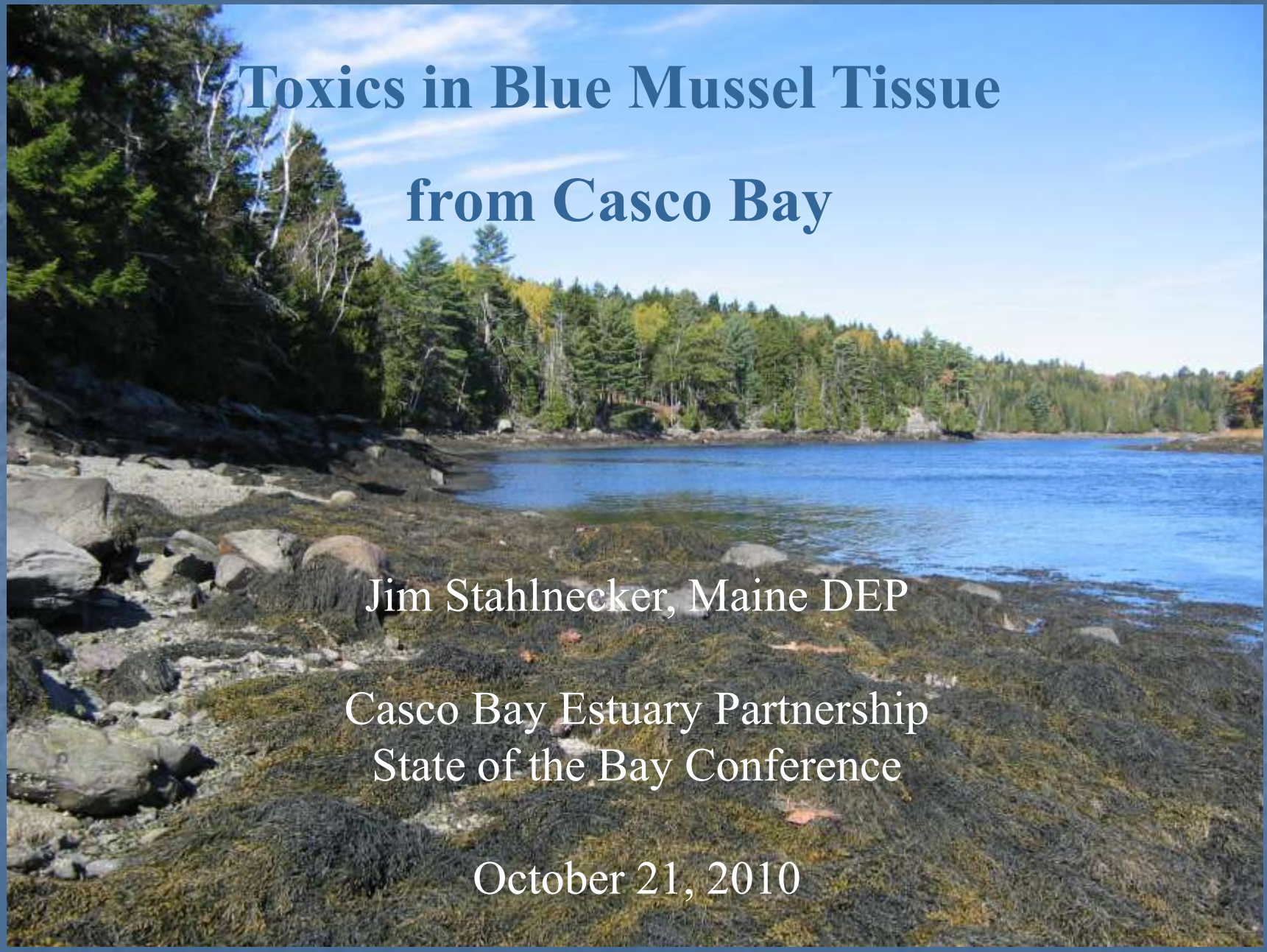
2010

Toxics in Blue Mussel Tissue from Casco Bay (2010 State of the Bay Presentation)

Jim Stahlnecker
Maine Department of Environmental Protection



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Jim Stahlnecker, Maine DEP

Casco Bay Estuary Partnership
State of the Bay Conference

October 21, 2010

Why Mussels?

- UBIQUITOUS
- SEDENTARY
- “HITS” WHEN WATER YIELDS ND
- GEOGRAPHIC RANGE, COMPARABILITY
- SWAT, GULFWATCH, NATIONAL STATUS & TRENDS PROGRAMS
- DATA FOR MANY ANALYTES AVAILABLE

Mytilus edulis

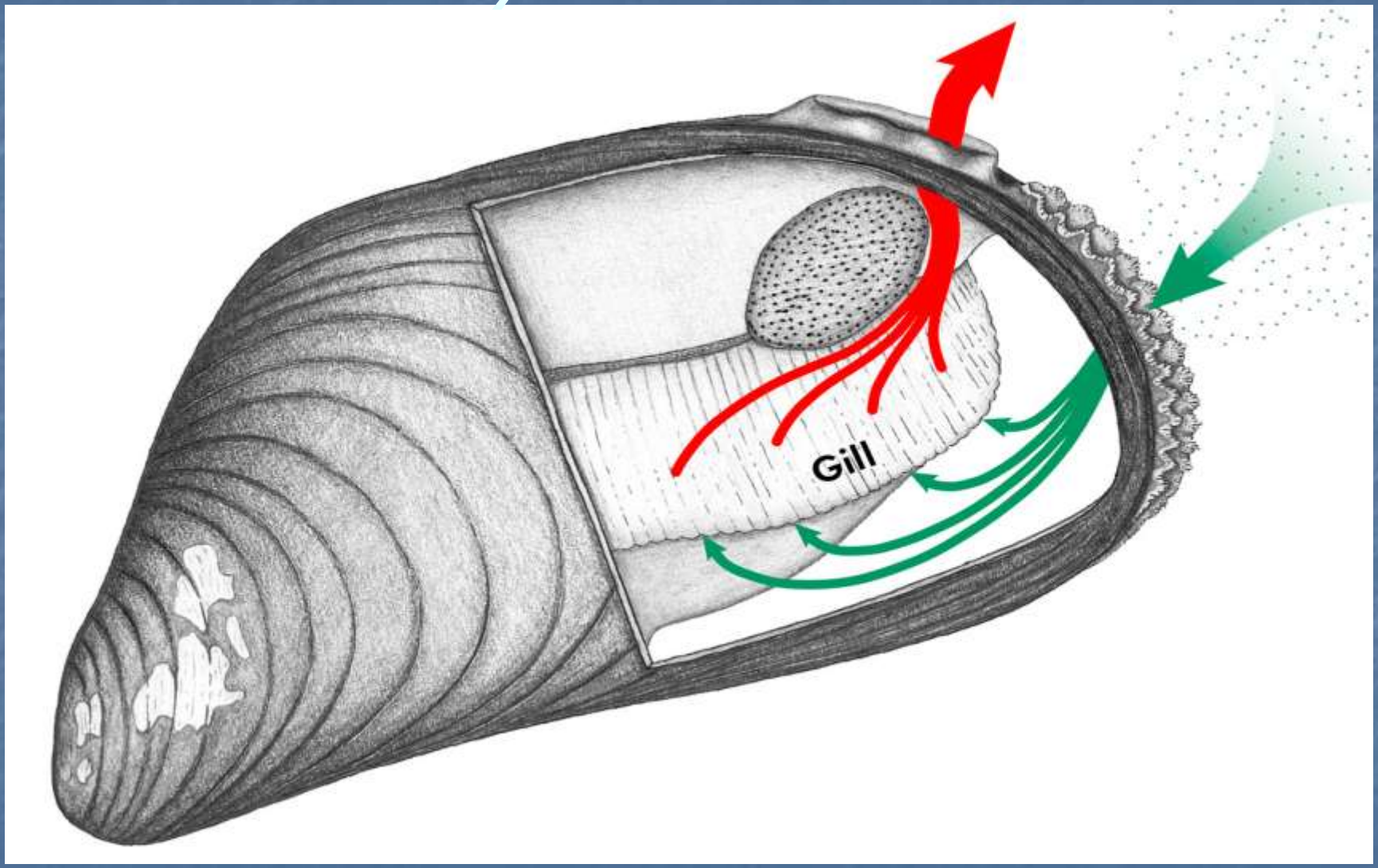
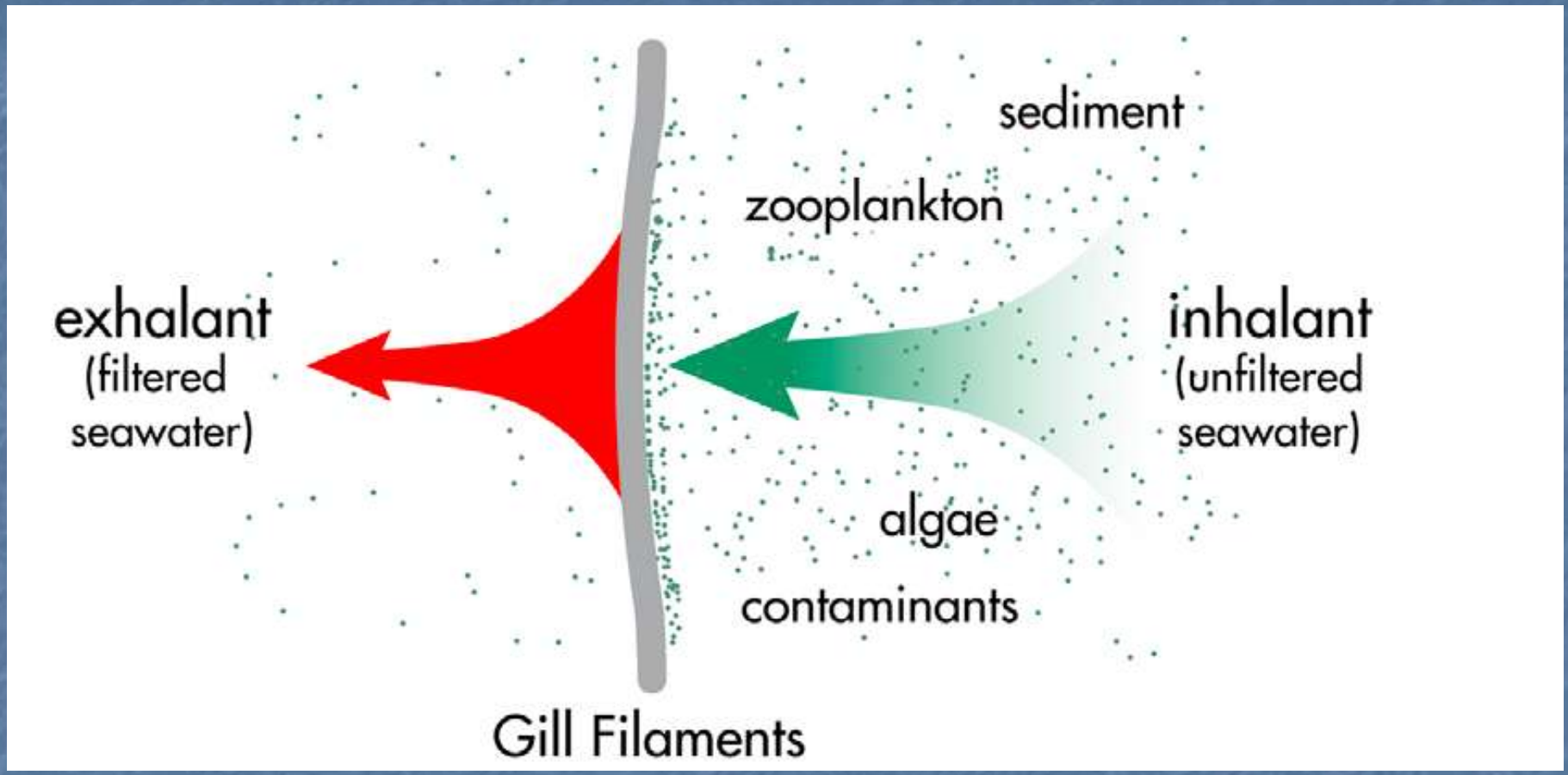


Illustration by Ethan Nedeau



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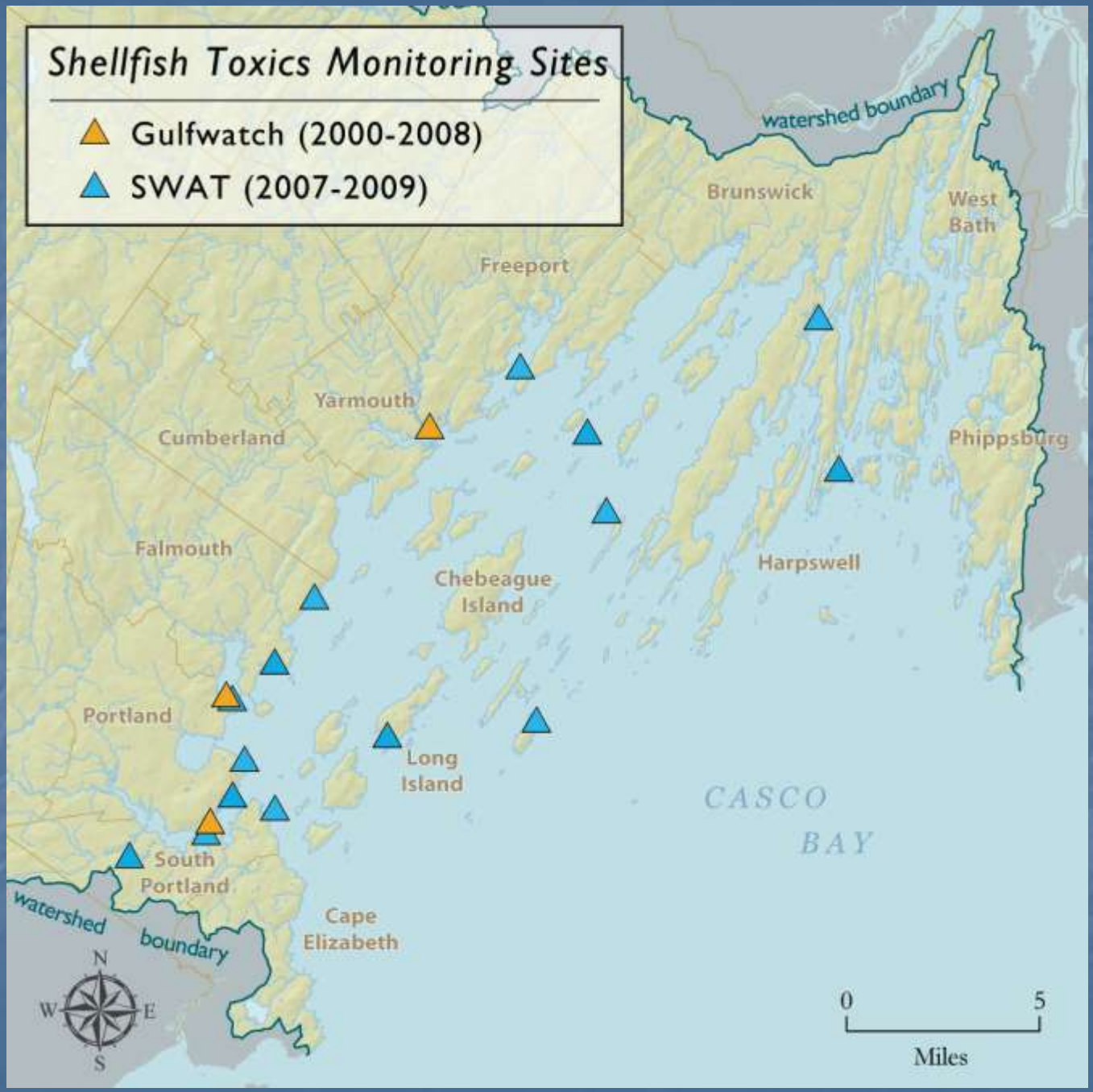
Statewide and GOM Monitoring History

- 1987 – Maine DEP begins using blue mussels as an indicator of toxic exposure
- DEP SWAT Program has 65+ stations statewide over 23 years
- CBEP/DEP collaboration on additional mussel sites in Casco Bay
- 1991 – Gulfwatch begins sampling across GOM in a joint US/Canadian monitoring program
- National Status and Trends Mussel Watch Program


Shellfish Toxics Monitoring Sites
Gulfwatch (2000-2008)
SWAT (2007-2009)
watershed boundary
Brunswick
West Bath
Freeport
Yarmouth
Cumberland
Phippsburg
Falmouth
Harpswell
Chebeague Island
Portland
Long Island
CASCO BAY
South Portland
Cape Elizabeth
watershed boundary
N
W
E
S
0
5
Miles

Blue Mussel Sampling Protocol

- Mid-October to mid-December annually
- Four sub-locations at each station (mean)
- Mussel shell length 50-60 mm.
- Composited samples of 20 and 30 mussels per sub-location
- Analysis for 10 metals, PAHs, PCBs, pesticides, dioxins and furans

Semper *Mytilus*?

Semper Paratus

Toxics Elevated[1,2] in Mussels Collected from Sampling Sites in Casco Bay 2007 – 2009
(Note that only East End Beach was sampled twice during this period)(DEP 2010)

Year Sampled	Sampling Location	Al	Fe	Cr	Cu	Ni	Pb	Zn	Hg	PCBs[3]	PAHs[4]	Organo-chlorine Pesticides[5]
2007	Spring Point, S. Portland				X[2]		X[2]					X[2]
	Middle Fore River, S. Portland				X[2]		X[2]	X[1,2]		X[2]	X[2]	X[2]
	East End Beach, Portland				X[2]		X[2]					X[2]
	Jewell Island, Punch Bowl											
	Falmouth Anchorage				X[2]							
	Harraseeket River, Freeport				X[2]							
	Mare Brook, Harpswell Cove				X[2]							
2008	Presumspcot River, Falmouth				X[2]		X[1,2]		X[2]			X[2]
	Middle Bay, Harpswell											
2009	Inner Fore River, Portland	X[1,2]	X[2]	X[1,2]	X[2]	X[2]				X[2]	X[2]	X[2]
	East End Beach, Portland	X[1,2]	X[2]	X[1,2]		X[2]	X[2]			X[2]		X[2]
	Mill Creek, Falmouth											
	Long Island											X[2]
	Maquoit Bay Freeport											
	Quahog Bay, Harpswell					X[2]						

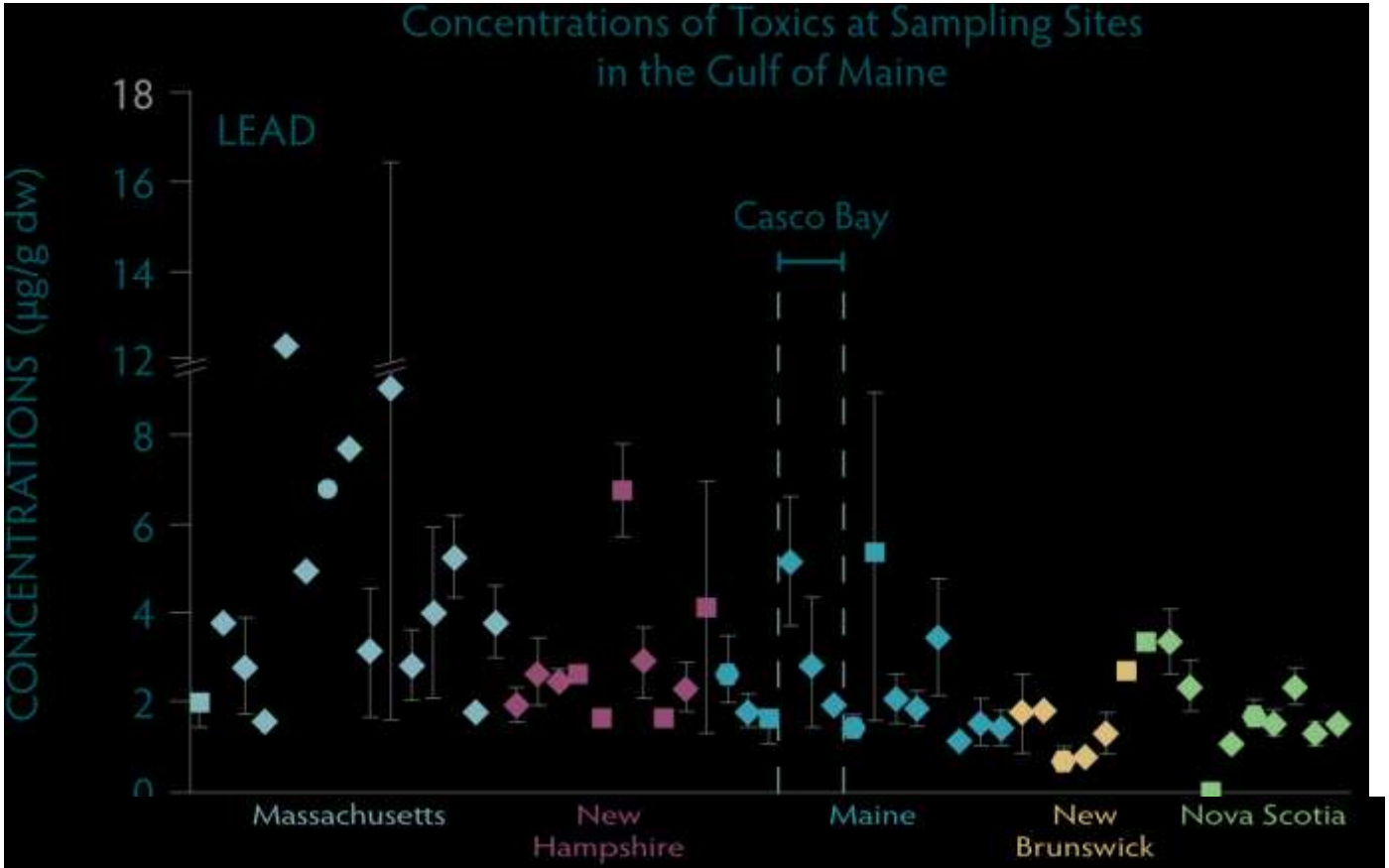
[1] Elevated based on Maine Reference Conditions, mean + 2 standard deviations (DEP 2005)
[2] Elevated based on Gulf of Maine-wide Gulfwatch 85th percentile value, *i.e.*, 85% of samples fall below the 85th percentile value (GOMC 2009)
[3] Sum of 19 PAHs
[4] Sum of 35 PCB congeners
[5] Sum of Organochlorine pesticides

Status of Casco Bay Mussels Pesticides

- DDT in low range nationally (NS&T)
- Dieldrins/chlordanes in low range nationally (NS&T)
- Sum of organochlorine pesticides higher than GOM 85th percentile (Gulfwatch) at some Casco Bay stations
- 2009 SWAT analysis for organophosphates, triazines, pyrethroids and organonitrogens were at non-detect levels

Status of Casco Bay Mussels Metals

- Al and Fe related to sediment ingestion
- Above Maine reference condition
  - Cr – Inner Fore River, East End Beach
  - Zn – Middle Fore River
  - Pb – Presumpscot River
- Above Gulfwatch 85th percentile
  - Additional sites exceed less rigorous standard for Cu, Ni, Pb, Hg and also for PCBs, PAHs
- Concentrated in the western portion of the bay

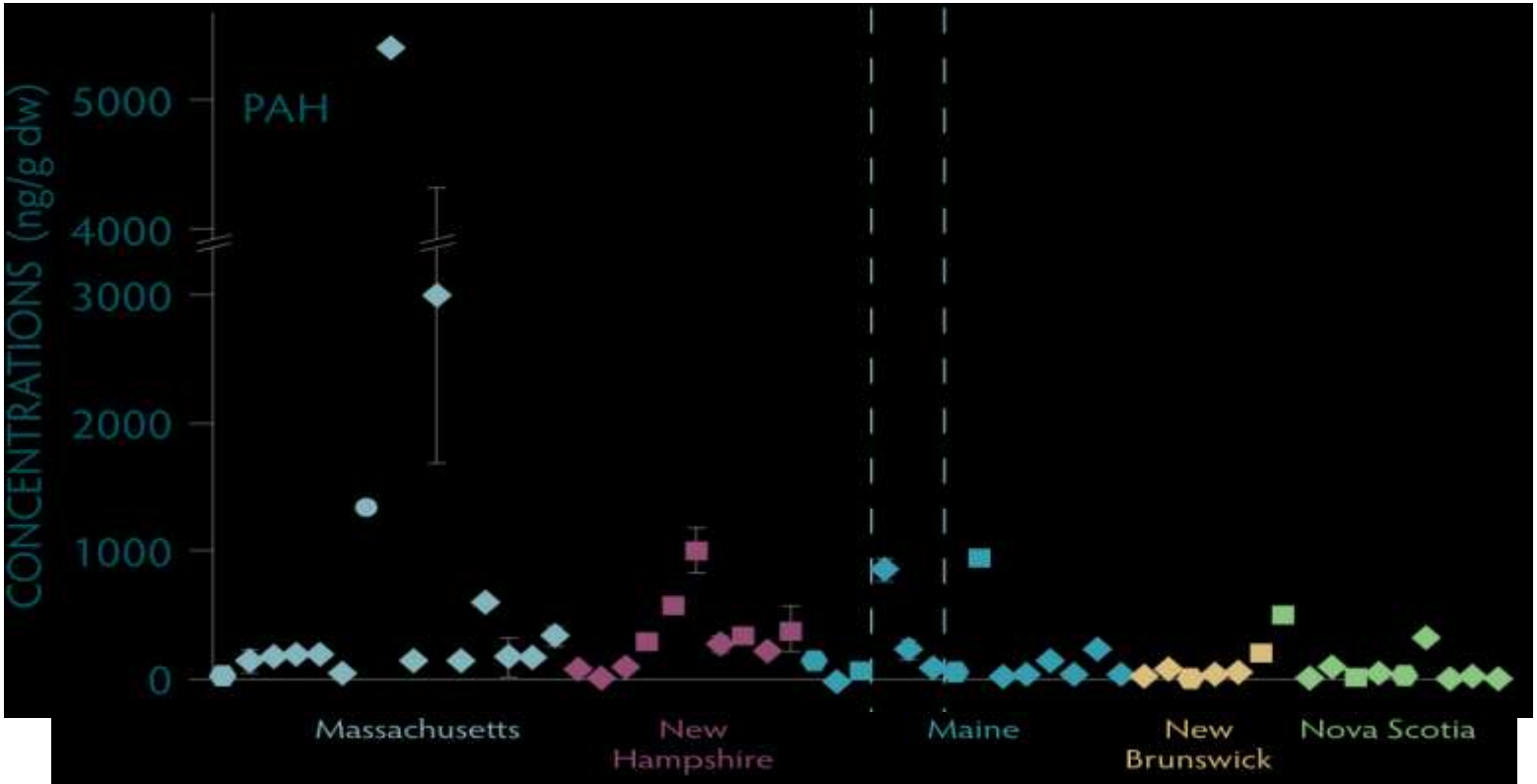


Eight-year (2000-2008) median and median absolute deviations[1] in concentrations in mussel tissues at all Gulfwatch sites, in geographic order (south to north along the x axis from Massachusetts to Nova Scotia).

- Benchmark site (sampled every year)
- Multi-year sites (sampled every 3 years)
- Sampled every 6 years
- Occasionally sampled sites

[1] In statistics, the median absolute deviation (MAD) is defined as the median of the absolute deviations from the data's median: $MAD = \text{median}_i (|X_i - \text{median}_j(X_j)|)$ In words, 50% of observations lie within the range defined by the MAD.

Concentrations of Toxics at Sampling Sites in the Gulf of Maine



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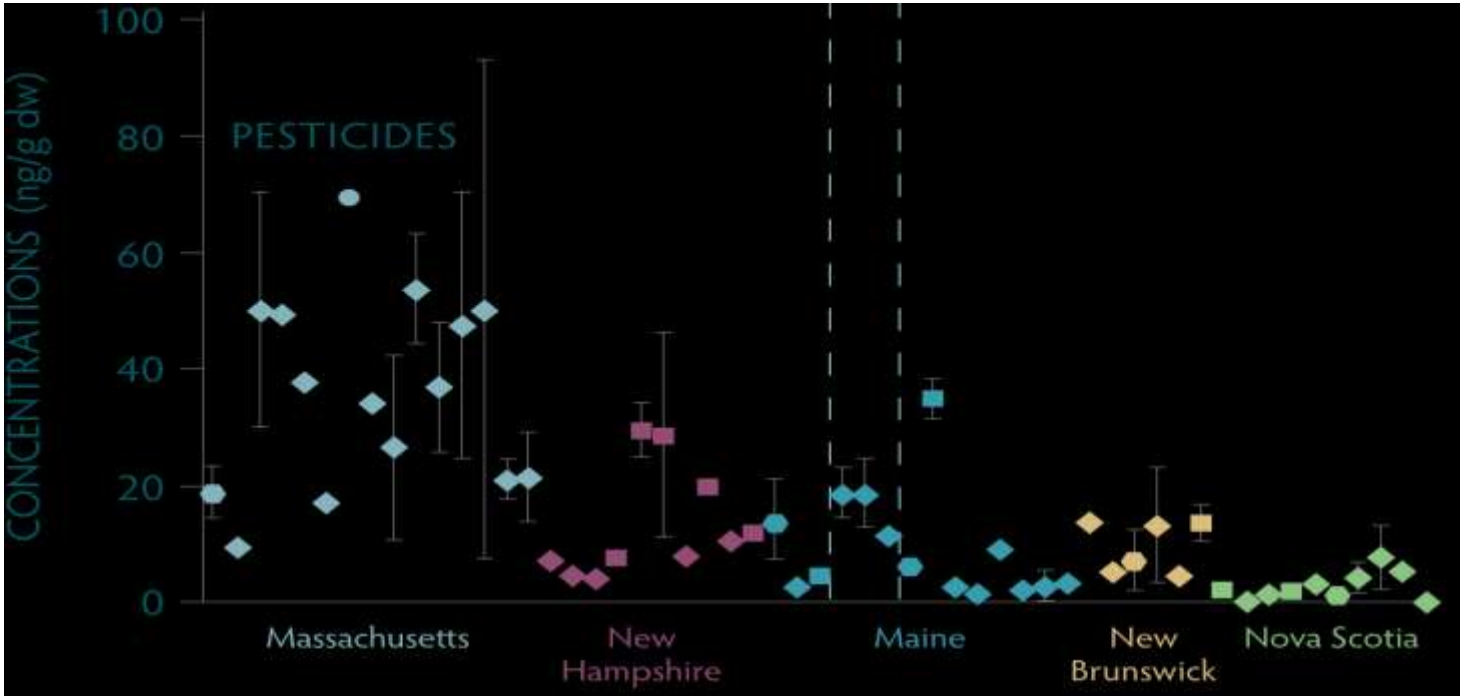

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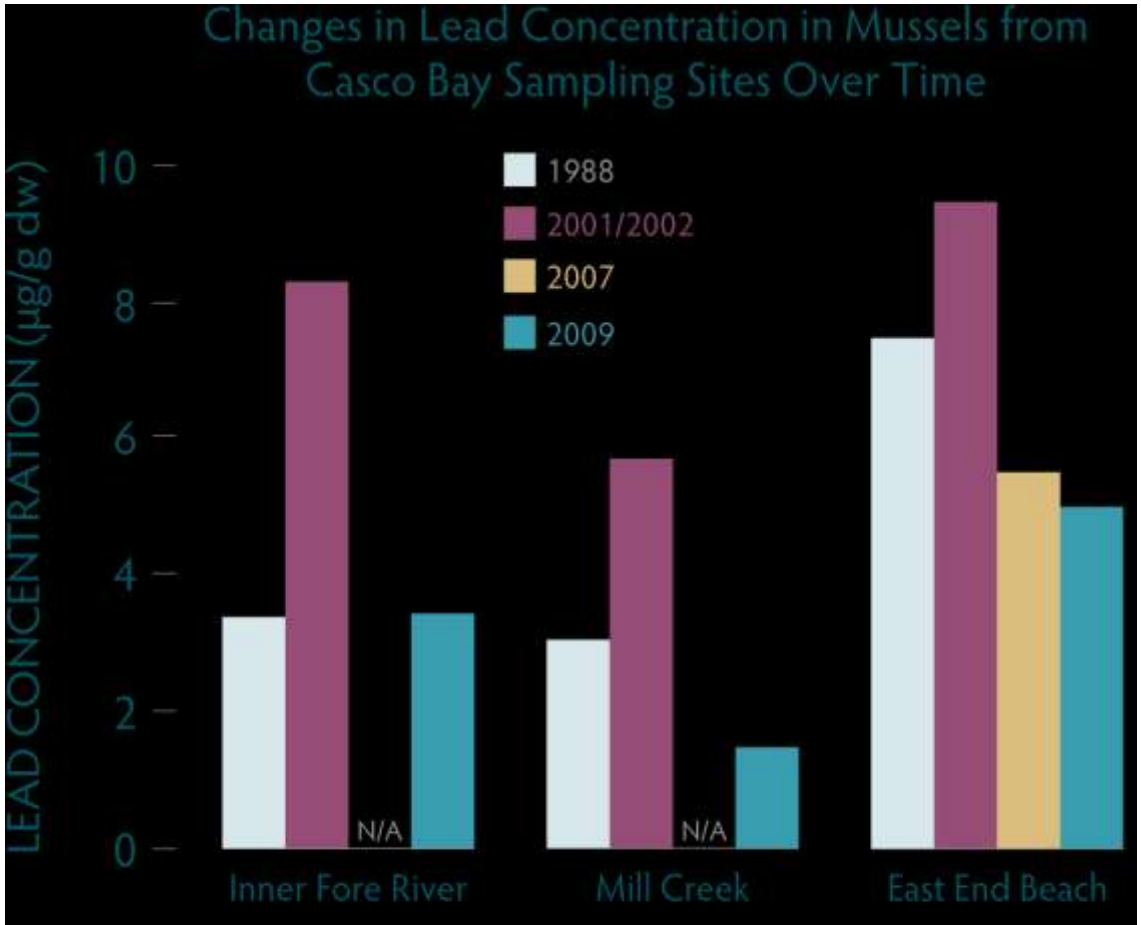
Trends in Toxics in Casco Bay and the Gulf of Maine

- Most metals appear to be declining (Pb) or remaining stable in time gulfwide
- Pb and some metals appear to be declining at Portland Harbor (2000-08)
- Σ24 PAHs elevated but appear stable in Portland Harbor (vs. 1993-2001)
- Chlorinated pesticides and PCBs show S to N regional trend, with highest Casco Bay levels at Portland Harbor

Gulfwatch Data for Metals in Portland Harbor

Year	Hg	Ag	Cd	Pb	Ni	Zn	Al	Cr	Fe	Cu
2000		0.1	1.78	11.5	2.45	357.5	370	2.3	737.5	12.3
2003	0.30	0.09	1.48	2.33	7.62	107.8	467		668.8	
2005	0.29	0.05	1.89	6.58	1.39	159.5	464	1.8	761.3	8.6
2007	0.2	0.02	1.39	4.34	0.95	146	250	1.7	444	7.6
2008	0.2	0.02	1.48	5.16	1.06	139	483	1.4	606	8.08

Most metals have decreased over time (units are µg/g dry weight).



DEP SWAT sampling over time at several Casco Bay sites suggests that while there was an initial increase in lead levels from 1988 to 2001/2002, there has been a decline in lead levels in more recent samples. Units are micrograms per gram dry weight. The Gulfwatch mussel sampling program (see table below) has observed a regional decline in lead levels over the past decade.

Conclusions

- Locations away from concentrated human activity have measurable but not elevated levels of toxics, in Casco Bay and in GOM
- Locations with elevated toxics:
  - Past manufacturing, pollutants in sediment
  - Harbors and commercial port areas
  - Mouths of rivers
  - Developed areas with runoff from impervious surfaces

Example: Inner Fore River

- Historical upstream industry
- Stroudwater River input
- Runoff from Jetport, Maine Mall

Example: East End Beach

- Urban runoff
- Dense residential development
- Dump leachate
- Presumpscot River input

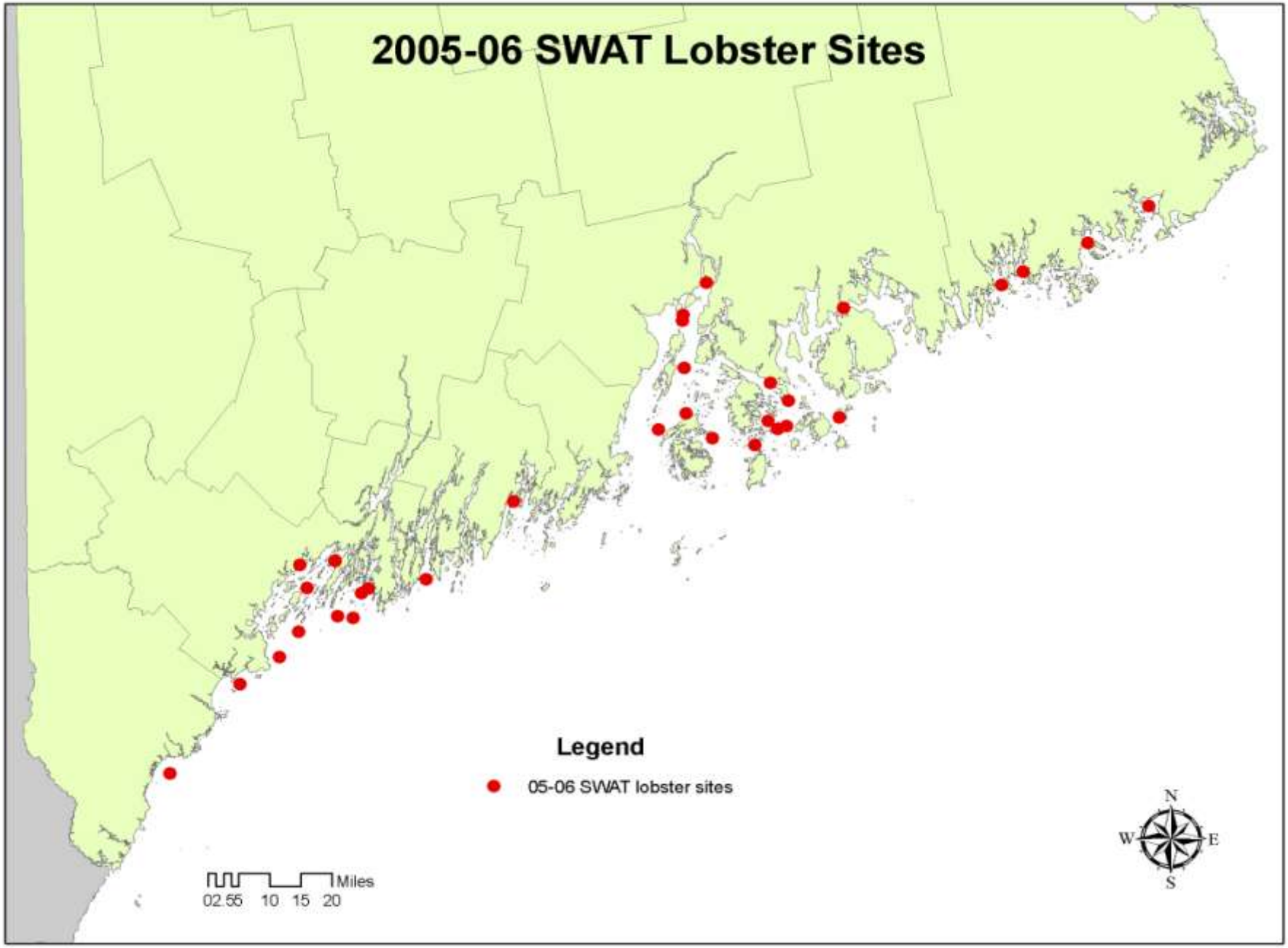
A Consistent Pattern

- Toxics vary with human activity patterns
  - DEP SWAT data – statewide, within Casco Bay
  - Gulfwatch data – gulfwide, within Casco Bay
  - National Status and Trends data – nationally
  - State of the Bay Indicator 10 – sediment data

How beautiful on the mountains are the feet of those who bring good news…

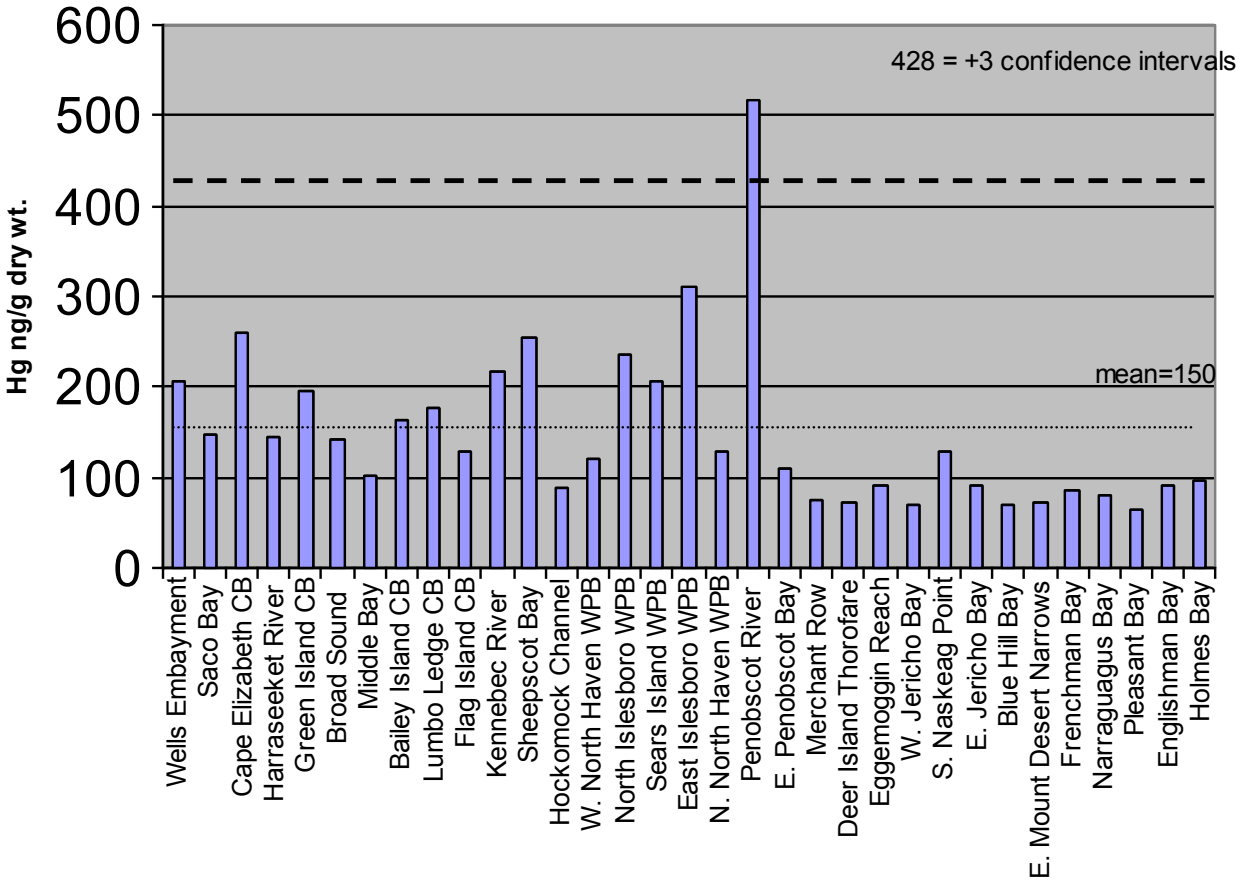
- Gulfwatch data suggest metals levels have decreased across the Gulf of Maine and in Casco Bay
- DEP SWAT data also suggest that Pb levels have decreased at several Casco Bay sites


DEPARTMENT OF ENVIRONMENTAL PROTECTION
STATE OF MAINE

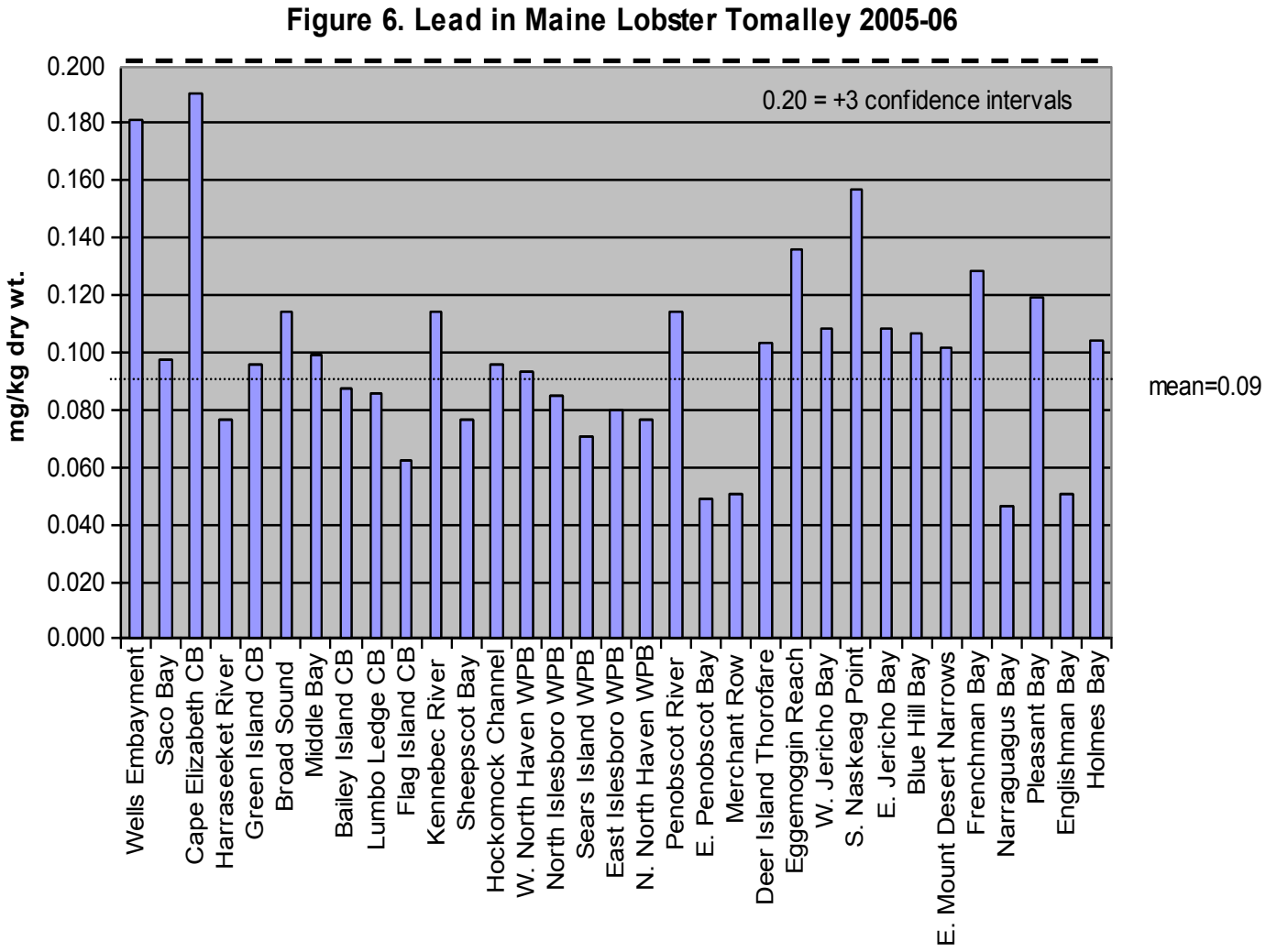

2005-06 SWAT Lobster Sites
Legend
05-06 SWAT lobster sites
Miles
0 2.5 5 10 15 20
N
W
E
S

Hg in LOBSTER TOMALLEY

Figure 2. Mercury in Maine Lobster Tomalley 2005-06

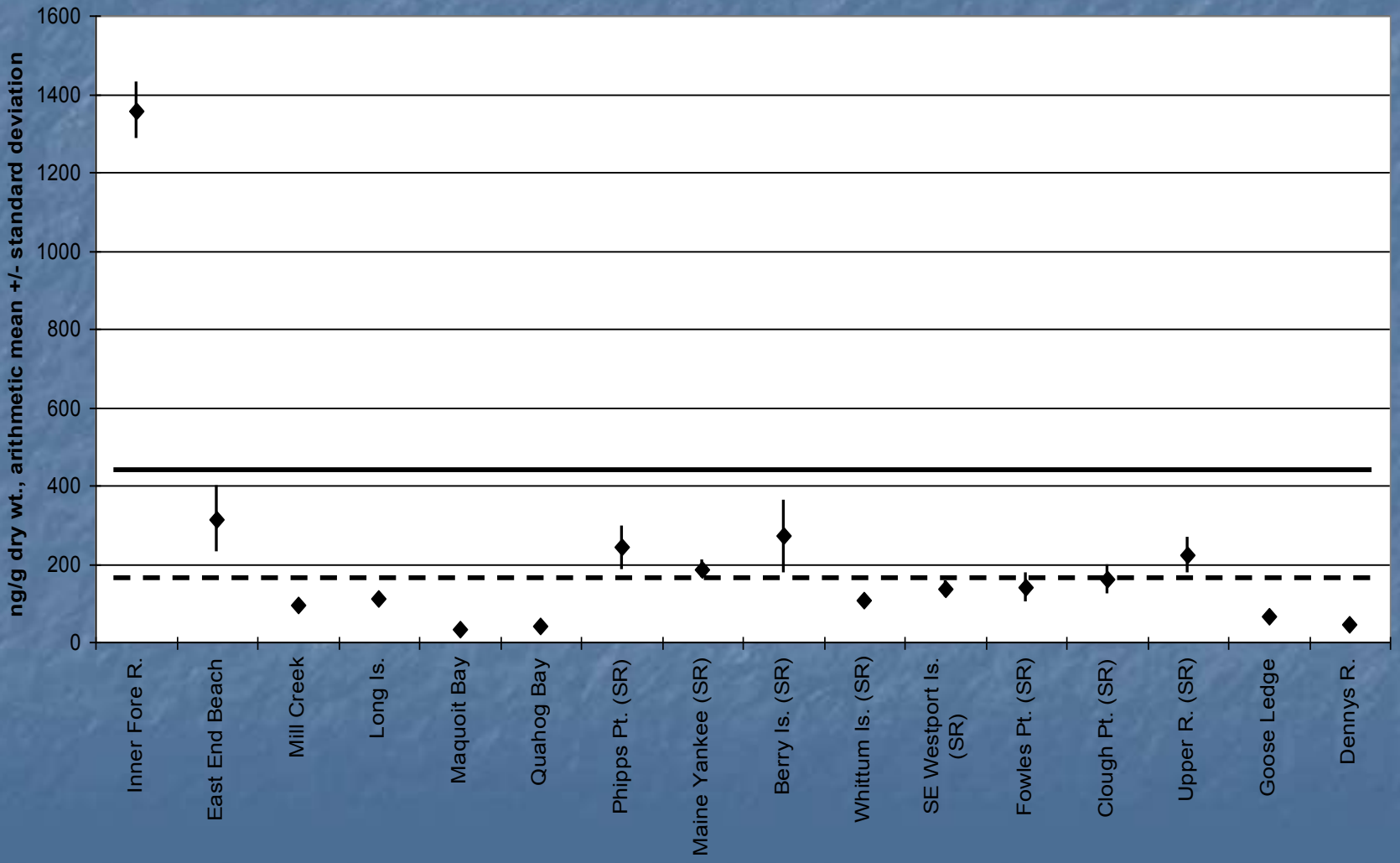


Pb in LOBSTER TOMALLEY



2009: 19 VS. GULFWATCH

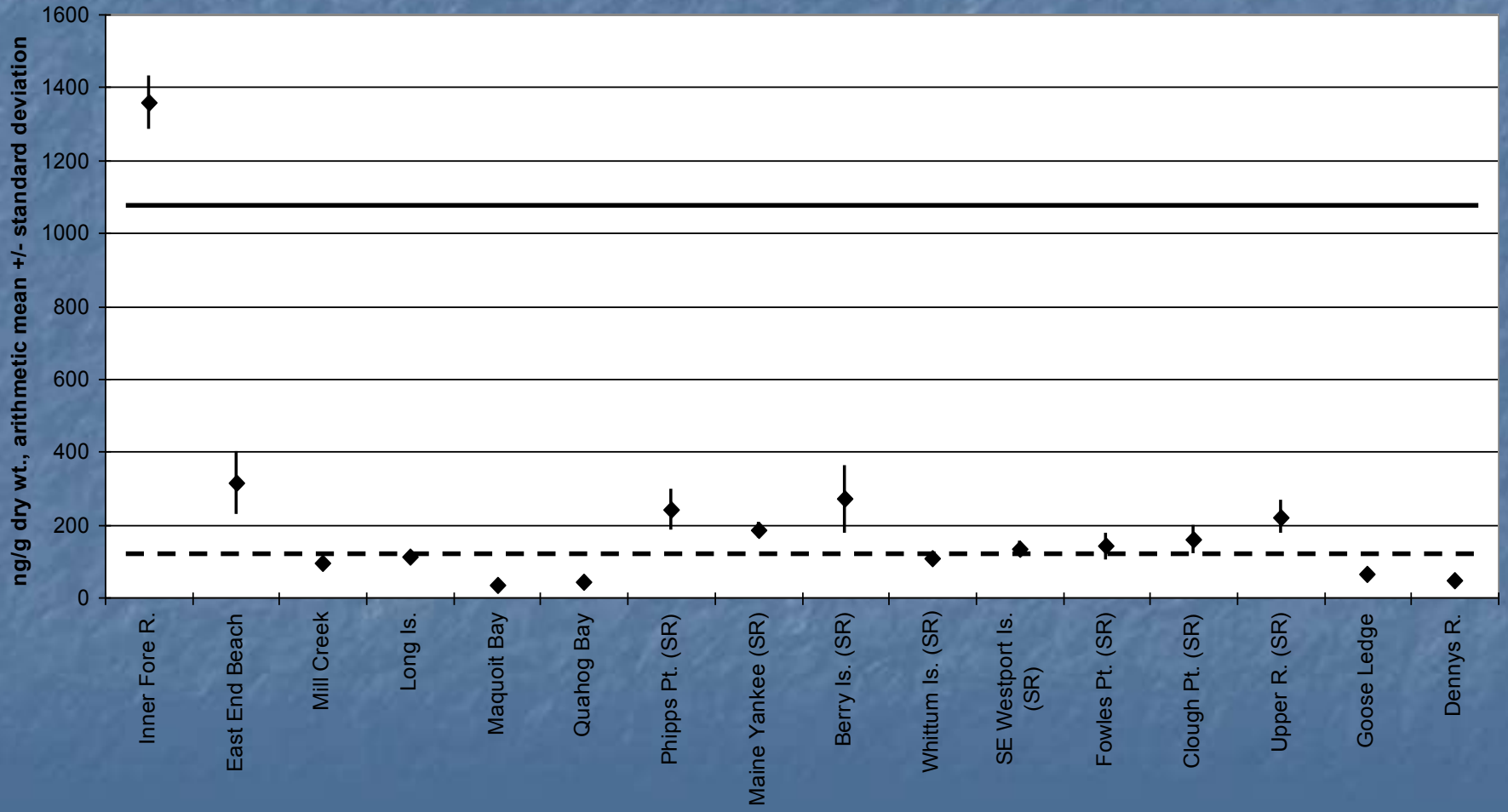
Figure 1.1.3.2.2: Sum of 19 PAHs in 2009 SWAT Blue Mussels



Dashed line = 2008 Gulfwatch Median (Sum 19 PAHs); Solid line = 2008 Gulfwatch 85th Percentile (Sum 19 PAHs).

2009: 19 VS. NS&T

Figure 1.1.3.2.3: Sum of 19 PAHs in 2009 SWAT Blue Mussels



Dashed line = 2008 National Status and Trends Median (Sum 19 PAHs); Solid line = 2008 National Status and Trends 85th Percentile (Sum 19 PAHs).

FLU+PYR/Σ(FP + C2-C4-P)