Using Biosentinels to Assess Mercury Risk in Wetland Restoration Projects

April Robinson\textsuperscript{1}, Darell Slotton\textsuperscript{2}, Jay Davis\textsuperscript{1}

\textsuperscript{1} San Francisco Estuary Institute, Richmond, CA
\textsuperscript{2} University of California at Davis, Davis, CA
Monitoring Approach

Why wetland restoration projects?
- Potential sites of high methylation
- Many restoration projects in the Bay
- Monitoring required by permits

Why biosentinels?
- Link to beneficial uses
- Interpret results as effects
- Relevant spatial and temporal scales
Science Advisory Group and Stakeholders

Jim Wiener          University of Wisconsin, La Crosse
Dave Evers          Biodiversity Research Institute
Harry Ohlendorf      CH2M Hill
Kathy Hieb           CDFW
Bruce Herbold        Independent Consultant

Stakeholders: Regional Water Board, BCDC, USACE, USGS, CDFW, USFW and others
1. What is the current potential for impairment of beneficial uses due to methylmercury in each major habitat of interest in the North Bay intertidal habitat restoration projects?

2. How do the status and trends in impairment due to methylmercury in one project compare to status and trends in impairment in other project and non-project wetlands in the region?

3. How will the status of impairment due to methylmercury in each major habitat of interest change over a timescale of years in response to the project?

4. Will tidal marsh restoration introduce a problematic amount of methylmercury into the Bay?
Species sampled

Fish
Mississippi Silversides (*MISI*)
Long jawed Mudsucker (*LOMU*)
Staghorn Sculpin (*STSC*)
Shimofuri Goby (*SHGO*)
Three-spined Stickleback (*THST*)
Rainwater Killifish (*RAKI*)
Topsmelt (*TOSM*)
Pacific Herring (*PAHE*)
Yellowfin Goby (*YEGO*)

Birds
Song Sparrow (*SOSP*)
Sites Sampled

- Petaluma
- Hamilton
- Sonoma
- Napa Slough
- Pond 2A
- Pond 3
- Pond 1
- Pond 2
- Pond 6A
- Pond 7A
- Pond 4/5
- Napa East
Seasonal effects

- Narrow sampling window (April-June)
- Sample during period of highest risk
- Sampled twice per season at two sites

Fish size effects

- Narrow size ranges
- Size standardized Hg concentrations for silversides
Variation in Methylmercury Exposure
What is the current potential for impairment of beneficial uses due to methylmercury in each major habitat of interest in the North Bay intertidal habitat restoration projects?
Methylmercury Risk to Fish and Piscivores
Methylmercury Risk to Marsh Songbirds

10% reduction in breeding success

5% reduction in breeding success

Graph showing mercury levels at different sites (Hamilton, Napa Slough, Petaluma, Pond 2A, Sonoma) with a y-axis labeled 'Mercury (ug/g ww)' and an x-axis labeled 'Site'.
Species Comparisons

Highest Concentrations
Mississippi Silverside
Shimofuri Goby
Longjaw Mudsucker

Lowest Concentrations
Pacific Herring
Topsmelt
Management Question 1

What is the **current potential for impairment** of beneficial uses due to methylmercury in each major habitat of interest in the North Bay intertidal habitat restoration projects?

- **No impairment of prey fish**
- **Potential impairment for piscivores and marsh songbirds**
- **Impairment risk depends on prey species and foraging location.**
- **Mercury risk may be offset by other benefits of restoration**
How do the status and trends in impairment due to methylmercury at this project compare to status and trends in impairment in other project and non-project wetlands in the region?
Site Types

- Non-tidal Managed Pond (Pond 2)
- Vegetated Tidal Marsh (Pond 2A)
- Breached Pond (Pond 3)
Non-tidal Managed Ponds

Mississippi Silversides
Breached Ponds

<table>
<thead>
<tr>
<th>Species</th>
<th>SHGO</th>
<th>STSC</th>
<th>TOSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Napa East</td>
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<tr>
<td>Pond 3</td>
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<td>Pond 4/5</td>
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Mercury (ng/g ww)

- Shimofuri Goby
- Staghorn Sculpin
- Topsmelt

*Graph showing mercury concentrations in different species.*
Vegetated Marsh (Channels and Ponds)

<table>
<thead>
<tr>
<th>Reference Marshes</th>
<th>Restored Marshes</th>
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<tbody>
<tr>
<td>Hamilton</td>
<td>Pond 2A</td>
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<tr>
<td>Napa Slough</td>
<td>Sonoma</td>
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<tr>
<td>Petaluma</td>
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</table>

Species: Shimofuri Goby, Staghorn Sculpin, Three-spined Stickleback

Mercury (ug/g ww)
Vegetated Marsh (Marsh Plain)

![Graph showing mercury levels in various sites]

- **Mercury (ug/g ww)**
- **Sites:** Hamilton, Napa Slough, Petaluma, Pond 2A, Sonoma

**Song Sparrow**
Management Question 2

How do the status and trends in impairment due to methylmercury at this project compare to status and trends in impairment in other project and non-project wetlands in the region?

- Mercury risk differed by site.
- Managed ponds had both the lowest and highest Hg concentrations.
- Restored marsh sites are no higher than reference marsh sites
- Pond 7A and Pond 2A are low, Pond 6A is high.
Management Question 3

How will the status of impairment due to methylmercury in each major habitat of interest change over a timescale of years in response to the project?
No Trend in Mercury Risk by Restoration Age

Breached in 2010

Breached in 1995

Increasing restoration age
Management Question 3

How will the status of impairment due to methylmercury in each major habitat of interest change over a timescale of years in response to the project?

• No trend in Hg with restoration age
• Baseline for future monitoring
4. Will tidal marsh restoration introduce a problematic amount of methylmercury into the Bay?

- Need alternative methods to determine this.
- Discussed at the RMP Methylmercury Forum (http://www.sfei.org/calendar_events/4326)
Conclusions

• **Multi-species biosentinel monitoring** is a cost effective way to answering mgmt. questions

• **Coordinated regional monitoring** allows spatial and temporal comparisons

• **Managed ponds** may represent the best opportunity to reduce Hg impairment but further research is needed.

• **Input from Science Advisory Group and Stakeholders** was key.
Acknowledgements

• State Coastal Conservancy
• Science Advisory Group and Stakeholders
• Field and lab assistants
  (UC Davis, SFEI, Texas A&M University)
Questions?
• **Goal:** Evaluate mercury impairment across restoration projects using biosentinel monitoring

• **Geographic Scope:** San Pablo Bay

• **Sampling Period:** 2012-2014

• **Funding:** State Coastal Conservancy
Monitoring Approach

- Monitoring should explicitly focus on the condition of identified beneficial uses or aquatic functions of interest to the managers or regulators.

- Monitoring results should directly inform project management actions or design decisions.

- To the extent possible, project data should be comparable from one time to another, from one project to another, and to ambient data.

- The precision and accuracy of the data should meet the decision criteria of the agencies for which the data are being collected.
Monitoring Approach

• Establish **thresholds** or **ambient concentrations** for comparison.

• When there are alternative monitoring methods to adequately answer a management or regulatory question, the **least expensive alternative method** that has the spatial and temporal precision to answer management questions is preferable.

• **Compliance monitoring** and **research** are related but different scientific activities.
Data Management and Availability

http://www.ceden.org
Fish Length Effects: Mississippi Silversides

- Napa East
- Napa Slough
- Pond 1
- Pond 2
- Pond 2A
- Pond 4/5
- Pond 6A
- Pond 7A
Sample Date Effects

[REPLACE!]
Indicate mercury exposure

- In a particular habitat or habitats
- In a particular part of the food web
- Over a particular spatial area
- Over a particular temporal period

• Integrate over appropriate spatial and temporal scales
• Exposure can be interpreted in terms of effects
• Identify problems or opportunities to be investigated by further research
Science Advisory Group Recommendations

• Monitoring should be designed to answer stakeholder questions.

• Prioritize sampling across multiple habitats using a palate of biosentinels over seasonal sampling.

• Sampling should be done when ecological risk is the highest (coinciding with timing of breeding for species of interest).

• Secondary biosentinels should be sampled in addition to primary species when possible.

• Let the conditions on the ground dictate which biosentinels to sample.
Field sampling

Primary Biosentinel Targets

- Mississippi Silversides
- Longjaw mudsuckers
- Song Sparrows
Sites Sampled
Comparisons with other datasets

- Comparisons are difficult, many confounding factors
- Broadly similar results to other datasets
- Lower than some South Bay and Delta sites