Addressing the Delta Methylmercury (MeHg) Conundrum

Prioritizing Nonpoint Source (NPS) Management Practices for On-site *and* Receiving Water Objectives

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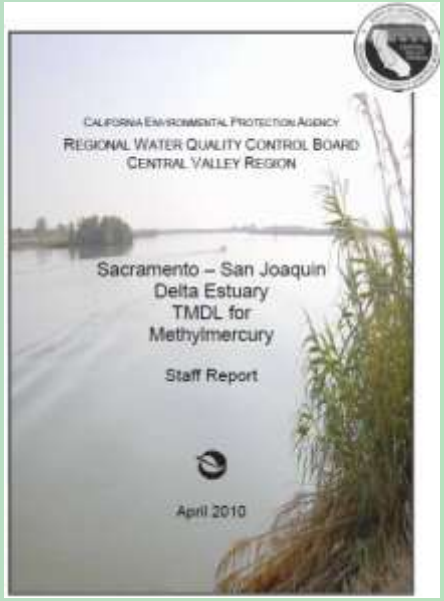
Overview

- The Problem
- The NPS Workgroup Approach
- Prioritization Results
- Conclusions & Recommendations

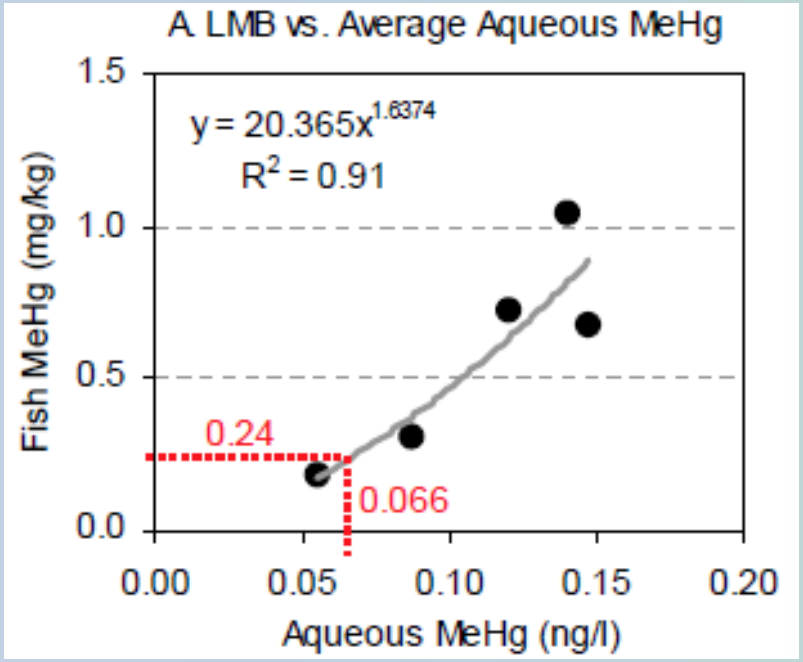


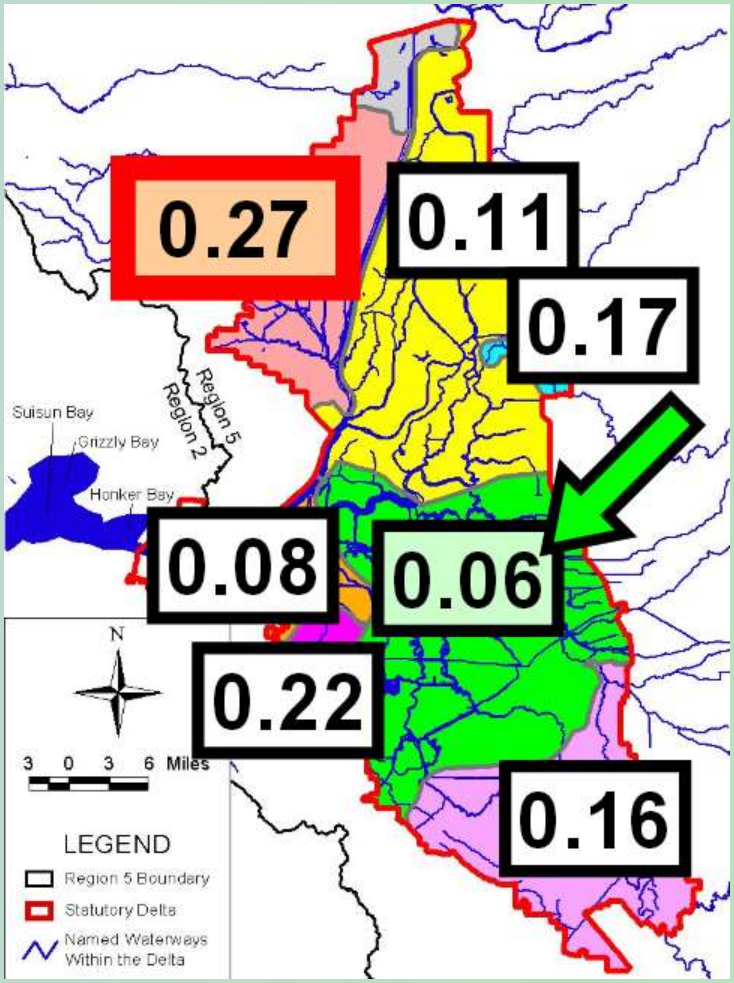
The TMDL Conundrum: How to reduce MeHg discharges (Hard Place) without worsening conditions on site (Rock)

THE PROBLEM

MeHg in Water Bioaccumulates

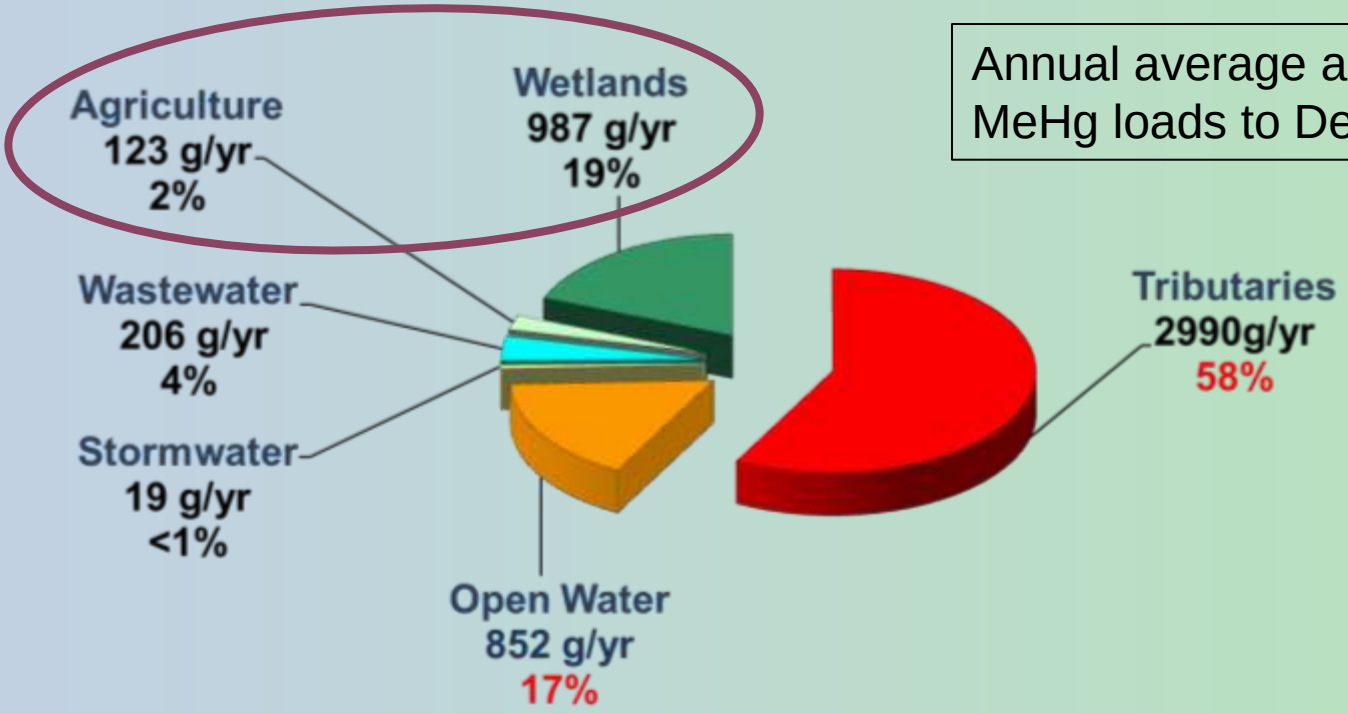
> 10^6 magnified in sportfish





MeHg (ng/L) in Delta open waters

TMDL Phase 1: **Characterize** MeHg Controls **by Category**



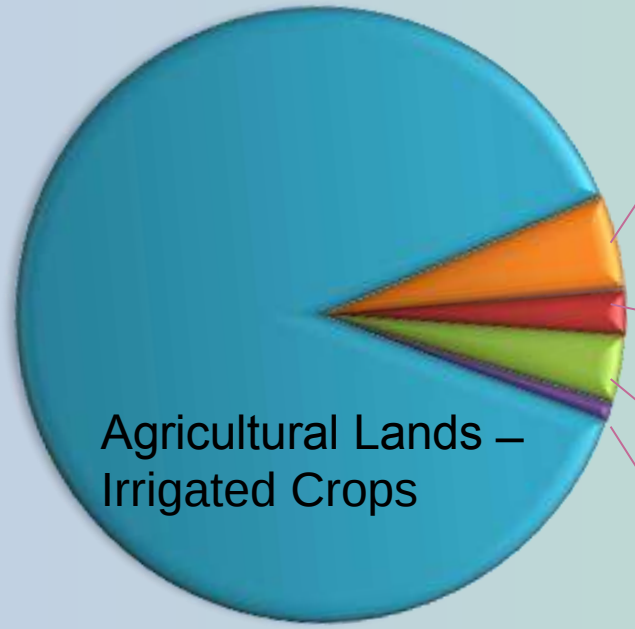
Annual average and % MeHg loads to Delta

- **Processes** driving MeHg production?
- **Constraints** on practices & effectiveness?

Areas of NPS Land Uses

~430,000 acres

<60,000 acres



Natural Hydrology Systems –
Brackish-Fresh Tidal Marsh

Managed Wetlands –
Permanent Wetlands

Agricultural Lands –
Flooded

Managed Wetlands –
Seasonal Wetlands

Natural Hydrology Systems –
Floodplains

Working together

THE NONPOINT SOURCES WORKGROUP APPROACH

Nonpoint Sources (NPS) Workgroup Cooperating Entities

Steering Committee

Cooperating Entities

Regulators
- USEPA
- CV-RWQCB

NPS Dischargers
- BLM
- US Fish & Wildlife Service
- CA Dept. Fish & Game
- DWR
- CA State Lands Comm.
- California Rice Comm.
- No. Cal. Water Assoc.
- San Jo. Co. RCD/San Jo. Co. & Delta WQ Coal.
- South Delta Water Agency
- The Nature Conservancy
- Ducks Unlimited
- California Waterfowl Ass'n .
- Westervelt Ecol. Serv.

Researchers
- USGS
- CA Dept. Fish & Wild. / MLML
- Office of Water Programs, CSUS

Our Hypothesis

Broad application of on-site MPs (Rock) will achieve NPS load allocations (Hard Place) with insignificant negative consequences.

Scoring Criteria Applied

Costs & Benefits

- Scientific Certainty
- Cost$
- MeHg Reduction Potential (Hard Place)
- Spatial Applicability

Practical Challenges

- Techn. Capacity to Implement
- Beneficial Use Impacts (Rock)
- Other Requirements (Rock)

The feasible subset of management practices (MPs)

PRIORITIZATION RESULTS

>400 individual scores!

Highlighting :	
-,0	Negative or low scores
-,0,+	Neutral or full range of scores
0,+	High or high range of scores
?	Not scored

Ben. Use Impacts, Other Req'mts

MeHg Reduction Potential

Potential Management Practices			Costs and Benefits				Practical Challenges			Overall Rank	
MP #	Management Type	Management Practice	ntific Certa	Costs	eduction P	tial Applicab	Capacity to Impl	U Impacher Req'n		Apply	Test
Managed Wetlands – Permanent Wetlands (MW-pw)											
MW-pw-1	Biogeochemistry	Apply coagulant	-,0,+	-	+	-,0	-,0	-,0	-	0	+
MW-pw-2	Biogeochemistry	Aerate	-	-	-	-	-,0	-,0,+	-,0	-	-
MW-pw-3	Biogeochemistry	Add nitrate	-	-	-	-	-	-	-	-	-
MW-pw-4	Biogeochemistry	Increase fish population	0	-	0	-	-,0	-,+	0	-	0
MW-pw-5	Biogeochemistry	Amend soil with iron	0	-	0,+	0,+	0	0	0	-	0
MW-pw-6	Hydrology	Recirculate drainage water	+	-	0	0	0	-,0	0	0	+
MW-pw-7	Hydrology	Increase water residence time	+	0,+	+	-	0,+	-	0,+	+	+
MW-pw-8	Hydrology	Increase water depth	0,+	0,+	0,+	-,0	0,+	-,0	-,0	+	+
MW-pw-9	Hydrology	Increase water velocity	0	-,0	0	-	-	-,0	-,0	-	+
MW-pw-10	Hydrology	Schedule water discharge	+	-,0,+	0	0	0	0	0,+	+	+
Managed Wetlands – Seasonal Wetlands (MW-sw)											
MW-sw-1	Biogeochemistry	Apply coagulant	+	-	+	-	-,0	-,0	-	-	+
MW-sw-2	Biogeochemistry	Aerate	-	-	-	-	-,0	0,+	0,+	-	-
MW-sw-3	Biogeochemistry	Add nitrate	-	-	-	-	-	-	-	-	-
MW-sw-4	Biogeochemistry	Amend soil with iron	-	-	-	-	-	-	-	-	-
MW-sw-5	Biogeochemistry	Amend soil with sulfate	-	-	-	-	-	-	-	-	-
MW-sw-6	Hydrology	Pre-flood wetland	-,+	-,0,+	-	0,+	0,+	-,+	+	-	+
MW-sw-7	Hydrology	Flood and hold	+	-,0	0,+	0	0,+	-,0,+	-,0	+	+
MW-sw-8	Hydrology	Delay fall flood up	-	0,+	0	-	-,0	-	-	0	+
MW-sw-9	Hydrology	Stagger flood/drain events	0	0	-	-	0	-,0	-	-	+
MW-sw-10	Hydrology	Increase water residence time	+	+	+	0	0	-,0	-,0	+	+
MW-sw-11	Hydrology	Recirculate drainage water	+	-	0	0	0	-,0	-,0	0	+
MW-sw-12	Hydrology	Increase water velocity	0	-	0	-	-	-,0	0	-	+
MW-sw-13	Hydrology	Use permanent ponds as treatn	+	-,0	-,+	0,+	0,+	-,0	0	+	+
MW-sw-14	Hydrology	Reduce flooding period	0	+	0,+	-	-	-	-,0	+/-	+
MW-sw-15	Soil/Vegetation	Burn vegetation and soil	0	-,+	0,+	-	-,+	-,+	-	0	+
MW-sw-16	Soil/Vegetation	Till vegetation below soil surfac	0	0	0,+	-	-,0	-	-,0	0	+
MW-sw-17	Soil/Vegetation	Bale and remove vegetation	0	-,0	0,+	-	-	-	-,0	0	+
MW-sw-18	Soil/Vegetation	Graze fields with livestock	0	-,0	0,+	-	-	-,0	0	0	+
Agricultural Lands – Flooded (AL-f)											
AL-f-1	Biogeochemistry	Apply coagulant	0,+	-	0	+	0	0	0	0	+
AL-f-2	Biogeochemistry	Add nitrate	-	0	0	0	0	-	-	-	-
AL-f-3	Biogeochemistry	Amend soil with iron	-	-	-,0	0	-,0	-	0	-	-
AL-f-4	Biogeochemistry	Amend soil with sulfate	-	-	-,0	0	0	-	-,0	-	-
AL-f-5	Hydrology	Increase water residence time	0,+	+	-,+	0	+	-,+	0	+	+
AL-f-6	Hydrology	Reduce flooding period	0	-,0	-,0	0,+	0,+	-	0	0	+
AL-f-7	Hydrology	Recirculate drainage water	-,+	-,0	+	0	-,+	-,0,+	-,+	+	+
AL-f-8	Hydrology	Stagger flood/drain events	0	-,0	0	0,+	+	0	0	0	+
AL-f-9	Hydrology	Use permanent ponds as treatn	0	-	+	-	0	-,0	0	+	+
AL-f-10	Hydrology	Irrigate fields in series versus pa	?	?	?	?	?	?	?	?	+
AL-f-11	Hydrology	Raise water depth in drainage d	+	0	+	0	+	0	0	+	+
AL-f-12	Soil/Vegetation	Burn vegetation and soil	-,0,+	0,+	+	-	-,+	-,0	-	-	+
AL-f-13	Soil/Vegetation	Till vegetation below soil surfac	0,+	-,0	0,+	0	+	-,0	-,0	0	+
AL-f-14	Soil/Vegetation	Bale and remove vegetation	-,0,+	-,0	0,+	-,+	-,+	-,0	-,0	0	+
Agricultural Lands – Irrigated (AL-irr)											
AL-irr-1	Biogeochemistry	Apply coagulant	?	-	0	+	?	?	+	0	+
AL-irr-2	Biogeochemistry	Amend soil with iron	-	-	-	-	-	-,0	-	-	-
AL-irr-3	Biogeochemistry	Amend soil with sulfate	-,+	-	-	-,0	-,0	-,0	-	-	-
AL-irr-4	Hydrology	Recirculate drainage water	-,0	-	0,+	-	-,0	-,0	-,0	-	-
AL-irr-5	Hydrology	Stagger flood/drain events	0	-	0	0	-,0	0	-,0	-	-
AL-irr-6	Hydrology	Use permanent ponds as treatn	0	-	0	0	0	0	0	0	+
AL-irr-7	Hydrology	Irrigate fields with drip irrigation	0	-,0	0,+	-	-	-	-,0	+	-
AL-irr-8	Soil/Vegetation	Burn vegetation and soil	-,+	-	-	-	-	-,0	-	-	-
AL-irr-9	Soil/Vegetation	Bale and remove vegetation	0,+	-,0	0	-,0,+	+	-,0,+	-,0,+	-	-
Natural Hydrology Systems – Floodplains (NHS-f)											
NHS-f-1	Biogeochemistry	Amend soil with iron	-	-	-	-	-,0	-,0	-	-	-
NHS-f-2	Biogeochemistry	Amend soil with sulfate	-	-	-	-	-,0	-,0	-	-	-
NHS-f-3	Soil/Vegetation	Burn vegetation and soil	0,+	0	+	0	0	-	-	+	+
NHS-f-4	Soil/Vegetation	Graze fields with livestock	0	0,+	0,+	-,+	-,+	0	0	+	+
NHS-f-5	Soil/Vegetation	Till vegetation below soil surfac	0	0	0,+	-,0	-,+	-,0	-,0	+	+
NHS-f-6	Soil/Vegetation	Bale and remove vegetation	0	0	0,+	-	-,0	-,0	0	+	+
Natural Hydrology Systems – Brackish-Fresh Tidal Marsh (NHS-bftm)											
NHS-bftm-1	Biogeochemistry	Add nitrate	-,0	-	-,0	-	-	-	-	-	-
NHS-bftm-2	Biogeochemistry	Apply coagulant	0,+	-	0,+	-,0	-,0	-	-	-	-
NHS-bftm-3	Biogeochemistry	Increase fish population	-,0	-	0	-,+	-,0	-,0,+	-,0	-	-
NHS-bftm-4	Hydrology	Stagger flood/drain events	0	-,0	-	-	-,0	-,0	-	-	0
NHS-bftm-5	Hydrology	Increase water residence time	0	0	-	-	0	-,0	-,0	0	0
NHS-bftm-6	Hydrology	Design new/restored tidal marsl	?	?	0,+	?	?	?	?	+	+

NPS Management Practices to **E**valuate or **A**pply

Biogeochemistry

- Apply coagulant

Soil / Vegetation

- Burn soil & veg.
- Till / incorp. veg.
- Bale & remove veg.
- Graze veg. w/ livestock

Hydrology

- Incr. residence time
- Flood & hold
- Use perm. ponds
- Recirculate drainage
- Raise ditch water depth
- Schedule discharges
- Use drip irrigation
- Flush marshes
- Stagger flood/drain events
- Reduce flooding period
- Incr. currents
- Pre-flood wetlands
- Delay fall flood-up
- Irrigate in series

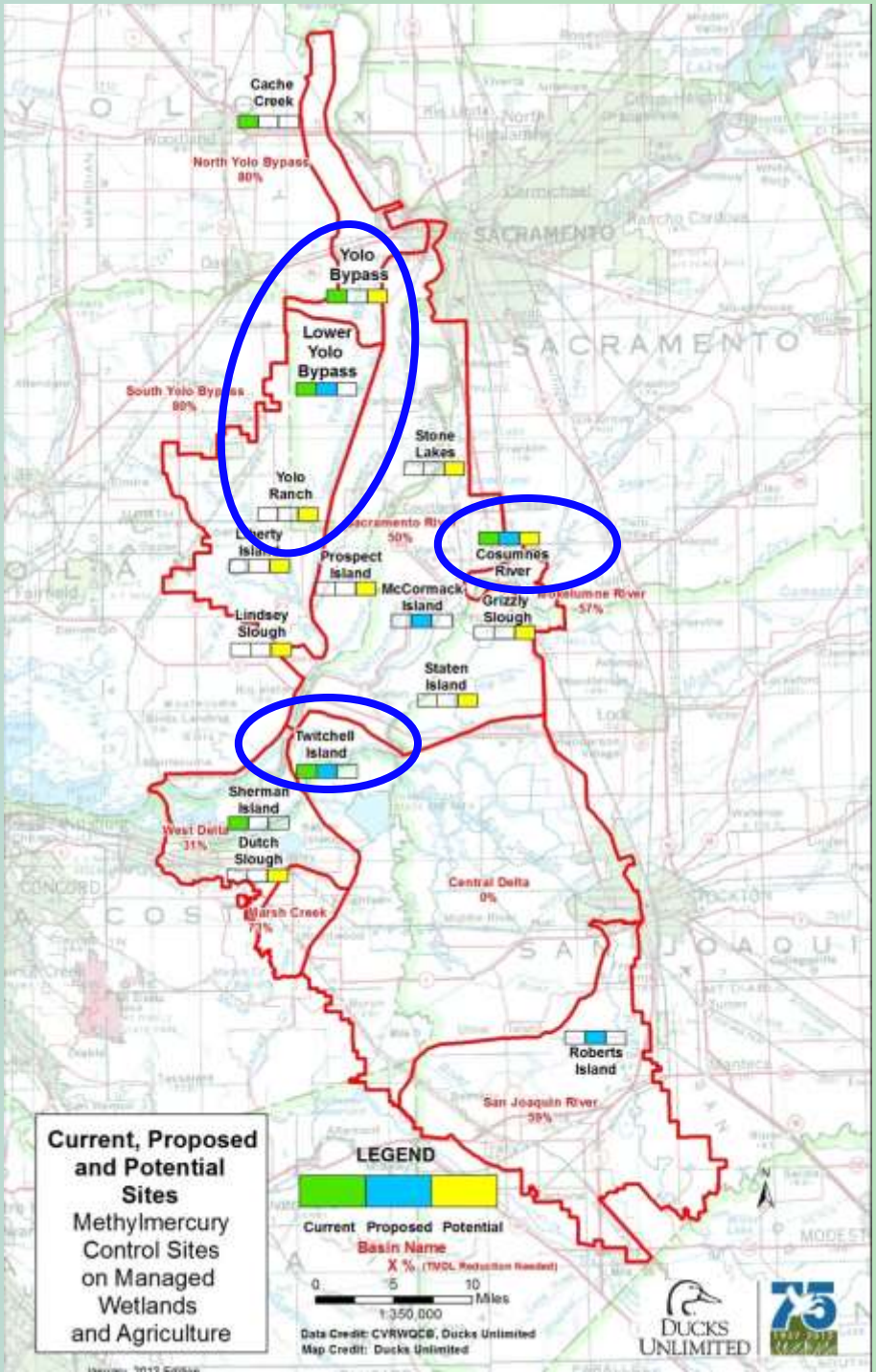
Promising MPs by Land Use

MP Types	Land Use Categories					
	Managed Seasonal Wetlands	Flooded Ag. Lands	Irrigated Ag. Lands	Managed Perm. Wetlands	Flood-plains	Brackish-Fresh Tidal Marsh
Biogeochemistry	E	E	E	E		
Soil / Vegetation	E	E			A	
Hydrology	E, A	E, A	E, A	E, A		E

E = Evaluate; **A** = Apply

- Biogeochemistry? Need data to evaluate
- Soil / Vegetation? Tough to manage
- Hydrology? Uncertain on-site impacts

Current Control Study Sites



Official BPA Cost Estimates

Component	Low	High	Term
Wetlands			
Compliance Monitoring	$14,000	$25,000	Annual
Control Studies	$730,000	**$4.7M**	Total
Management Practices	$212,000	$289,000	Annual
Irrigated Agriculture			
Compliance Monitoring	$14,000	$25,000	Annual
Control Studies	$290,000	**$1.4M**	Total
Management Practices	$220,000	$460,000	Annual

Actual $study Cost$

- 3-year study on 10 wetlands ~ $1.0-1.9 M
- 3-year study on 4 wetlands ~ $1M
- 2-year Cosumnes study ~ $1.5 M
- Yolo Rice study ~ $2 M
- Yolo by DFG ~ $1.5 M
- Twitchell Is ~ $1 M

TOTAL to date > $8M

CONCLUSIONS & RECOMMENDATIONS

Control Study Workplan

- **What we know (USGS):** Synthesis of key findings & knowledge gaps
- **What to do (MLML):** Management practices described & scored
- **Where to do it (DU):** Land uses by subarea

Long-term Approach

- Conceptual → Mechanistic → Scale
  - Land use analysis
  - Science synthesis
  - Management Practices evaluation
- Long-term interests
  - Modeling
  - Cost-benefit
  - Attainability
  - Climate change

Summary

- Discharge regulations impact other management objectives.
- Reducing MeHg exports could exacerbate MeHg exposure on-site.
- MeHg control studies (**E**valuation and **A**pplication) need to address this TMDL conundrum.

For more information

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