

Use of Empirical Data to Address Data Gaps Associated with Criteria Used for Regulating Dredged Material Management

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Presentation Outline

1

SF Bay dredged material characterization
Bioaccumulation triggers and their basis

2

Successful update of mercury trigger

3

Data suggesting current PAH trigger is overly
conservative

4

Discussion

Bioaccumulation Triggers

- Established by June 2011 Essential Fish Habitat (EFH) consultation agreement
- Suitability for unconfined open water disposal sites in San Francisco Bay
- Defines sediment concentrations requiring bioaccumulation testing
- Total DDTs, total chlordane, dieldrin, and dioxins/furans
 - Triggers use biologically-based values from the Pacific Northwest
- Mercury, total PCBs, and total PAHs
 - Triggers based on San Francisco Bay ambient sediment concentrations

Programmatic EFH Conservation Measures for the LTMS Program Agreed-upon by USACE, EPA, and NMFS

Table 1. Initial (2011) Sediment Chemistry Bioaccumulation Trigger (BT) Levels, for Unconfined in-Bay Placement at Designated San Francisco Bay Disposal Sites

	Mercury (mg/kg)	Total PAHs (µg/kg)	Total PCBs (µg/kg)	Total DDTs (µg/kg)	Total Chlordane (µg/kg)	Dieldrin (µg/kg)	Dioxins/ Furans (pg/g)
Bioaccumulation Trigger (Initial)	0.33	4800	16	50	37	1.9	10
Basis	a	a	a	b	b	c	d

Updated annually, defined as the 90th UCL of the 90th percentile of the previous 10 years of data

Based on published values from Puget Sound, WA

A Better Idea

Use Bioaccumulation Data to Set Bioaccumulation Triggers

- More scientifically defensible
- Makes use of local (San Francisco Bay) data
- Reduces expensive bioaccumulation testing when not necessary
- Allow smaller dredging projects to move forward with fewer obstacles

In 2012, USEPA, Region IX led an effort to compile existing bioaccumulation data

Data from Sites throughout San Francisco Bay (2001-2012):

- 60 sample locations, 2 species = 120 individual laboratory exposures
- Sediment mercury concentrations up to 2.62 ppm
- Focus on the 50 sample locations in the range of 0 to 0.5 ppm mercury (below the TMDL maximum)

Summary and Evaluation of Bioaccumulation Tests for Total Mercury Conducted by San Francisco Bay Dredging Projects

Prepared in Support of

Modifying the June 9, 2011
Programmatic Essential Fish Habitat (EFH) Consultation Agreement
For San Francisco Bay Maintenance Dredging Projects



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February 2, 2012

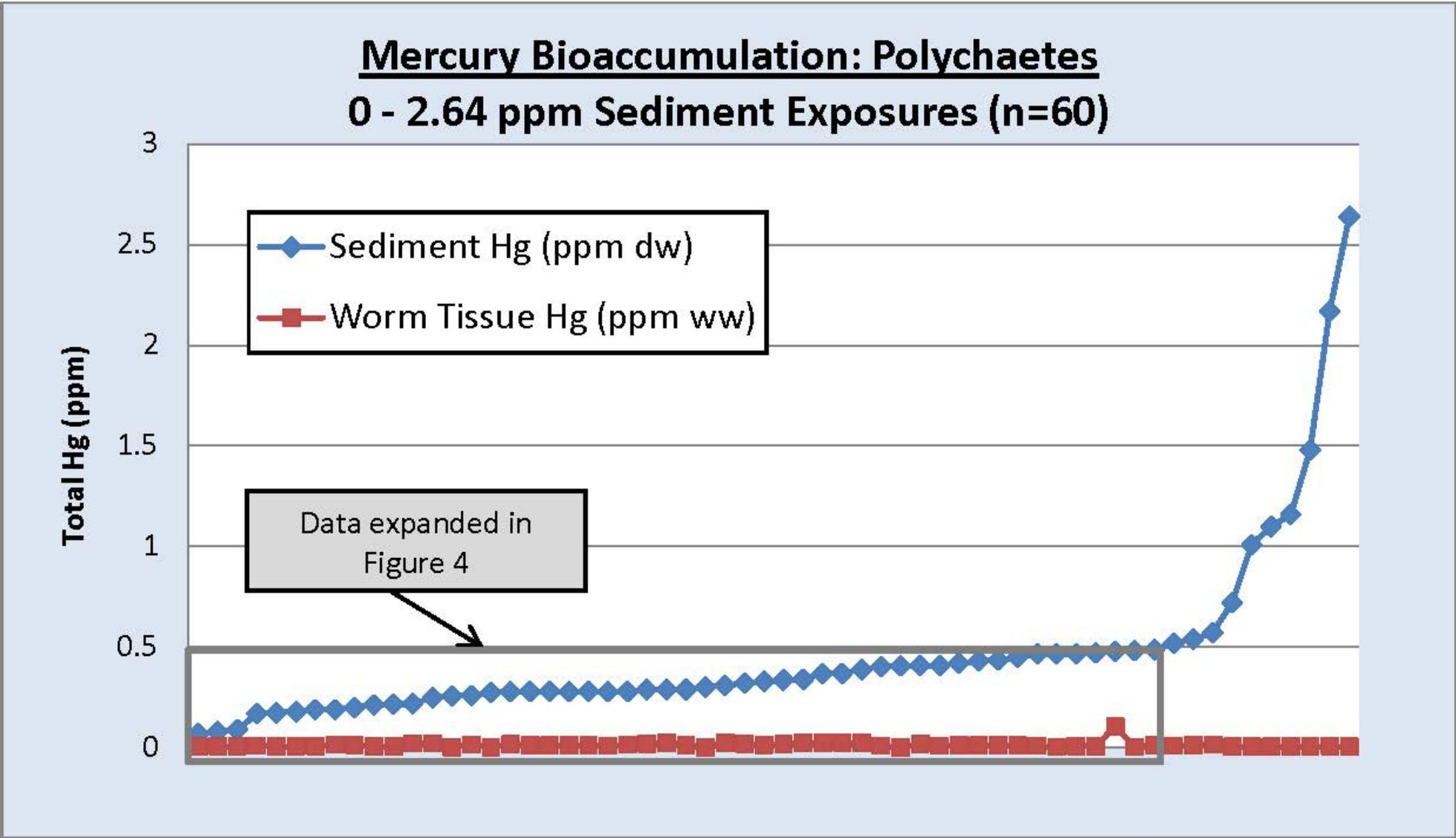
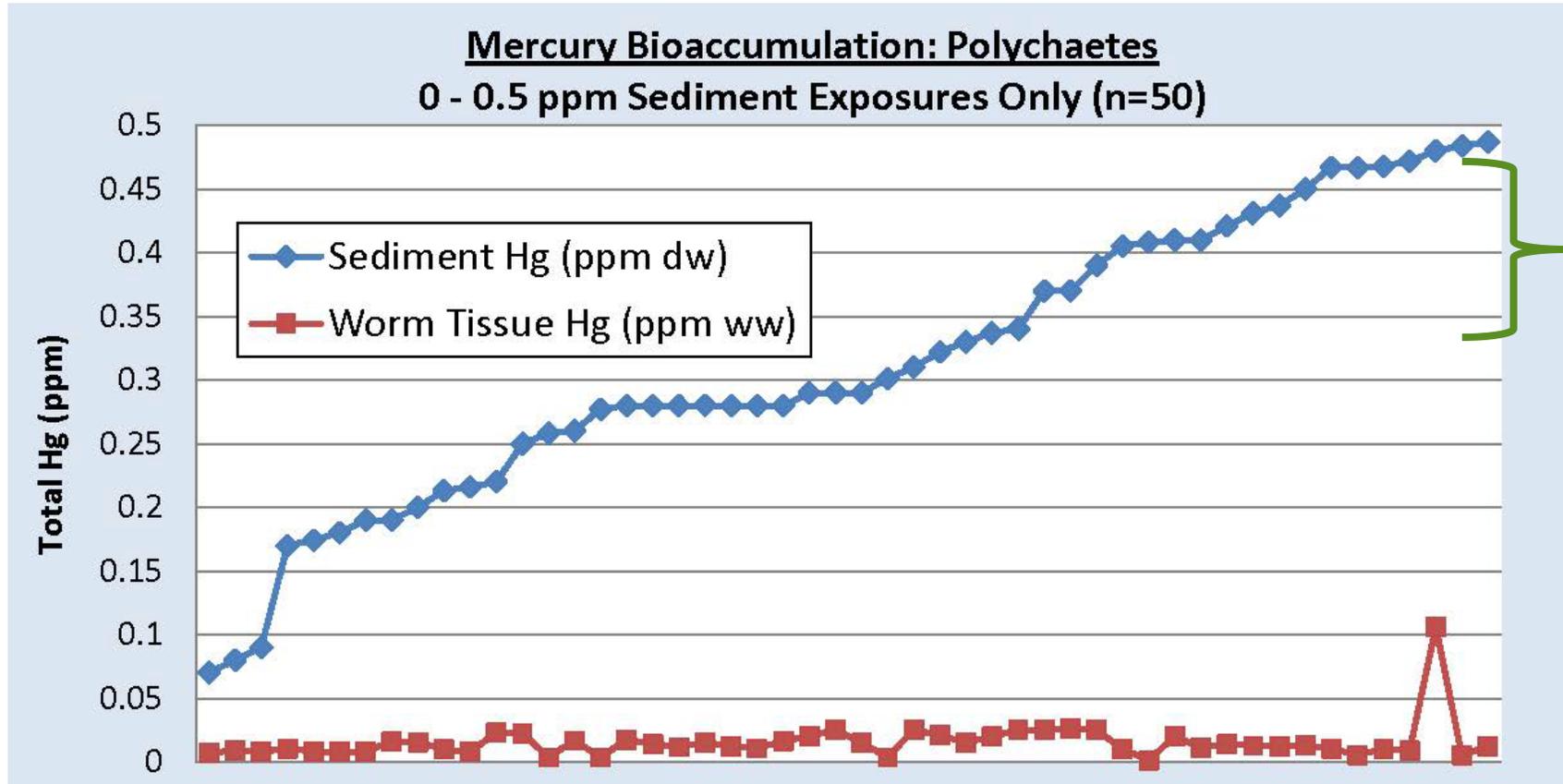


Figure 2. Total Mercury in Sediment and Exposed Polychaetes
*Summary and Evaluation of Bioaccumulation Tests for Total Mercury
 Conducted by San Francisco Bay Dredging Projects, Feb 2, 2012*

- 2012 Bioaccumulation trigger = 0.34 ppm (required additional studies)
- 2012 TMDL maximum = 0.471 ppm (maximum for in-water disposal)



Sediment in this range would require bioaccumulation studies

Figure 4. Total Mercury in Sediment and Exposed Polychaetes
Summary and Evaluation of Bioaccumulation Tests for Total Mercury
Conducted by San Francisco Bay Dredging Projects, Feb 2, 2012

**Bioaccumulation Test Results for Total Mercury in Relation to
San Francisco TMDL Objectives (Sediment Hg < 0.5 ppm, n=50/species)**

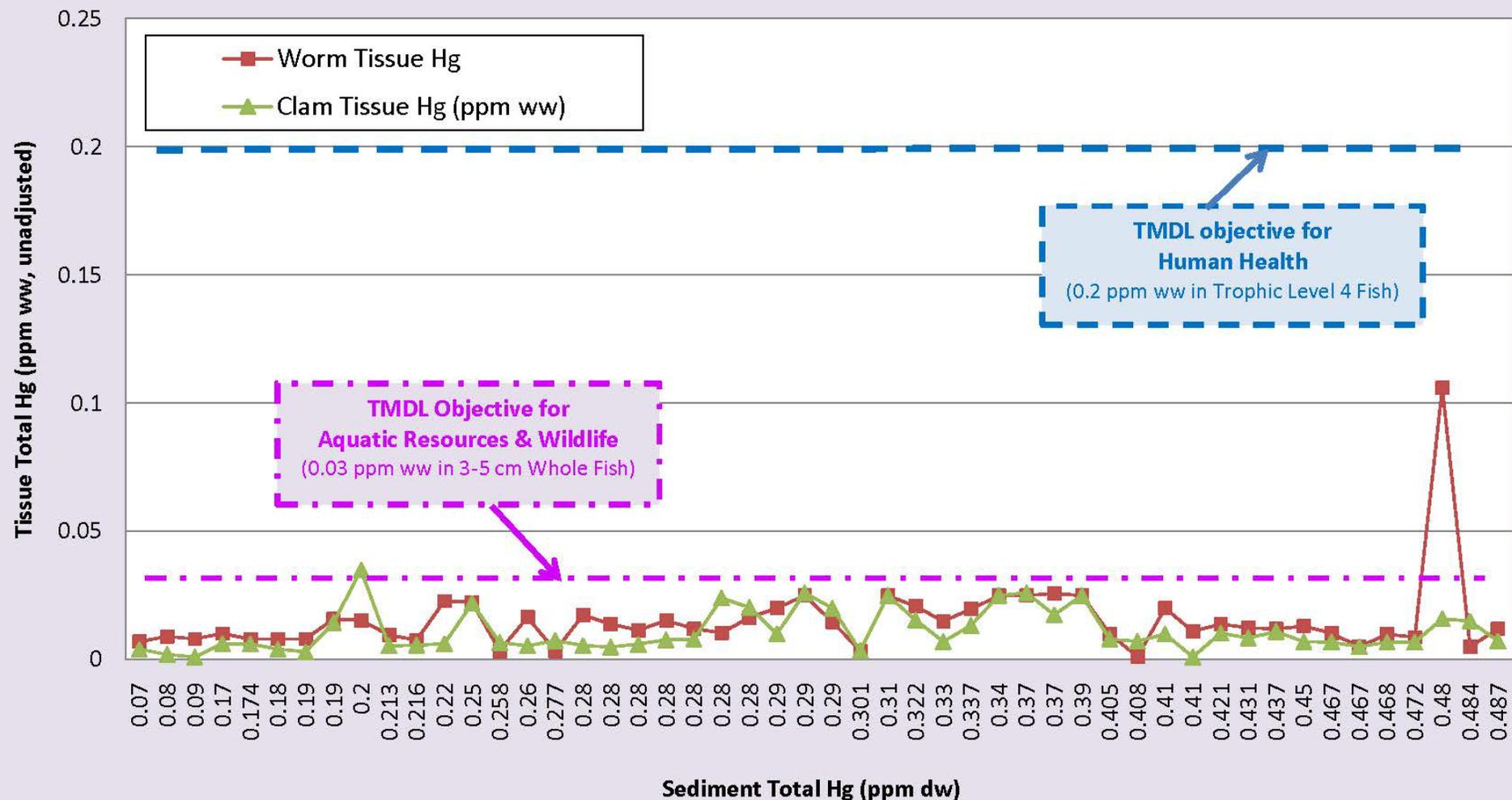
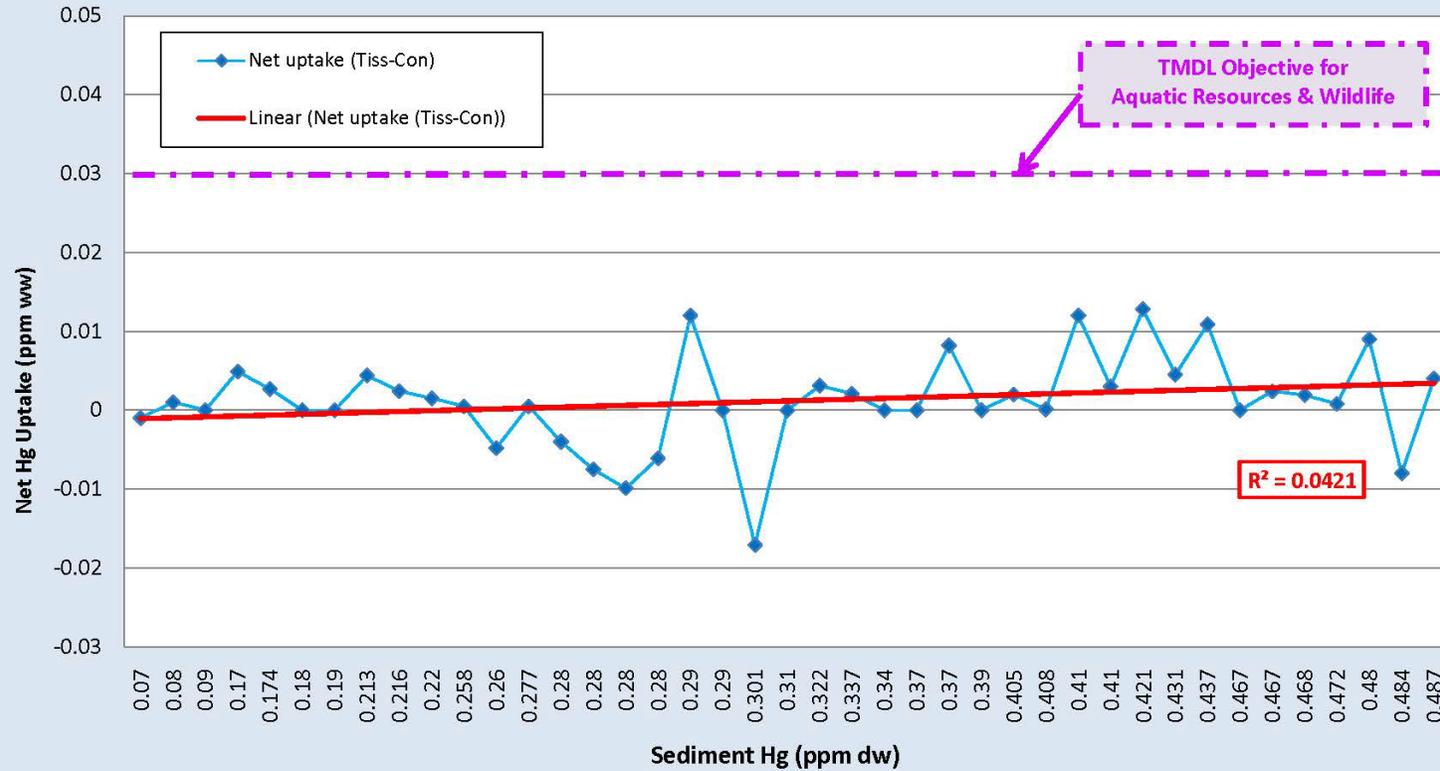
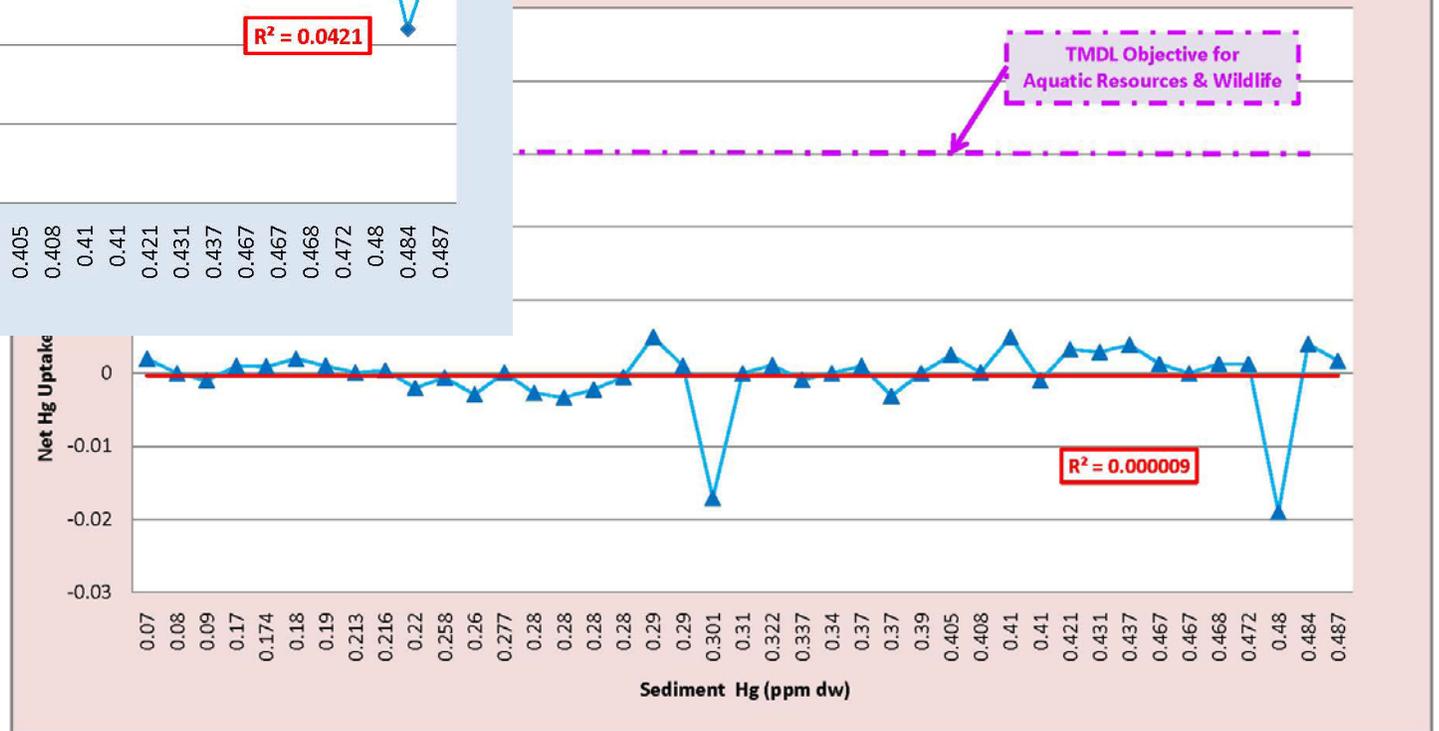


Figure 6. Tissue Concentrations Following Laboratory Exposure
Summary and Evaluation of Bioaccumulation Tests for Total Mercury
 Conducted by San Francisco Bay Dredging Projects, Feb 2, 2012

Net Mercury Uptake by Polychaetes Exposed to SF Bay Sediments <0.5 ppm (n=41)



Net Mercury Uptake by Clams Exposed to SF Bay Sediments >0.5 ppm (n=41)



Figures 7 and 8. Net Mercury Uptake (Control-Adjusted) Following Laboratory Exposure

Summary and Evaluation of Bioaccumulation Tests for Total Mercury Conducted by San Francisco Bay Dredging Projects, Feb 2, 2012

Conclusions

- Little or no mercury bioavailability from the sediment tested
- No relationship between mercury concentrations in sediment and mercury concentrations in tissues of exposed organisms
- Bioaccumulation tests add no value to regulatory decision making process

Outcome

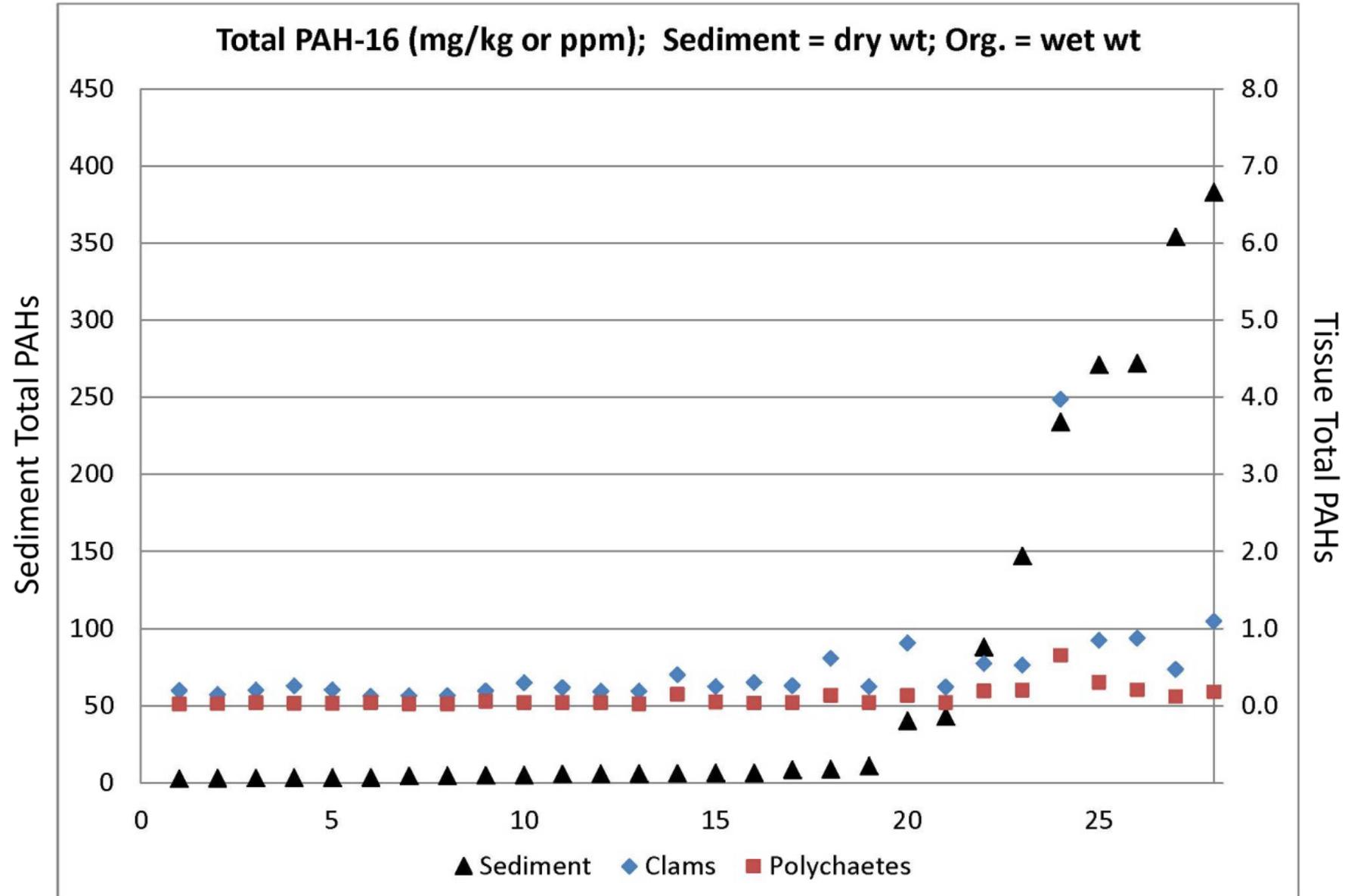
- In March, 2012, the Programmatic EFH agreement was amended to eliminate the bioaccumulation trigger for mercury for in-Bay disposal.
- Eliminated the need for bioaccumulation testing for mercury
- TMDL limit governs maximum mercury concentration for in-Bay disposal

Can the Approach used to Modify the Bioaccumulation Trigger also be used for PAHs?

A recent study suggests it should be considered.

- Data set consists of 28 sediment samples
- Total PAH (16 compounds) concentrations from 2.7 to 370 ppm
- Total PAH bioaccumulation trigger is approximately 4.7 ppm
- 30-day laboratory exposures with two organisms (polychaete and clam)
- Compare tissue PAH concentrations to toxicity reference values (TRVs) to see if the bioaccumulation trigger is a predictor of benthic toxicity
- Look for evidence of bioaccumulation (i.e., increased tissue concentrations with increasing sediment concentrations)

Data from 28 Sediment Samples



TRVs for Individual PAHs Based on Laboratory Studies

Table 6-4. Summary of ERED Tissue PAH ‘Effect’ Concentrations Used to Determine Potential Benthic Impacts.

PAH	Species	Reported “Effects” Concentration (µg/kg ww)	TRV (µg/kg ww)	Type of Effect	Toxicity Endpoint	Lifestage	Reference
Acenaphthene	<i>Mytilus edulis</i>	29,400	1,470*	behavior	ED50	adult	Donkin et al 1989
Benzo(a)pyrene	<i>Mytilus edulis</i>	300	300*	reproduction	LOED	not listed	Ertman et al. 1995
Fluoranthene	<i>Capitella sp.</i>	43,8000	43,8000	growth	NOED	adult	Bach et al. 2005
Fluoranthene	<i>Mytilus edulis</i>	627,000	31,350	behavior	ED50	adult	Donkin et al 1989
Fluoranthene	<i>Mytilus edulis</i>	220	220*	reproduction	LOED	not listed	Ertman et al. 1995
Phenanthrene	<i>Mytilus edulis</i>	30,700	1,535	behavior	ED50	adult	Donkin et al 1989
Phenanthrene	<i>Nereis arenaceodentata</i>	780	780	behavior	LOED	immature	Emery et al. 1996
Phenanthrene	<i>Nereis arenaceodentata</i>	780	780	growth	LOED	immature	Emery et al. 1996
Phenanthrene	<i>Nereis arenaceodentata</i>	780*	780*	reproduction	LOED	immature	Emery et al. 1996
Phenanthrene	<i>Nereis arenaceodentata</i>	780	780	mortality	NOED	immature	Emery et al. 1996
Pyrene	<i>Mytilus edulis</i>	189,000	9,450*	behavior	ED50	adult	Donkin et al 1989

ED = Effect Dose; LD = Lethal Dose; LOED - lowest observed effect dose; NOED = no observed effect dose.

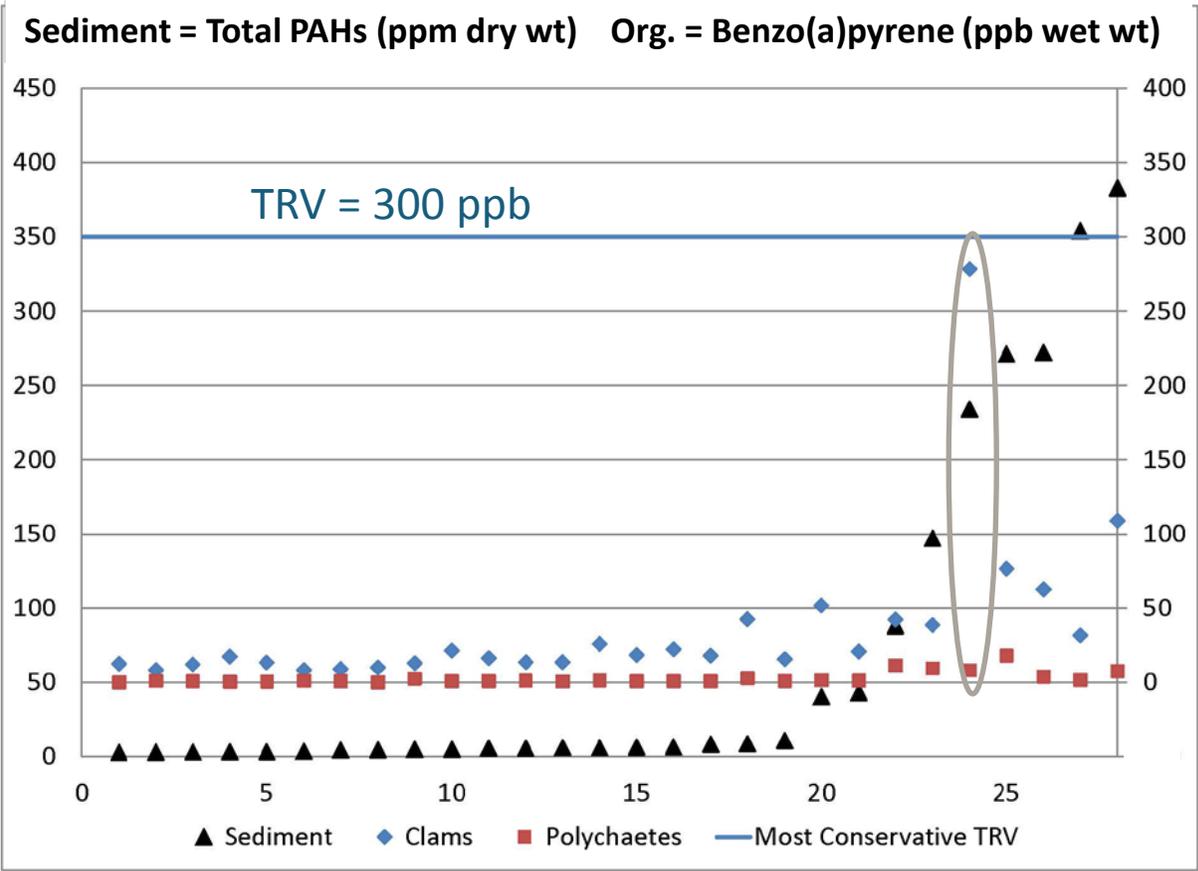
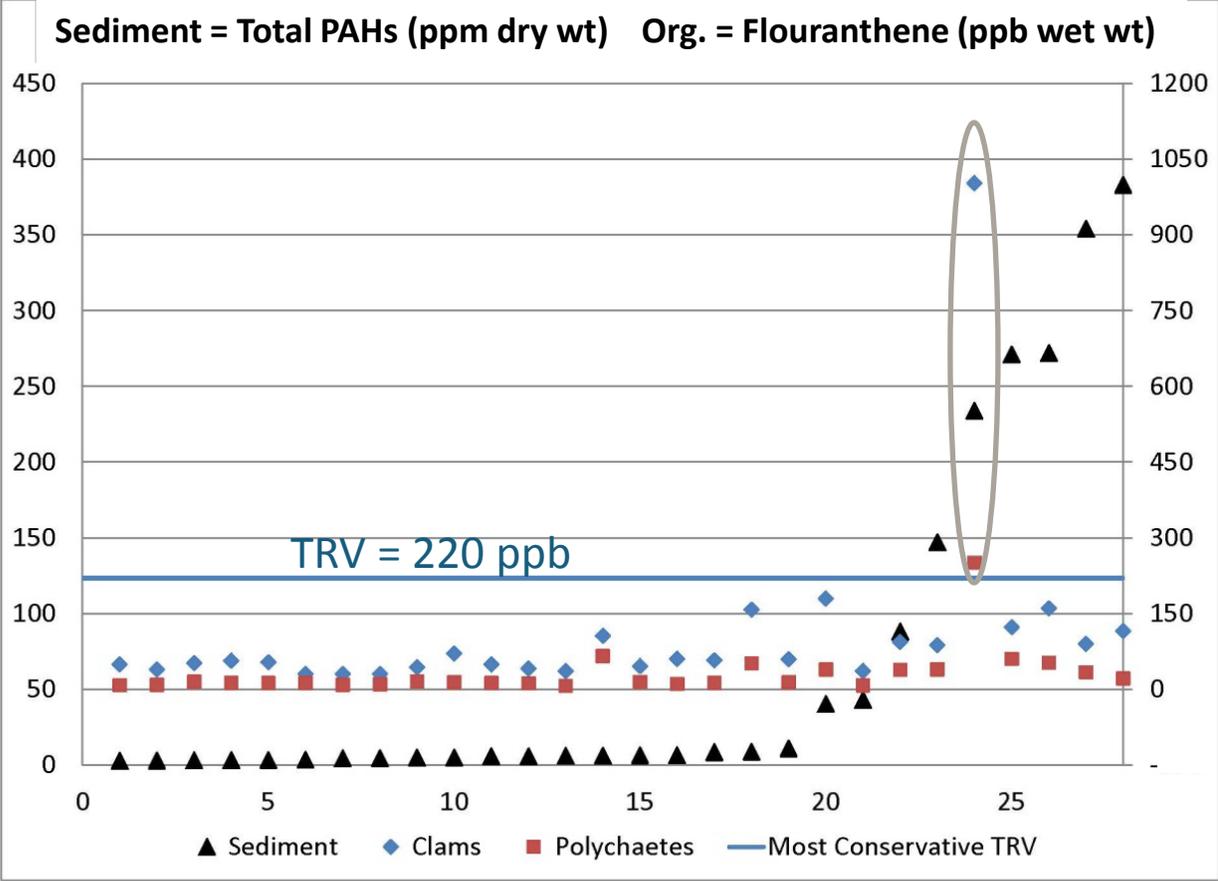
* For each of the PAHs, the most sensitive “Effects” Concentration selected for use in TRV development.

Characterization of the Sediment from Alameda Point Channel: Results of Dredge Materials Sampling and Analysis, July 2015.

Only one TRV was exceeded, for one sediment sample

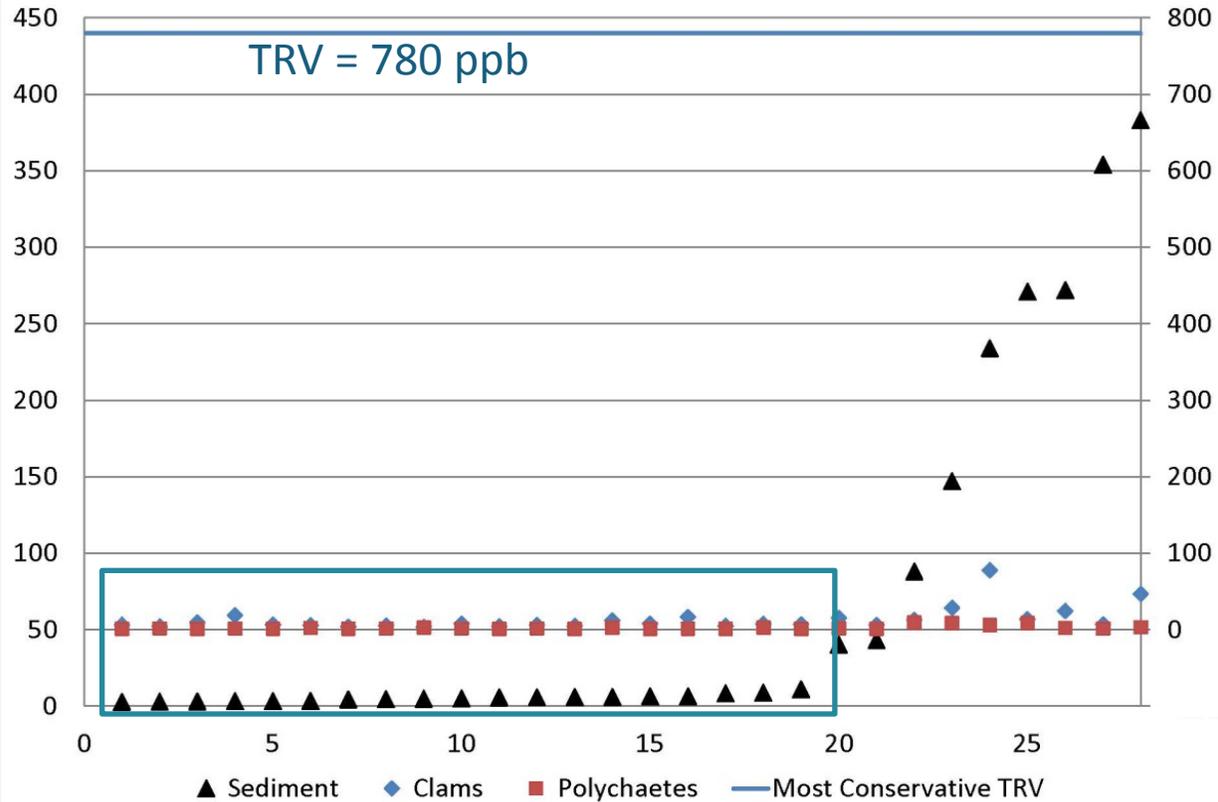
PAH	Lowest TRV	Maximum Obs. Tissue Conc. (ppb wet weight)
Acenaphthene	1,470	13
Benzo(a)pyrene	300	278
Fluoranthene	220	1002
Naphthalene	31,300	7.3
Phenanthrene	780	78
Pyrene	9,450	1482

The only sample with a TRV exceedance (flouranthene) or near-exceedance (benzo(a)pyrene) has 234 ppm total PAHs – 1 ½ orders of magnitude above the Bioaccumulation Trigger (BT)

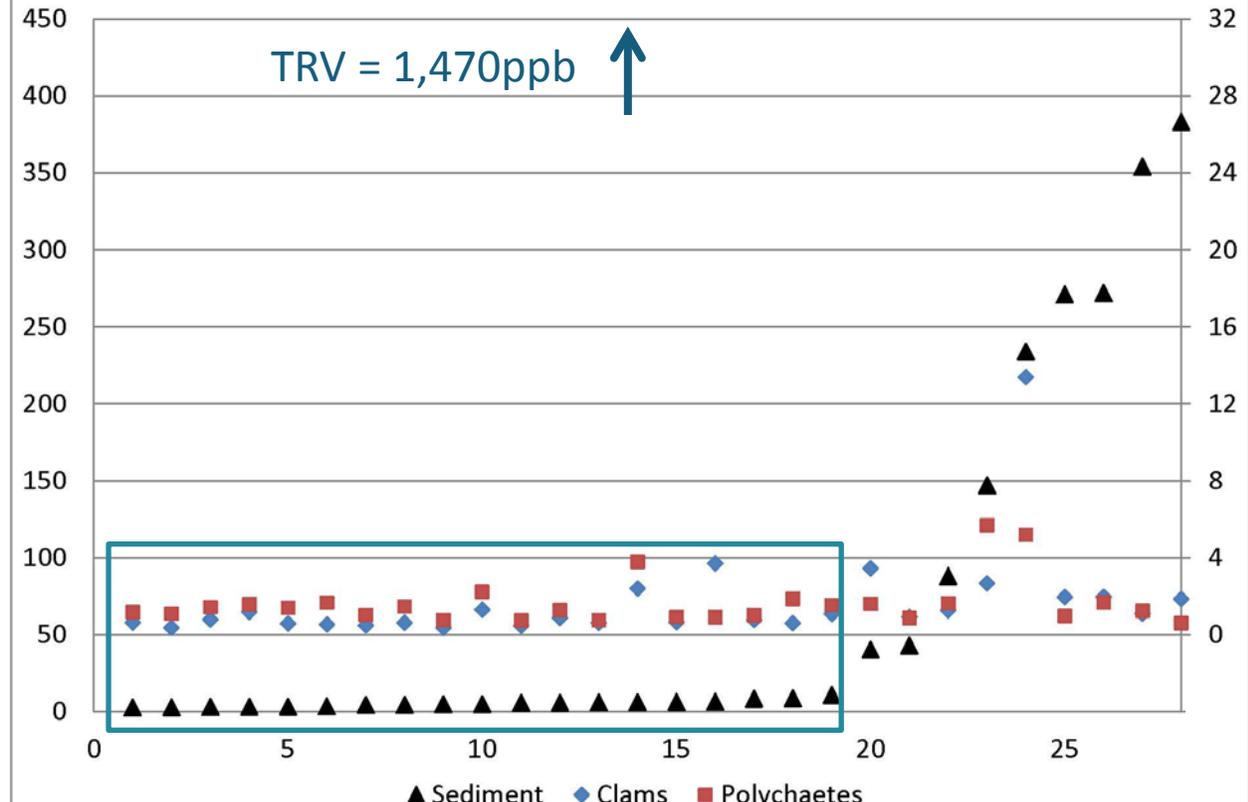


For all other individual PAHs, the tissue concentrations from laboratory exposures are well below the TRVs

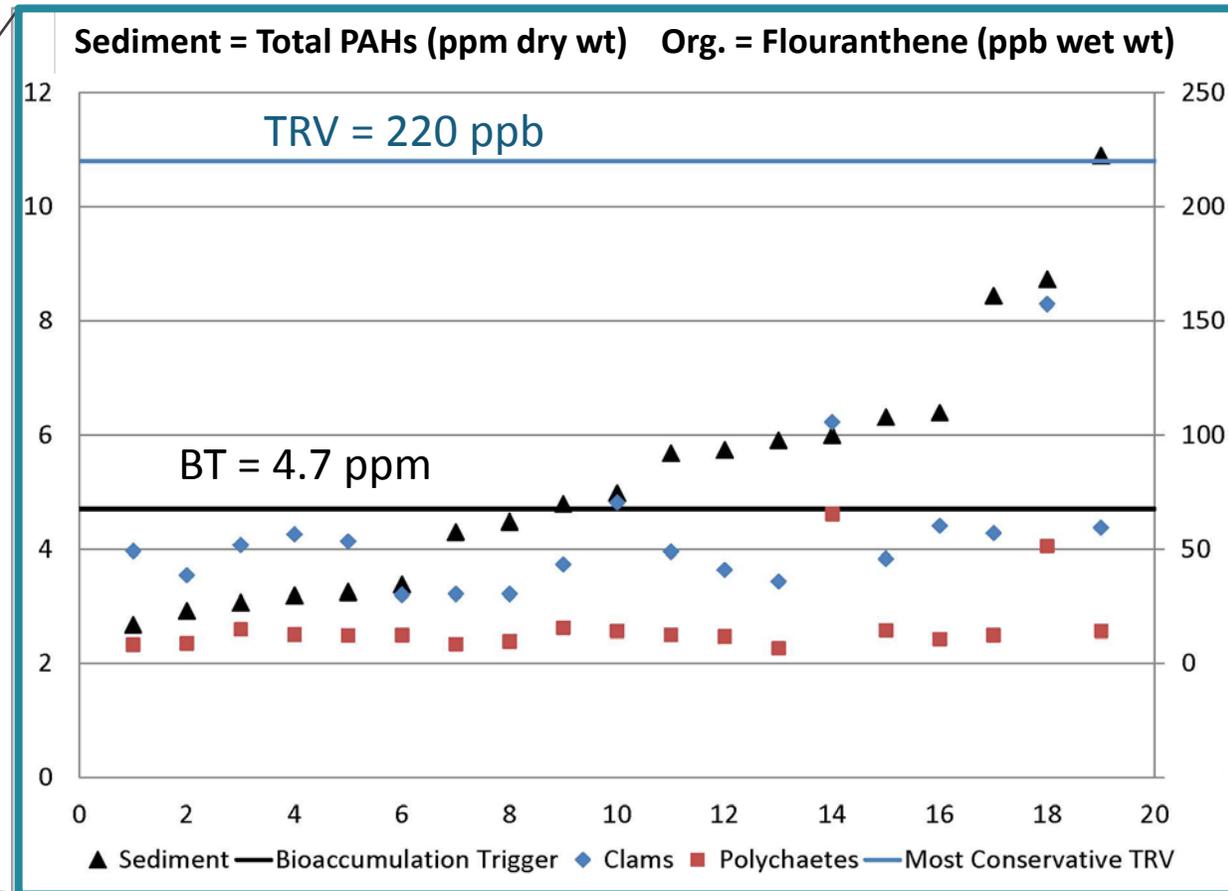
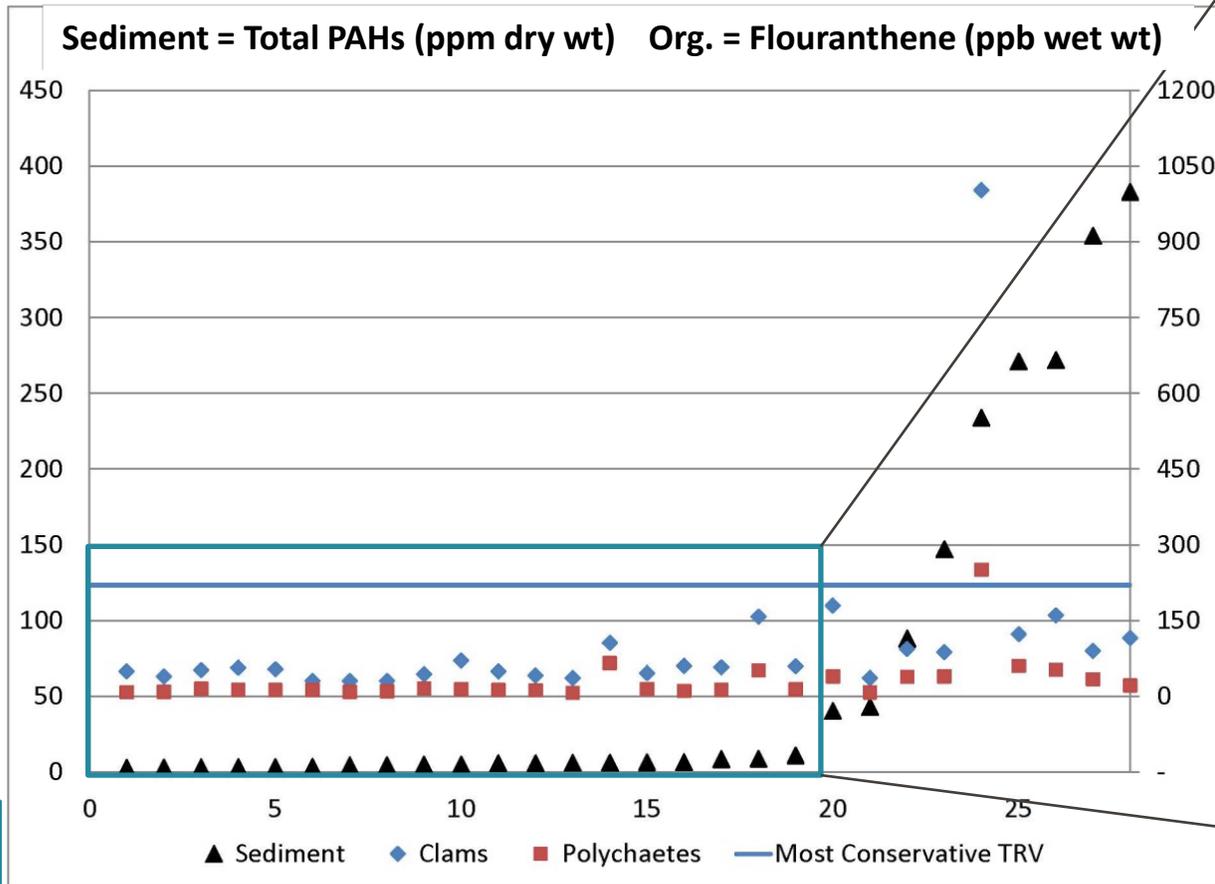
Sediment = Total PAHs (ppm dry wt) Org. = Phenanthrene (ppb wet wt)



Sediment = Total PAHs (ppm dry wt) Org. = Acenaphthene (ppb wet wt)

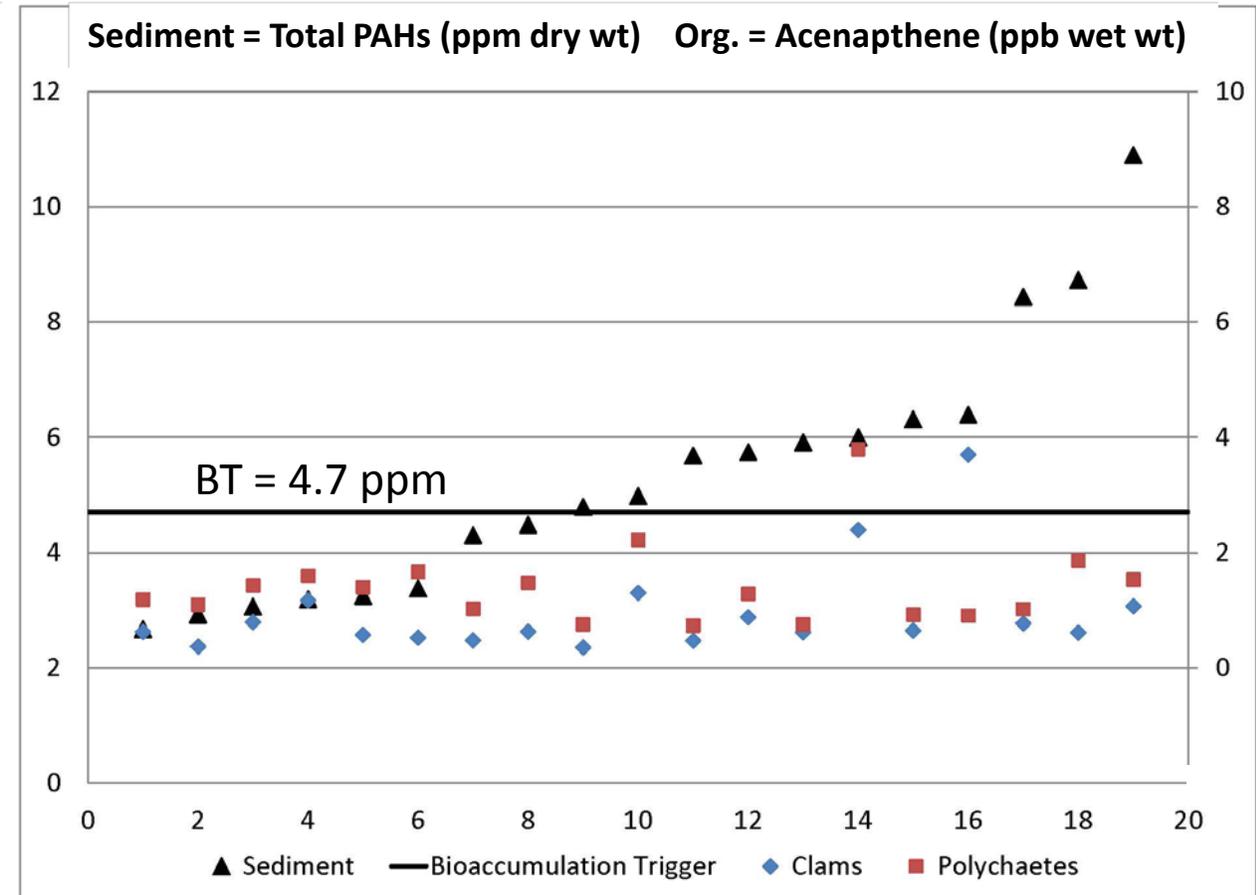
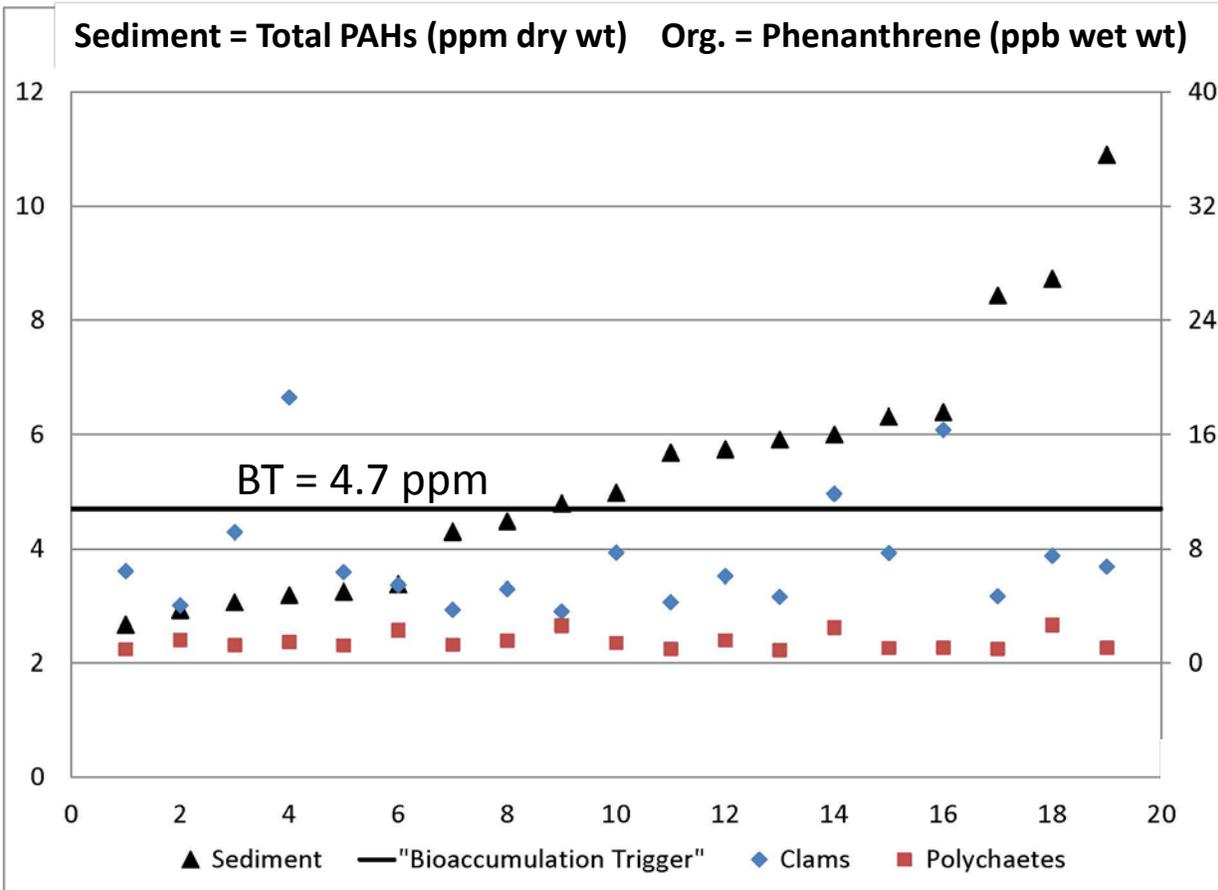


Focus on the 19 sediment samples with < 12 mg/kg total PAHs

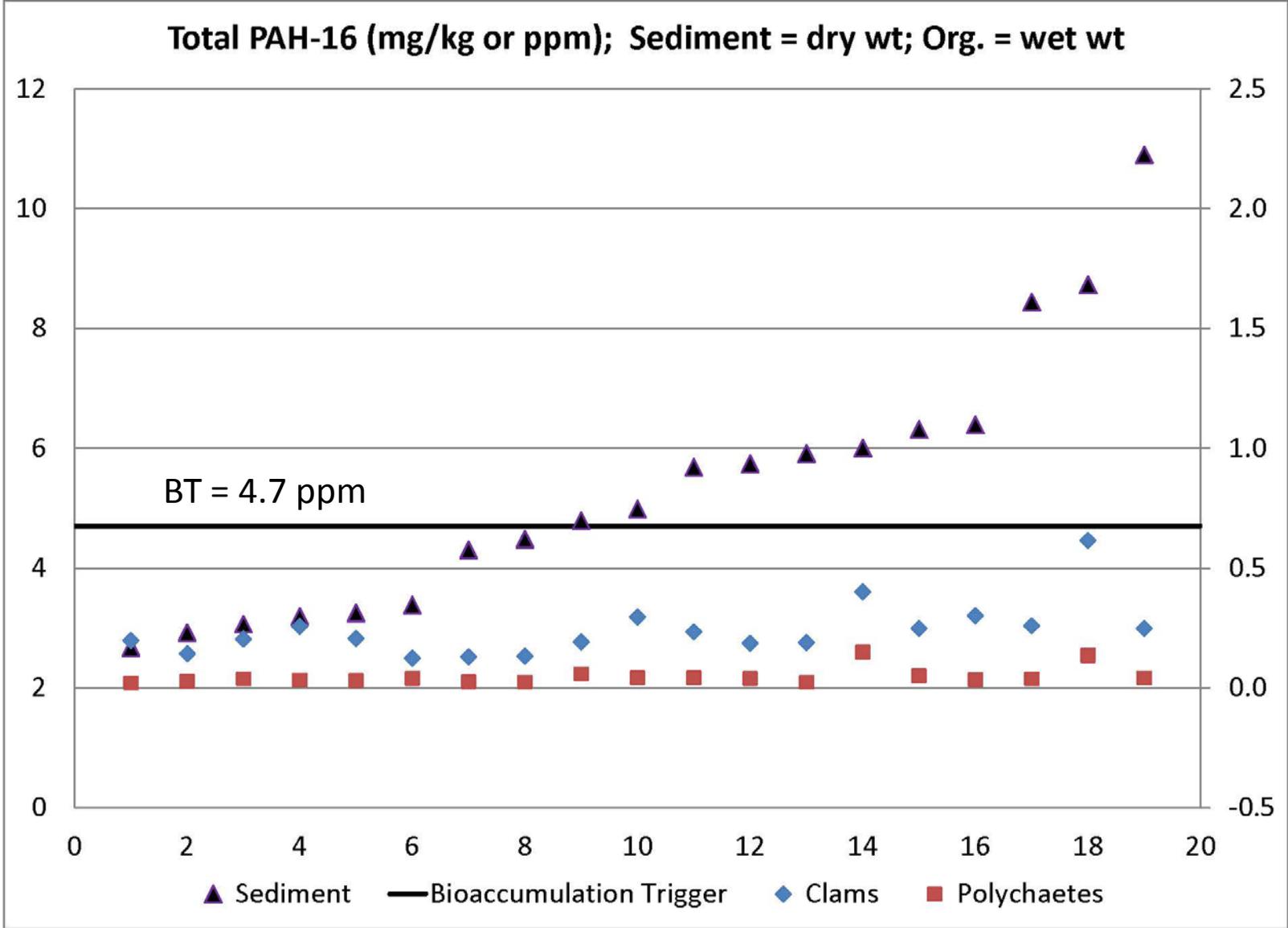


Sediment Samples with < 12 mg/kg total PAHs

- Most PAHs show little apparent dose relationship



Current Bioaccumulation Trigger May be Too Conservative



Conclusions

- Benthic toxicity is not equivalent to bioaccumulation risk; however tissue concentrations measured in laboratory exposures are orders of magnitude lower than toxicity reference values (TRVs)
- Sediments with total PAH concentrations up to twice the bioaccumulation trigger resulted in no incremental PAH bioaccumulation in tissues
- Similar to mercury, a Total PAH bioaccumulation trigger based on ambient sediment concentrations may be too conservative

Potential Next Steps

- Compile PAH bioaccumulation data from San Francisco Bay sediments
- Revision of the mercury criteria should serve as a model for reconsideration of the total PAH bioaccumulation trigger