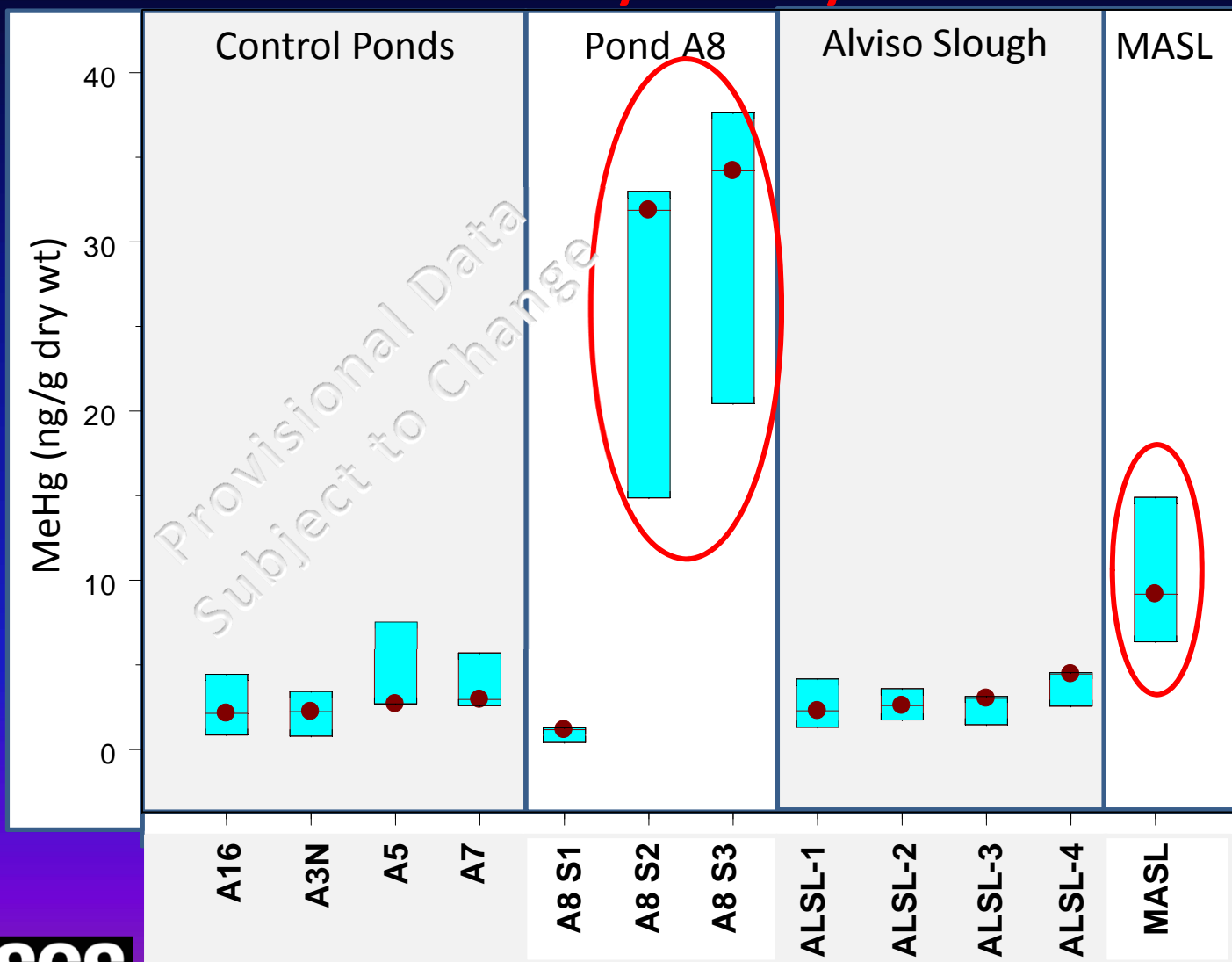
Total Mercury



Alviso Slough / Pond A8 Study: 2010 (pre-breach)

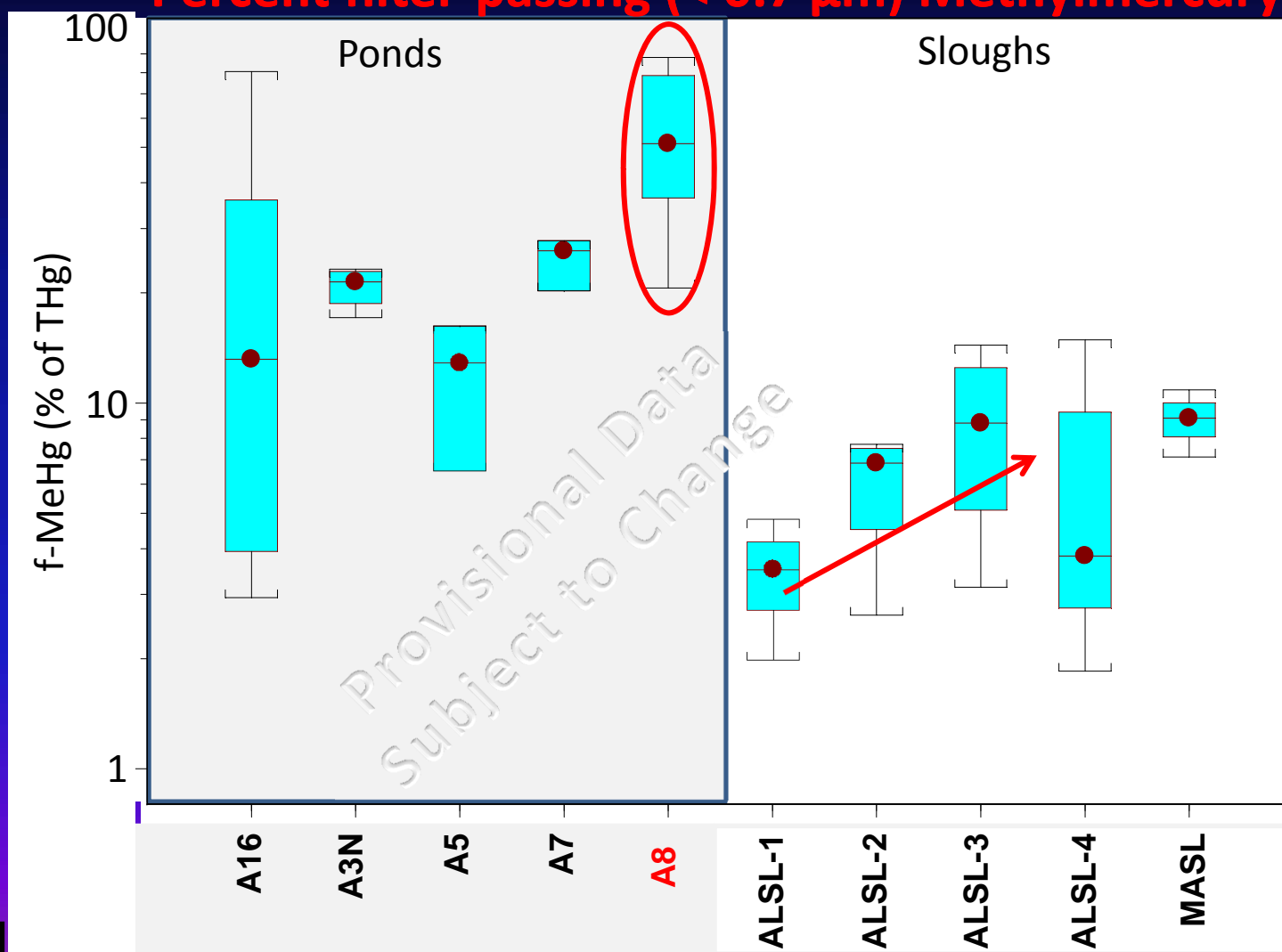
SEDIMENT (0-2 cm) / May-August

Methylmercury



Alviso Slough / Pond A8 Study: 2010 (pre-breach) SURFACE WATER / April-August

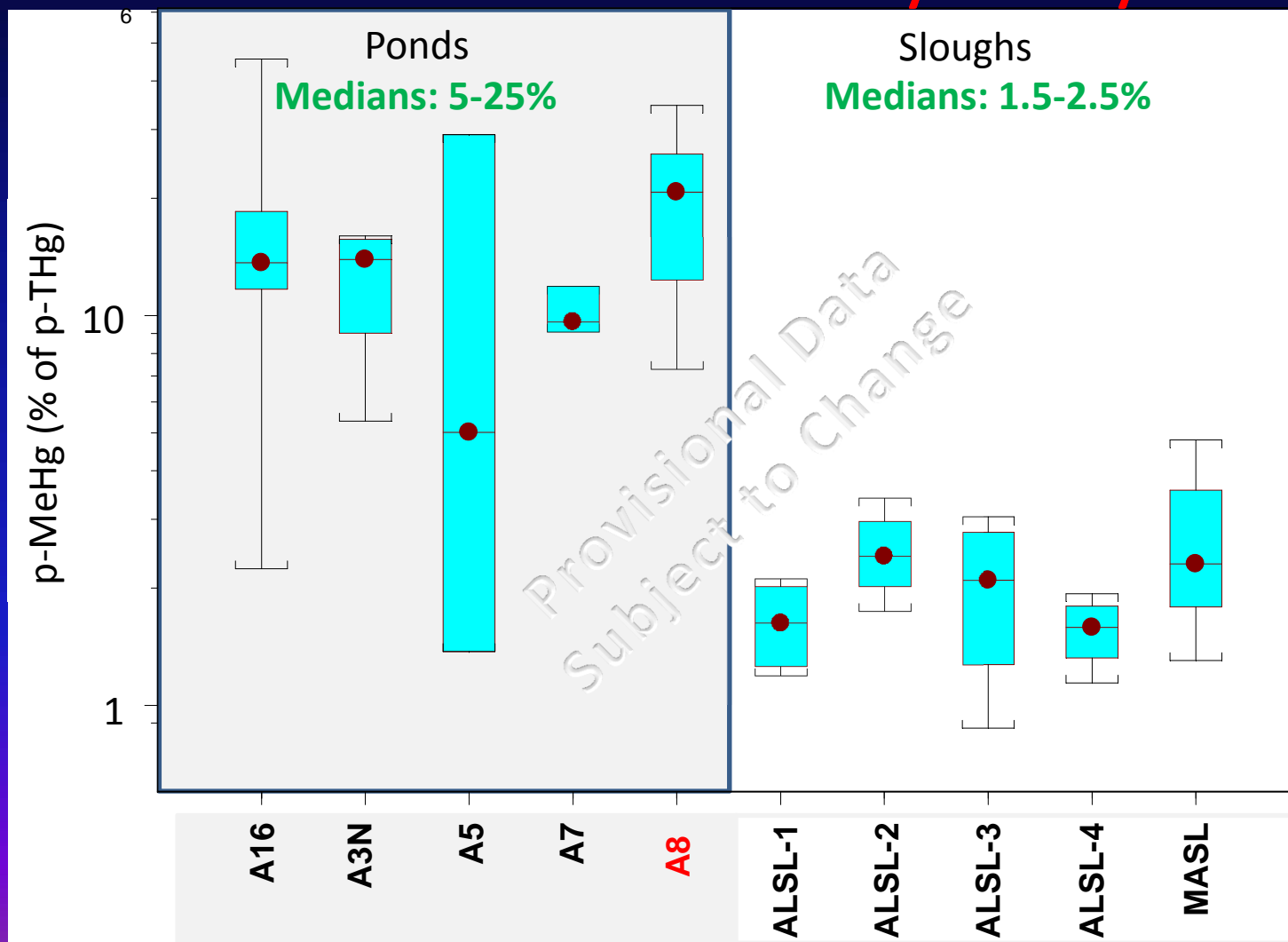
Percent filter-passing ($< 0.7 \mu\text{m}$) Methylmercury



Alviso Slough / Pond A8 Study: 2010 (pre-breach)

SURFACE WATER / April-August

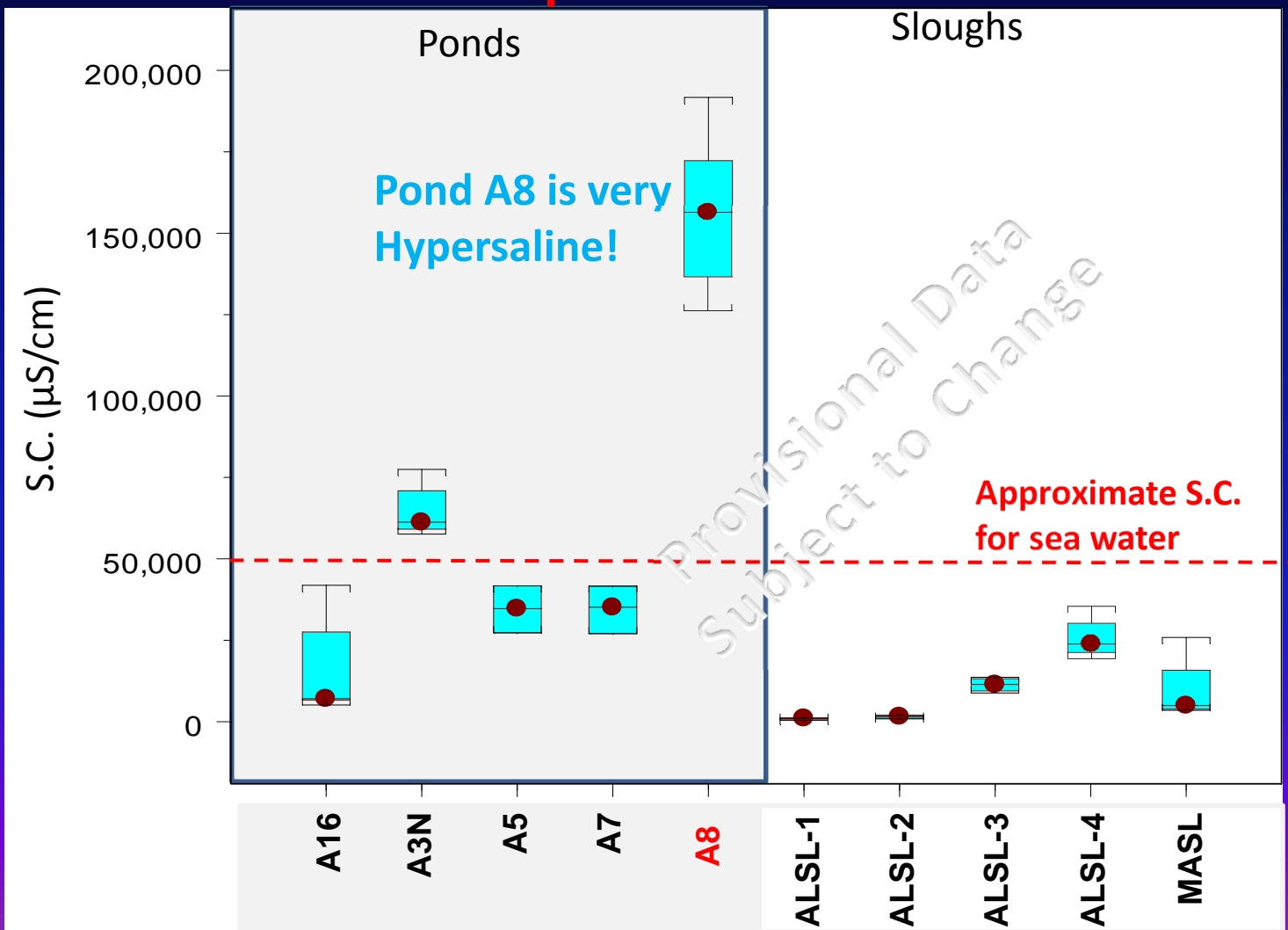
Percent Particulate Methylmercury



Alviso Slough / Pond A8 Study – 2010 (pre breach)

SURFACE WATER / April-August

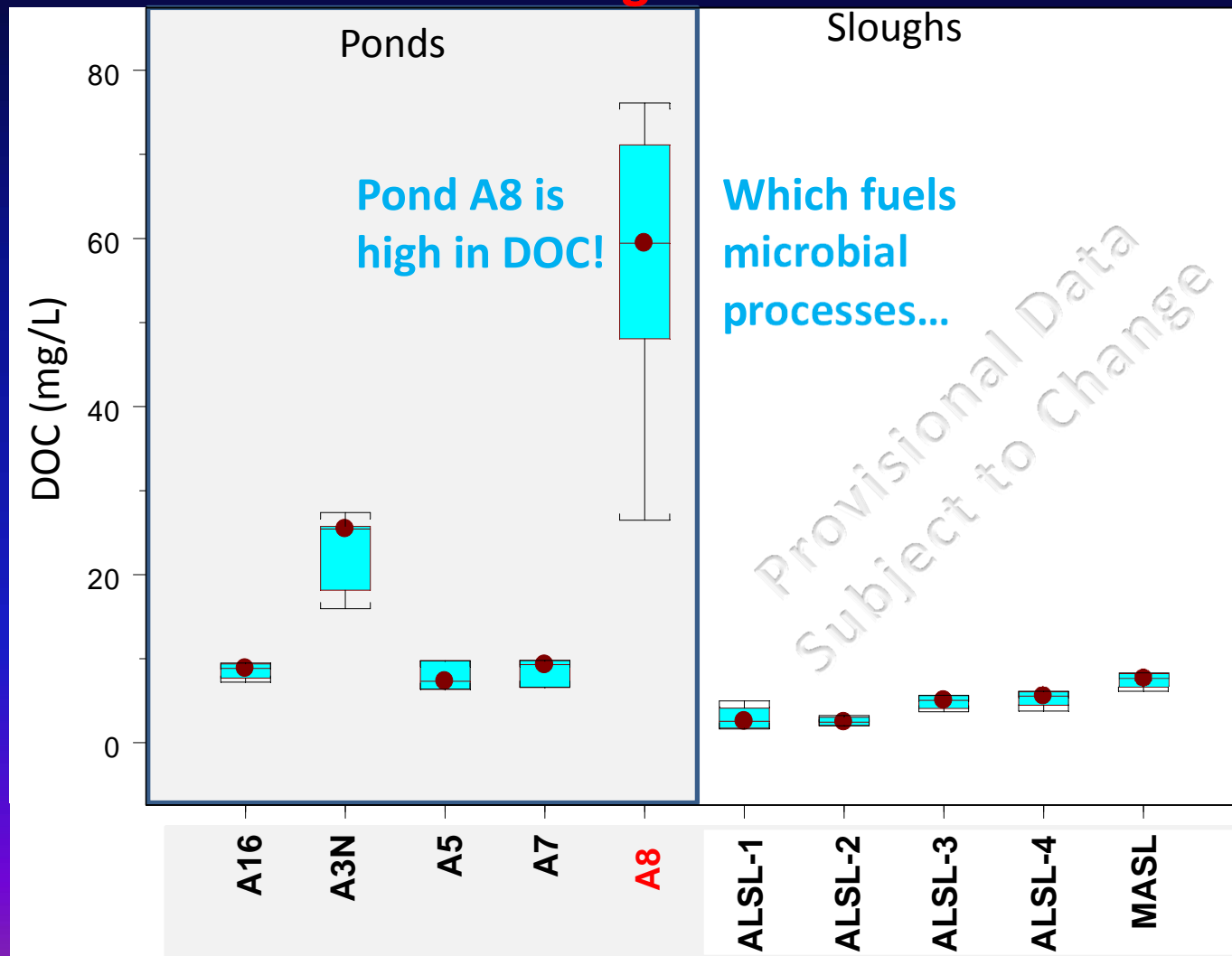
Specific Conductance



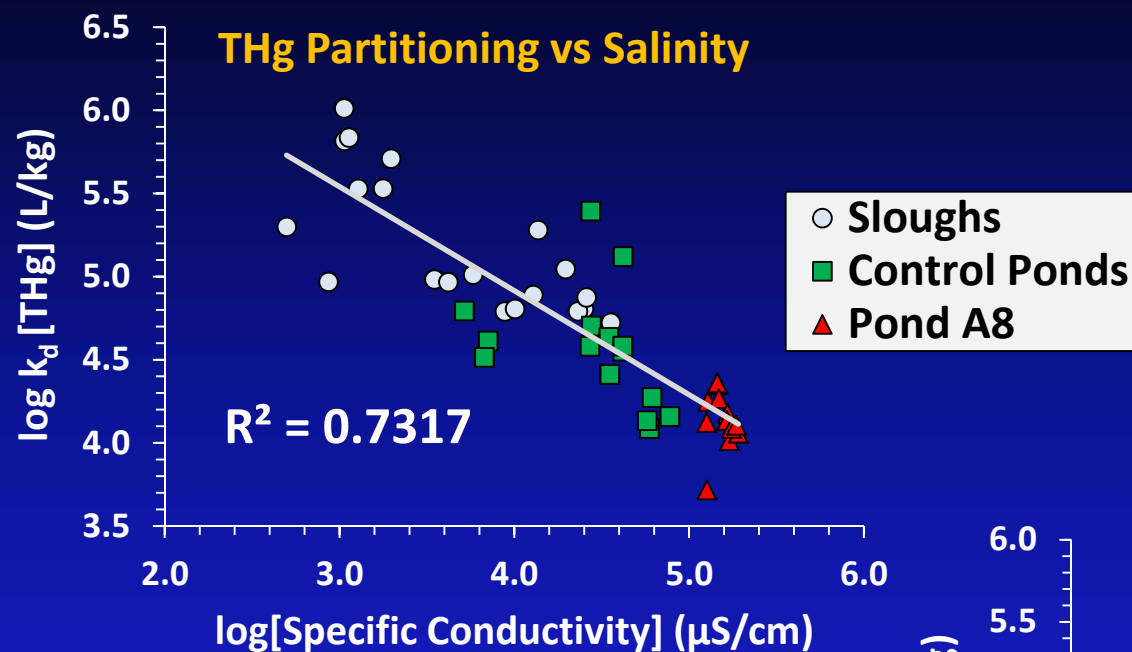
Alviso Slough / Pond A8 Study – 2010 (pre breach)

SURFACE WATER / April-August

Dissolved Organic Carbon

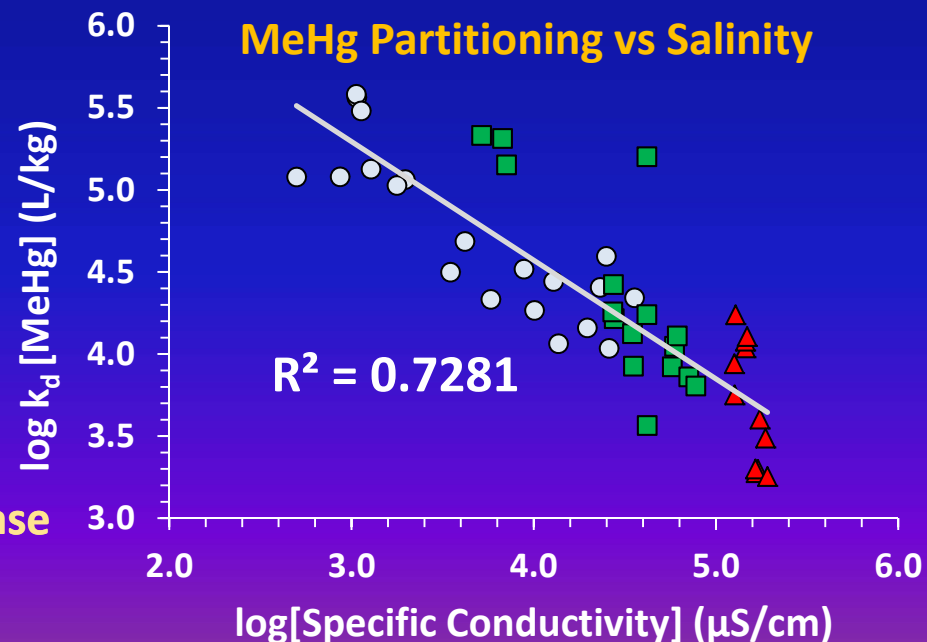


The dissolved-particulate partitioning of THg and MeHg as a function of salinity

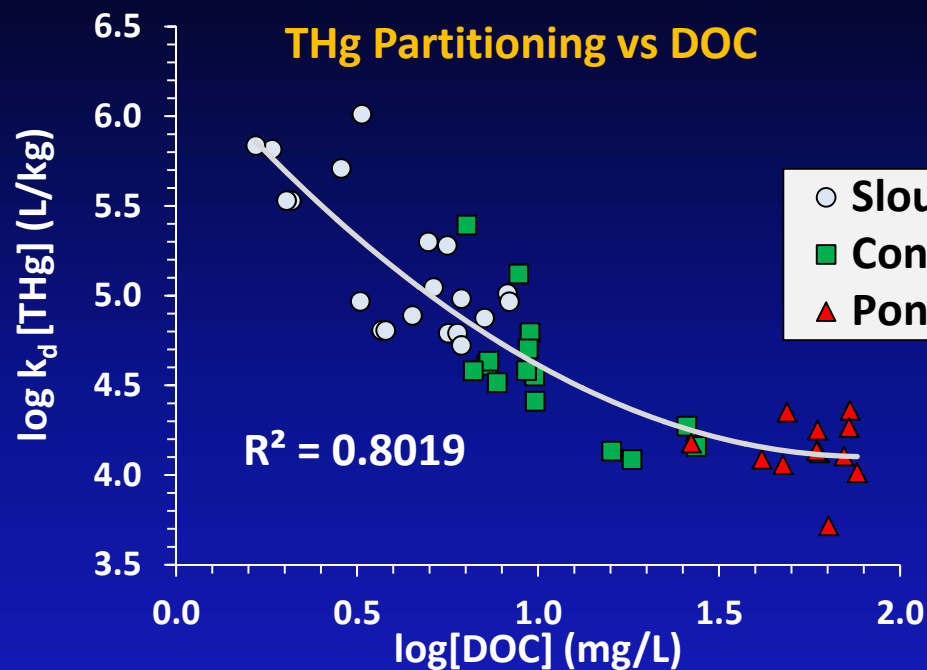


Provisional Data
Subject to Change

Higher k_d = partitioning towards particles
Lower k_d = partitioning towards dissolved phase

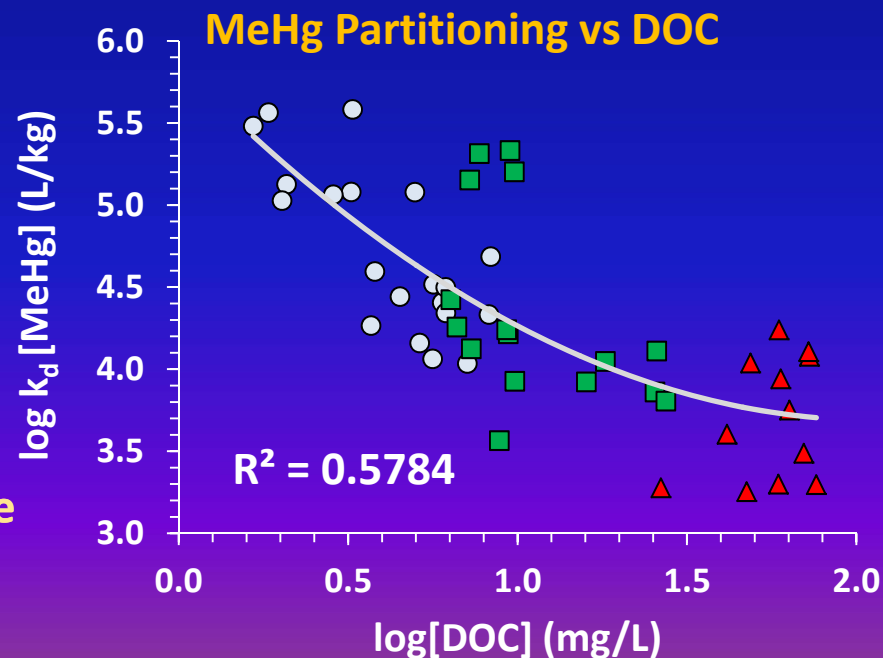


The dissolved-particulate partitioning of THg and MeHg as a function of dissolved organic carbon



Provisional Data
Subject to Change

Higher k_d = partitioning towards particles
Lower k_d = partitioning towards dissolved phase



Take Home Message

Pond A8 fish, water and sediment are contaminated with THg & MeHg

Pond A8 is an extreme (hypersaline) environment with very high DOC



THg and MeHg partitioning in surface water is a function of salinity and DOC, which may ultimately control Hg-bioaccumulation in ponds and sloughs.

Pre-breach (2010) sampling is complete; analyses are ongoing; Post-breach (2011) sampling is pending

PREDICTION: Tidal flushing of Pond A8 will decrease MeHg in Pond A8 biota in the long term