

# Chemical Stressors and the Chesapeake Bay

## Emerging concerns about new and old contaminants

STAC Dec 2016



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# Mercury – an old friend



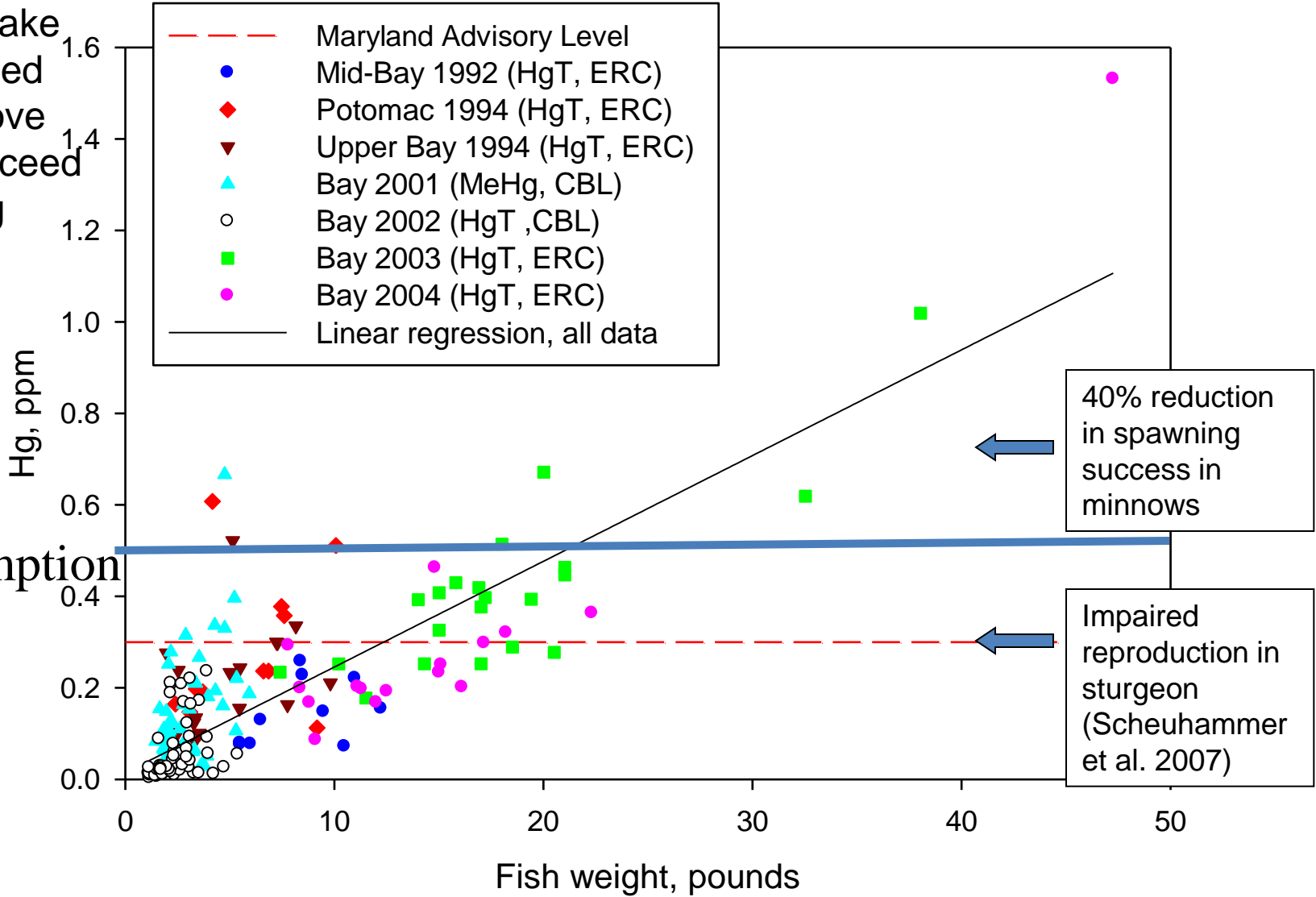
Fish consumption advisories?



# Chesapeake Bay Striped Bass

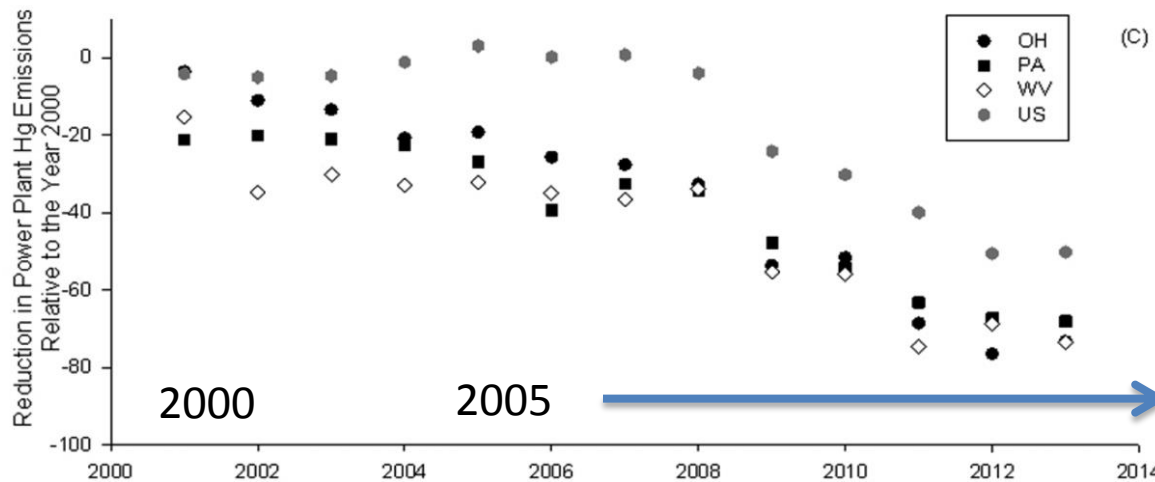
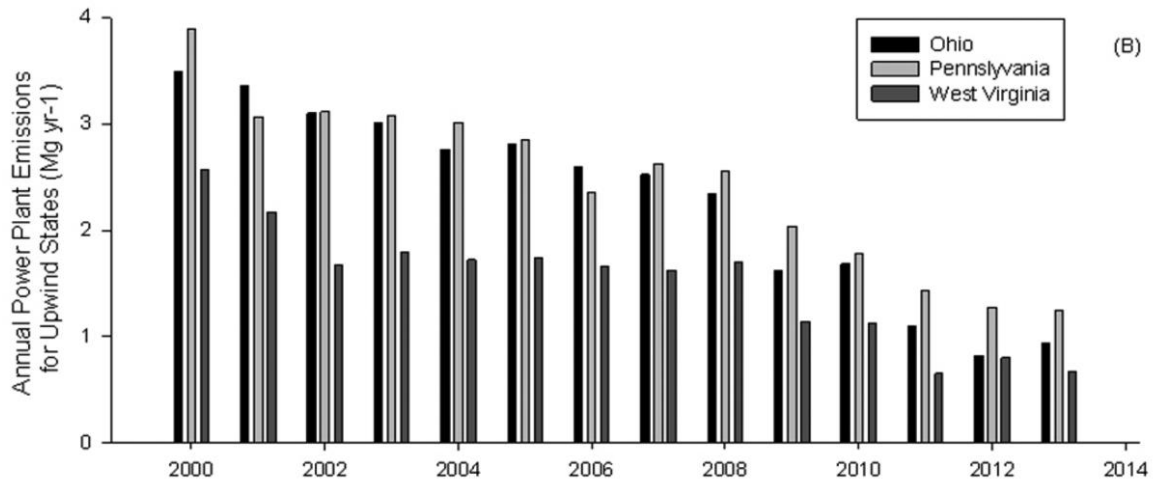
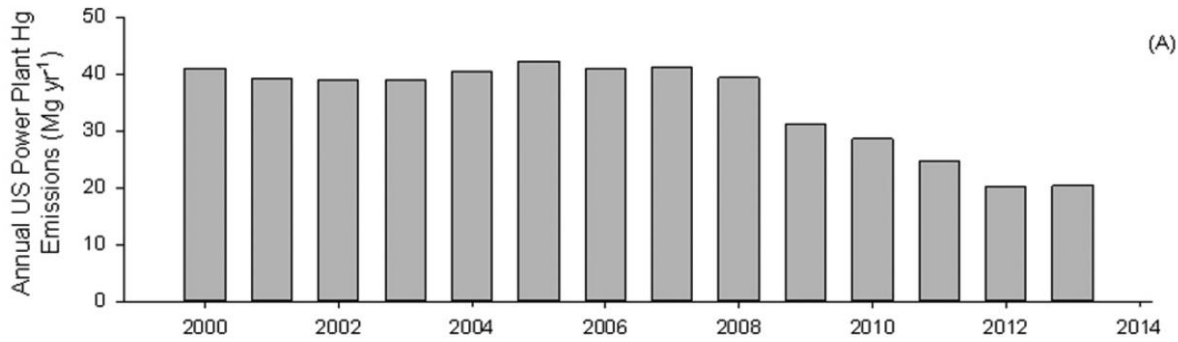
On average,  
Chesapeake  
Bay Striped  
Bass above  
10 lbs exceed  
0.235 mg  
Hg/kg

Consumption  
Limit

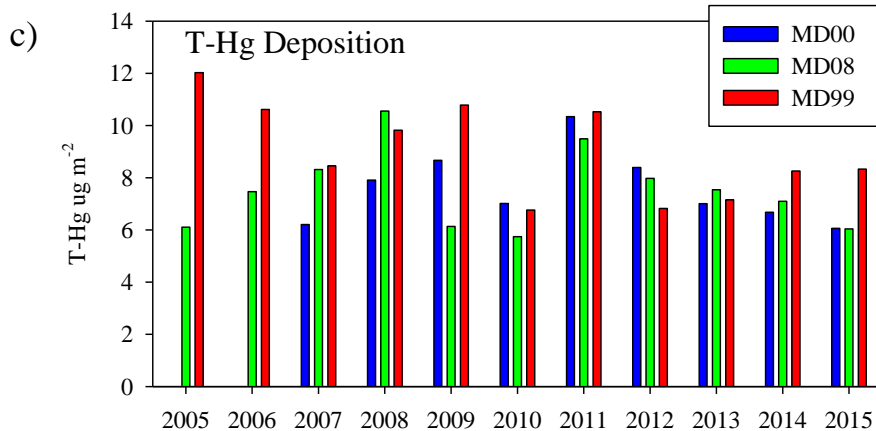
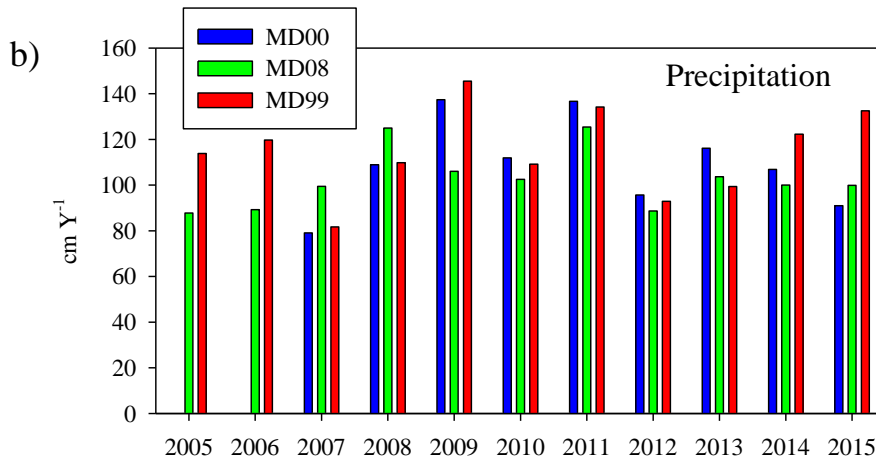
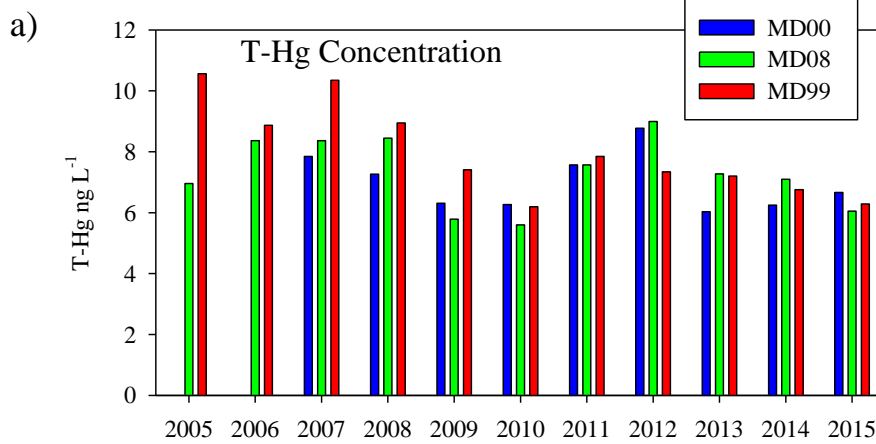


Adult Striped Bass 1992-2004  
n = 201

$r^2 = 0.72$   
RSD of the slope 5%



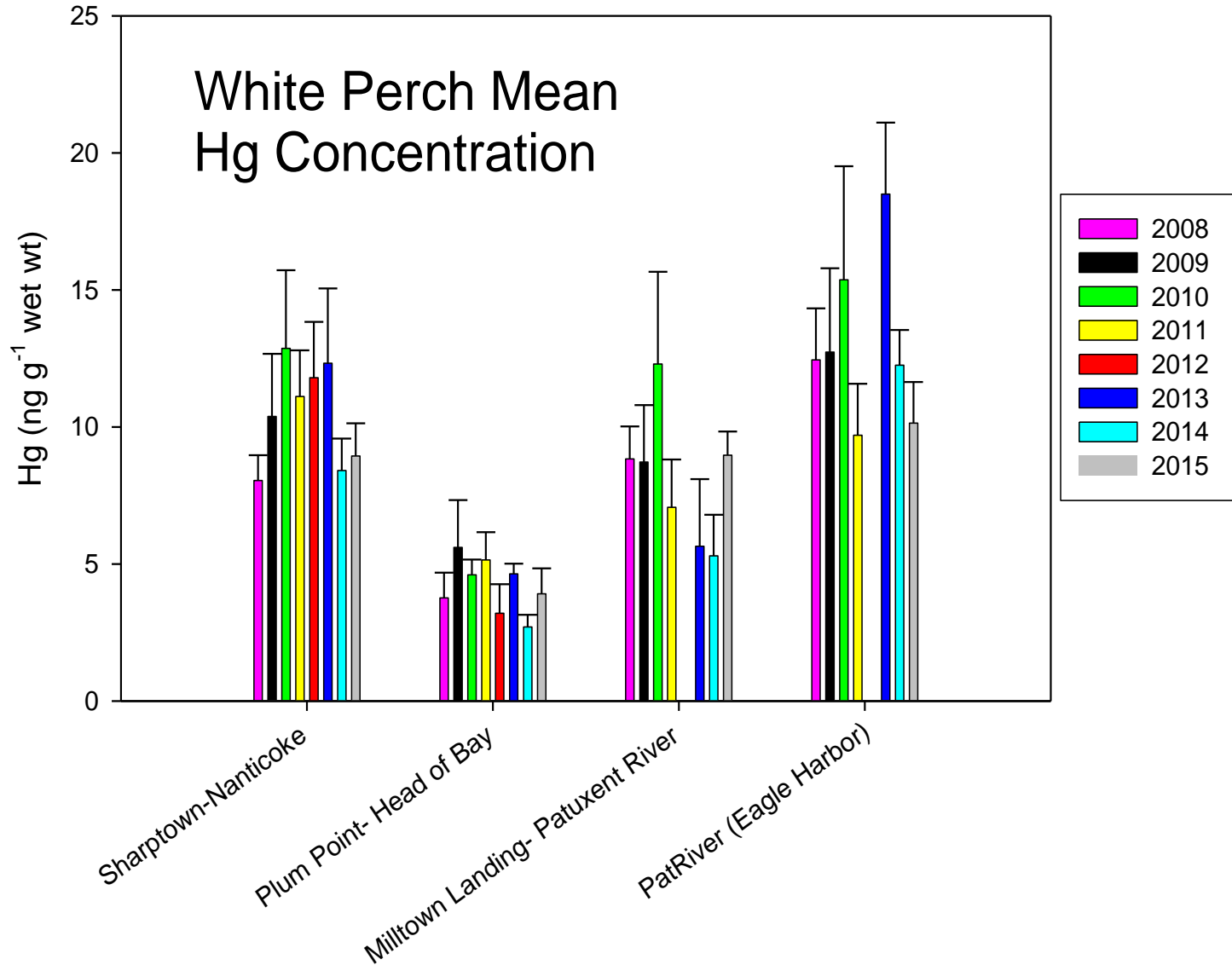
# Mercury Emissions

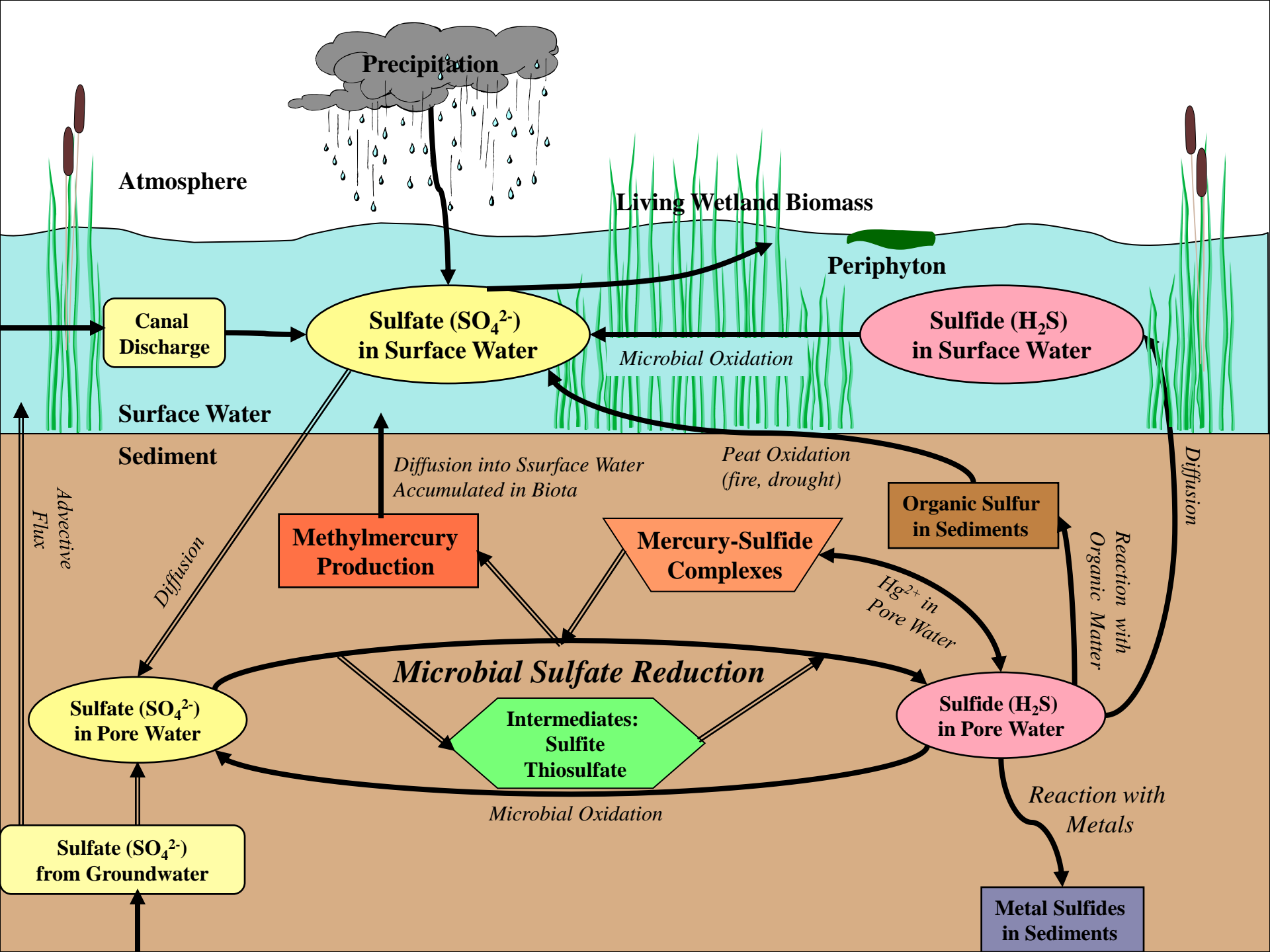


# Mercury in Wet Deposition

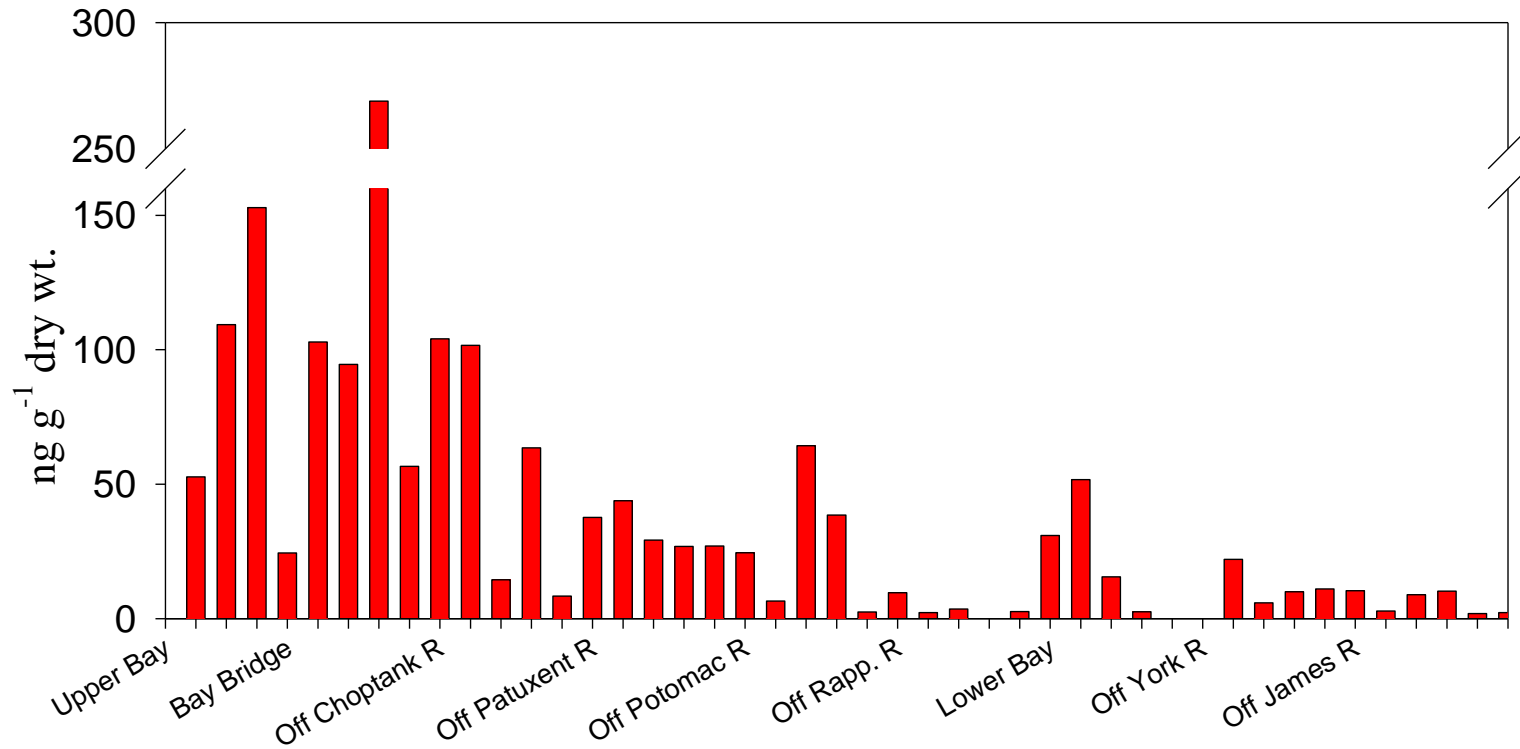
MD 00 SERC  
 MD 08 Western MD  
 MD 99 Beltsville

# Young of the Year Fish Study



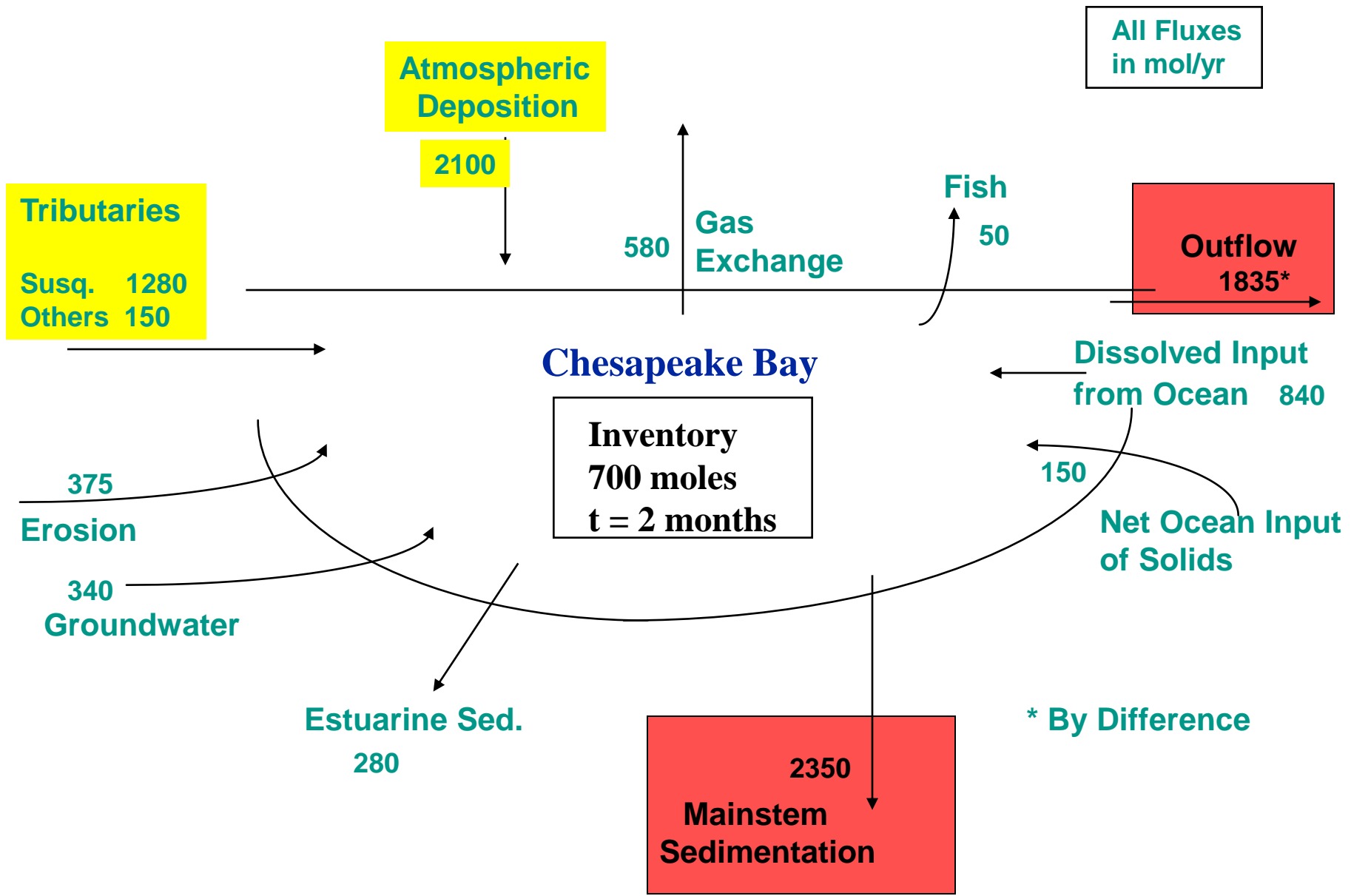


# Transect of Mercury in top 10 cm of Sediment Down the Chesapeake Bay



Pattern suggests north to south influence but.....

# Mercury Budget for the Chesapeake Bay



All Fluxes in mol/yr

**Tributaries**  
Susq. 1280  
Others 150

**Atmospheric Deposition**  
2100

580  
**Gas Exchange**

**Fish**  
50

**Outflow**  
1835\*

**Chesapeake Bay**

**Inventory**  
700 moles  
t = 2 months

**Dissolved Input from Ocean**  
840

375  
**Erosion**

340  
**Groundwater**

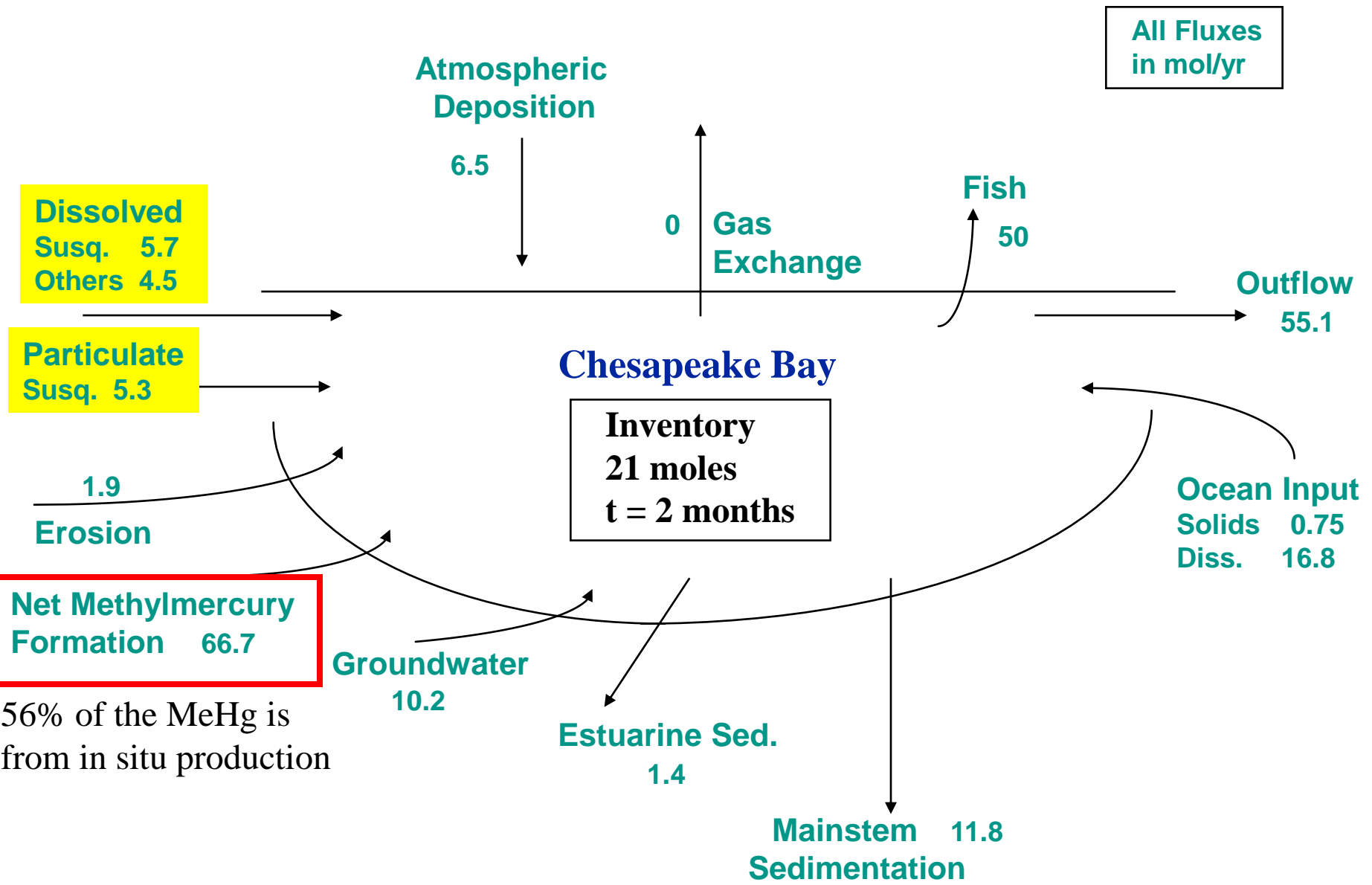
**Estuarine Sed.**  
280

**Net Ocean Input of Solids**  
150

**Mainstem Sedimentation**  
2350

\* By Difference

# Methylmercury Budget





# Susquehanna Mercury Flux

Data unpublished

Estimated Load 2015

T-Hg  $1.2 \text{ ug m}^{-2} \text{ yr}^{-1}$

MeHg  $0.02 \text{ ug m}^{-2} \text{ yr}^{-1}$ .

This is similar to that of Mason (Lawson et al 2001) who estimated the 1999 flux as being  $1.35$  and  $0.03 \text{ ug m}^{-1} \text{ yr}^{-1}$ .

## Watersheds at SERC (with Gilmour)

### Past Use

Watersheds have all been logged and used for agriculture at sometime.

### Current Use

Watershed 110 has the oldest forest - 80 years

Watershed 109 has a large forest buffer around the stream

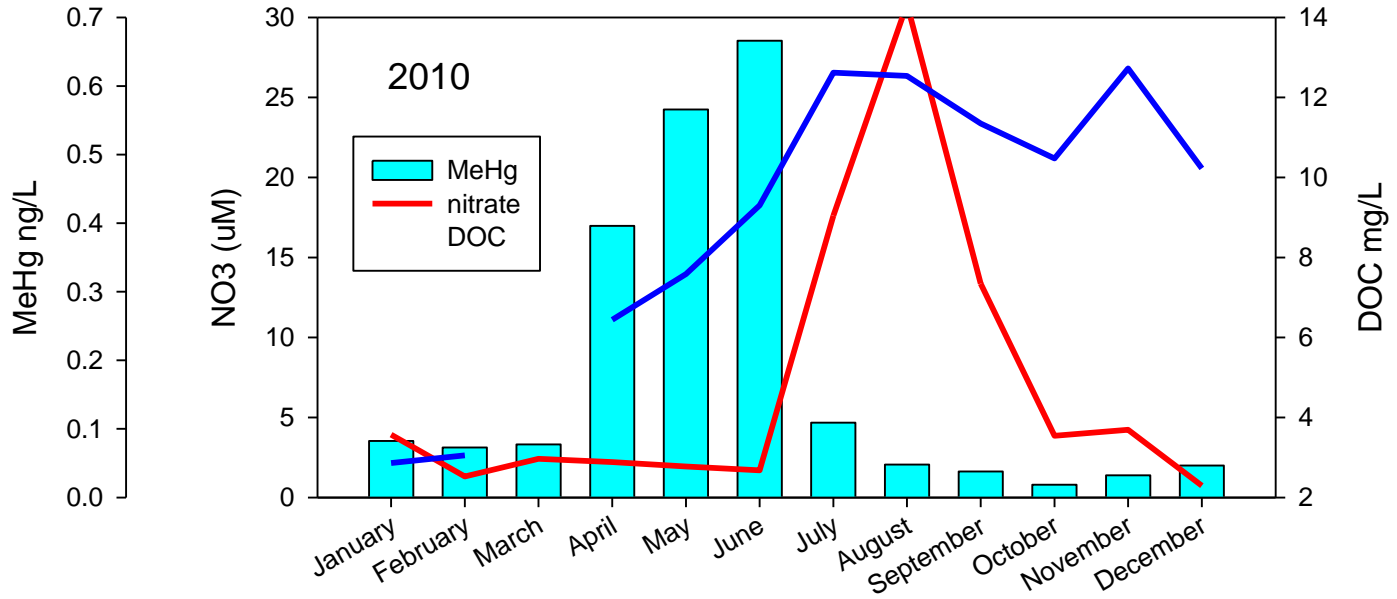
SERC Watershed	101	109	110
Area, hectares	226	17	6
Land use %			
Wetland	2	0	0
Developed	4	0	0
Forest	50	17	100
Agriculture	43	83	0

## Average Fluxes of Dissolved Hg and MeHg from SERC Watersheds 2007-2013.

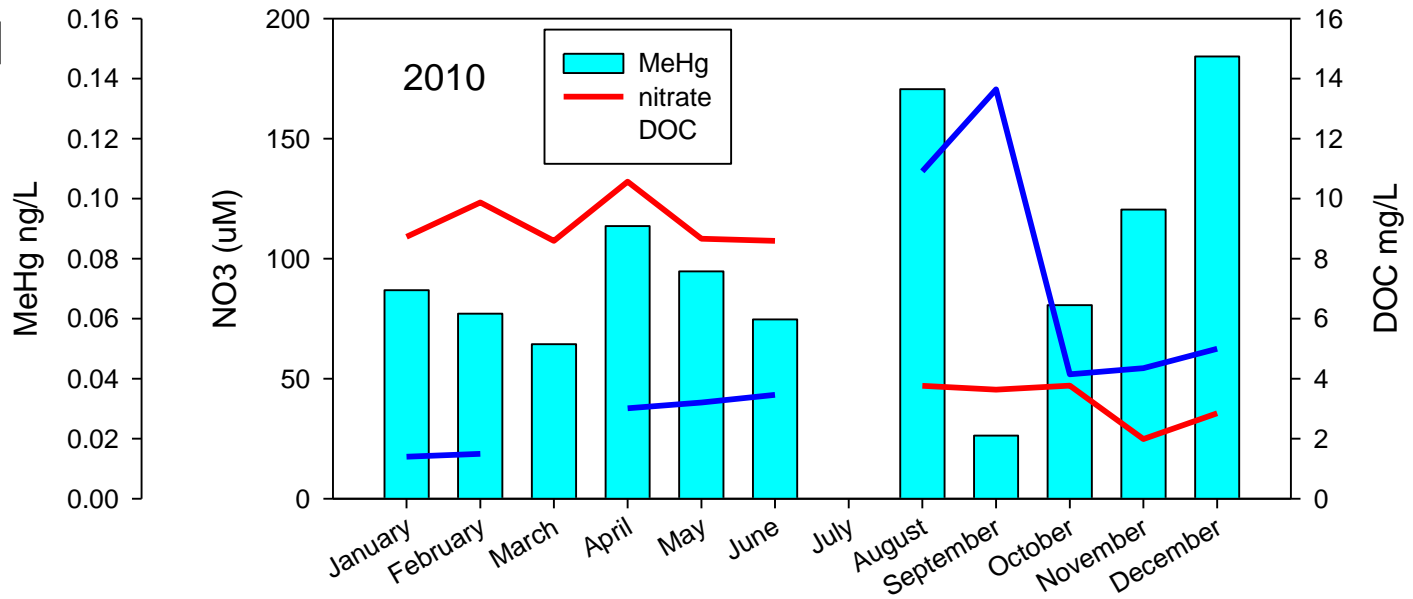
Site	Area	T-Hg Dissolved	MeHg Dissolved
	ha	mg/ha	mg/ha
109	17	5.7	0.4
110	6	17.1	0.8

Watershed 109 Agricultural  
Watershed 110 100% Forest

# Watershed 110



# Watershed 109



# Schematic Model of Biogeochemical Processes in Riparian Zone

Agriculture

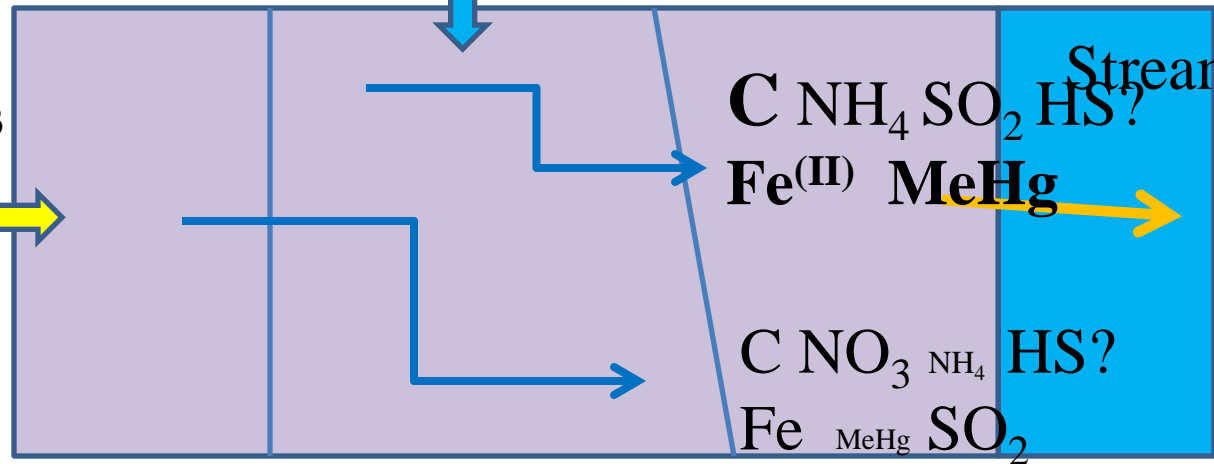


Forested



SO<sub>2</sub> NO<sub>3</sub>  
C Hg

SO<sub>2</sub> NO<sub>3</sub>  
Hg C



Stream

C NH<sub>4</sub> SO<sub>2</sub> HS?  
Fe<sup>(II)</sup> MeHg

C NO<sub>3</sub> NH<sub>4</sub> HS?  
Fe MeHg SO<sub>2</sub>

Iron reduction

Respiration

Denitrification

sulfate reduction

Carbon transformations

Timing of processes are different between the two watersheds

How many small streams are there?

18,000 watershed in VA of less than 200 ha

Havens et al 2006 –US EPA (CD # 973078-01)

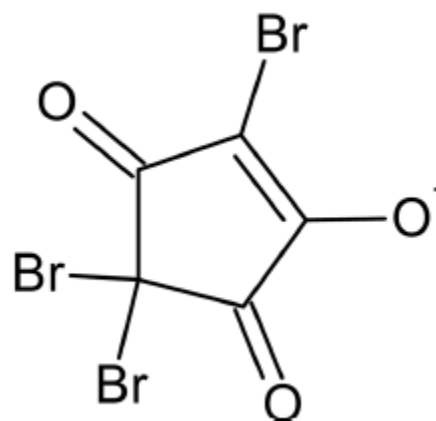
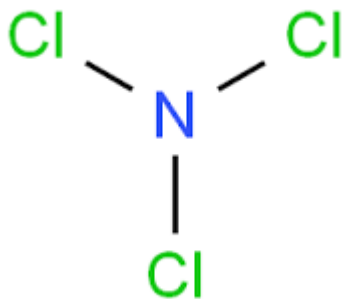
Based on the mean Hg and MeHg concentration in the two SERC watersheds, the load of Hg in the respective “dissolved” fractions from VA watersheds alone is similar to that of the Susquehanna River.

Changing conditions in the watershed that favor increased net methylation will increase production and load

As the Bay and its watershed move from eutrophic to oligotrophic we must be prepared for some unintended consequences

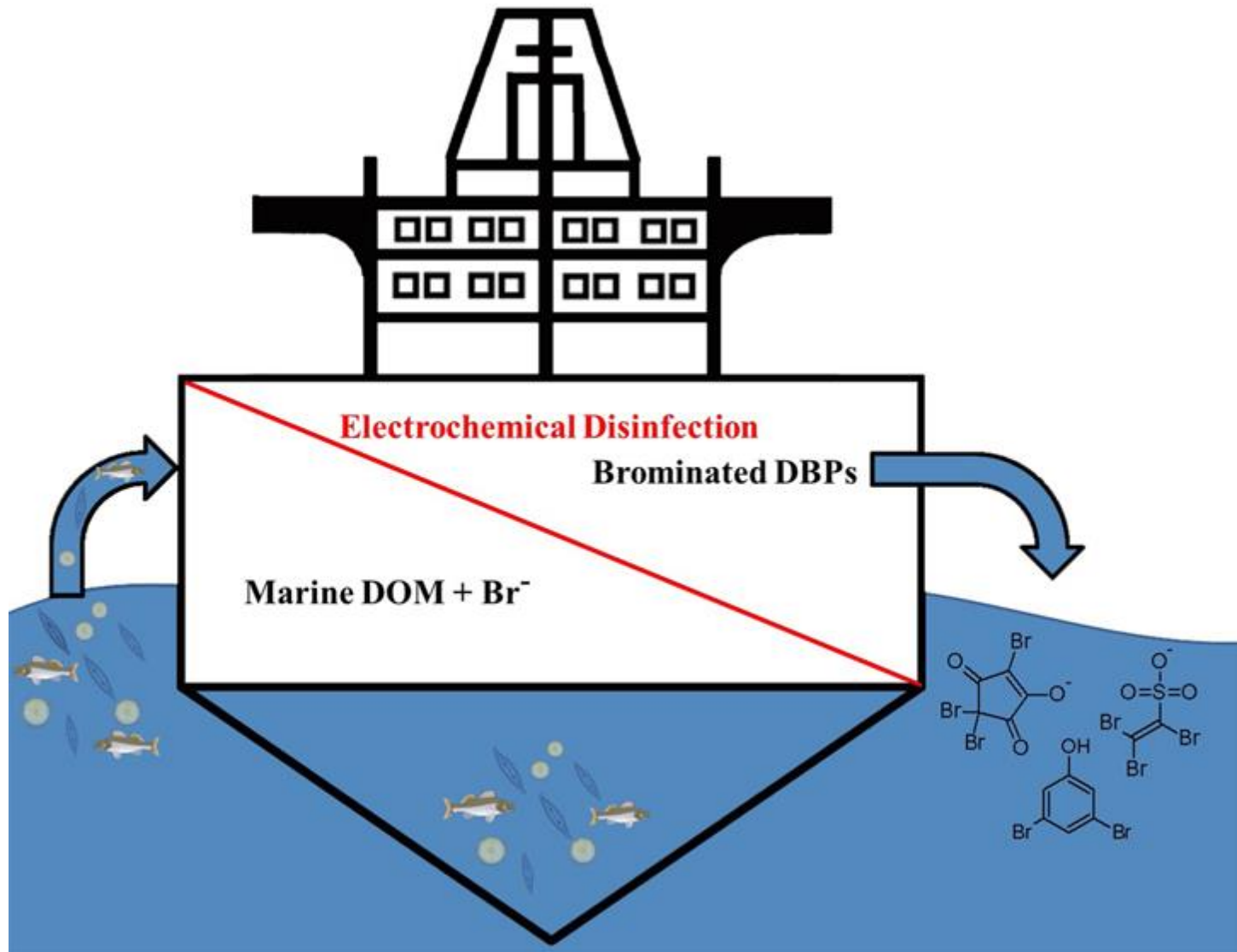
## Bromination of Marine Dissolved Organic Matter following Full Scale Electrochemical Ballast Water Disinfection

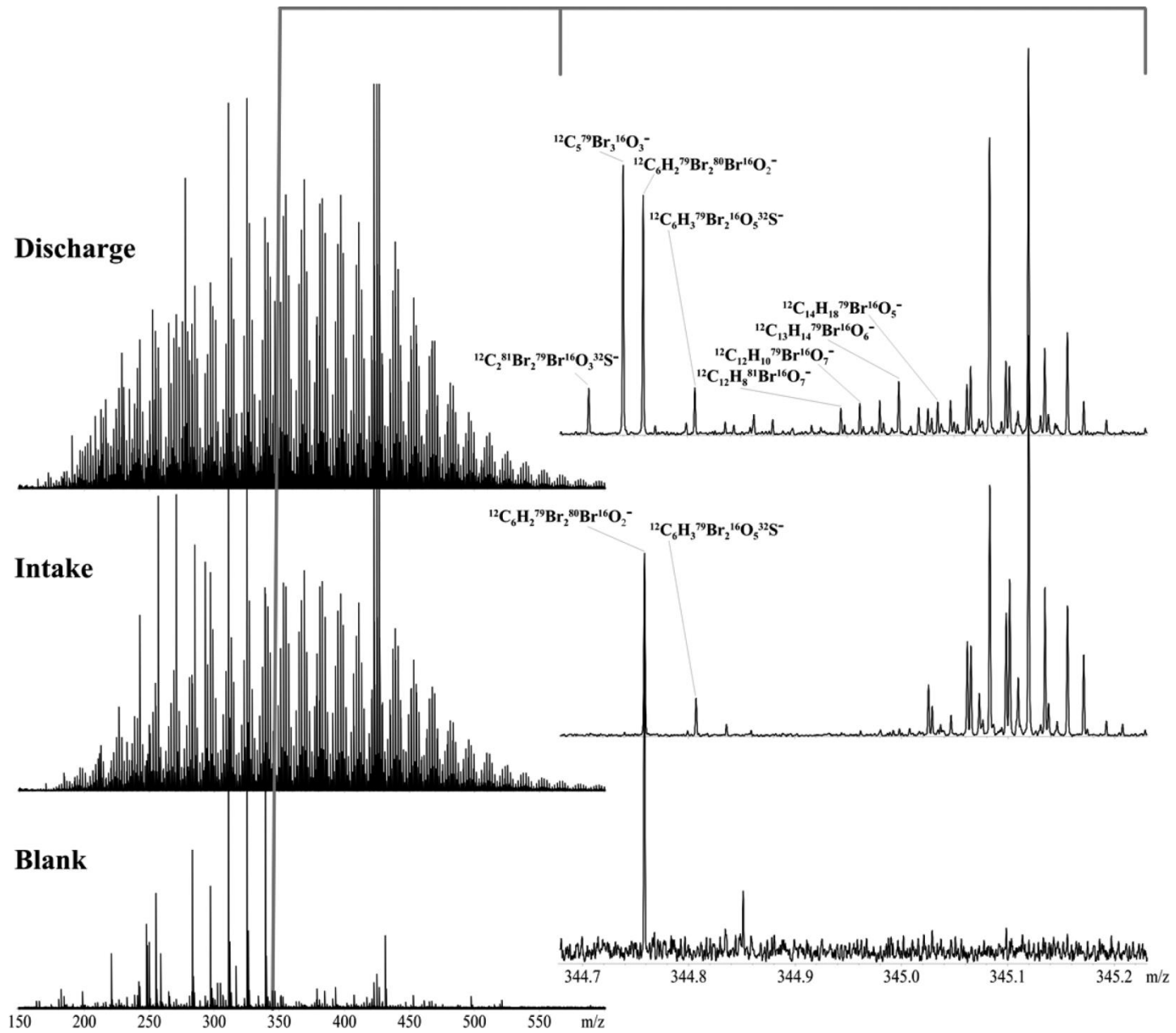
Michael Gonsior,<sup>\*,†</sup> Carys Mitchelmore,<sup>†</sup> Andrew Heyes,<sup>†</sup> Mourad Harir,<sup>‡</sup> Susan D. Richardson,<sup>§</sup>  
William Tyler Petty,<sup>§</sup> David A. Wright,<sup>†,⊥</sup> and Philippe Schmitt-Kopplin<sup>‡,||</sup>



Formation of some brominated compounds associated with chlorination known to be a problem but Br concentrations in freshwater 0.5 mg/L or less  
Br in seawater 60-80 mg/L

Began investigation because of use of  
Chlorine in “salty” environments





Many have formula similar to our friends the PBDE's  
Likely have the same structures and modes of action

Reasons why important Shipping –  
larger ships and more ships

Defouling of power plant cooling equipment

Desalinization – removal of salt

Waste water treatment

Thanks for listening