

# Managing Salt Ponds to Increase Waterbird Nesting Habitat While Minimizing Methyl Mercury Biomagnification: *Implications for the South Bay Salt Pond Restoration Project*



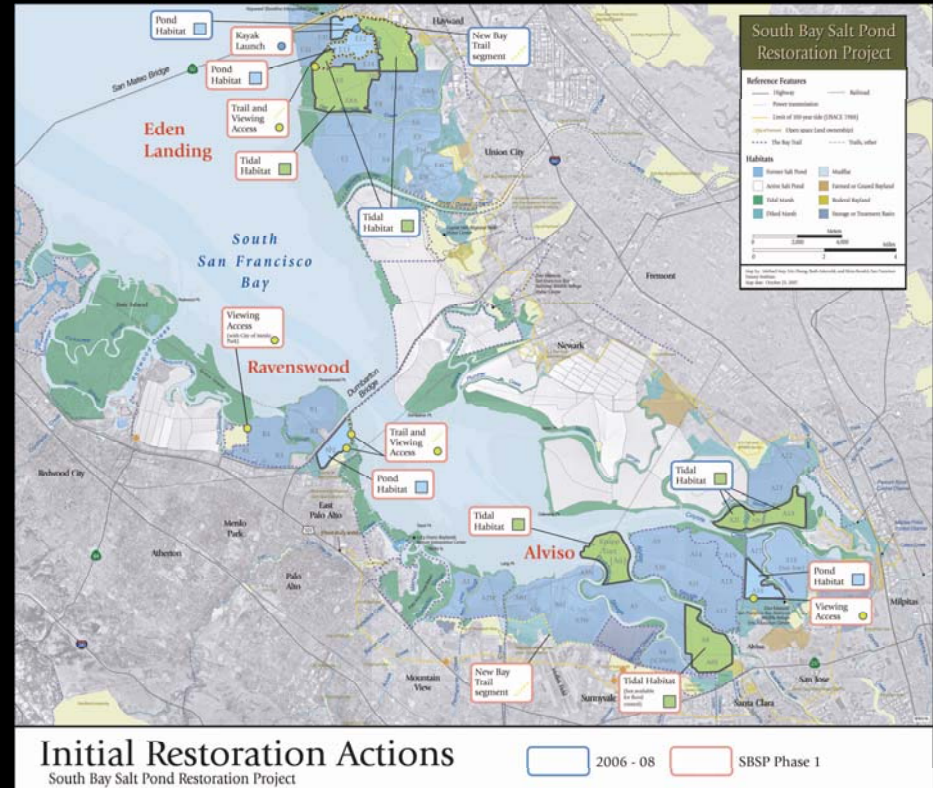
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(16 September 2009)

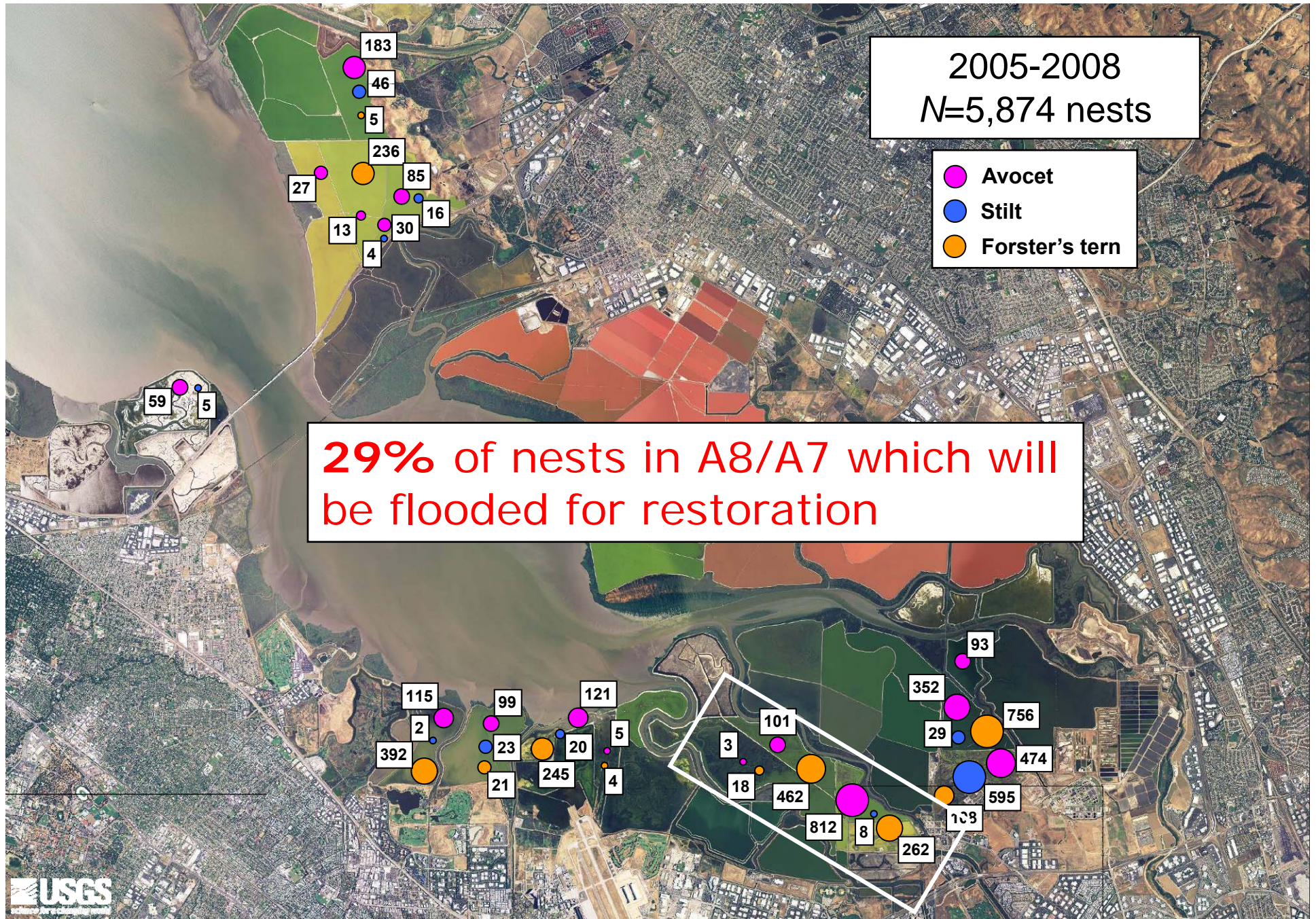
# South Bay Salt Pond Restoration Project

- Plans to convert 50-90% of salt ponds (~25,000 acres ) into tidal marsh
- Salt ponds are preferred habitat for waterbirds
- Need to enhance remaining salt ponds to maintain current waterbird populations
- *But unclear how to manage salt ponds to increase waterbird foraging and nesting opportunities while minimizing methyl mercury production*





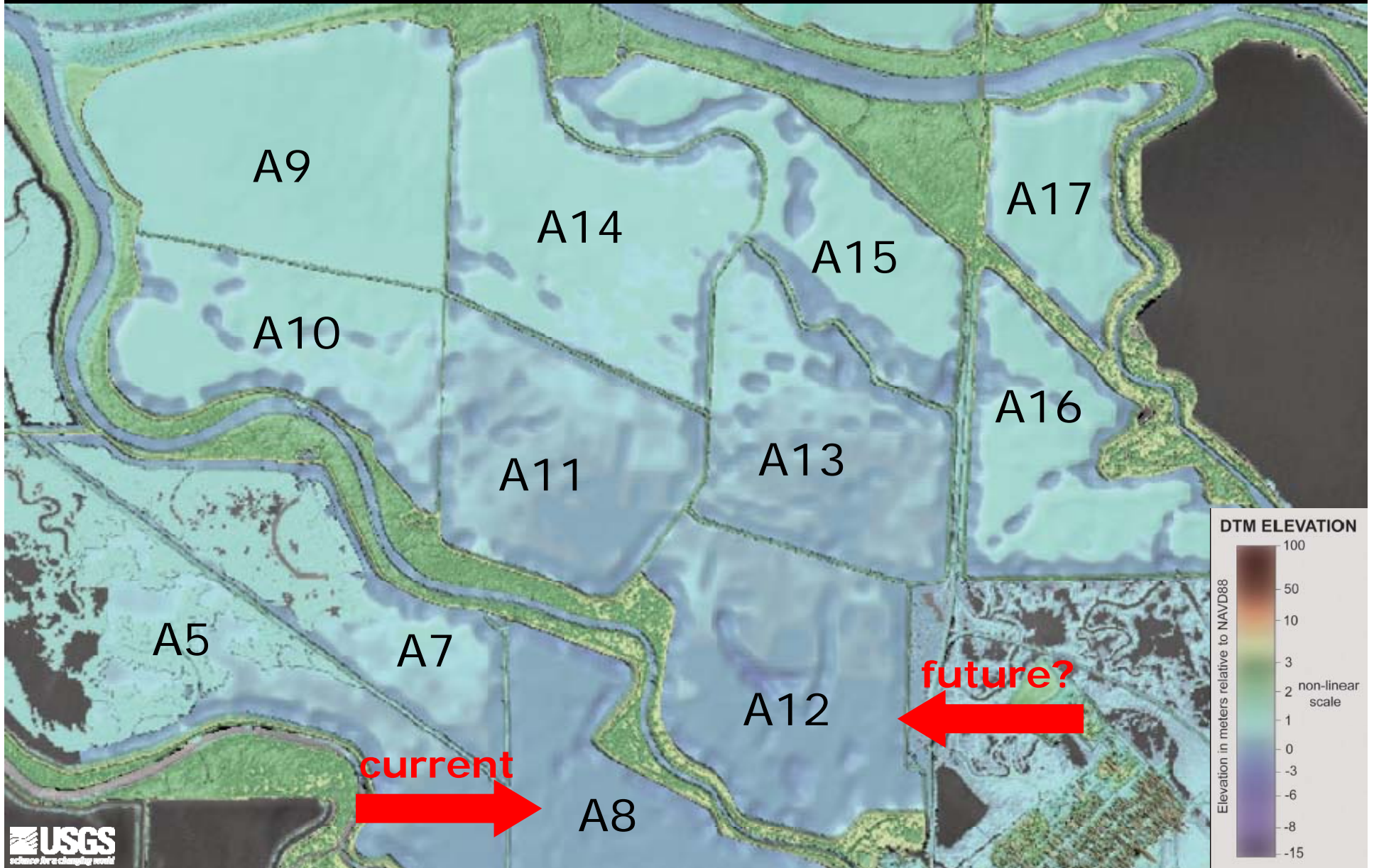
# Waterbird Nesting Colonies in South San Francisco Bay





# Pond Bathymetry

Foxgrover et al. 2007



# Pond A12 Water Management

**Before**



**After**



- High-salinity
- Deep water
- No nesting habitat
- No prior history of nesting

- Water levels lowered
- Substrate exposed suitable for nesting islands



# Pond A12 Nesting Islands

Monitored:

- waterbird nesting response
- Hg in water over time
- Hg in fish over time
- Hg in waterbird eggs



# Waterbird Nesting Effort A8 and A12

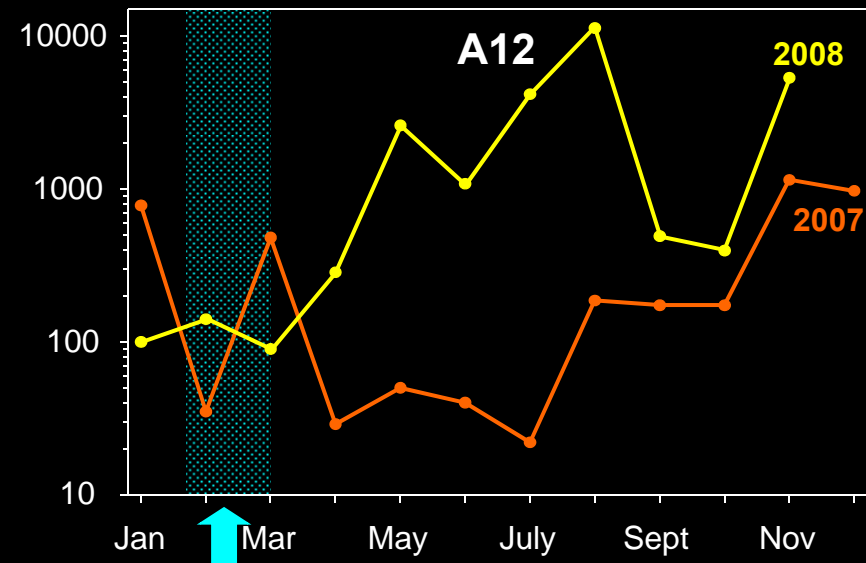
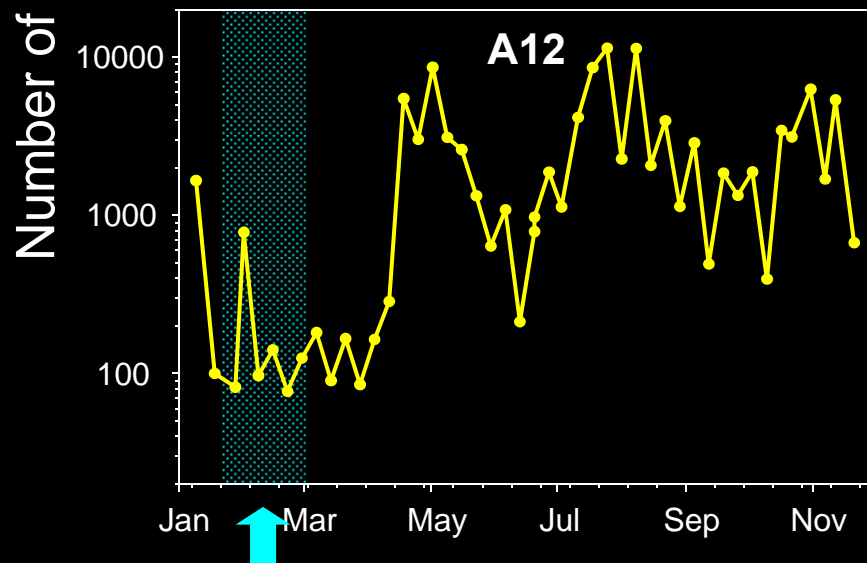
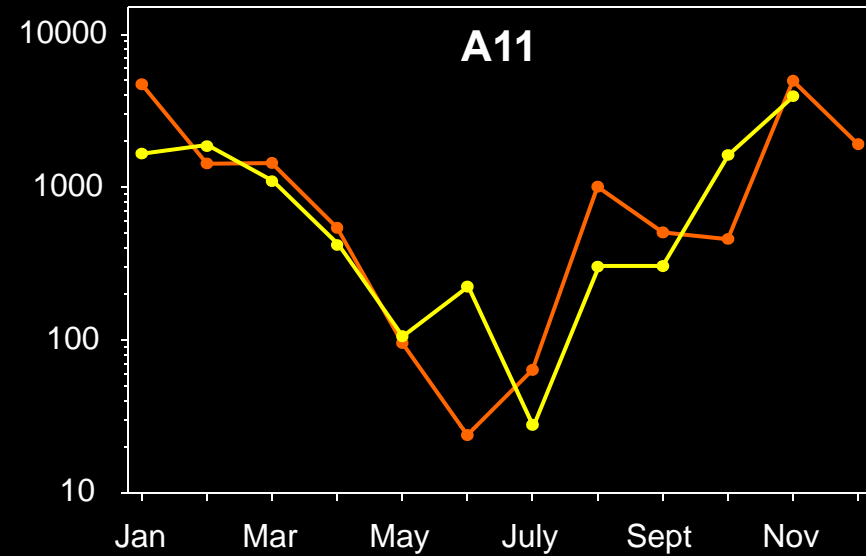
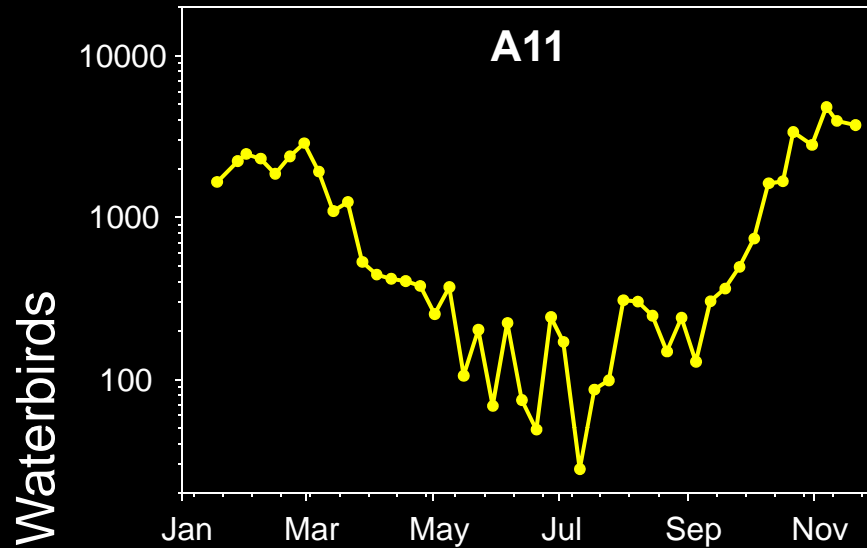
- Avocet
- Stilt
- Forster's tern

A8  
Avocet=211  
Stilt=6  
Tern=69

A12  
Avocet=321  
Stilt=5  
Tern=73

# Waterbird Abundance Over Time

—●— 2007  
—●— 2008



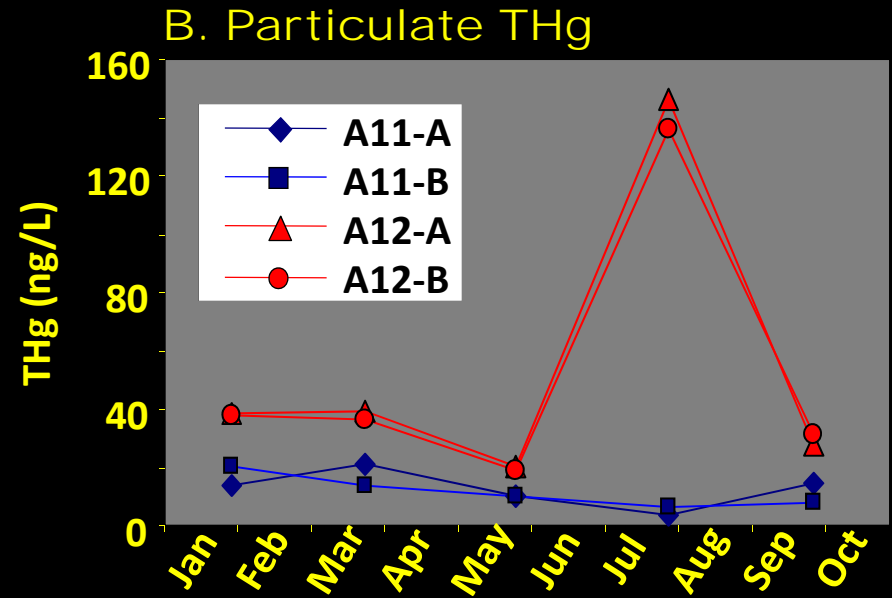
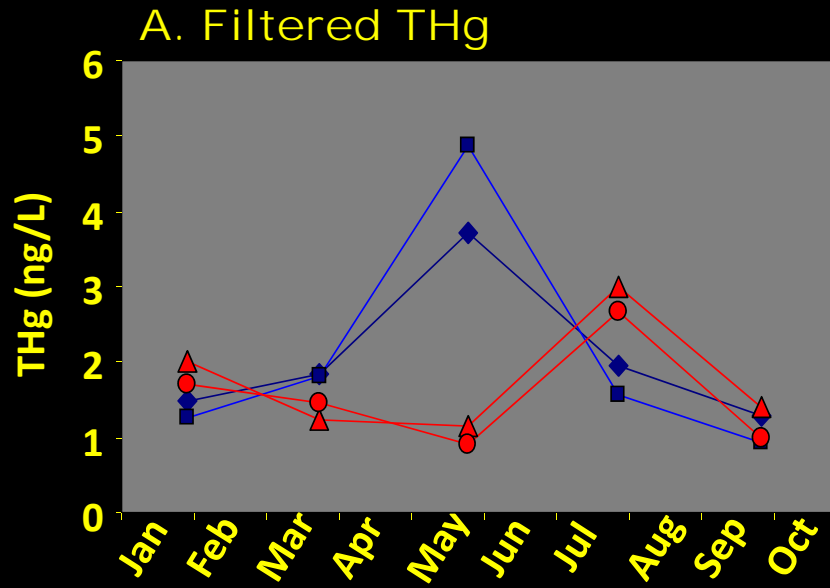
water lowered

water lowered

Athearn & Takekawa



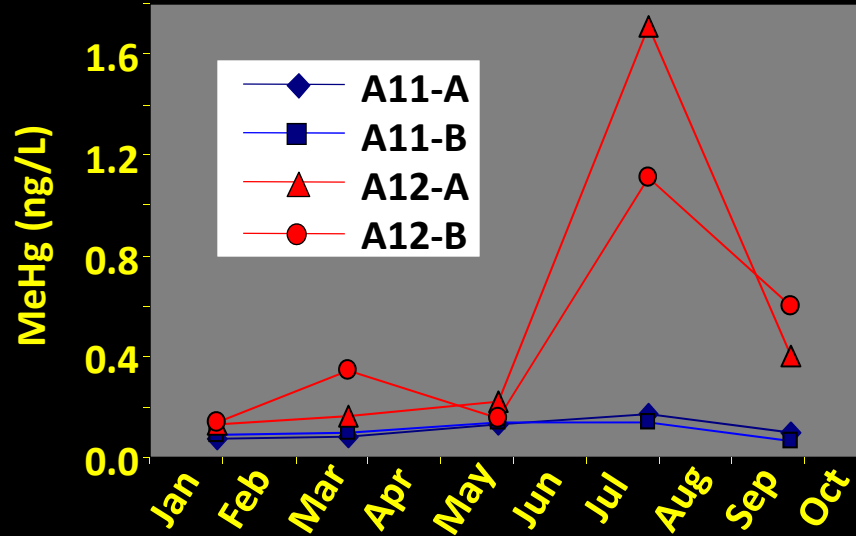
# Total Mercury



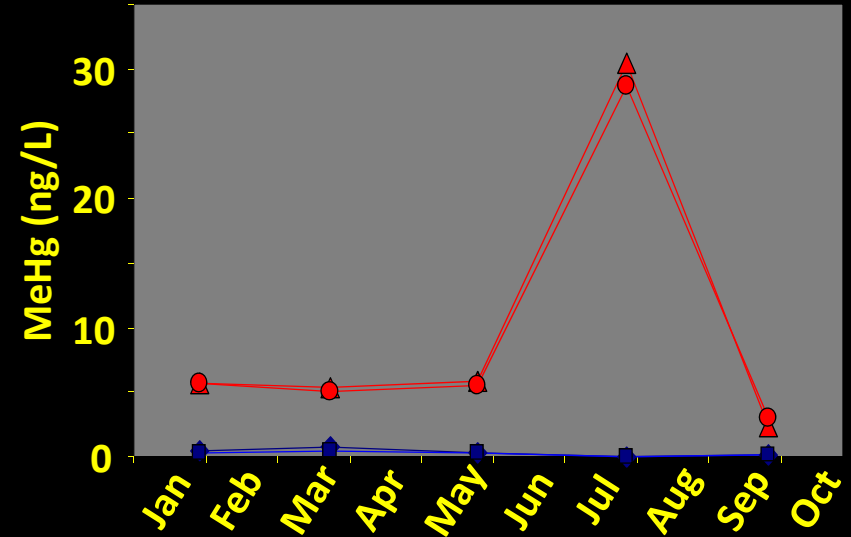
- Most THg in the particulate fraction
- THg higher in A12 (July peak)

# Methylmercury

A. Filtered MeHg



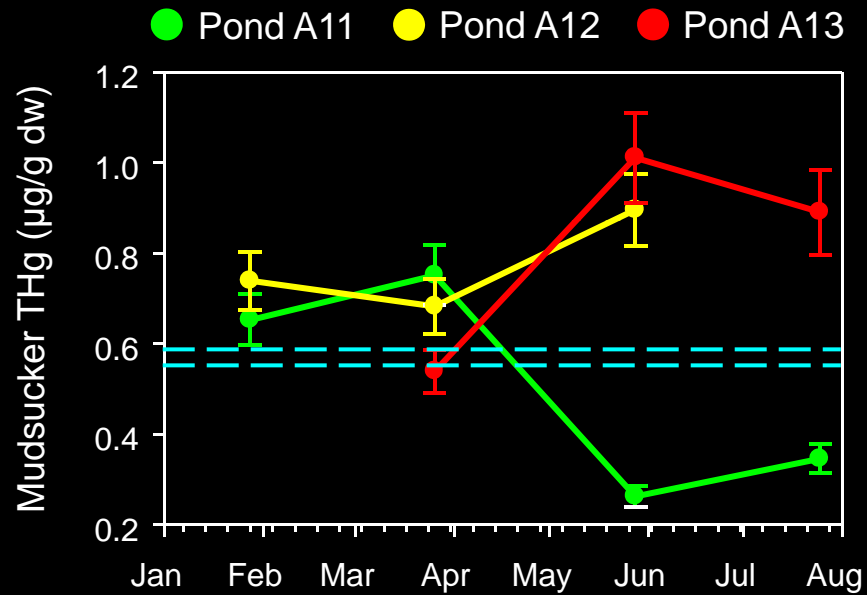
B. Particulate MeHg



- Most MeHg in the particulate fraction
- Higher MeHg in A12 (July peak)

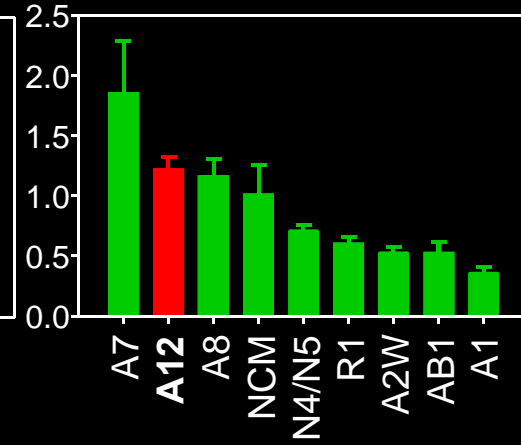
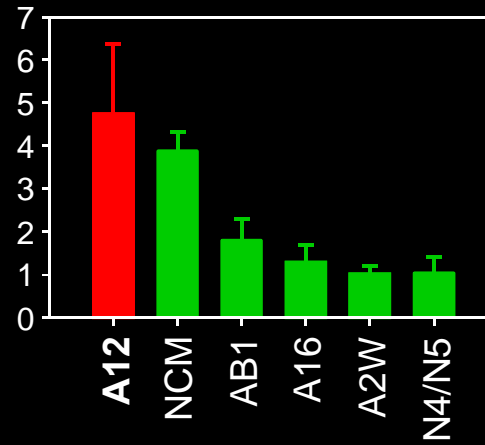
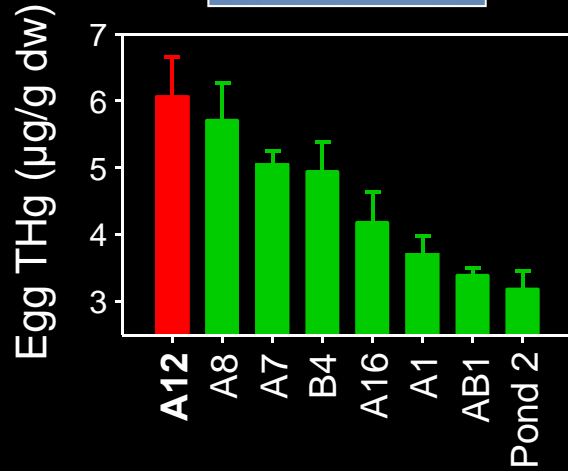


# Mercury Bioaccumulation in Fish



2005-2006 Fish mercury concentrations before altered water management

# Mercury Bioaccumulation in Waterbird Eggs

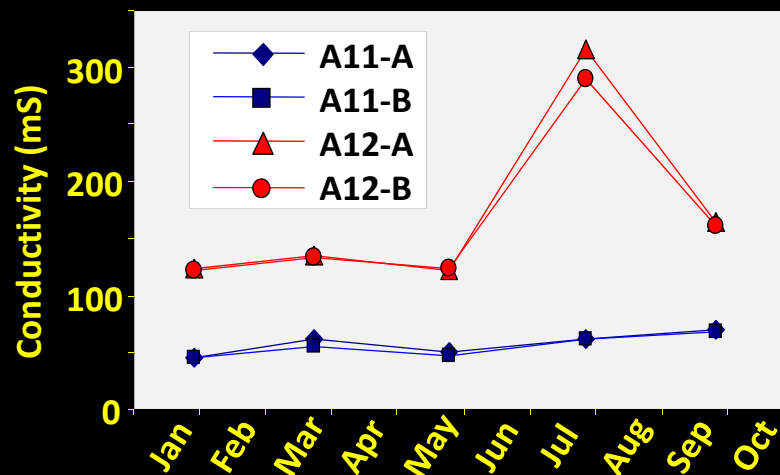


Wetland Site

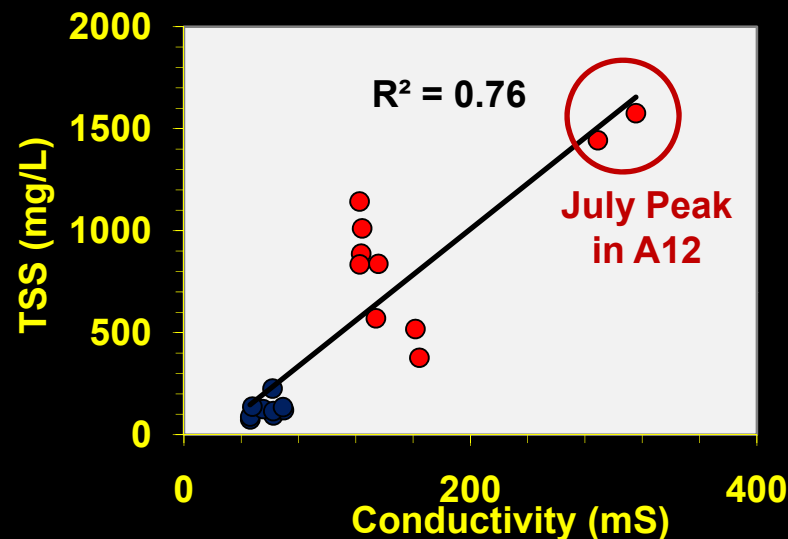


# What Drives These Trends in MeHg?

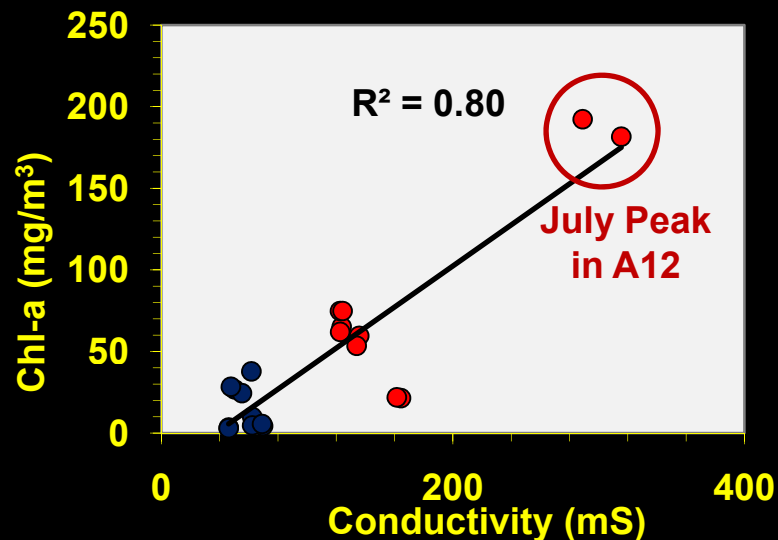
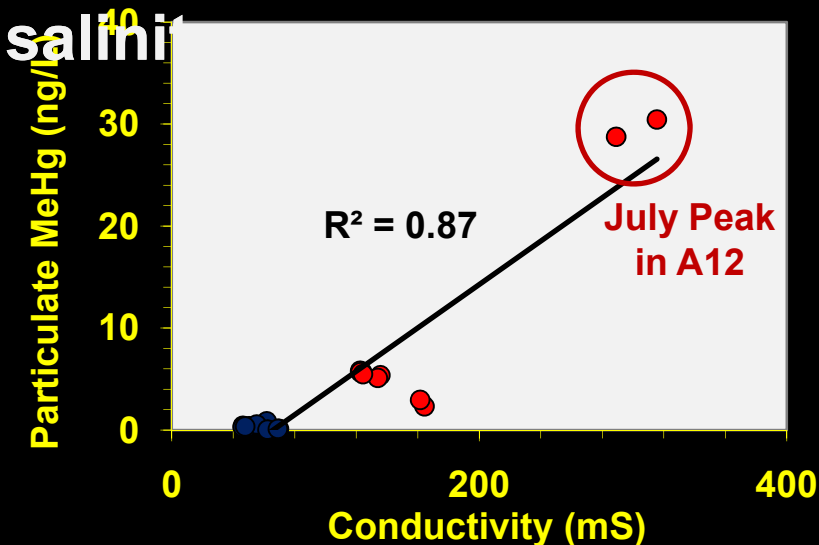
1) Salinity was higher in A12 and peaked in July



2) Total Suspended Solids and chlorophyll track salinity

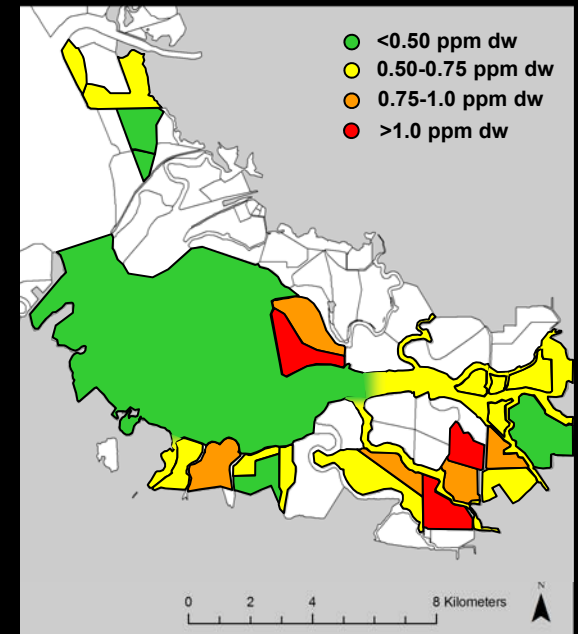
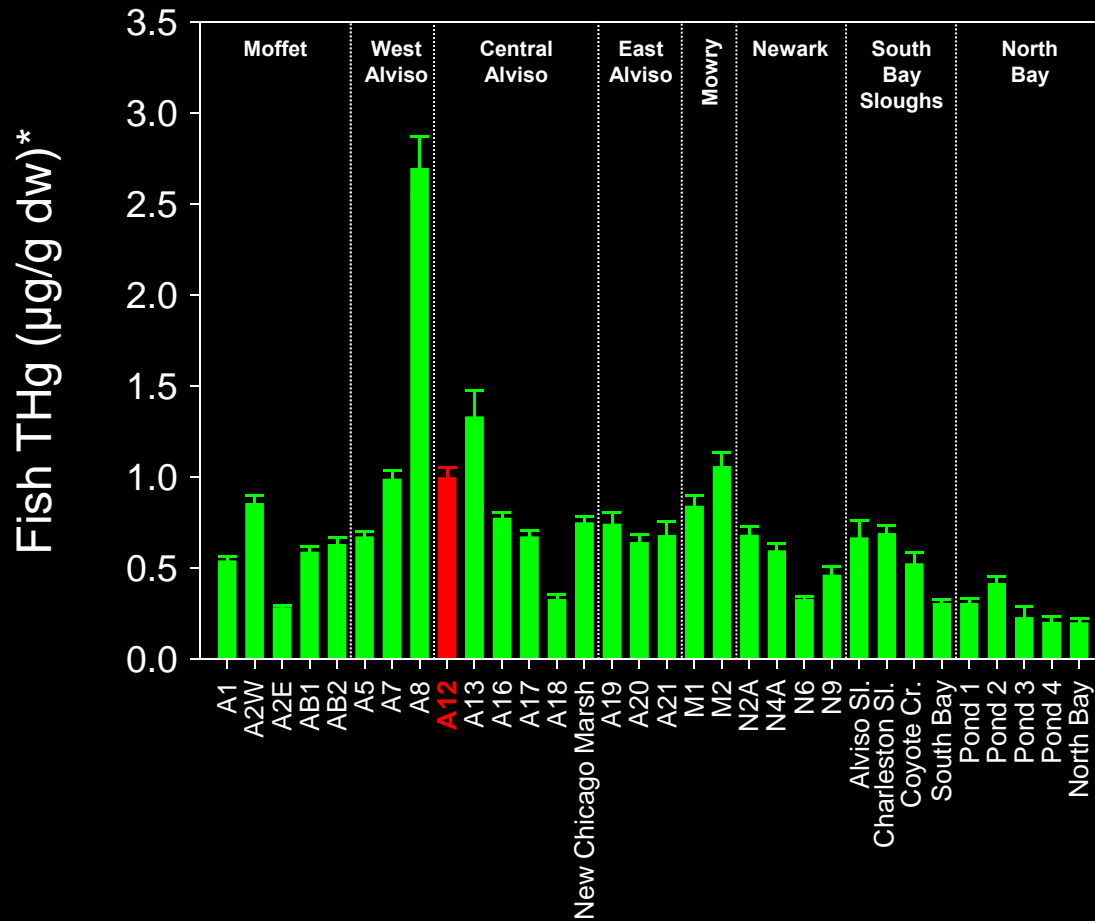


3) Particulate MeHg tracks salinity



# Fish Mercury Among Habitats

N=3,033 fish  
10 species



\*least-square means  
controlling for species,  
year, date, site, length,  
& body condition

\*0.8=fish effects;  
1.2=bird effects



# Fish Mercury Correlated Pond Salinity?

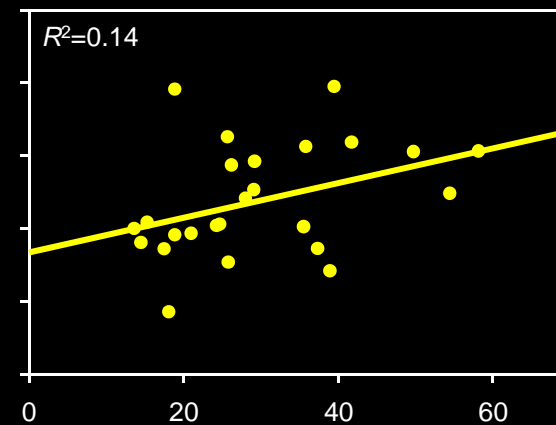
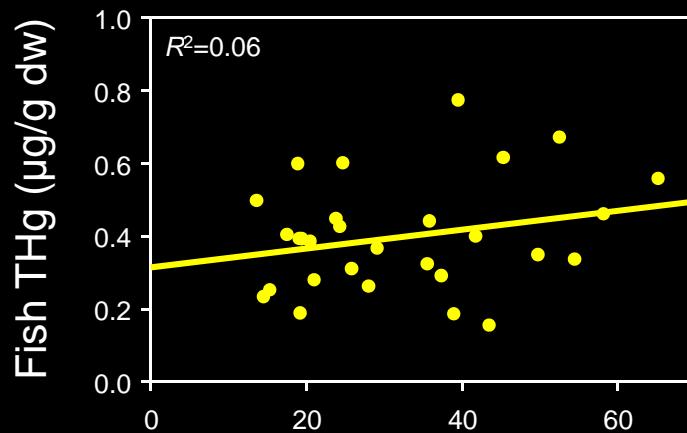
$N=16$  ponds over 4 years



Mudsucker

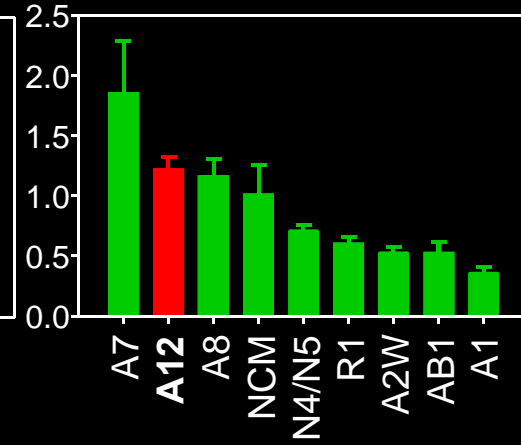
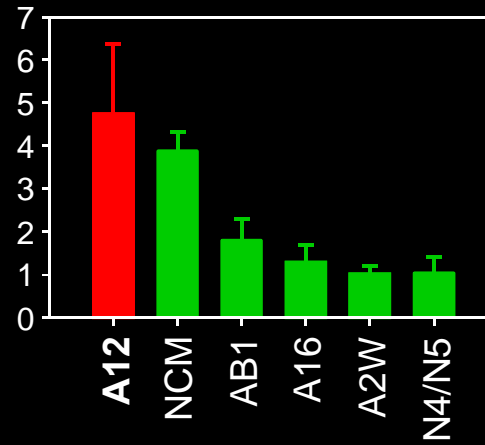
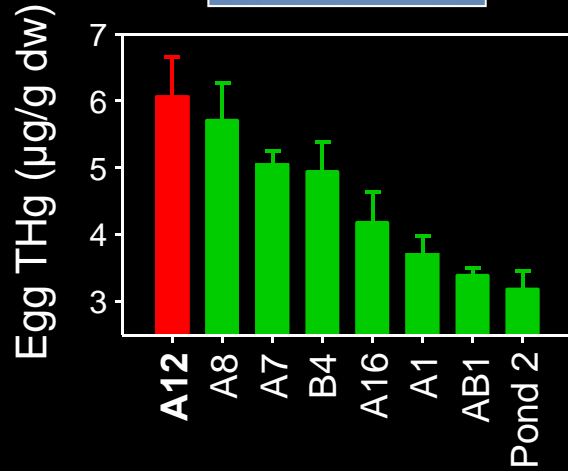


Stickleback



Pond Salinity (ppt)

# Mercury Bioaccumulation in Waterbird Eggs



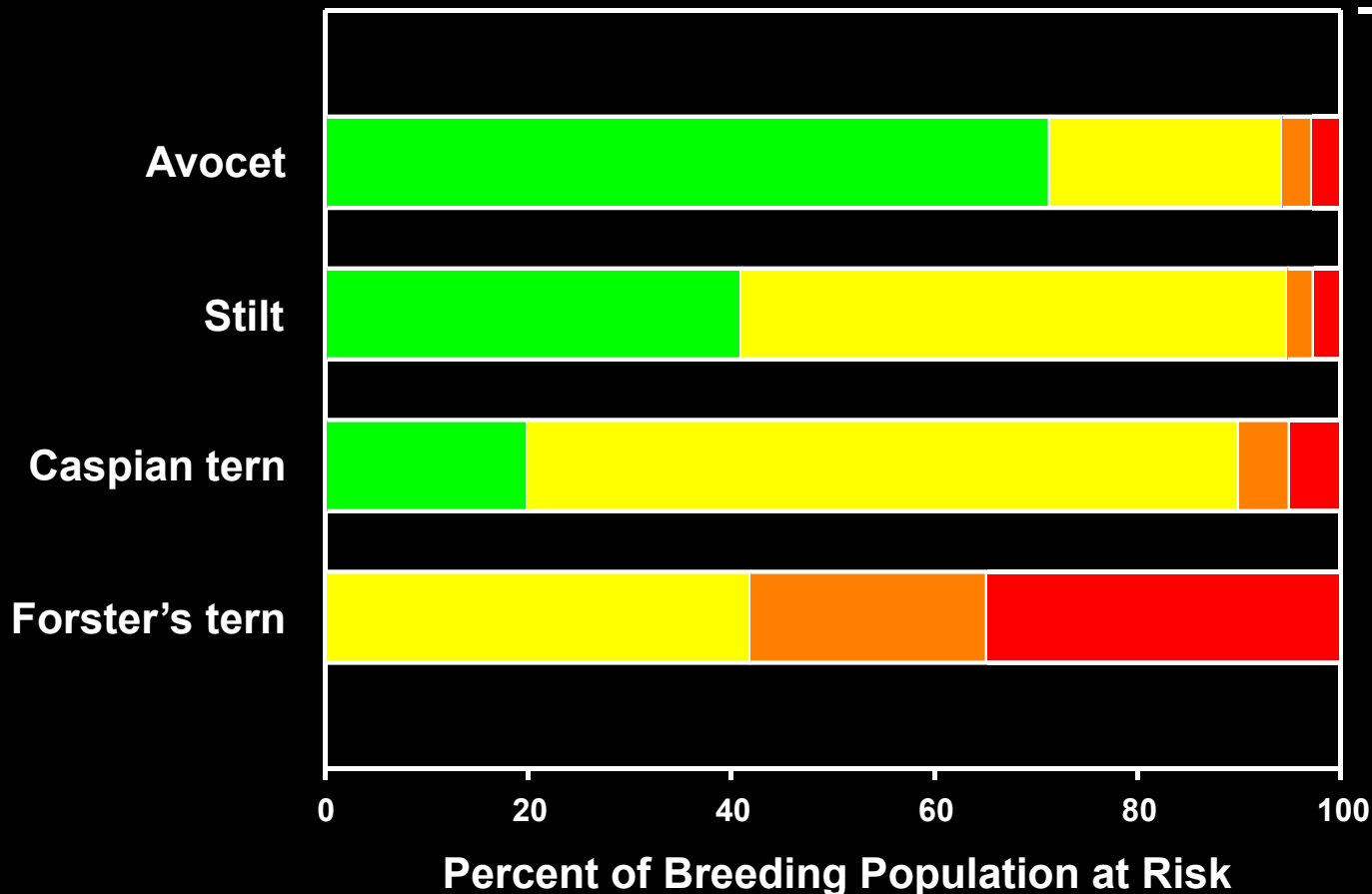
Wetland Site



# Percent of Population at Risk

## Breeding Birds Only

Risk Factor:  
High + Extra High



6%



5%



10%



58%



Percent of Breeding Population at Risk

\* Based on breeding adult blood Hg concentrations

Low Risk

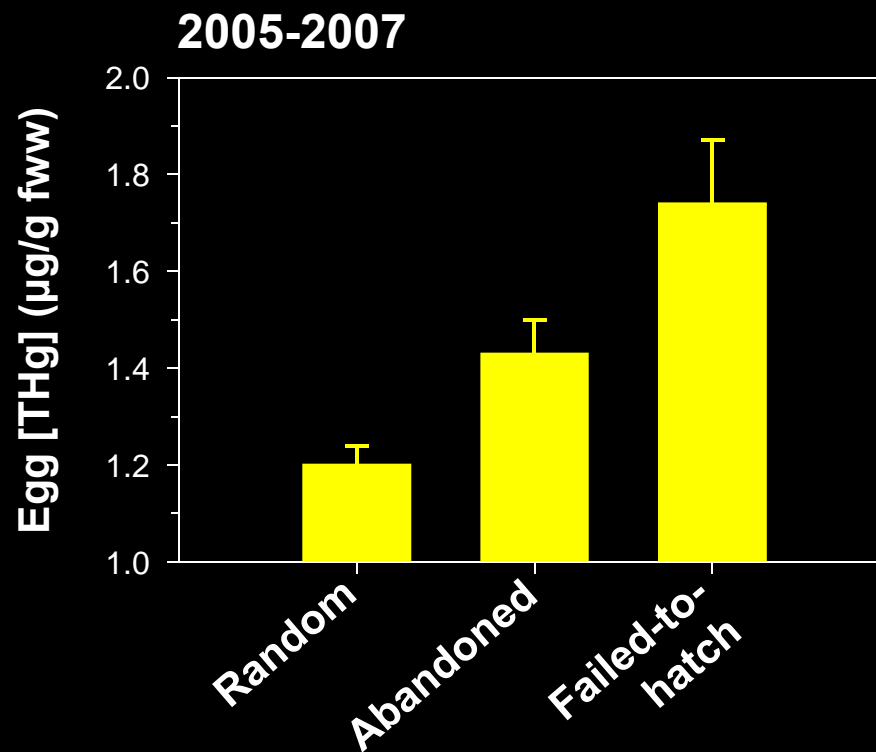
Moderate Risk

High Risk

Extra-High Risk

# Effects of Mercury on Egg Hatchability

## Forster's Terns



$P < 0.001^*$

$F_{2,341} = 13.58$

$N = 73$  failed eggs in  
successful nests



\*Statistically controlled  
for effects of colony site  
and year



# Summary



- We successfully created waterbird nesting habitat (+400 nests) by lowering water levels



- But, methyl mercury production was elevated
- Methyl mercury subsequently biomagnified up the food web, with waterbird egg concentrations highest in Pond A12 than in other ponds



- Further study is necessary to determine if similar water management actions will increase methyl mercury bioaccumulation within other salt pond habitats as the South Bay Salt Pond Restoration Project proceeds



## Funding

- U.S. Fish and Wildlife Service
- U.S. Fish and Wildlife Service Coastal Program
- U.S. Geological Survey

## Support

- Staff of Don Edwards San Francisco Bay National Wildlife Refuge

## Contact

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