

How the Bay Regional Monitoring Program Integrates Research and Monitoring

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**Presented at the 2016 Bay-Delta
Mercury Workshop**



***“to avoid increasing – and to eventually decrease
– biotic exposure to methylmercury”***

Wiener et al. 2013

Core Components

1. Quantification and evaluation of mercury and methylmercury sources
2. Remediation of mercury source areas
3. Quantification of effects of ecosystem restoration on methylmercury exposure
4. Monitoring of mercury in fish, health-risk assessment, and risk communication
5. Assessment of ecological risk
6. Identification and testing of potential management approaches for reducing methylmercury contamination

Management Goals

- To identify mercury sources that contribute most strongly to the production and **bioaccumulation** of methylmercury
- To identify remedial actions that can reduce loadings of mercury from sources to surface waters and decrease the **exposure of aquatic biota** to methylmercury
- To document and understand the effects of ecosystem restoration in wetland, floodplain, and riverine habitats on the production and **bioaccumulation** of methylmercury in the Bay-Delta ecosystem
- To protect human health by assessing and reducing exposure to methylmercury-**contaminated fish**
- To provide a **“performance measure”** to gage methylmercury contamination of the Bay-Delta ecosystem during restoration
- To protect **fish and wildlife** from adverse effects of methylmercury exposure
- To identify and evaluate potential landscape management approaches for reducing the production and abundance of methylmercury in the ecosystem, as well as the associated **exposure of resident biota**

“The establishment of a systematic monitoring program for mercury in fish is a high priority”

Wiener et al. 2013

Fish Monitoring

- What has been done
- What is being done
- What is not being done



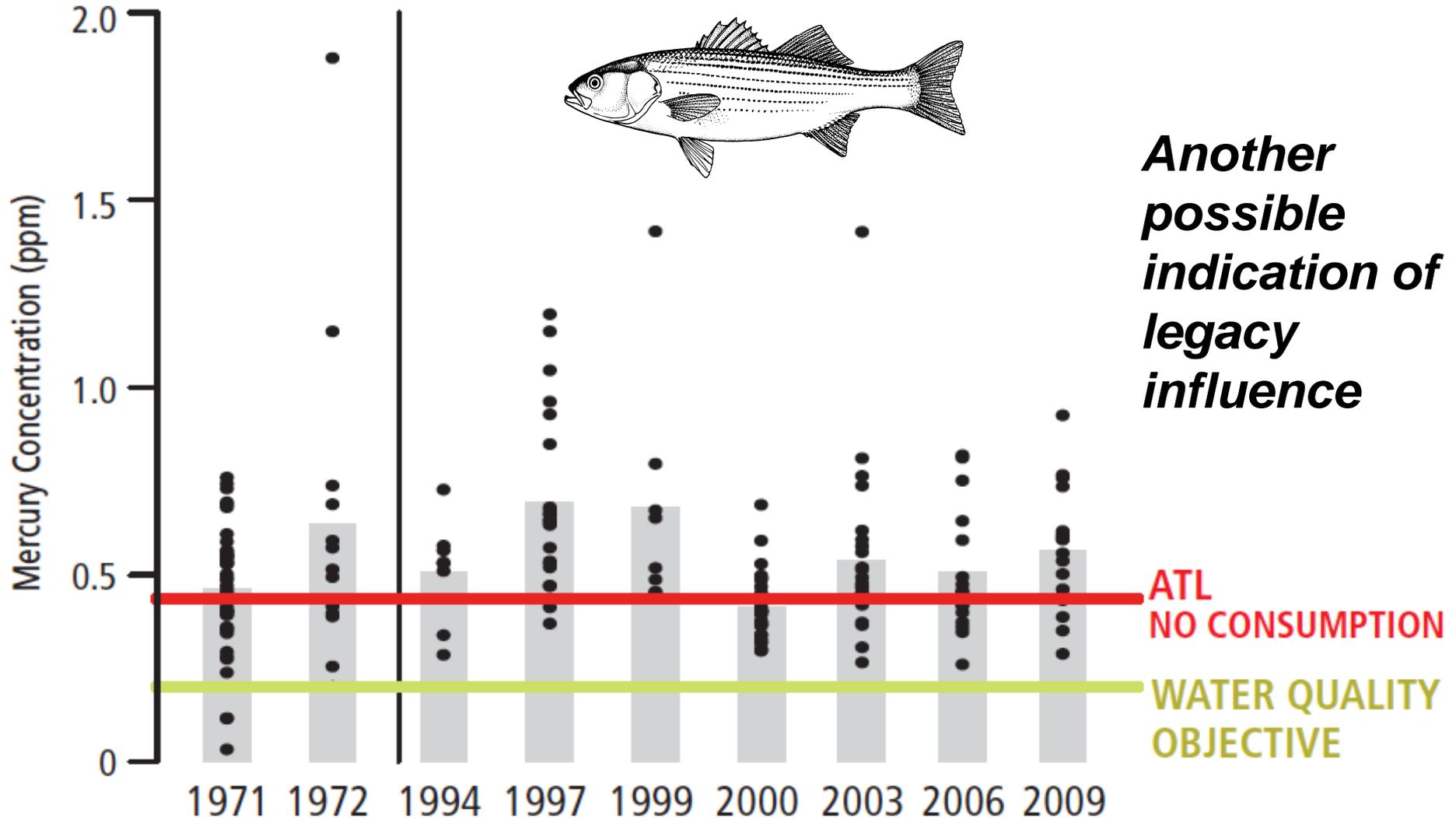
San Francisco Bay Regional Monitoring Program



Goal

Collect data and communicate information about water quality in San Francisco Bay in support of management decisions

No Change for Open Bay Since 1971



The RMP Mercury Strategy

2008-
2012

Goal: Collect data to support management decisions

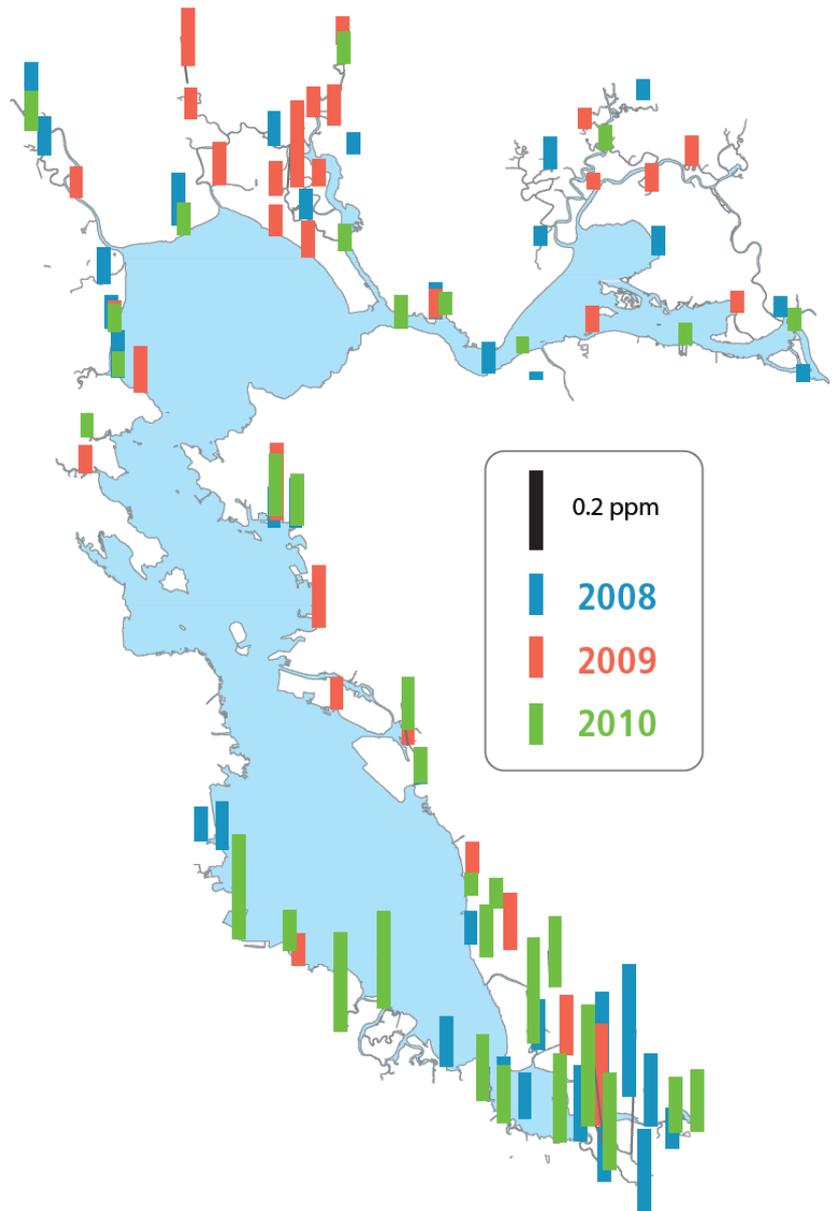
External
Advisors

Priority Questions

1. Where and when is mercury entering the food web?
2. What are the high leverage processes, sources, and pathways?
3. What are the best opportunities for management intervention?
4. What are the effects of management actions?
5. Will total mercury reductions result in reduced food web accumulation?

Small Fish Monitoring

- SFEI and UC Davis
- 2008-2010
- Regional variation
- Lots of seasonal variation
- No clear high leverage pathways
- POTW effluent appears to be a low leverage pathway

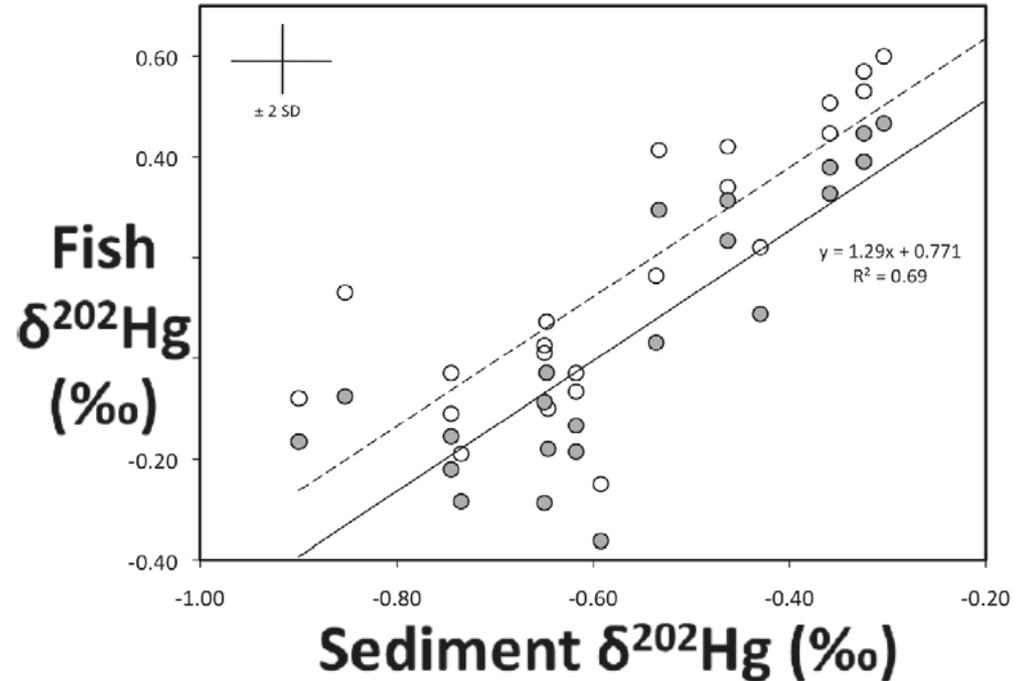


Greenfield et al. 2013. ET&C 32 (12): 2728–2737.
Greenfield et al. 2013. STOTEN 444: 591-601.

Mercury concentrations (ppm) in silverside from 2008-2010.

Legacy Hg Matters

- Joel Blum et al.
- 2008-2009
- Hg isotope study
- Hg from historic mining regions is clearly a concern
- Elemental Hg from gold mining, urban/industrial, and atmosphere is also important

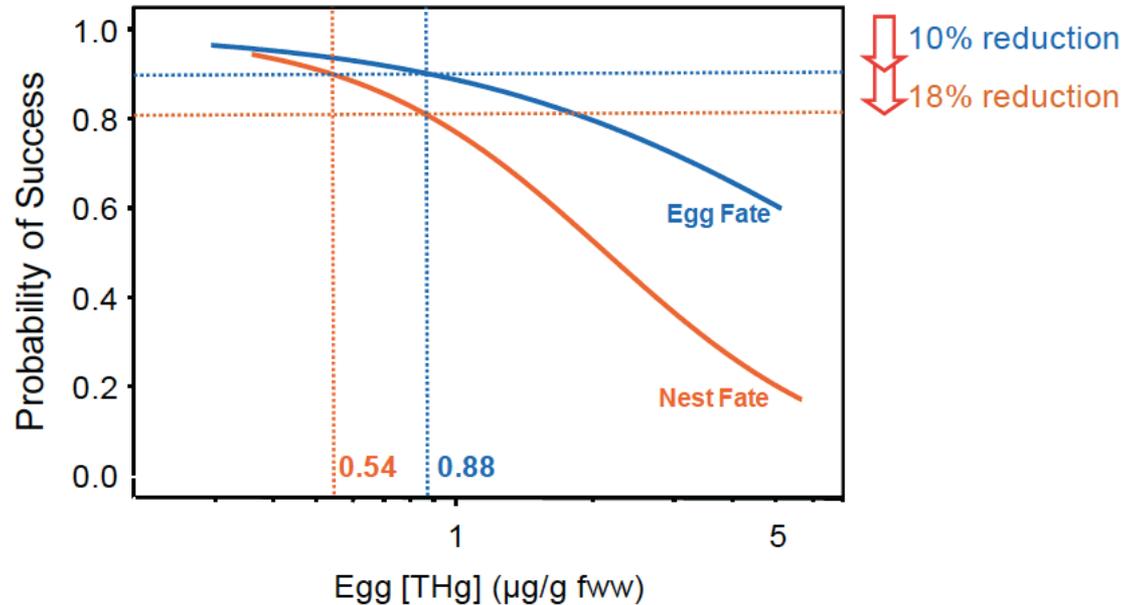


Gehrke et al. 2011. ES&T 45 (4), pp 1264–1270

***Support for Bay TMDL
long-term strategy of
controlling THg***

The TMDL Avian Egg “Target” is Protective

- Collin and Josh
- 2008-2009
- Studies of mercury and selenium effects on Forster’s terns



Eagles-Smith and Ackerman. 2010. Development of Impairment Thresholds for the Effects of Mercury on Forster’s Tern Reproduction in San Francisco Bay – Data Summary. USGS, Western Ecological Research Center, Davis, CA.

Reducing Methylmercury Accumulation in the Food Webs of San Francisco Bay and Its Local Watershed

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San Francisco Estuary Institute

Richard Looker, Carrie Austin

San Francisco Bay

Regional Water Quality Control Board

Mark Marvin-DiPasquale

U.S. Geological Survey

Robert Brodberg

California Office of Environmental Health Hazard Assessment

Joel Blum

University of Michigan



**Can we do anything to reduce
food web methylmercury in
the next 10-20 years?**

Habitats

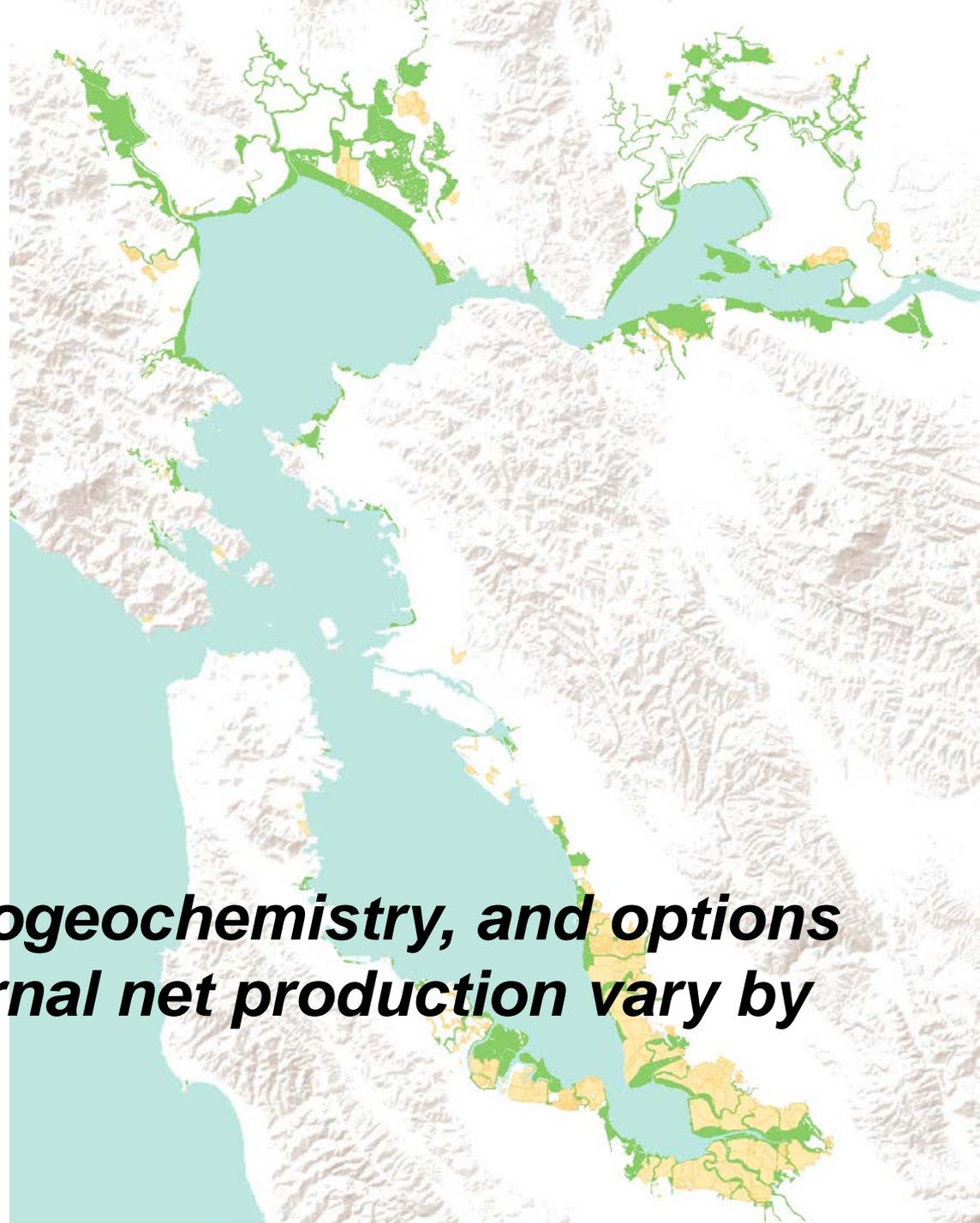
Open Bay

Tidal Marsh

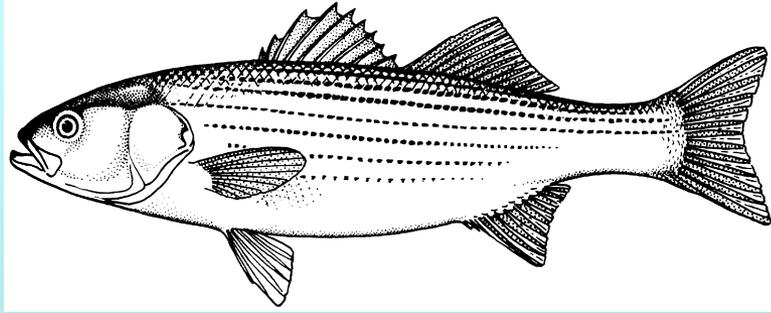
Managed Pond

Reservoir

Species at risk, biogeochemistry, and options for managing internal net production vary by habitat



Open Bay



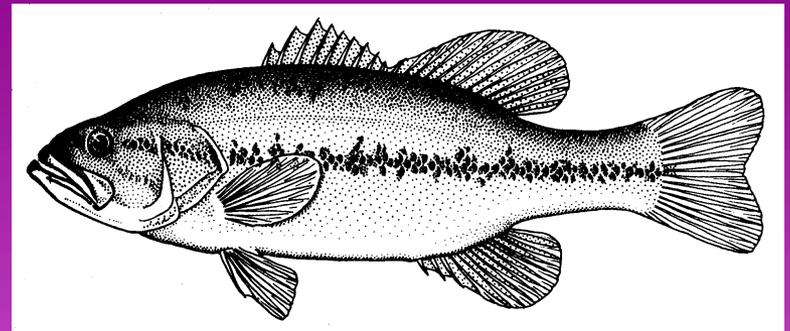
Tidal Marsh



Managed Pond

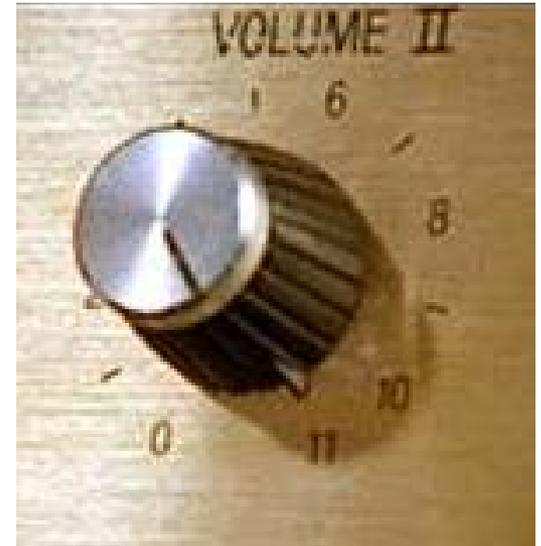


Reservoir



Open Bay: Possible Knobs

- Elective strategies
 - Slow knobs
 - THg inputs: mining region runoff, urban runoff
 - Fast knobs
 - Nutrient control?
- Non-elective changes
 - Suspended sediment regime
 - Temperature change
 - Sea level rise
 - Food web shifts



Tidal Marsh



Knobs

- Elective strategies
 - Slow knobs
 - THg inputs
 - Fast knobs
 - Design of restored marshes
- Non-elective changes
 - Temperature change
 - Food web shifts

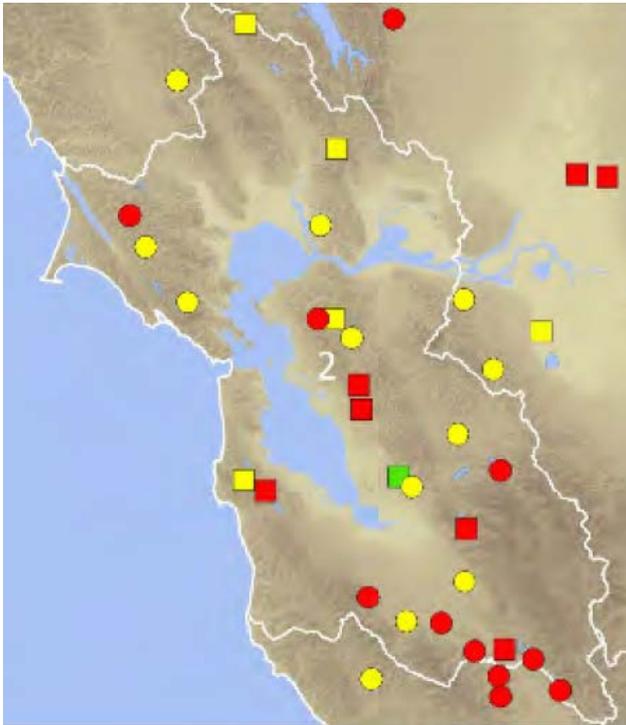
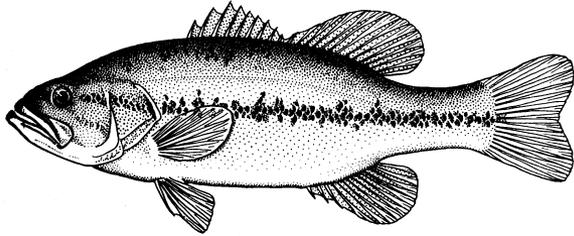
Managed Pond



Knobs

- Elective strategies
 - Slow knobs
 - THg inputs
 - Fast knobs
 - Pond management
 - Pond placement
- Non-elective changes
 - Temperature change
 - Food web shifts

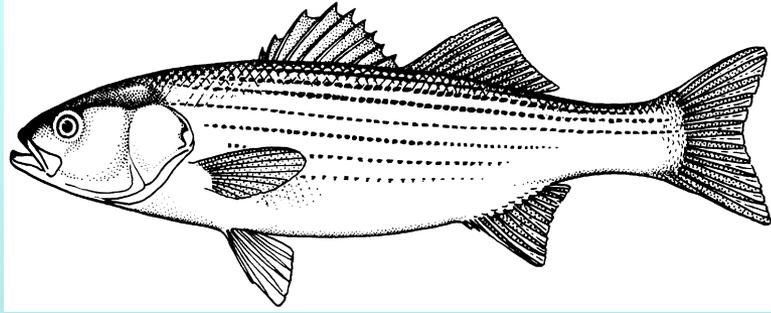
Reservoir



Knobs

- Elective strategies
 - Slow knobs
 - THg inputs
 - Fast knobs
 - Water management
 - Water chemistry
 - Fishery management
- Non-elective changes
 - Temperature change
 - Food web shifts

Open Bay



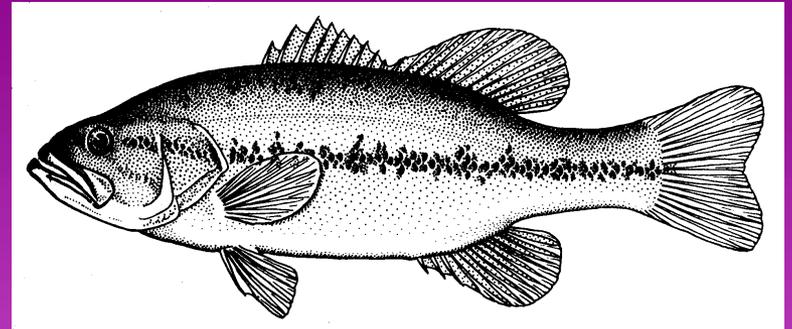
Tidal Marsh



Managed Pond



Reservoir

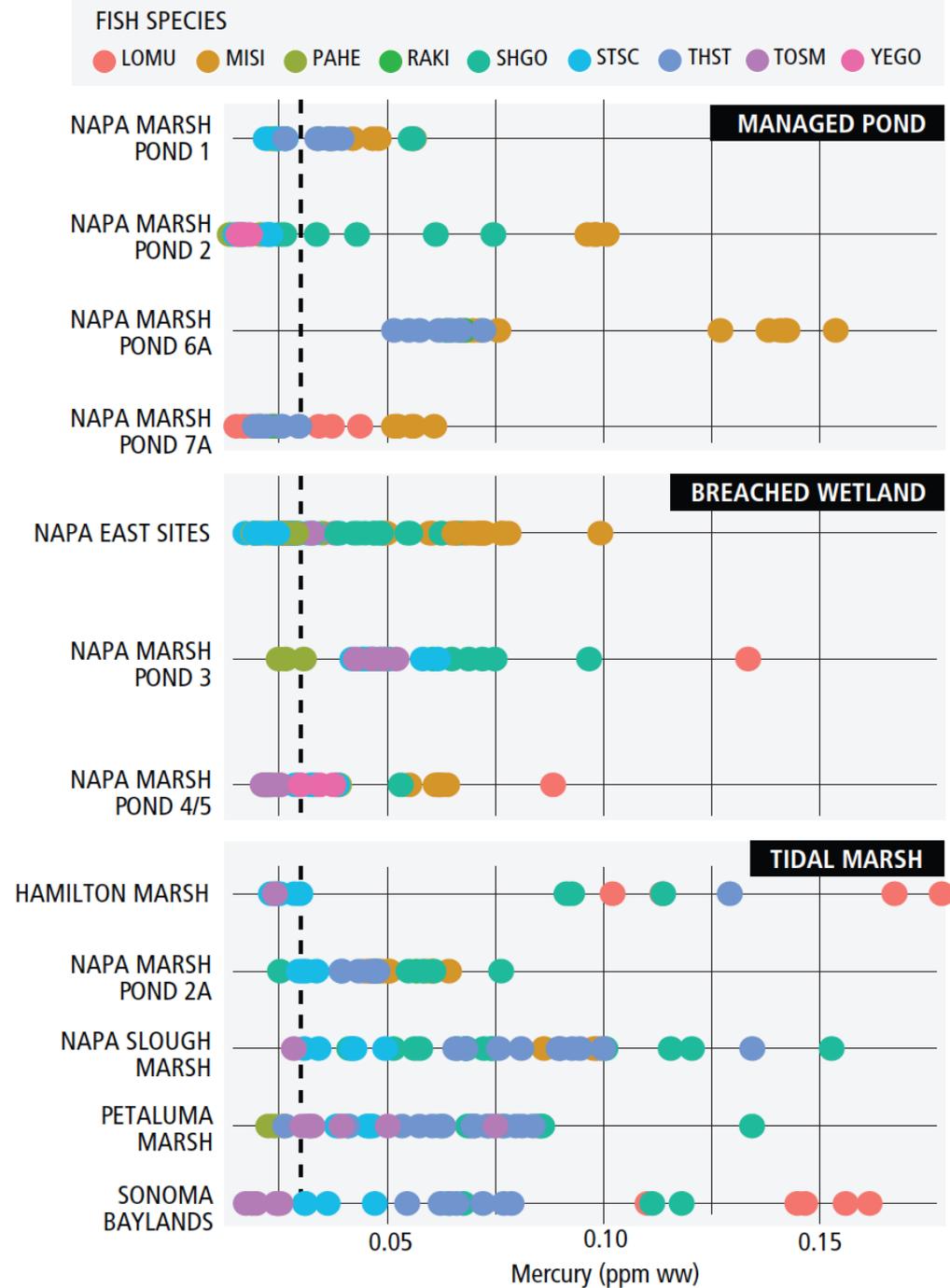


RMP Marsh Mercury Forum (2013)

- External advisors: Jim Wiener, Rob Mason, Jeremy Lowe
- Increases most likely in the year or two following restoration. Longer-term monitoring needed to assess the potential increases at later stages.
- Regional increases in biota are far less likely to be detectable than site increases. However, aggregate effect is a concern.
- Support for a regional approach to monitoring, with some sites selected for detailed investigation. Biosentinels needed to track trends and generate hypotheses, and process studies to test hypotheses and gain mechanistic understanding.
- Continued research and pilot studies may identify design features for some sites that minimize methylmercury accumulation in the food web.

North Bay Biosentinel Project

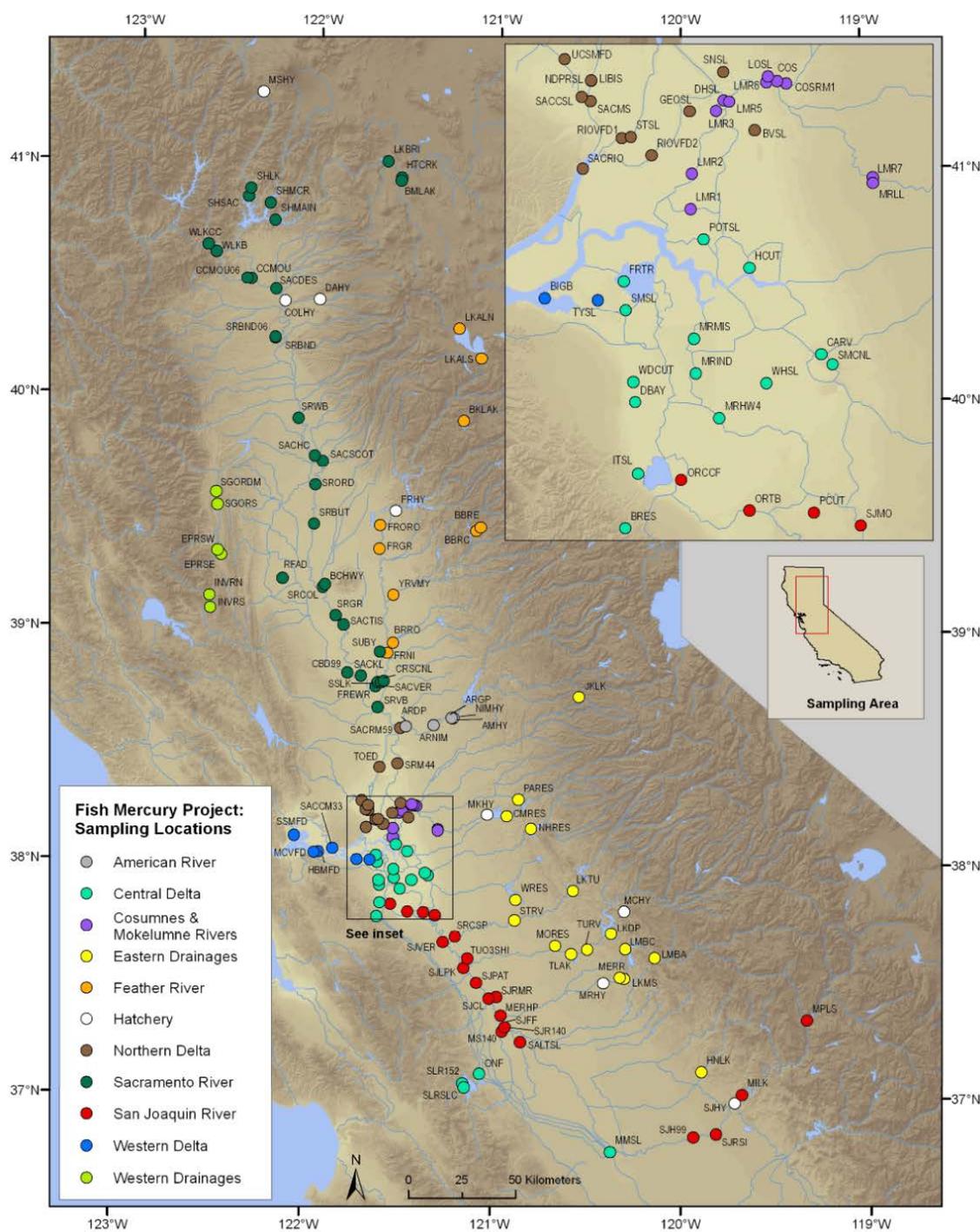
- SFEI and UCD
- 2012-2013, 2016-2017
- External advisors: Wiener, Evers, Ohlendorf...
- Breached wetlands not elevated
- Significant variation among managed ponds



The Delta

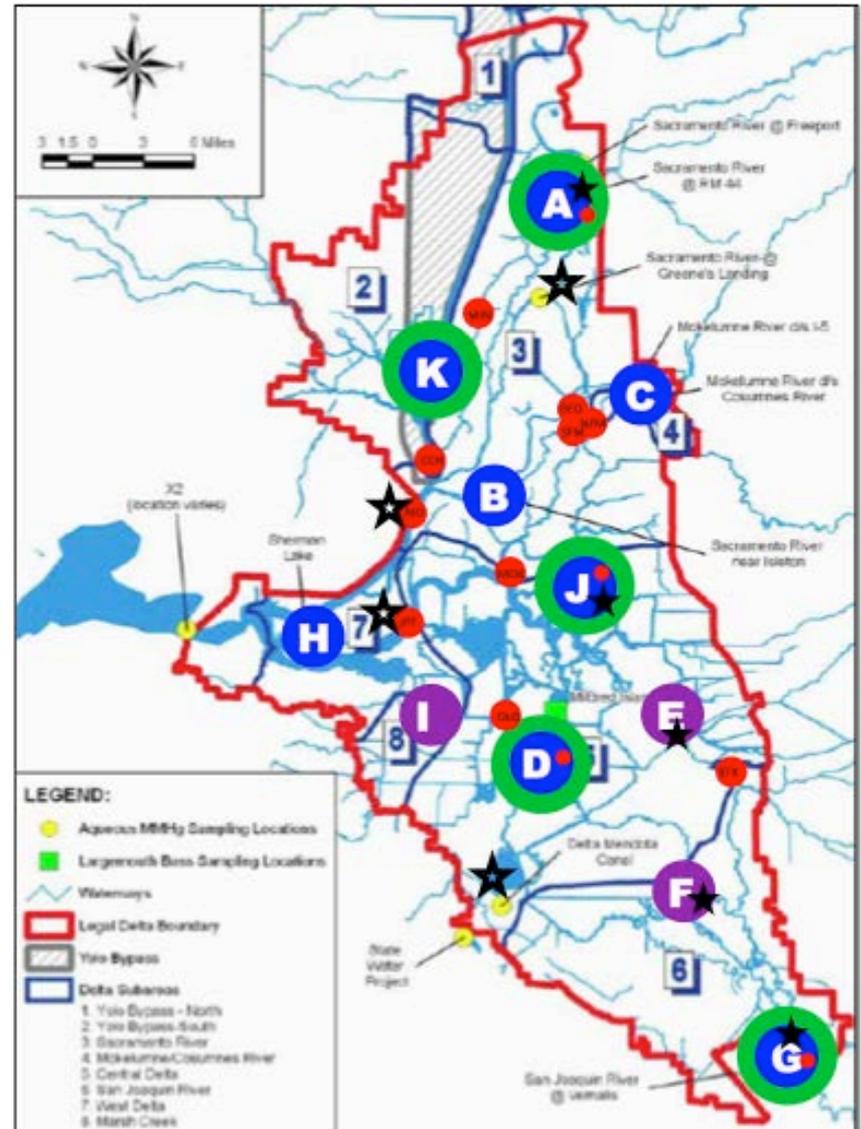
The Fish Mercury Project

- \$4.5 million from CALFED
- 2005-2007
- Sport fish and small fish
- Advisors: Wiener, Bodaly, Grieb, Knuth, McCann
- Significant communication component
- Extensive stakeholder involvement, environmental justice considerations



Delta Regional Monitoring Program

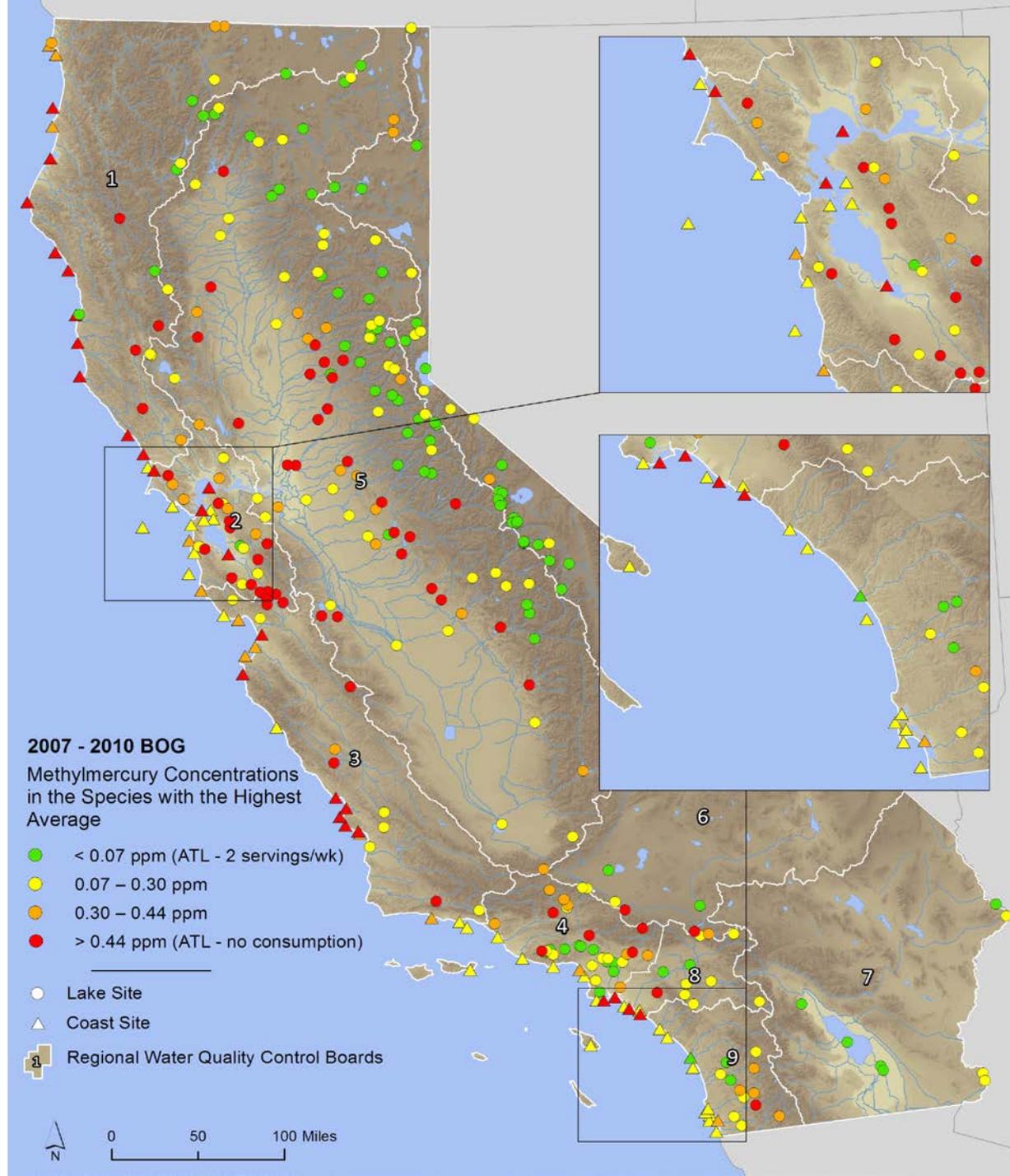
- Began 2015
- Structured similar to Bay RMP
- Participant funds just beginning to flow
- Initial priorities: pesticides, pathogens, nutrients, mercury
- Mercury plan developed for sport fish and water
- No funds yet for implementing the mercury plan



Statewide Monitoring – Surface Water Ambient Monitoring Program

Statewide Sport Fish Surveys

- SWAMP
- 2007-2011
- Advisors: Wiener, Schmitt, Ohlendorf
- Finding accumulation in even the most remote corners of the state



Statewide Mercury Control Program

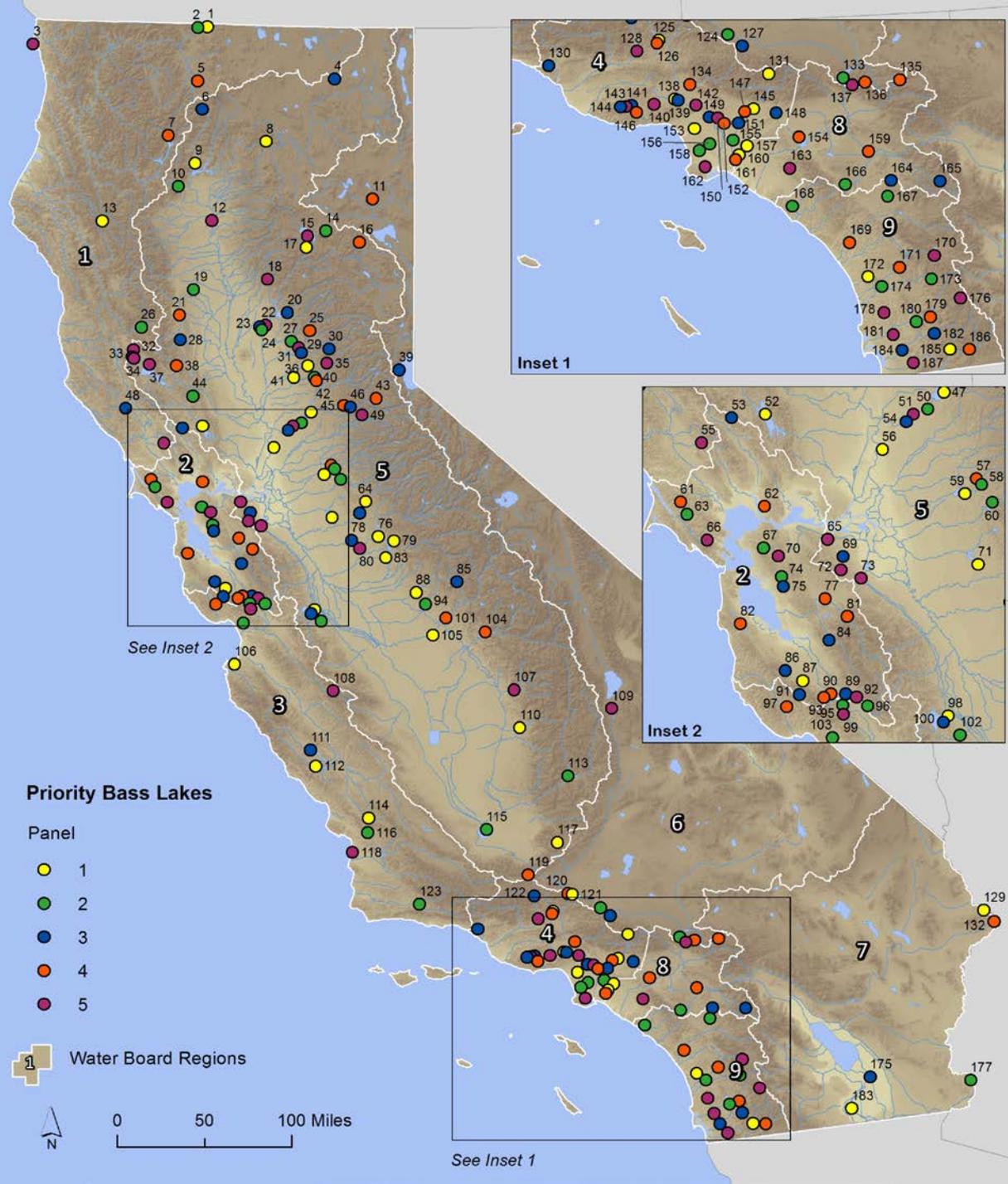
- **Statewide TMDL for Reservoirs**
- **Statewide Mercury Water Quality Objectives**

Additional consumption advisories

- **Statewide advisory for reservoirs**

Long-term Sampling Plan for Bass Lakes

- Regular updates on lake status
- Statewide and regional trends
- Includes prey fish



“The establishment of a systematic monitoring program for mercury in fish is a high priority”

Wiener et al. 2013

My Thoughts on Information Needs and Next Steps: San Francisco Bay

- Continued RMP status and trends monitoring of ambient concentrations and loads
- Better regional coordination of marsh restoration monitoring and process studies
 - Coordinated external peer review
- Managers consider options for managed ponds

My Thoughts on Information Needs and Next Steps: The Delta

- Implementation of the existing Delta RMP mercury monitoring plan for sport fish and water
- Systematic local and regional biosentinel monitoring and research related to management actions
 - Restoration projects
 - Wetland management
 - Agricultural practices
 - Hydrological alterations

Grebe Study
Clean Lakes Study
– quick mention

MERCURY

The Mercury Strategy began with a multi-year suite of studies in 2008. The synthesis completed in 2012 led to a focus on reducing methylmercury production in tidal marsh restoration projects and salt ponds.

Mercury and methylmercury studies and monitoring in the RMP from 2008 to 2017. Numbers indicate budget allocations in \$1000s.

General Area	Element	Mercury Questions Addressed	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Mercury Strategy	Methylmercury Synthesis	1,2,3,4,5				75						
	Food Web Uptake (Small Fish) (Status and Trends)	1,4	150	150	150	20			TBD	TBD	TBD	TBD
	High Leverage Pathways (DGTs)	2	58	58								
	High Leverage Pathways (Isotopes)	2,5	40	40								
	Methylmercury Fate Model	3,4		25								
	Methylmercury in Marshes and Salt Ponds	1,3,4					25					
RMP Total			248	273	150	95	25	0	TBD	TBD	TBD	TBD
Non-RMP Total			0	0	0	0	0	0	TBD	TBD	TBD	TBD
Overall Total			248	273	150	95	25	0	TBD	TBD	TBD	TBD

Possibilities: RFP to determine contribution of air dep, coordinated monitoring of wetland restoration impact on MeHg, dredged material re-use, fate on the margins in sensitive areas, effectiveness of management actions, demethylation patterns, marsh design, pond design and management, continued long-term monitoring to evaluate impact of climate change, awareness of safe eating guidelines

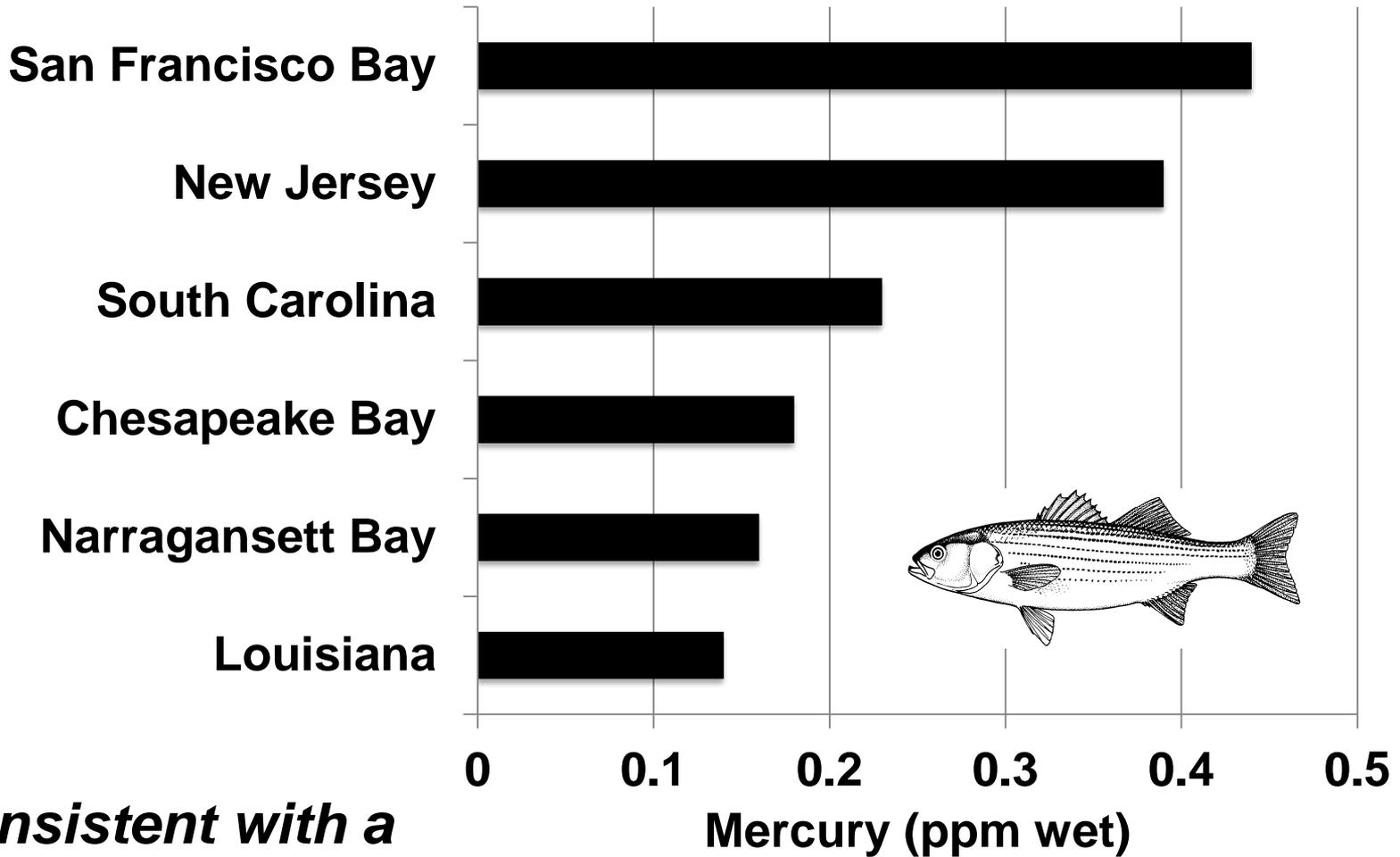
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High Hg in Bay Striped Bass



Consistent with a large role of the mining legacy