Contaminant Residues in Demersal Fish, Invertebrates, and Deployed Mussels in Selected Areas of The Puget Sound, WA

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Project ENVVEST, Technical Coordinator
June 14, 2007

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Acknowledgements
ENVVEST Technical Working Group
PSAMP Demersal Fish Monitoring
Sandra O'Neill, James West, et al. WDFW
Tom Ostrom, Suquamish Tribe
Jill Brandenberger, PNNL
Michael and Sandra Salazar, Applied Biomonitoring
Scott Steinert, CSC
Brad Davidson, SSC-SD

Puget Sound Mussel Watch
PSAMP
FV Chasina
Strait of Georgia
Vendovi
Port Gardner
Hood Canal
Elliott Bay
Sinclair Inlet
Commencement Bay
You are Here
Nisqually

Historic and Cultural Fishing Grounds of Suquamish Tribe

Overview

- Data on Tissue Residues
  - PSAMP Monitoring (2003 PCB data)
  - ENVVEST (2003 and 2005)

    As, Cd, Cu, Cr, Hg, Ni, Pb, Zn, PCBs, & (PAHs mussels)

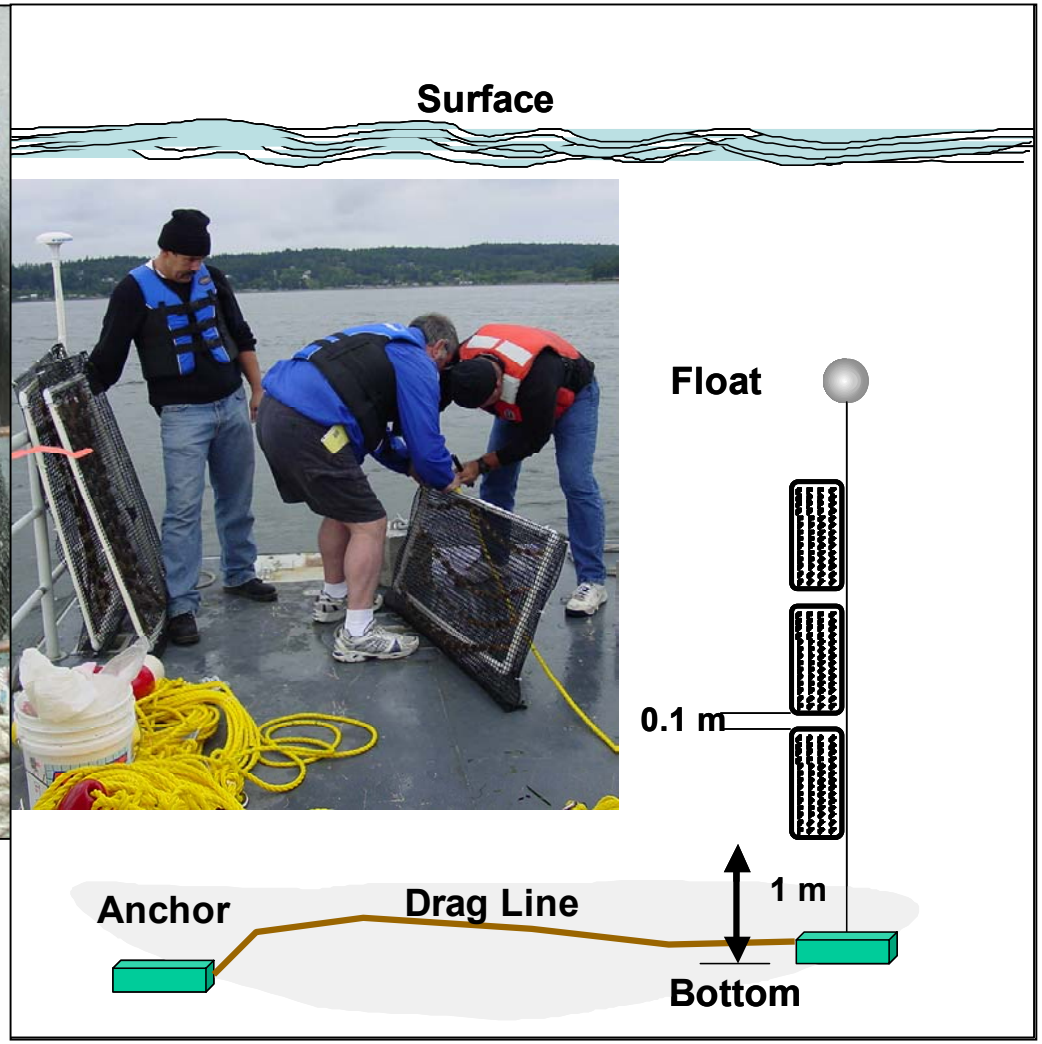
    growth (mussels)
  - Puget Sound Mussel Watch (2000, 2002, 2004)
- Tissue Residue Benchmarks
- Bioaccumulation and Trophic Transfer
- Summary

Biota Sampling

Bottom Fish Sampling

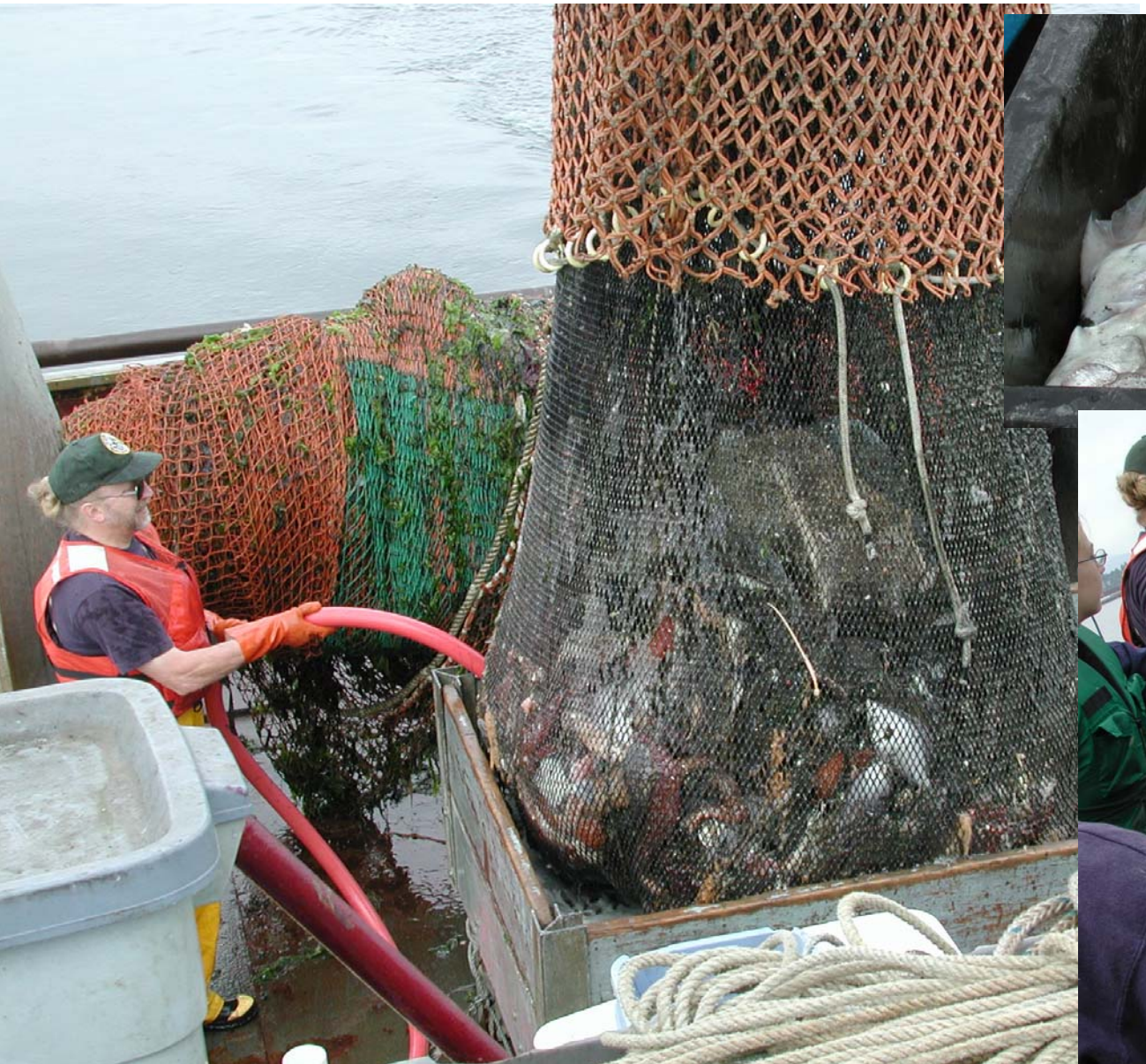
Bottom fish trawl in Sinclair Inlet.

Caged Mussel Study



Mussel cage configuration.

Fish Sampling Sinclair Inlet



Contents of Net Trawl from Sinclair Inlet

Contents of Net Trawl from Sinclair Inlet

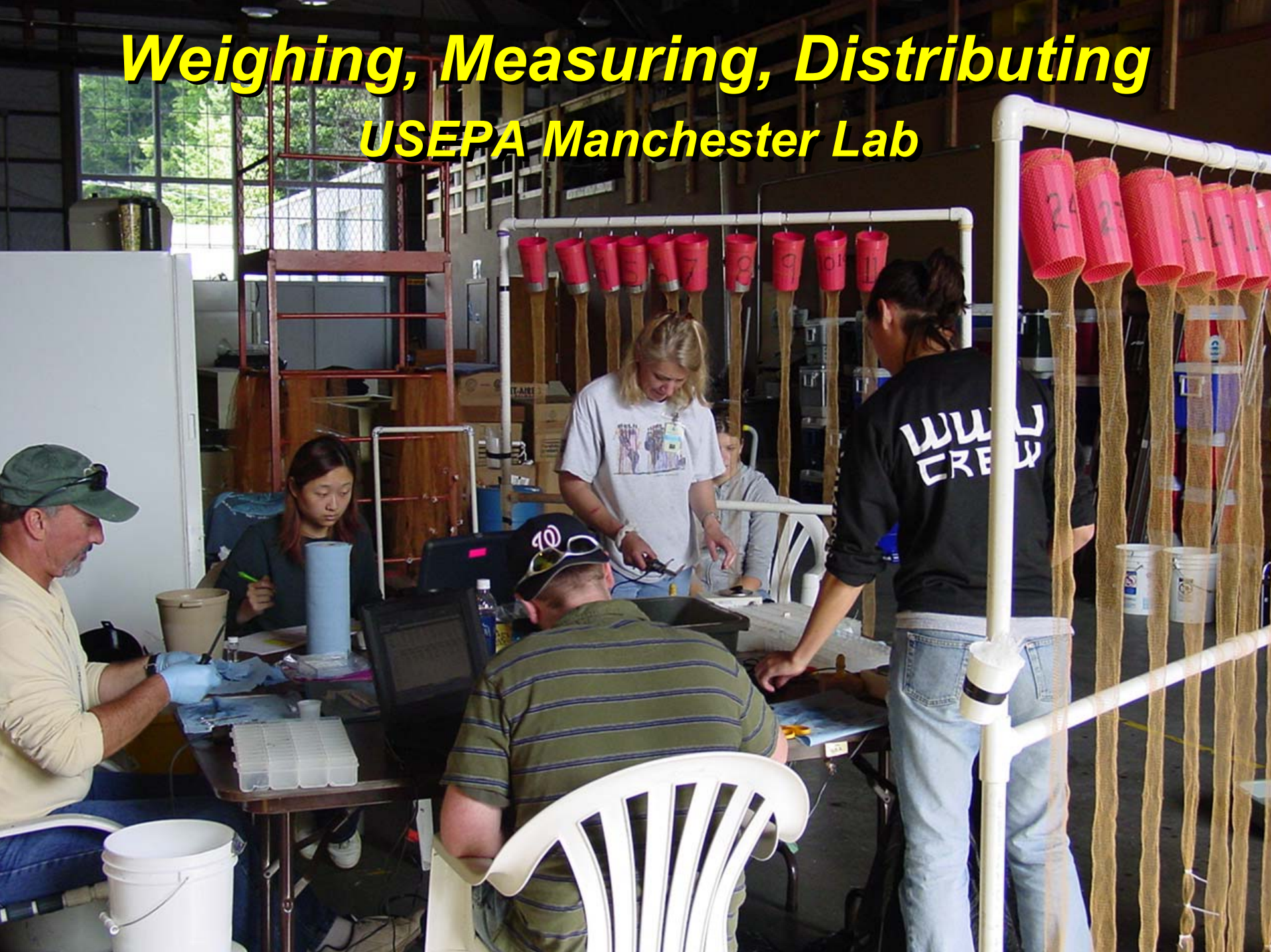
Obtaining Mussels for Caged Mussel Study

Taylor United Mussel Farm

Shelton, WA

Weighing, Measuring, Distributing

USEPA Manchester Lab



Attaching Bags to Cages

Cages & Anchor

Prior to Deployment

Mussel Cage Retrieval

Tissue Residue Benchmarks

- Screening Values Based on Water Quality Criteria
- Critical Body Residues
- Dietary Benchmarks
- Seafood Benchmarks

Tissue Residue Benchmarks (Cont.)

- Screening Values Based on Water Quality Criteria
  - Tissue Screening Value (TSV)
  - Bioaccumulation Critical Value (Bcv)
- Critical Body Residues
- Dietary Benchmarks
- Seafood Benchmarks (WDOH 2006)

US EPA Water Quality Criteria

Current National Recommended Water Quality Criteria | US EPA - Microsoft Internet Explorer

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Address http://www.epa.gov/waterscience/criteria/wqcriteria.html

Priority Pollutants

			Freshwater		Saltwater		Human Health for the consumption of		
	Priority Pollutant	CAS Number	CMC (acute) (µg/L)	CCC (chronic) (µg/L)	CMC (acute) (µg/L)	CCC (chronic) (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)	FR Cite/ Source
1	Antimony	7440360					5.6 B	640 B	65FR66443
2	Arsenic	7440382	340 A,D,K	150 A,D,K	69 A,D,bb	36 A,D,bb	0.018 C,M,S	0.14 C,M,S	65FR31682 57FR60848
3	Beryllium	7440417					Z		65FR31682
4	Cadmium	7440439	2.0 D,E,K,bb	0.25 D,E,K,bb	40 D,bb	8.8 D,bb	Z		EPA-822-R-01-001 65FR31682
5a	Chromium (III)	16065831	570 D,E,K	74 D,E,K			Z Total		EPA820/B-96-001 65FR31682
5b	Chromium (VI)	18540299	16 D,K	11 D,K	1,100 D,bb	50 D,bb	Z Total		65FR31682
6	Copper	7440508	13 D,E,K,cc	9.0 D,E,K,cc	4.8 D,cc,ff	3.1 D,cc,ff	1,300 U		65FR31682
7	Lead	7439921	65 D,E,bb,gg	2.5 D,E,bb,gg	210 D,bb	8.1 D,bb			65FR31682
8a	Mercury	7439976							62FR42160
8b	Methylmercury	22967926	1.4 D,K,hh	0.77 D,K,hh	1.8 D,ee,hh	0.94 D,ee,hh		0.3 mg/kg J	EPA823-R-01-001
9	Nickel	7440020	470 D,E,K	52 D,E,K	74 D,bb	8.2 D,bb	610 B	4,600 B	65FR31682

Tissue Residue Benchmarks (Cont.)

- Screening Values Based on Water Quality Criteria
- Critical Body Residues
  - No Observed Effects Dose (NOED) (ERED Database)
  - Lowest Observed Effects Dose (LOED) (ERED Database)
- Dietary Benchmarks
- Seafood Benchmarks

US Army Corps of Engineers
Environmental Residue Effects Database

Environmental Residue Effects Database Home Page - Microsoft Internet Explorer

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Back Search Favorites

Address http://el.erdc.usace.army.mil/ered/ Go

Google ERED Go RS Bookmarks 49 blocked Check AutoLink AutoFill Send to ERED Settings

The Environmental Residue-Effects Database (ERED)

U.S. Army Corps of Engineers | Engineer Research and Development Center | Environmental Laboratory | Search EL

The U.S. Army Corps of Engineers/U.S. Environmental Protection Agency Environmental Residue-Effects Database (ERED) is a compilation of data, taken from the literature, where biological effects (e.g., reduced survival, growth, etc.) and tissue contaminant concentrations were simultaneously measured in the same organism. Currently, the database is limited to those instances where biological effects observed in an organism are linked to a specific contaminant within its tissues.

Technical Points of Contact: Dr. Todd Bridges E-mail Charlie Lutz E-mail

- Quality Assurance/Quality Control Issues
- User Directions
- Data Coverage
- Dredging Applications
- The Nature of Toxicological Effects
- Interpreting Bioaccumulation
- Acknowledgments

Internet

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Tissue Residue Benchmarks (Cont.)

- Screening Values Based on Water Quality Criteria
- Critical Body Residues
- Dietary Benchmarks
  - Exposure to a Predator based on No Observed Adverse Effects Level (NOAEL), 100% of diet, dose scaled to body weight and consumption rate
    - Omnivore – Black Duck
    - Piscivore – Osprey
    - Marine Mammal – Harbor Seal Pup
- Seafood Benchmarks (WDOH 2006)

Tissue Residue Benchmarks (Cont.)

- Screening Values Based on Water Quality Criteria
- Critical Body Residues
- Dietary Benchmarks
- Seafood Benchmarks (WDOH 2006)
  - NonCancer (Recreational and Tribal Fishers)
  - Cancer (Recreational and Tribal Fishers)

Washington State Department of Health

Human Health Evaluation of Contaminants in Puget Sound Fish

October 2006

Prepared by
The Washington State Department of Health
Division of Environmental Health
Office of Environmental Health Assessments
Olympia, Washington

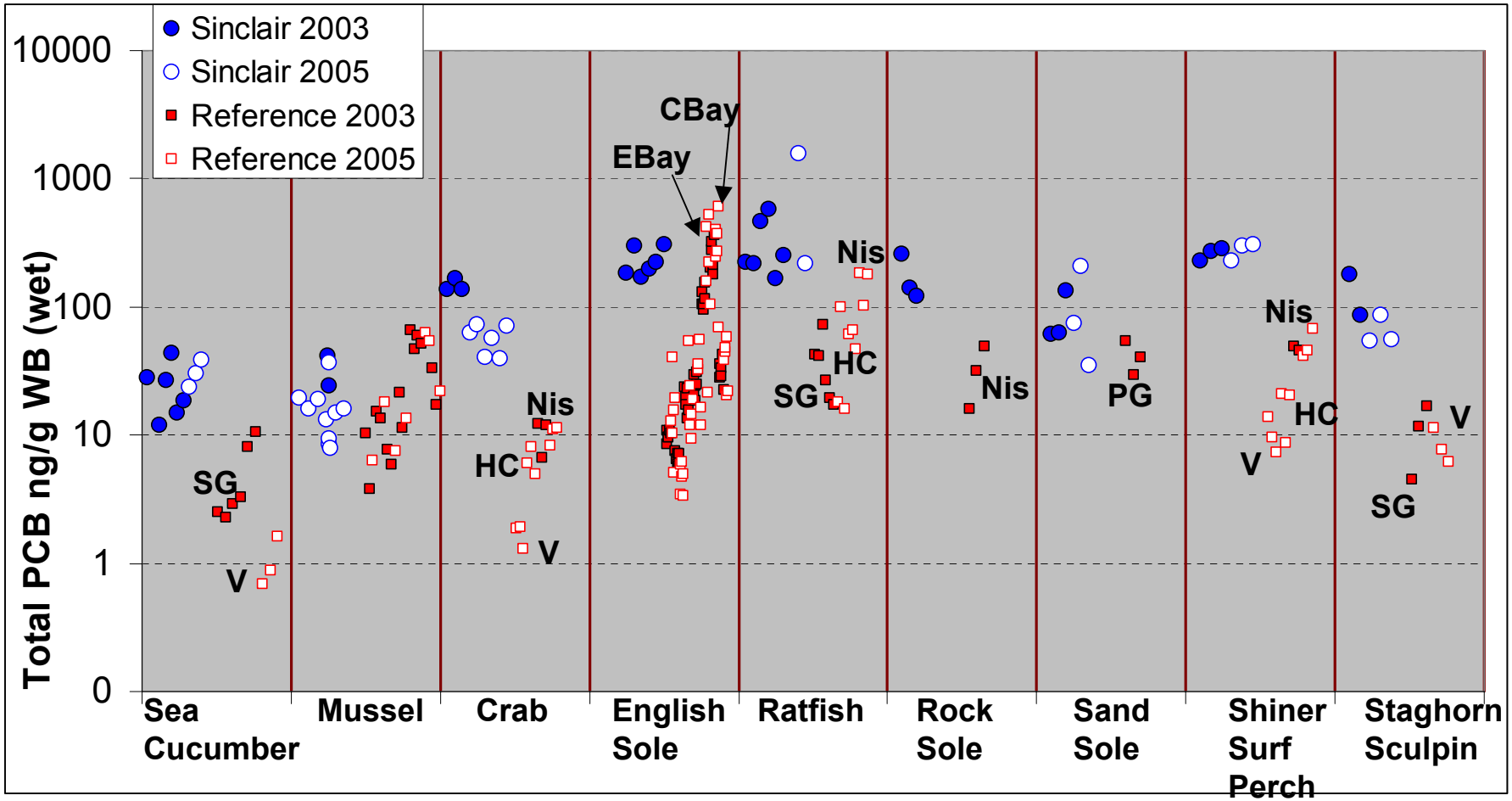
Washington State Department of Health
Division of Environmental Health

http://www5.doh.wa.gov/ehp/oehas/fish/psampreport-10-06.pdf

Comparison of Contaminant Levels in Biota

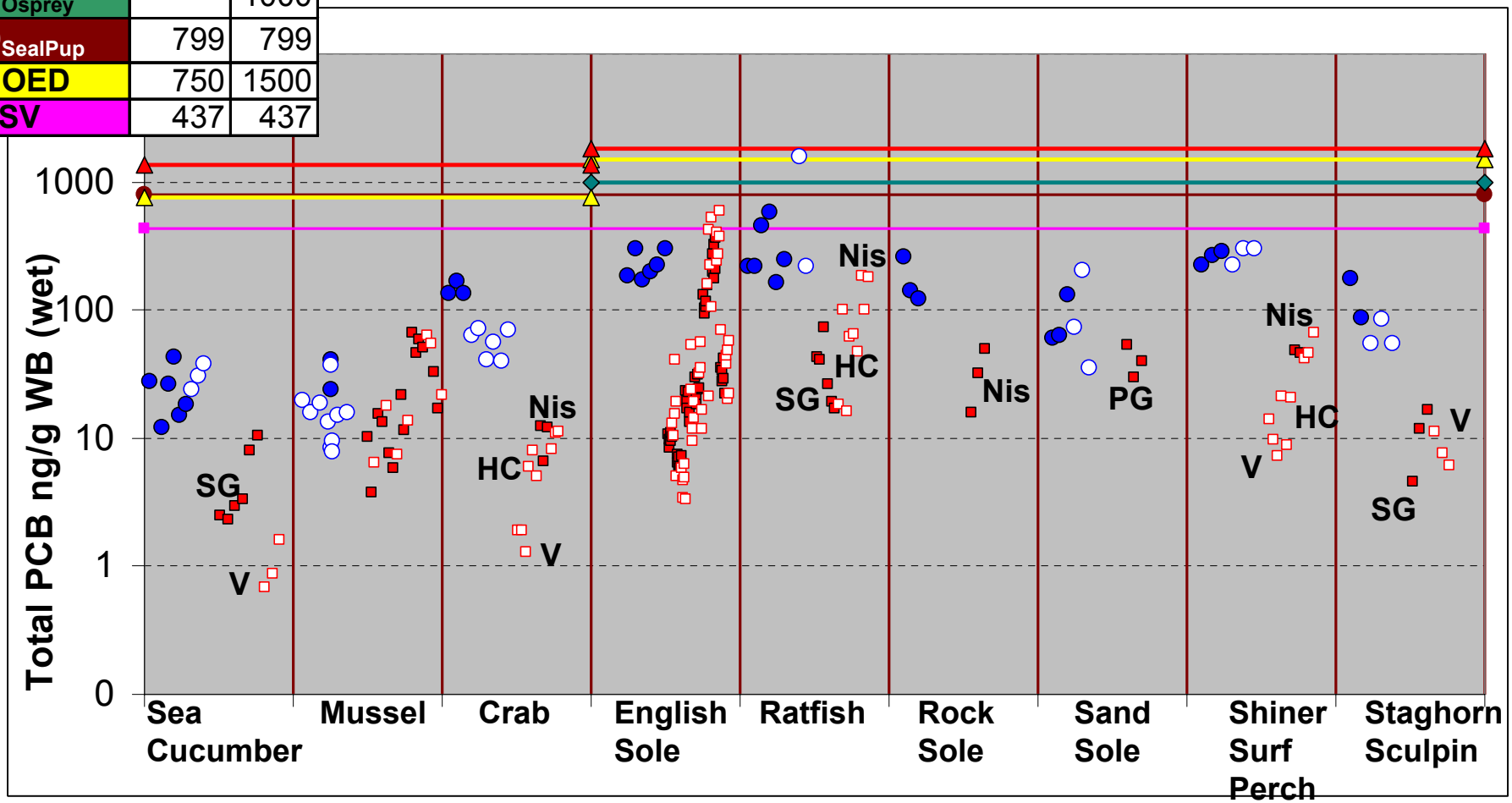
- Species
- Regions of the Sound

PCB Tissue Residues

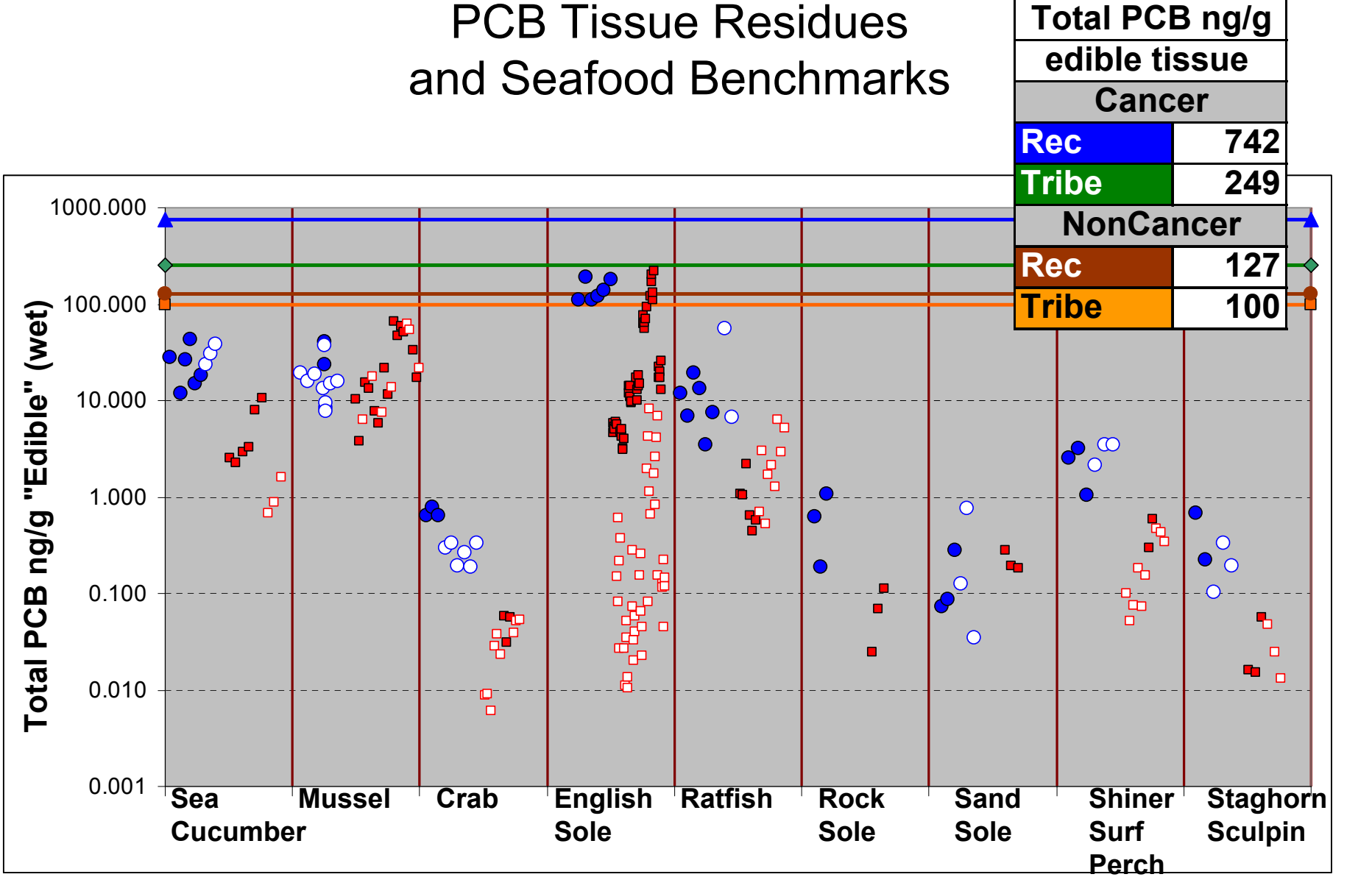


PCB Tissue Residues and Ecological Benchmarks

Total PCB ng/g whole body wet weight	Invert.	Fish
LOED	1375	1800
D_{Osprey}		1000
$D_{SealPup}$	799	799
NOED	750	1500
TSV	437	437



PCB Tissue Residues and Seafood Benchmarks



(Whole Body)

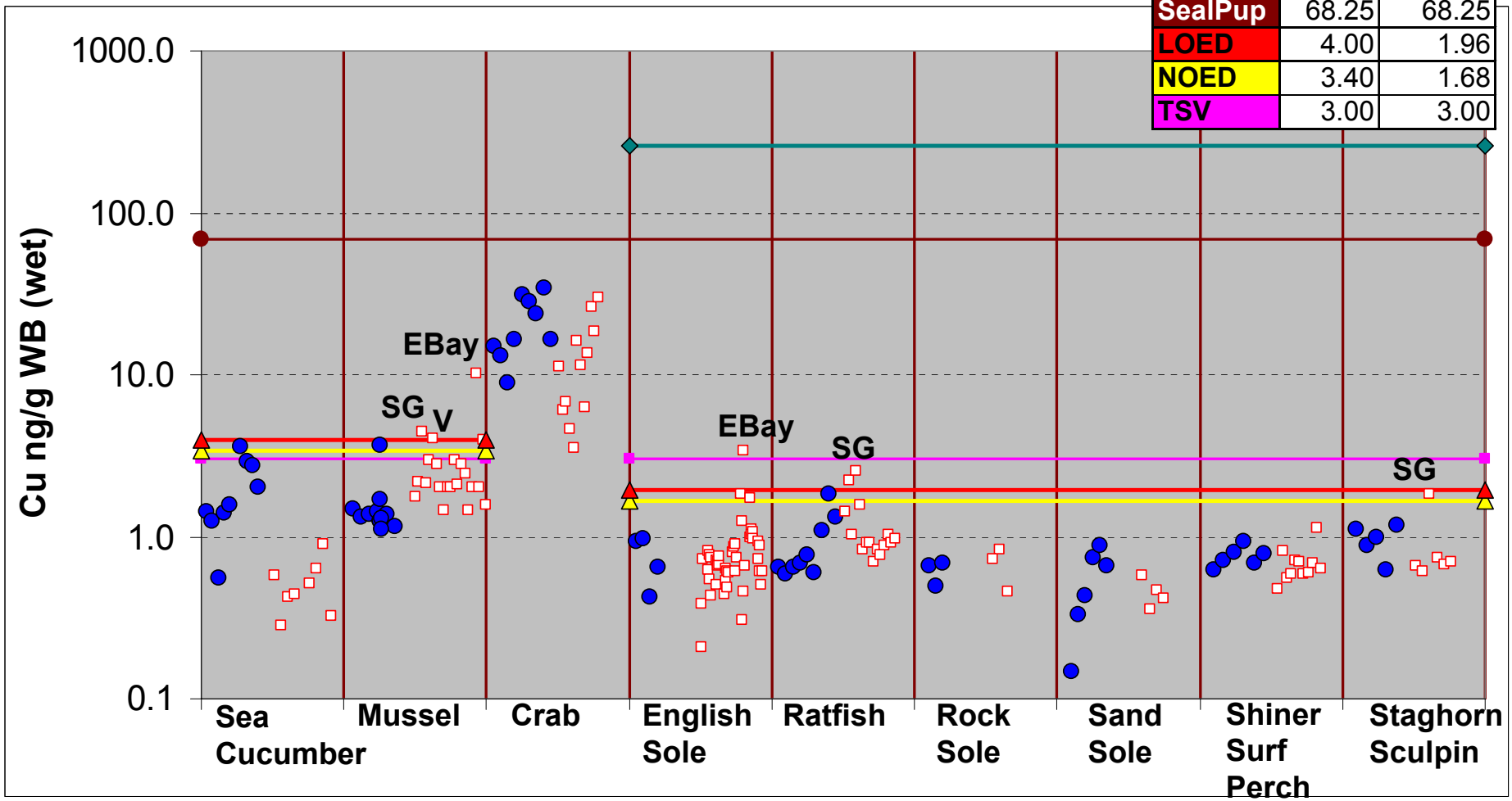
Similar to Maine Lobster

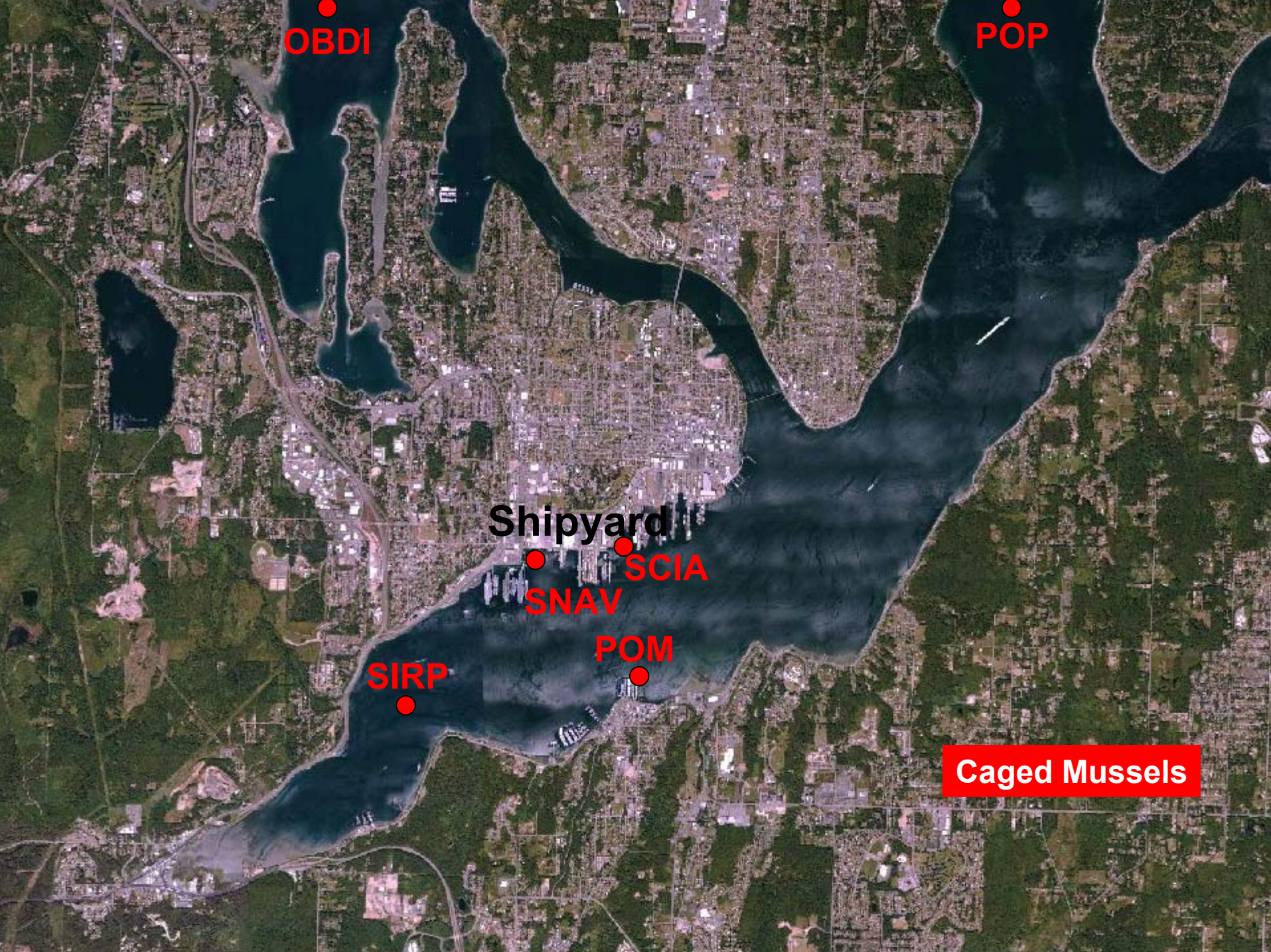
3.44 = ratio of whole body lipid to muscle lipid (skin off fillet)
(Ave of ENVVEST WB)/((Ave of PSAMP Muscle)
in English Sole

Ingestion rates for English Sole (Urban, Near Urban, Non Urban)
Fishers were Suquamish Tribe and Recreational Sportsfisher Adult

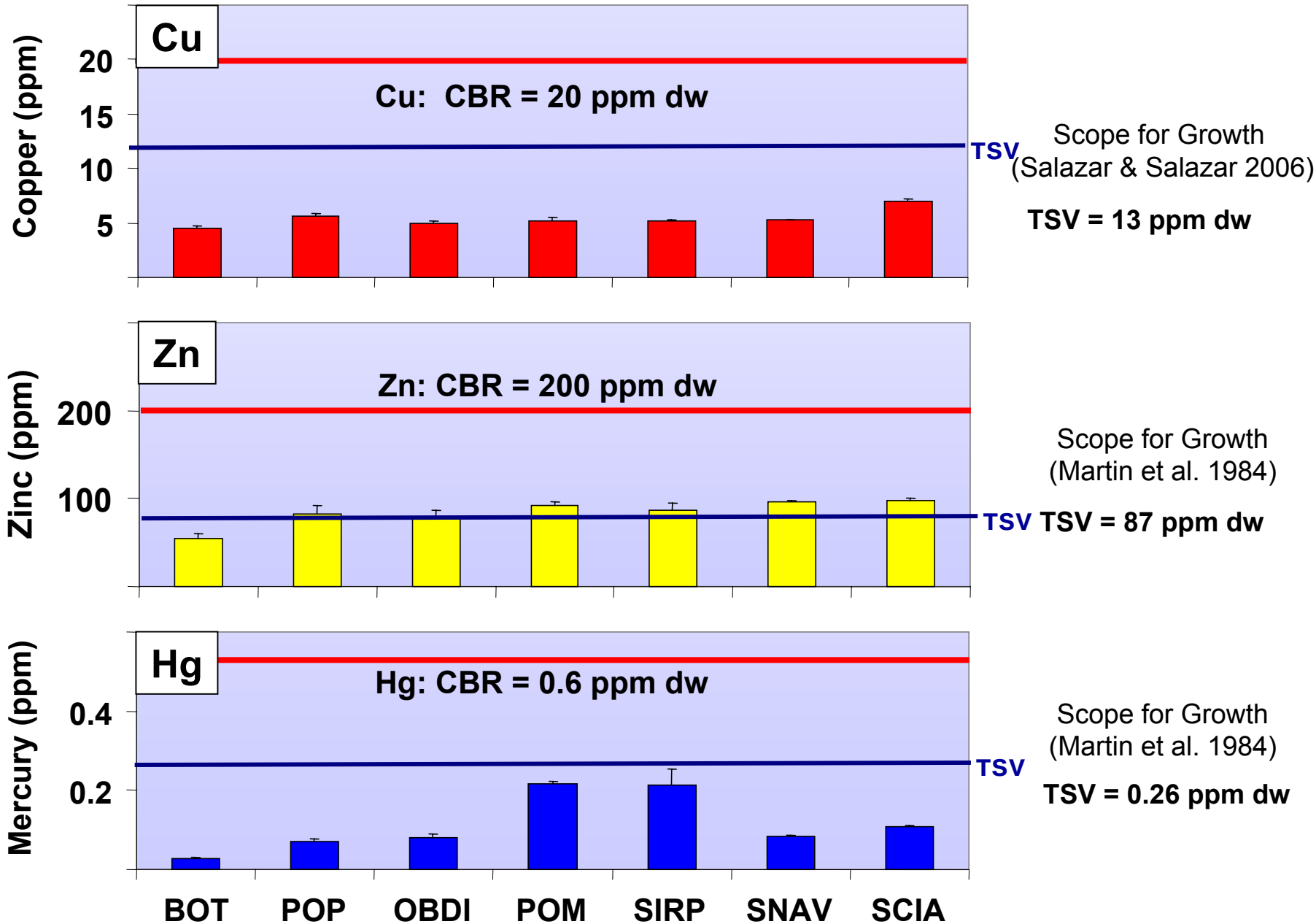
Cu Tissue Residues and Ecological Benchmarks

Cu ug/g		
whole body wet		
	Invert.	Fish
BDuck	522.22	522.22
Osprey		261.11
SealPup	68.25	68.25
LOED	4.00	1.96
NOED	3.40	1.68
TSV	3.00	3.00

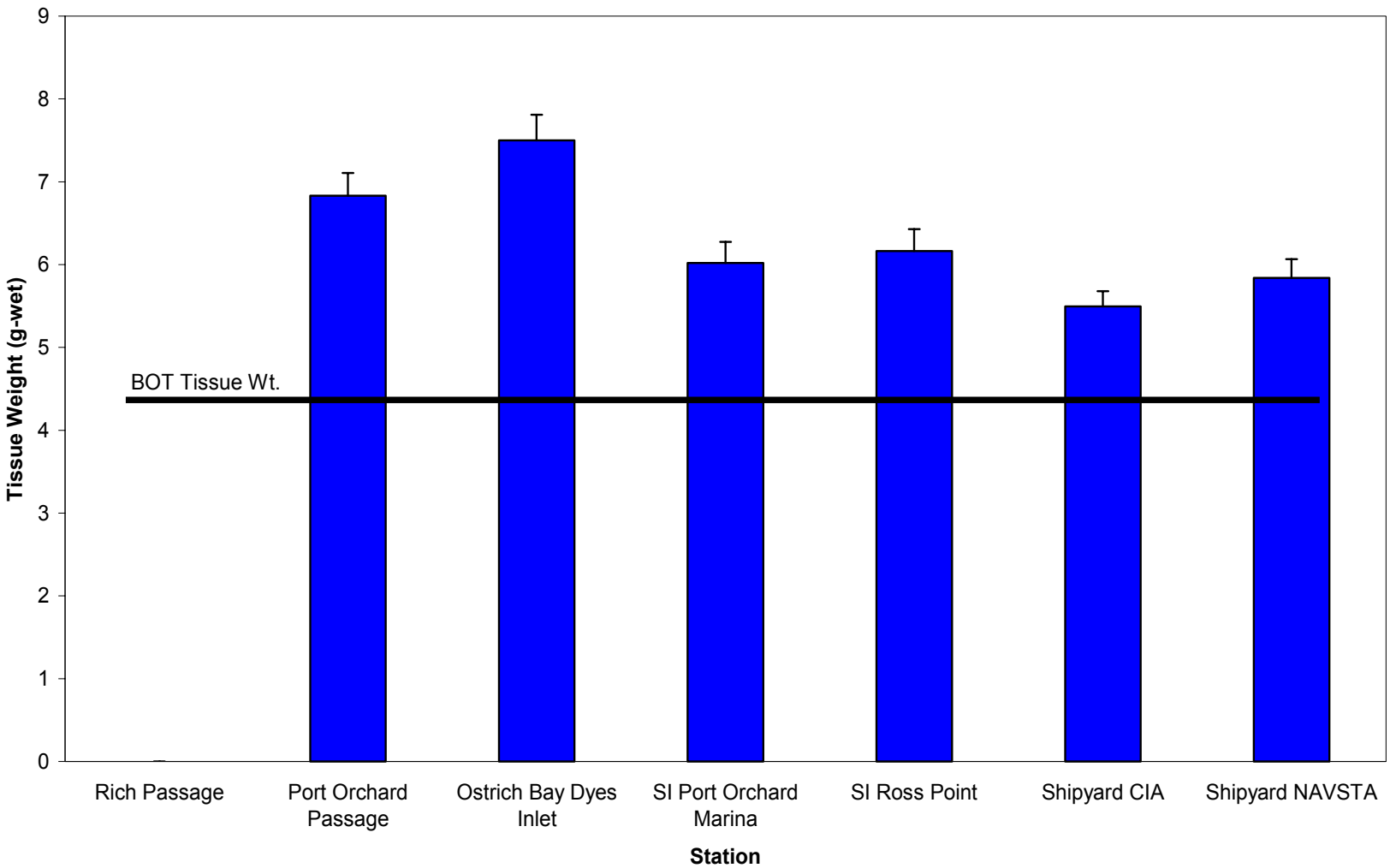



OBDI
POP
Shipyard
SCIA
SNAV
POM
SIRP
Caged Mussels

Critical Body Residues (CBRs) for Mussels



Mussel Growth at End of Test



Food Web Magnification Factor

$FWMF = e^b$

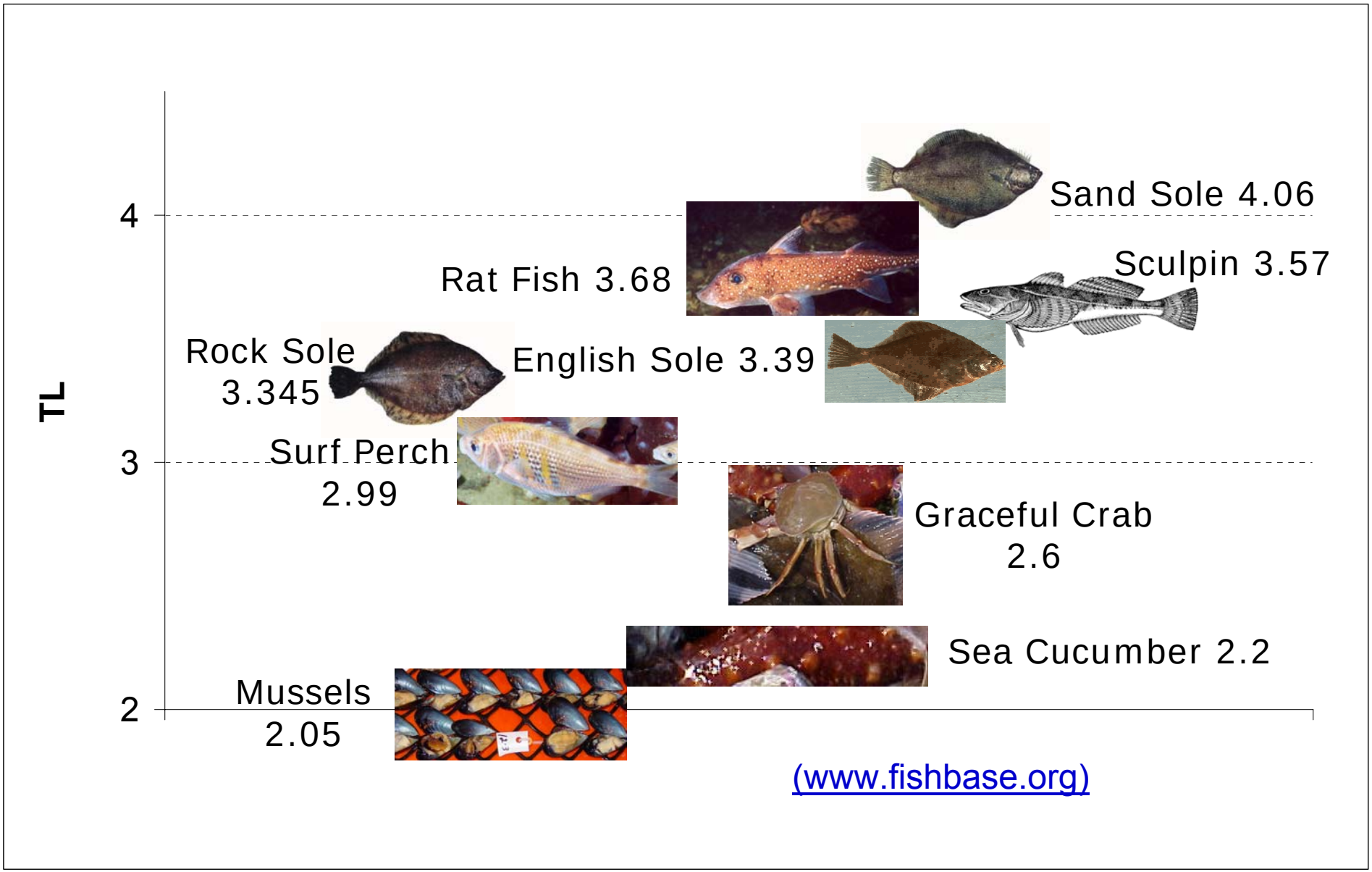
$Ln(Concentration) = a + b(TrophicLevel)$

$FWMF > 1$ Biomagnification

$FWMF < 1$ Trophic Dilution

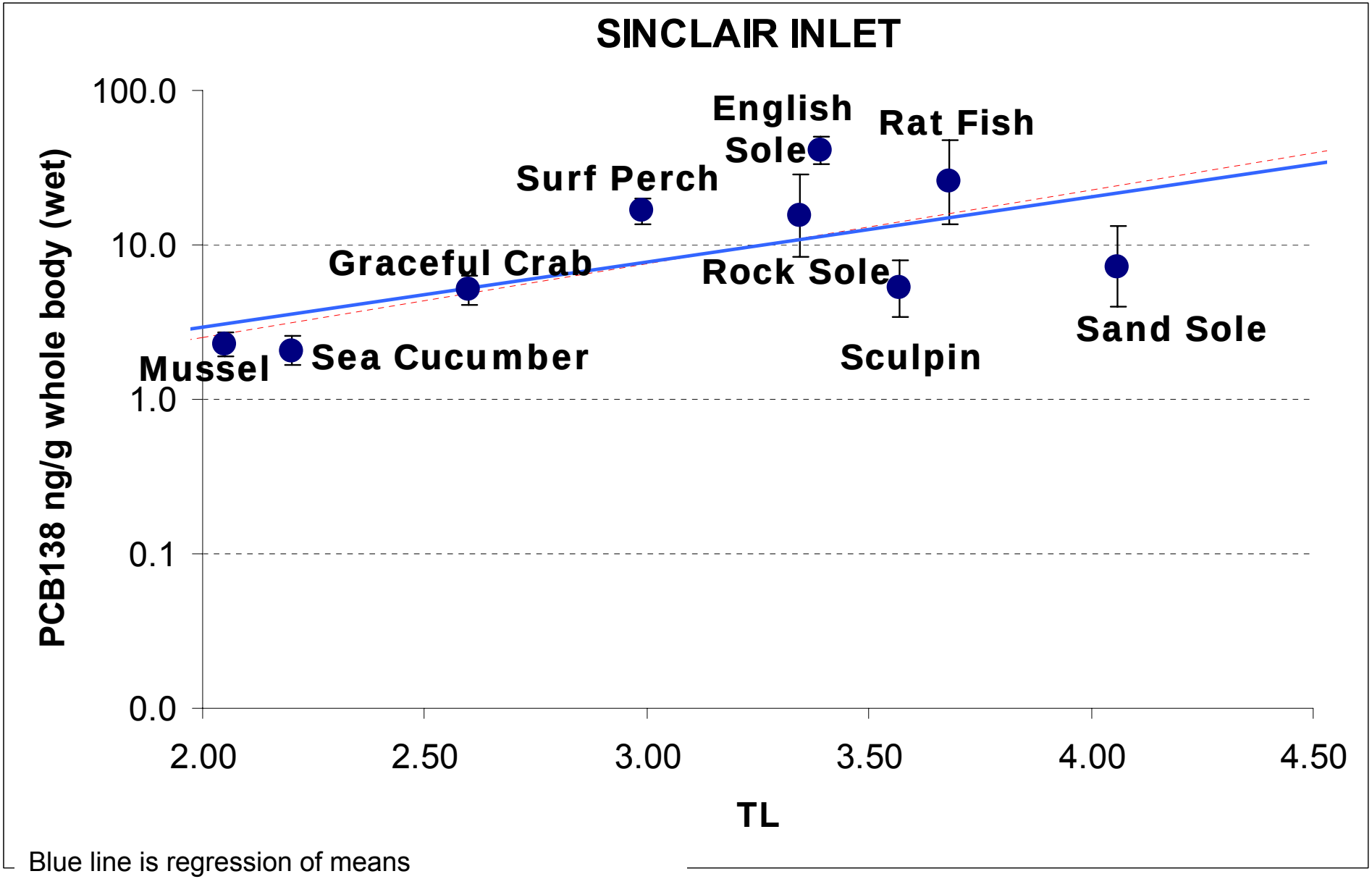
(Fisk et al. 2001, Mackintosh et al. 2004)

Trophic Level Assignment



FWMF = 3.0

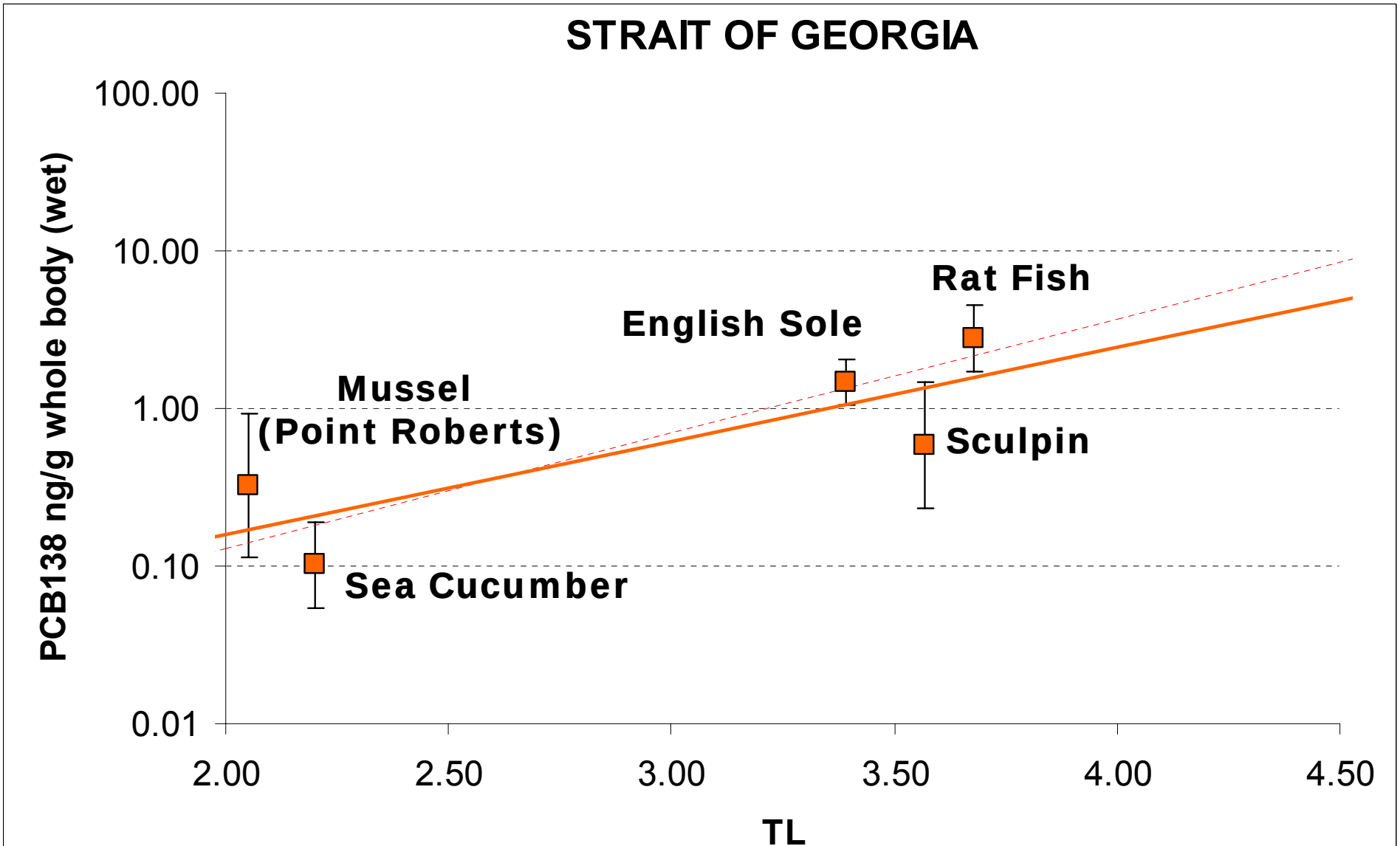
PCB138 Accumulation



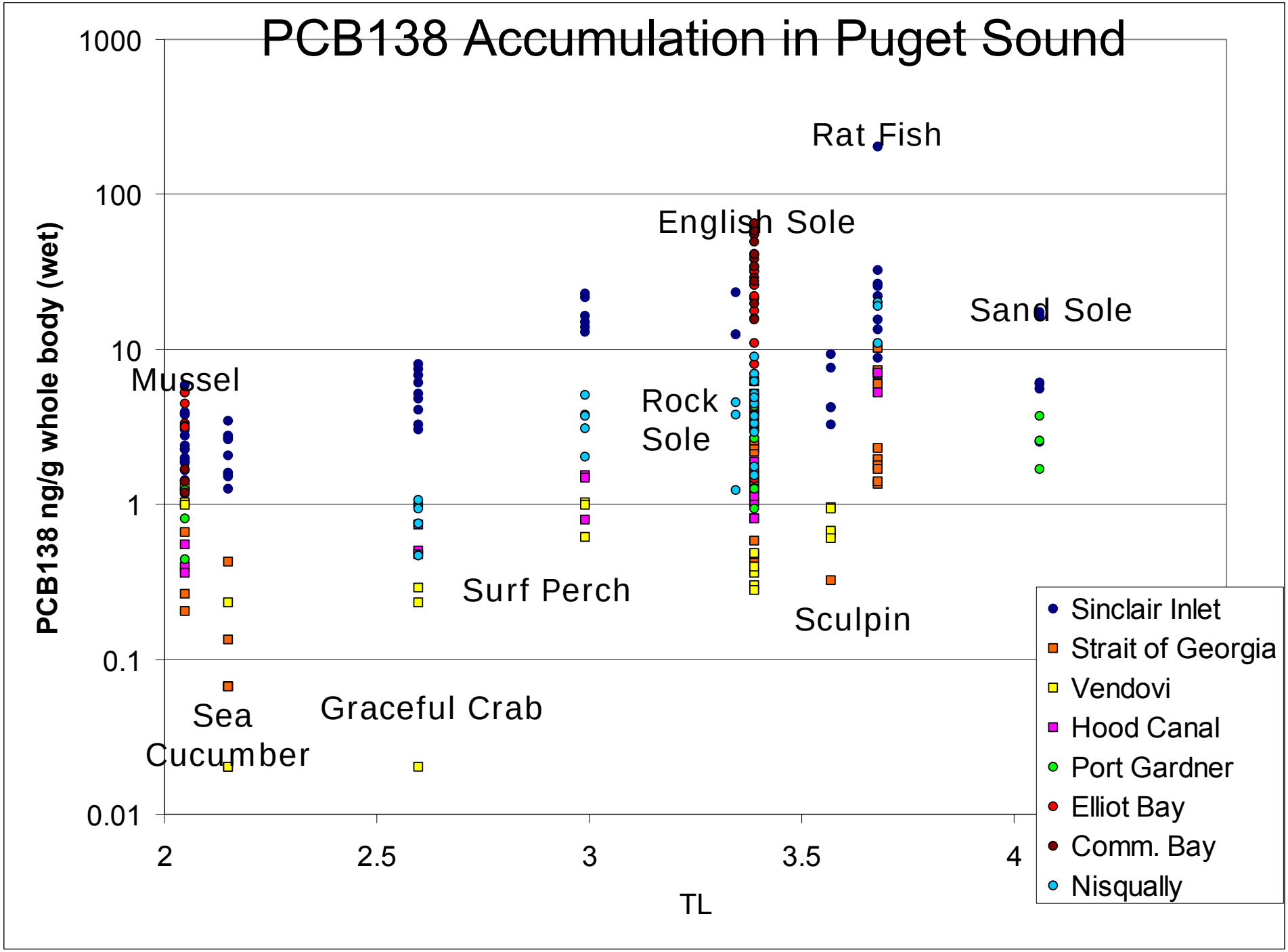
Blue line is regression of means
Red dashed line is regression of individual data points

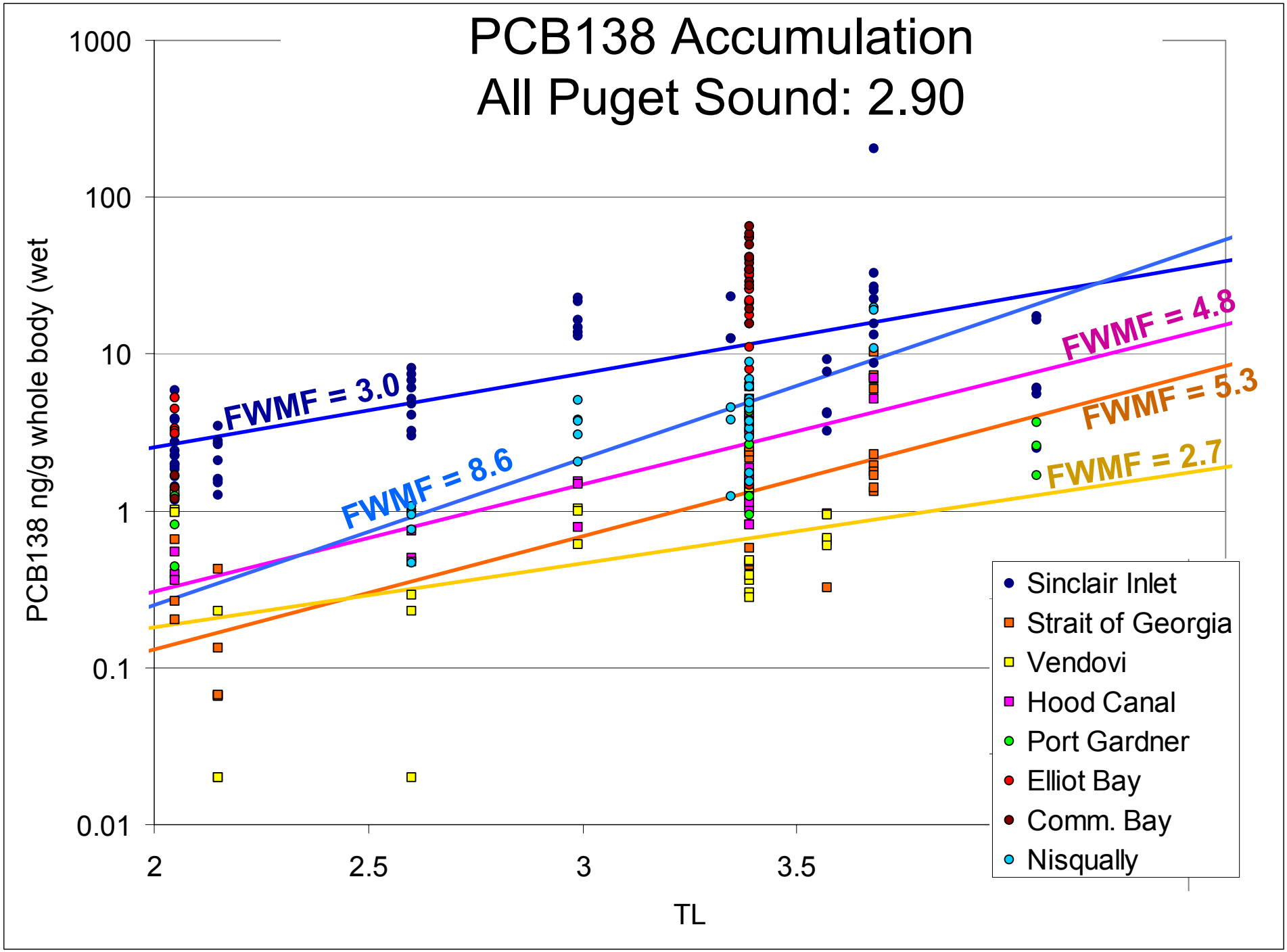
FWMF = 5.3

PCB138 Accumulation

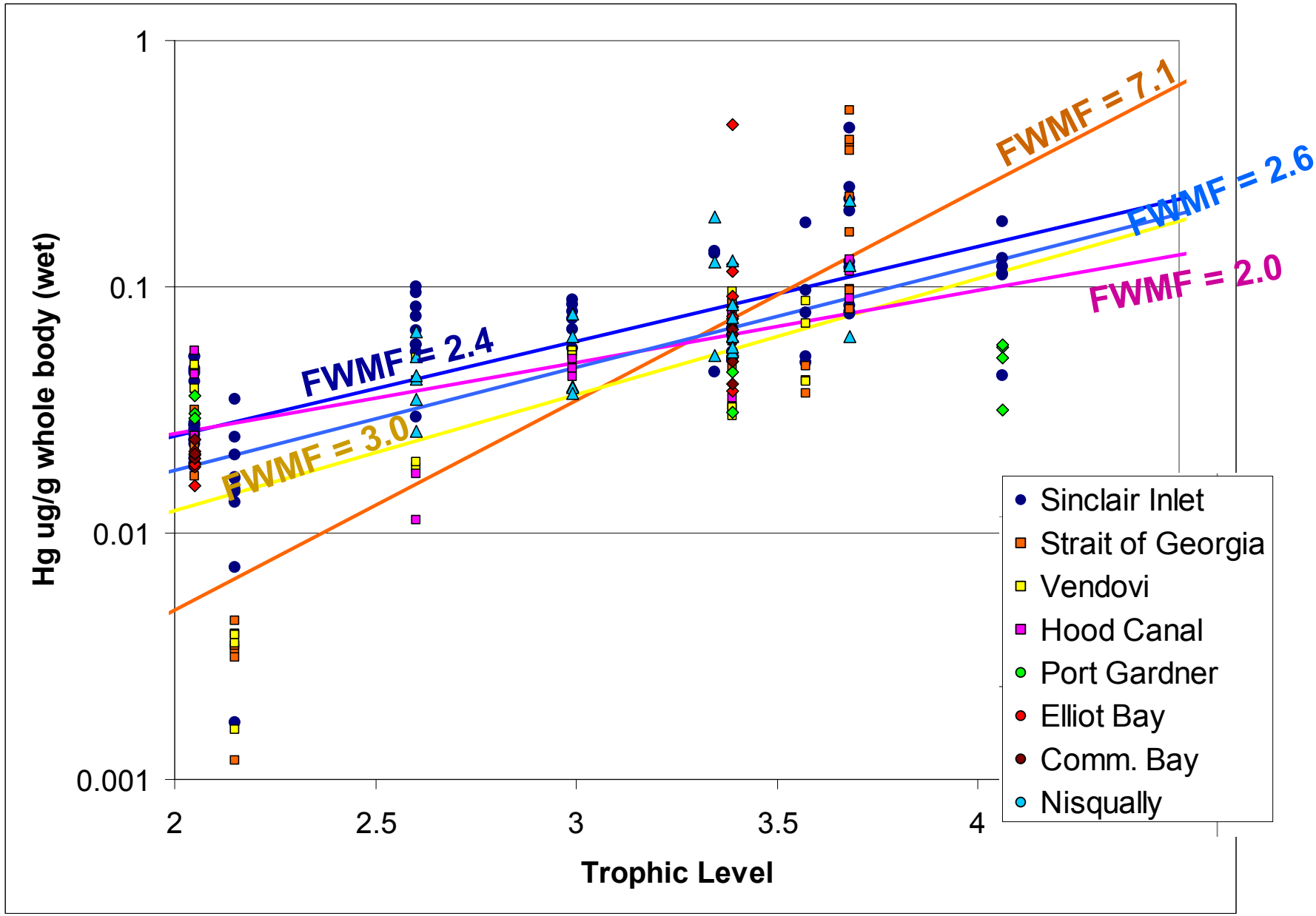


Orange line is regression of means
Red dashed line is regression of individual data points


PCB138 Accumulation in Puget Sound
PCB138 ng/g whole body (wet)
1000
100
10
1
0.1
0.01
2
2.5
3
3.5
4
TL
Rat Fish
English Sole
Sand Sole
Mussel
Rock Sole
Surf Perch
Sculpin
Sea Cucumber
Graceful Crab
Sinclair Inlet
Strait of Georgia
Vendovi
Hood Canal
Port Gardner
Elliot Bay
Comm. Bay
Nisqually

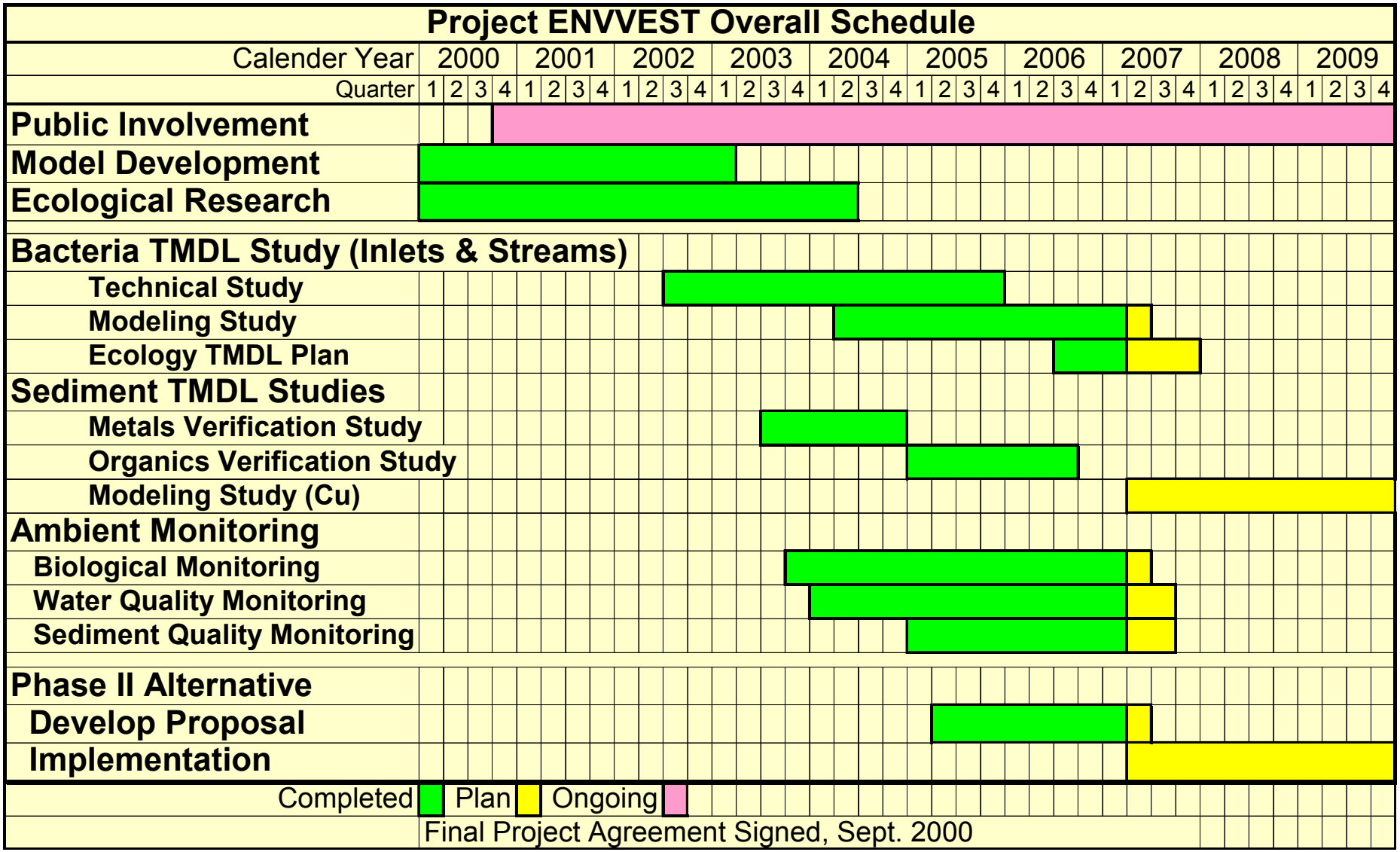

PCB138 Accumulation
All Puget Sound: 2.90
PCB138 ng/g whole body (wet
1000
100
10
1
0.1
0.01
2
2.5
3
3.5
TL
FWMF = 3.0
FWMF = 8.6
FWMF = 4.8
FWMF = 5.3
FWMF = 2.7
Sinclair Inlet
Strait of Georgia
Vendovi
Hood Canal
Port Gardner
Elliot Bay
Comm. Bay
Nisqually

Mercury Accumulation
All Puget Sound: FWMF=2.65



Conclusions

- Monitoring framework needed to provide context for interpreting data results
- Tissue Residue Benchmarks provide a means of evaluating exposure levels
- Data on contaminant levels across the food web are needed to evaluate bioaccumulation
- What are the Biota Telling Us?
  - Gradients of exposure across Puget Sound Region
  - Some of the more conservative benchmarks were exceeded
  - Some contaminants are biomagnifying

ENVVEST Technical Working Group Clambake featuring Manila clams harvested from Dyes Inlet provided courtesy of the Suquamish Tribe

Current Schedule