

Delta restoration and water quality

USGS CAWSC
Biogeochemistry Program

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Delta Independent Science Board
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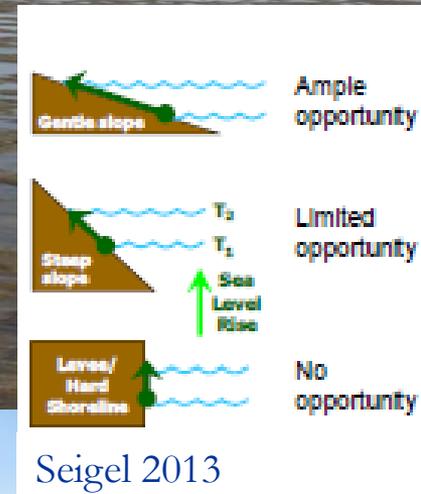
Primary WQ issues related to restoration *and* climate change

- Biogeochemical effects on ecosystem function
 - OM cycling (human and ecosystem health)
 - Drinking water (DOC production = DBP)
 - POM feeds the Delta
 - Nutrient cycling
 - Nitrate conversion to ammonium/DON?
 - Phosphorus limitation?
 - Contaminant cycling
 - Mercury, Pesticides, Selenium
- Contaminant sources and Delta WQ (ex: Hg!)

Contrasting zones of restoration

■ Delta edge/periphery (Liberty Island)

- Focus of most restoration effort
 - tidal range, easy hydrologic linkage
 - Quick return to historic hydrology



■ Central Delta

■ Sunken "heart" of the Delta (Twitchell Island)

- Levees will fail if nothing done

■ Region is not a "lost cause" but an *opportunity*

- Accommodation space! Pros vs cons
- Not another Frank's Tract, or worse?

■ Restoration options differ as do WQ effects

USGS Delta WQ research sites

Yolo
Bypass
corridor

Cache
Slough
complex

Cosumnes/
Mokelumne
Complex

X2
corridor

Deeply
subsidized
Peat
islands

Drinking Water
exports
corridor



Grizzly Bay

Brown's Island

San Francisco

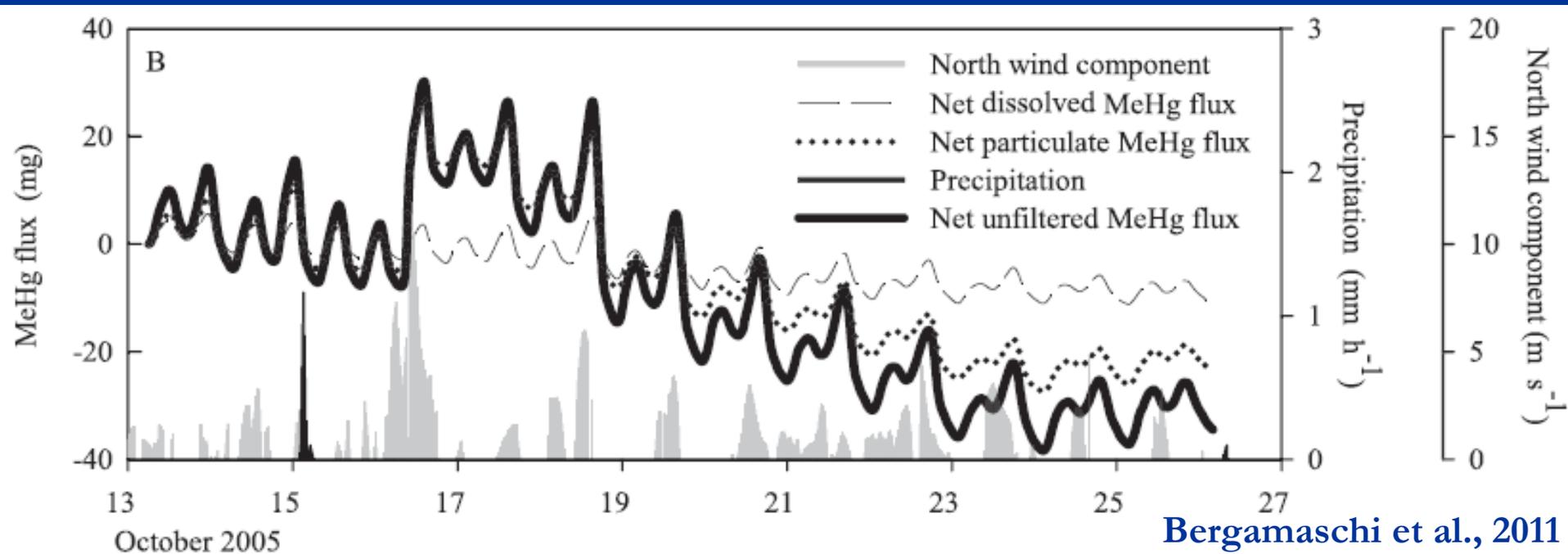
Sacramento



Highlights of contributions to science-based decision making to meet (co-equal) goals of restoration and maintaining water quality

In situ tools: Brown's Island

- Understanding of design elements for tidal wetland restoration
 - Hydrodynamic sills, slough orientation, topographic features
- Development of *in situ* sensors and proxies
 - understand biogeochemical processes at the timescales they occur
 - inform restoration effects in near real-time (adaptive management!)

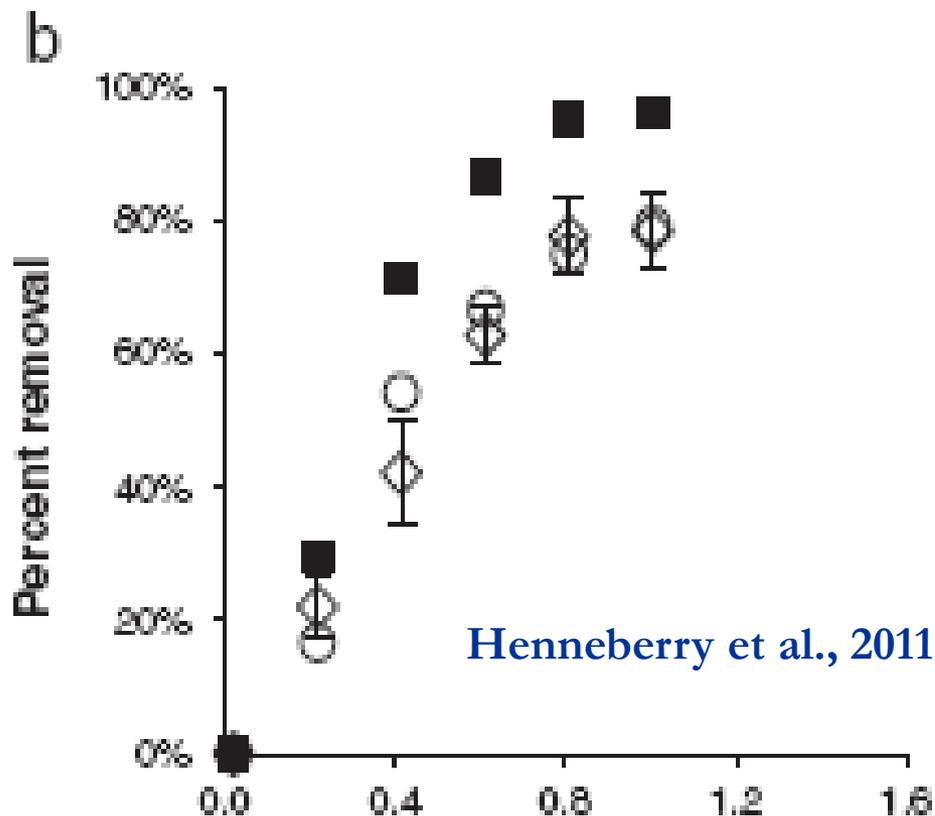


Funding: CALFED, USGS coop

CoPI's: USGS – Bergamaschi, Fleck, Schoellhamer, Ganju

CA DFG, Moss Landing Marine Lab, U of Maine

Contaminant removal technologies (LICD)



- Development of *in situ* technology to remove contaminants from water via coagulation of particles and DOM
- Treats drainage waters on subsided islands prior to discharge
- Potential for field-based applications throughout Delta

Funding: EPA RARE, DWR, USGS coop
CoPI's: USGS – Kraus, Fleck, Ackerman, Krabbenhoft.
UCD, TetraTech

Yolo Bypass and Cosumnes River Preserve wetlands studies

- Development of land and water management actions on the field scale that help wetland managers and rice producers meet MeHg reduction goals
 - Addresses Delta MeHg TMDL paradox (export vs exposure)
 - Information about how the layout of wetland mosaic and water delivery can promote wildlife diversity and reduce MeHg exposure while *also* reducing MeHg exports
 - Information about how management of vegetation in wetlands and rice fields can minimize DOC and MeHg exposure and export

Funding: Water Boards, CALFED, EPA 319h, USGS coop
CoPI's: USGS – Fleck, Ackerman, Marvin-DiPasquale,
Alpers, Windham-Myers... many more

Thank You

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The following slides
are for review as a
handout and will not
be included in the
presentation

Summary of recent and ongoing USGS research projects in the Delta

Partial list

Criteria for research sites

- Priority habitats for restoration
 - Tidal wetlands, floodplains, rice fields, managed wetlands, intertidal/subtidal rearing, agriculture
- Priority areas for restoration/climate sensitivity
 - X2, Smelt corridors, deeply subsided islands, floodplains, “source areas”
- Priority zones for restoration
 - Delta edge vs Central Delta’s “sunken heart”
- Priority WQ issues related to change

Brown's Island

- Priority habitat: tidal wetland
- Priority area: X2 corridor
- Restoration zone: Delta periphery, edge
- Approach: Used novel, high-frequency in situ monitoring approach to obtain process-level understanding of exchange between wetland and surrounding waters

Brown's Island

- Take home:
 - Exchange of WQ constituents (DOC, MeHg, SSC) is highly variable, ultimate net flux is largely dependent on episodic events that are affected most by geometry, orientation
 - Simple wetland design elements may be feasibly implemented to optimize ecosystem function while minimizing WQ effects to surrounding waters (trade off?)

Funding: CALFED, USGS coop

CoPI's: USGS – Bergamaschi, Fleck, Schoellhamer, Ganju
CA DFG, Moss Landing Marine Lab, U of Maine

Yolo Bypass; Cos-Mok Complex

- Priority habitat: managed wetlands (rice), floodplain
- Priority area: MeHg source area, rearing habitats, floodplain
- Restoration zone: Delta periphery, edge
- Approach:
 - Process-level studies of mercury and organic matter cycling and management control measures to optimize ecosystem function while minimizing (improving?) WQ effects

Yolo Bypass; Cos-Mok Complex

■ Study Locations

- Cosumnes River Preserve, Yolo Bypass Wildlife Area

■ Take home

- MeHg production and transport temporally variable and may be disconnected in seasonal wetlands (rice)
- Can implement management actions to reduce MeHg production and export to Delta waters
- Simple wetland design elements potentially can benefit both resident and downstream biota (incl. humans)

Funding: Water Boards, CALFED, EPA 319h, USGS coop
CoPI's: USGS – Fleck, Ackerman, Marvin-DiPasquale, Alpers, Windham-Myers... many more

Central Delta

- Priority habitat: agriculture, managed wetland
- Priority area: subsided island, DOC source area to drinking water corridor
- Restoration zone: Central Delta
- Approach:
 - Process-level studies of wetland restoration on subsided islands, conversion to rice, approaches to levee stability vs status quo with respect to DOM, nutrients, MeHg, pesticides

Central Delta

- Study locations
 - Twitchell, Staten, Bouldin Islands
- Take home:
 - Wetland restoration on deeply subsided islands can be implemented to regrow the Delta at rates far greater than historic accretion – potentially without major effects to surrounding waters?
 - Conversion of subsided islands from corn/oats to rice can potentially arrest subsidence without negative WQ effects to surrounding waters
 - But... may be a trade-off for resident biota?

Funding: DWR, CALFED, USGS coop, Water Boards

CoPI's: USGS – Fujii, Bergamschi, Miller, Fleck, Ackerman... Many more

Cache Slough Complex

- Priority habitat: wetland, floodplain, breached island, smelt rearing habitat
- Priority area: subsided island, DOC source area to drinking water corridor,
- Restoration zone: Floodplain, Delta edge
- Approach:
 - Process-level studies of wetland restoration on subsided islands, conversion to rice, approaches to levee stability vs status quo with respect to DOM, nutrients, MeHg, pesticides

Cache Slough Complex

- Study locations
 - Liberty Island, Sacramento River and Deep-water ship channel
- Take home
 - Strong seasonal variation in particle character of turbidity field
 - In situ monitoring technologies provide valuable insights and unmatched ability to track biogeochemical processes in real time

Funding: CALFED, IEP, USGS

CoPI's: USGS –Fleck, Bergamaschi, Downing, Pellerin.

U of SoCar, Oregon State U, UCD, many more...

Summary of future research efforts

Partial list of currently active USGS
CAWSC proposals and development
efforts

(in addition to further developing
currently funded projects)

1) Improved monitoring network

- Expand Delta hydrodynamic network to include *in situ* fdom and turbidity (and other sensors?) to help constrain Delta MeHg, THg, DOC (and nutrient?) budget
 - Currently have 3 sites instrumented for fdom and turbidity but no \$ for MeHg or THg calibrations
 - Additional sites need instrumentation

Funding: USGS/IEP

PI's: USGS – Bergamaschi, Pellerin, Downing.

2) Improved sensors and proxy development for in situ monitoring

- Further development of proxies for in situ monitoring of varied habitats
 - Particle characterization
 - Algal content and speciation
 - Additional contaminant proxies?
 - Establishment of standards and methods for monitoring dynamic systems

3) Wetland control measures

- Design wetlands to minimize MeHg concentrations and exports using wetland mosaic...
 - Vegetated area preferred by wildlife has higher than normal flow-through to reduce MeHg in surface waters which flows into an open water area where particle settling and photodemethylation are promoted to reduce MeHg export at the outlets...
 - Baseline study proposed. Need additional \$ for more comprehensive assessment

Funding: EPA 319(h) (Proposal submitted)

CoPI's: USGS - Eagles-Smith, Ackerman, Fleck, Windham-Myers, Marvin-DiPasquale. BLM - McQuillen

4) Hg Atmospheric deposition studies (linking air and water quality in the Delta)

- Currently monitoring Hg atm dep in west Delta but no \$\$ has appeared in support
- No data exist for determining the relative contribution of sediment Hg (HgS or Hg0) and atm dep Hg (RGM, RPM)
- Review of data suggest that open water loads are equal in magnitude to direct atm dep which may suggest atm Hg drives open water MeHg production
- Important because if atm Hg drives methylation in Delta, controlling mining source will have little effect

Funding: none, proposal development, cost-share EPA/USGS pilot study
CoPI's – Krabbenhoft, Bergamaschi, EPA