Apr 21st, 10:30 AM - 12:00 PM

Results from biennial mussel watch monitoring in Sinclair and Dyes Inlets, Puget Sound, Washington from 2010 to 2018

Robert Johnston
Society of Environmental Toxicology and Chemistry Pacific Northwest Chapter, rkj.johnston@gmail.com

2020 Salish Sea Ecosystem Conference

Session 1.1B:

The Environmental Toxicology and Chemistry of the Salish Sea Ecosystem

Virtual Conference April 21, 2020

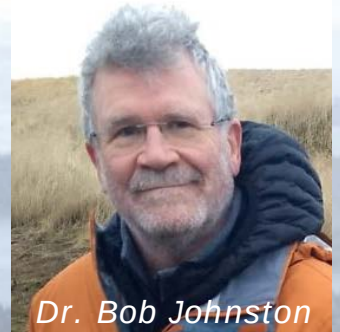
Pacific Northwest Chapter of the Society of Environmental Toxicology and Chemistry
https://pnw-setac.org/

Results from Biennial Mussel Watch Monitoring in Sinclair and Dyes Inlets, Puget Sound, Washington from 2010 to 2018

Robert K. Johnston, Applied Ecological Solutions, Bremerton, WA
J. Strivens, J. Brandenberger, LJ. Kuo, Pacific Northwest National Laboratory, Sequim, WA
J. Frew, N. Hayman, Naval Information Warfare Center, San Diego, CA
T. Richardson, Puget Sound Naval Shipyard & IMF, Bremerton, WA

Pacific Ocean

2020 Salish Sea Ecosystem Conference

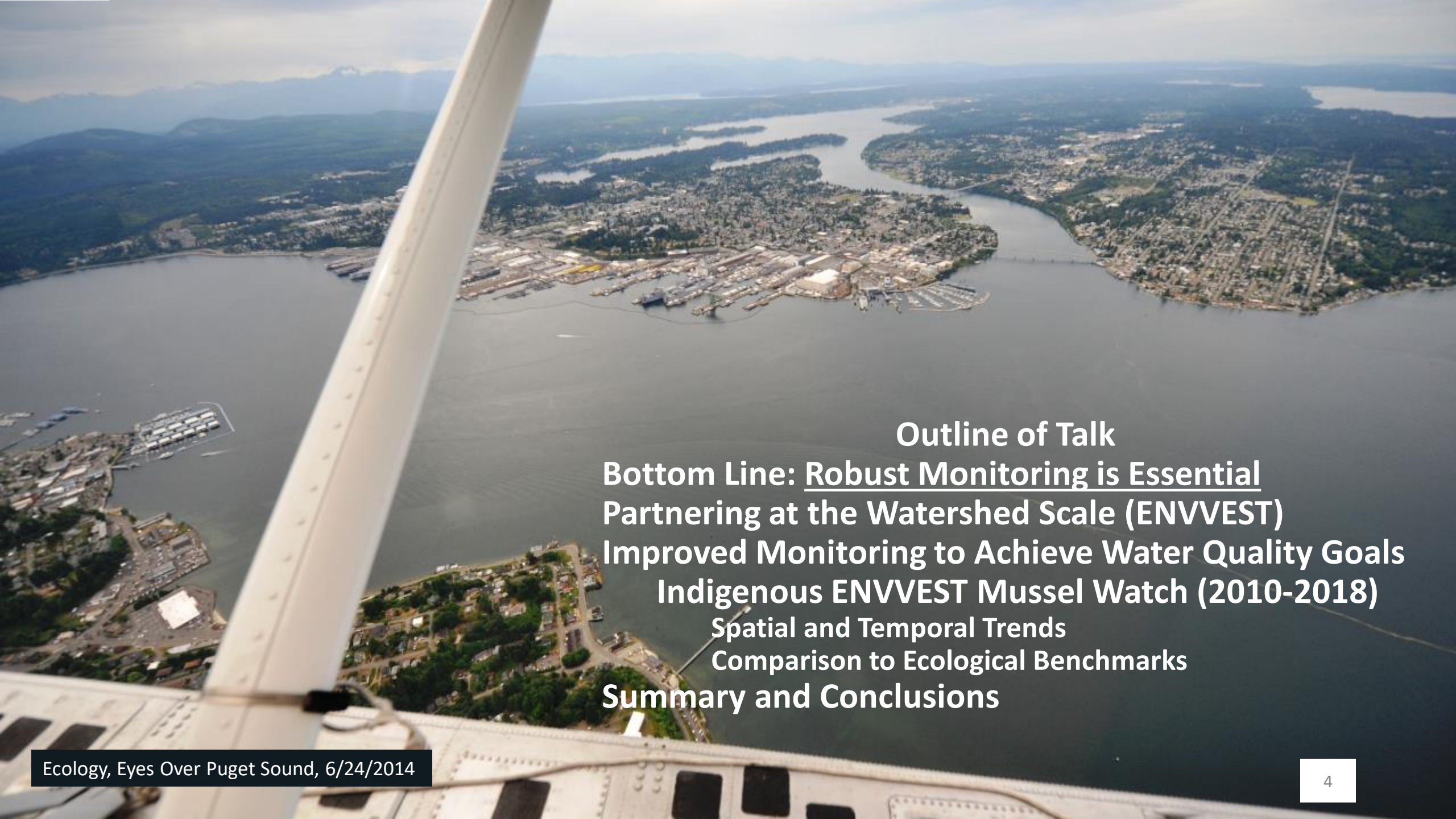


Dr. Bob Johnston

Virtual Conference April 21-22, 2020

drbobjohnston@appecosol.com


I am here
Pacific Ocean
Bremerton, WA



Outline of Talk

Bottom Line: Robust Monitoring is Essential

Partnering at the Watershed Scale (ENVVEST)

Improved Monitoring to Achieve Water Quality Goals

Indigenous ENVVEST Mussel Watch (2010-2018)

- **Spatial and Temporal Trends**
- **Comparison to Ecological Benchmarks**

Summary and Conclusions

Ecology, Eyes Over Puget Sound, 6/24/2014

Puget Sound Naval Shipyard & IMF (PSNS&IMF)

Project ENVVEST (ENVironmental InVESTment)

- Final Project Agreement (Sep. 2000) PSNS&IMF/EPA/Ecology
- Cooperative technical studies with local agencies and stakeholders for watershed monitoring and modeling
- Pool resources to solve environmental problems

Pay off – Regulatory flexibility, goodwill from stakeholders and public, and real improvements in environmental quality

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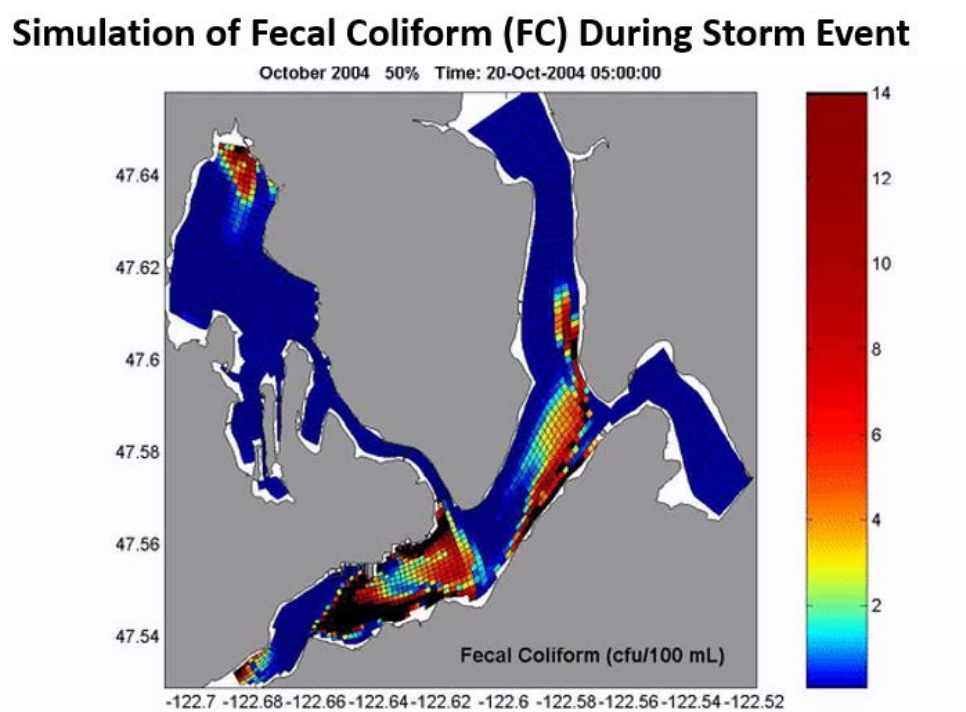


(Johnston et al. 2009; Lawrence et al. 2012)

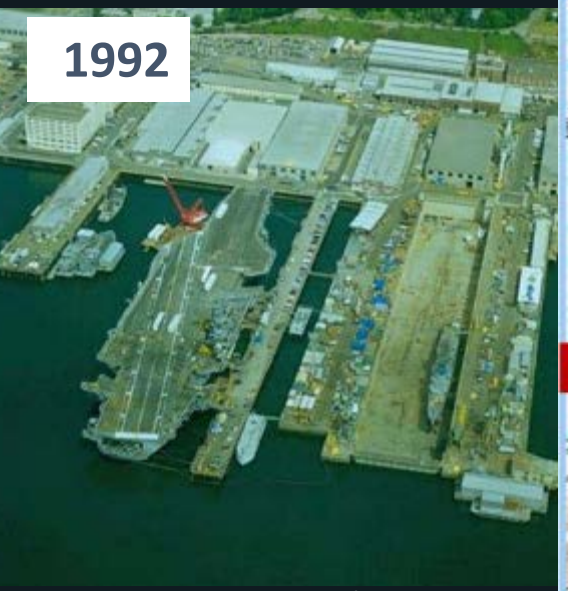
Improved Monitoring to Assess Water Quality Goals

- **EFFLUENTS AND RECEIVNG WATERS**
- **STORMWATER**
- **SEDIMENT**
- **BIOTA**
  - **BIENNIAL MUSSEL WATCH SAMPLING (2010-2018)**

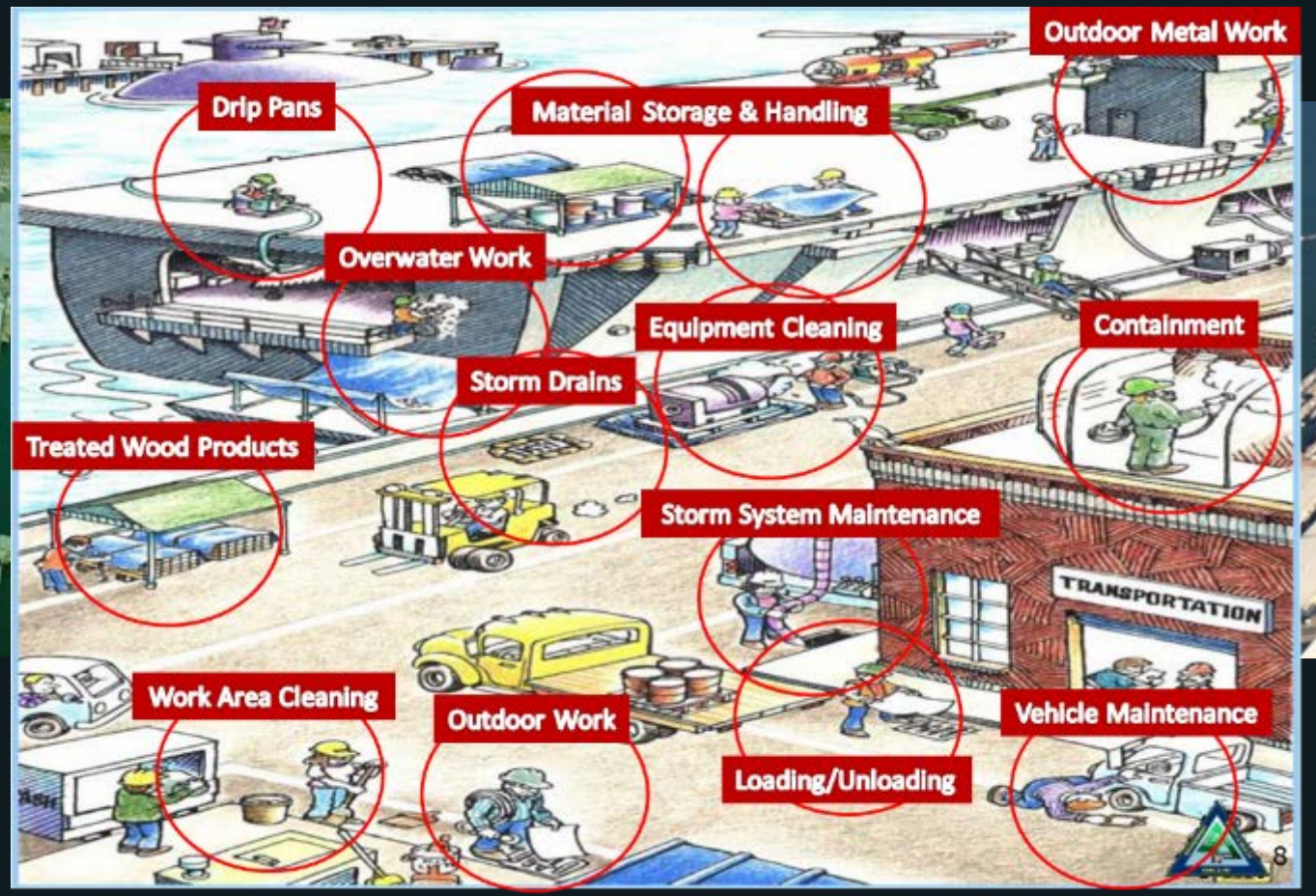
(Johnston et al. 2010, 2018a,b)

Water Pollution Prevention Best Management Practices (BMPs)

Continuous Process Improvement is Working!



Source: WA State Dept. of Ecology



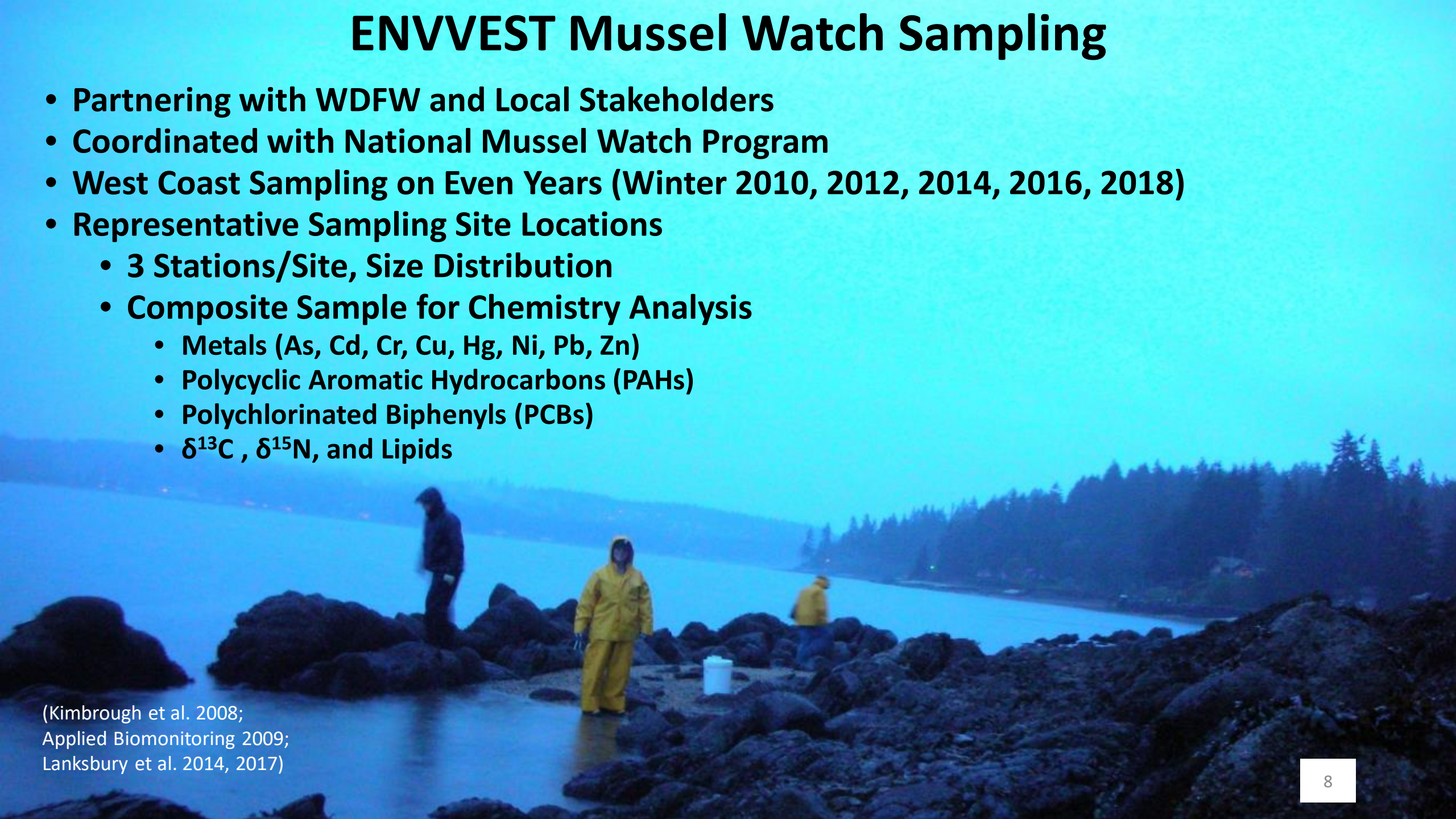
Source: Puget Sound Naval Shipyard & IMF

Source: WA State Dept. of Ecology
Eyes over Puget Sound

Major Programs include improvements to meet All Known, Available and Reasonable Treatment (AKART) requirements (US Navy 2012), Records of Decision (RODs) to remediate contaminated soil and sediment sites (US Navy 2017), and in-water work to repair and replace pier and dry dock infrastructure (Johnston et al. 2019).

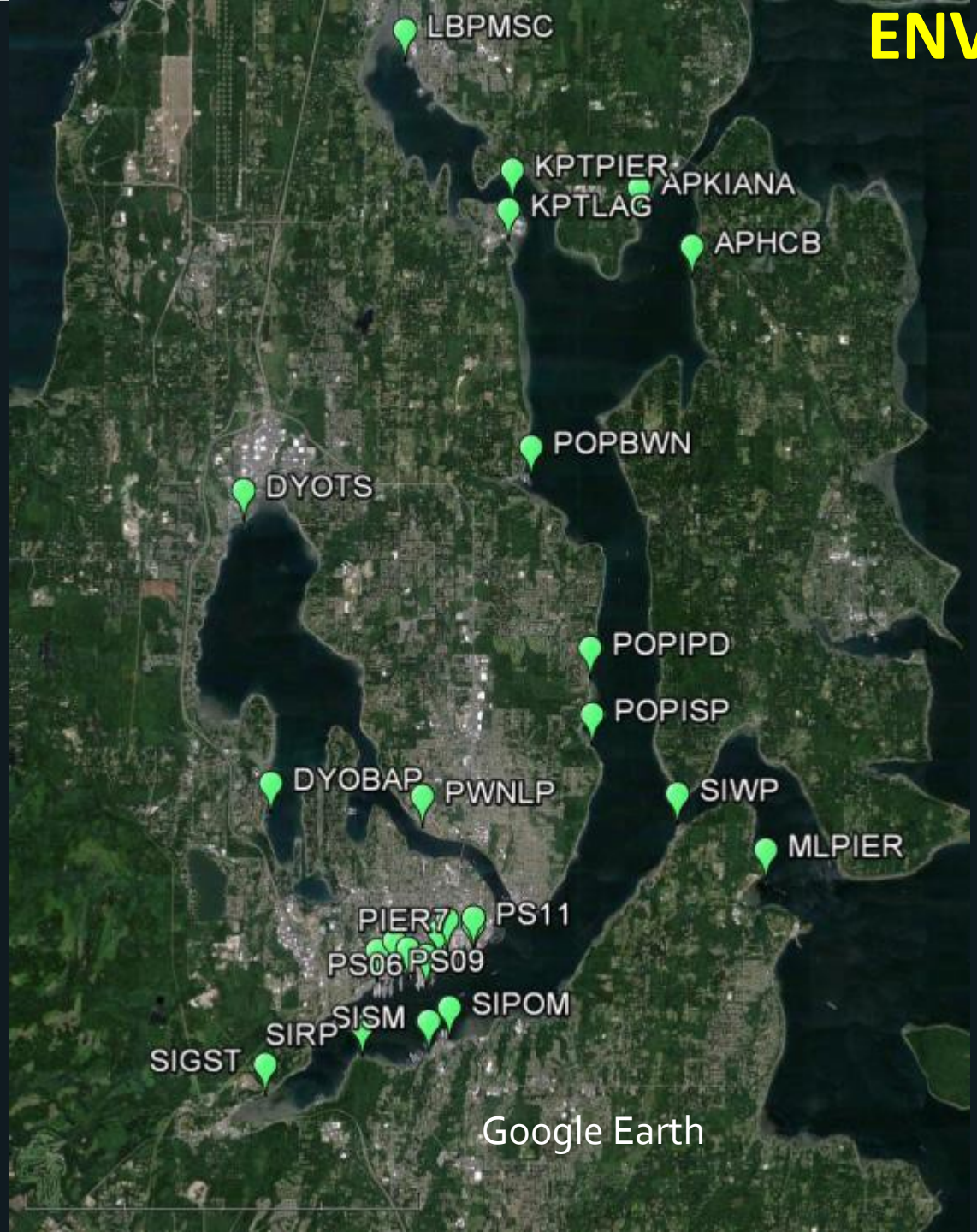
ENVVEST Mussel Watch Sampling

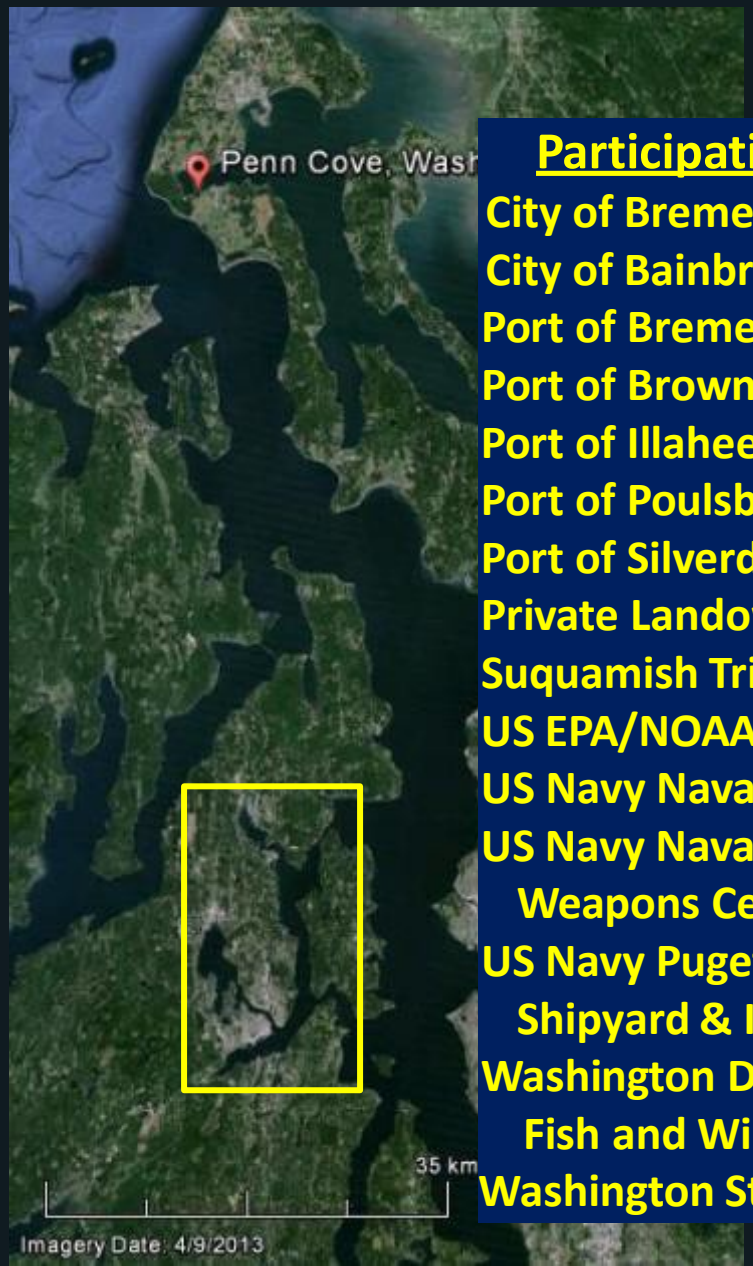
- Partnering with WDFW and Local Stakeholders
- Coordinated with National Mussel Watch Program
- West Coast Sampling on Even Years (Winter 2010, 2012, 2014, 2016, 2018)
- Representative Sampling Site Locations
  - 3 Stations/Site, Size Distribution
  - Composite Sample for Chemistry Analysis
    - Metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn)
    - Polycyclic Aromatic Hydrocarbons (PAHs)
    - Polychlorinated Biphenyls (PCBs)
    - $\delta^{13}C$, $\delta^{15}N$, and Lipids



(Kimbrough et al. 2008;
Applied Biomonitoring 2009;
Lanksbury et al. 2014, 2017)

ENVVEST Mussel Watch Stations 2010 - 2018

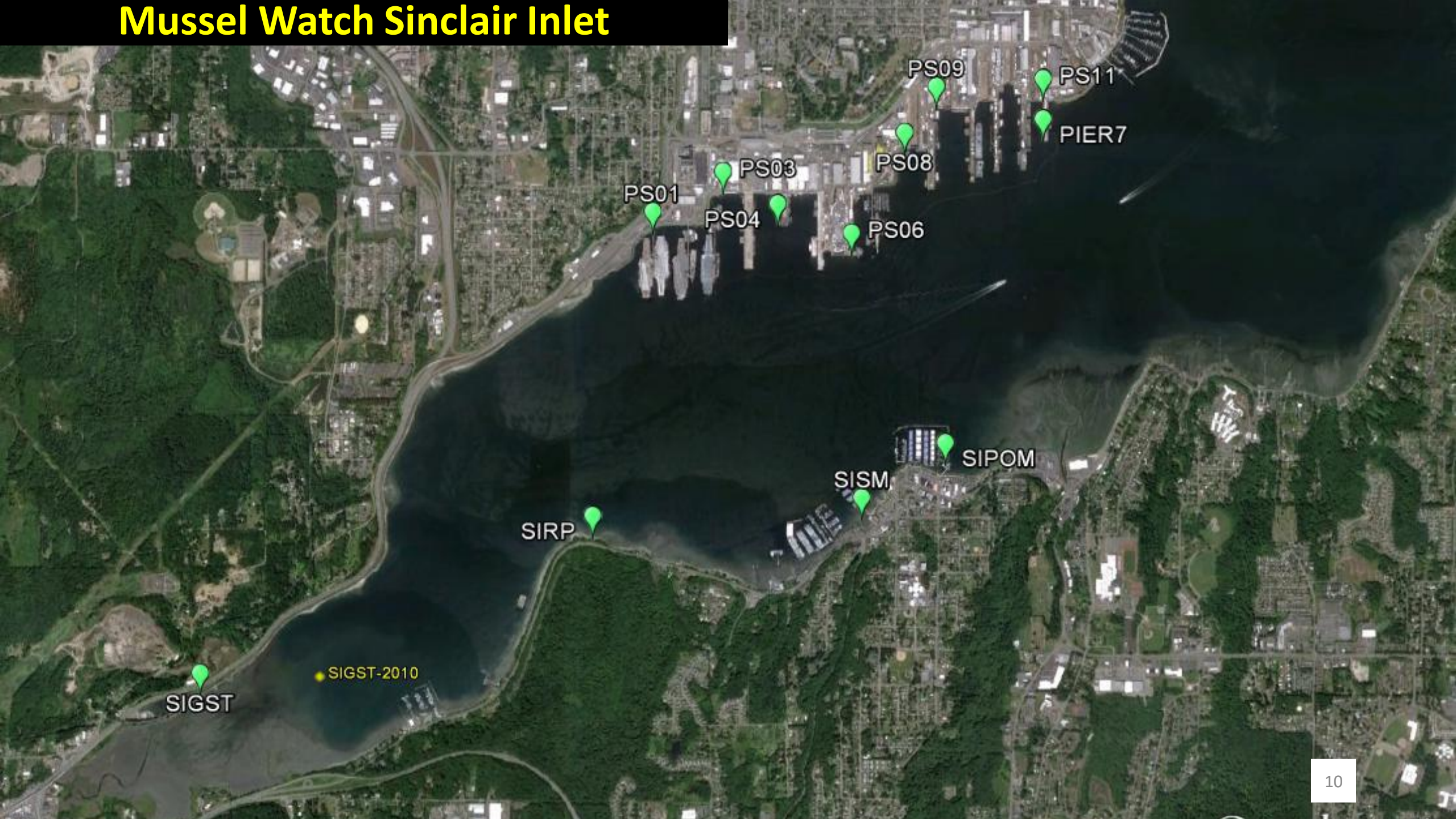




Participating Jurisdictions

- City of Bremerton Parks & Rec
- City of Bainbridge Island
- Port of Bremerton
- Port of Brownsville
- Port of Illahee
- Port of Poulsbo
- Port of Silverdale
- Private Landowner
- Suquamish Tribe
- US EPA/NOAA Manchester Lab
- US Navy Naval Base Kitsap
- US Navy Naval Underwater Weapons Center Keyport
- US Navy Puget Sound Naval Shipyard & IMF
- Washington Department of Fish and Wildlife
- Washington State Parks Illahee

Mussel Watch Sinclair Inlet



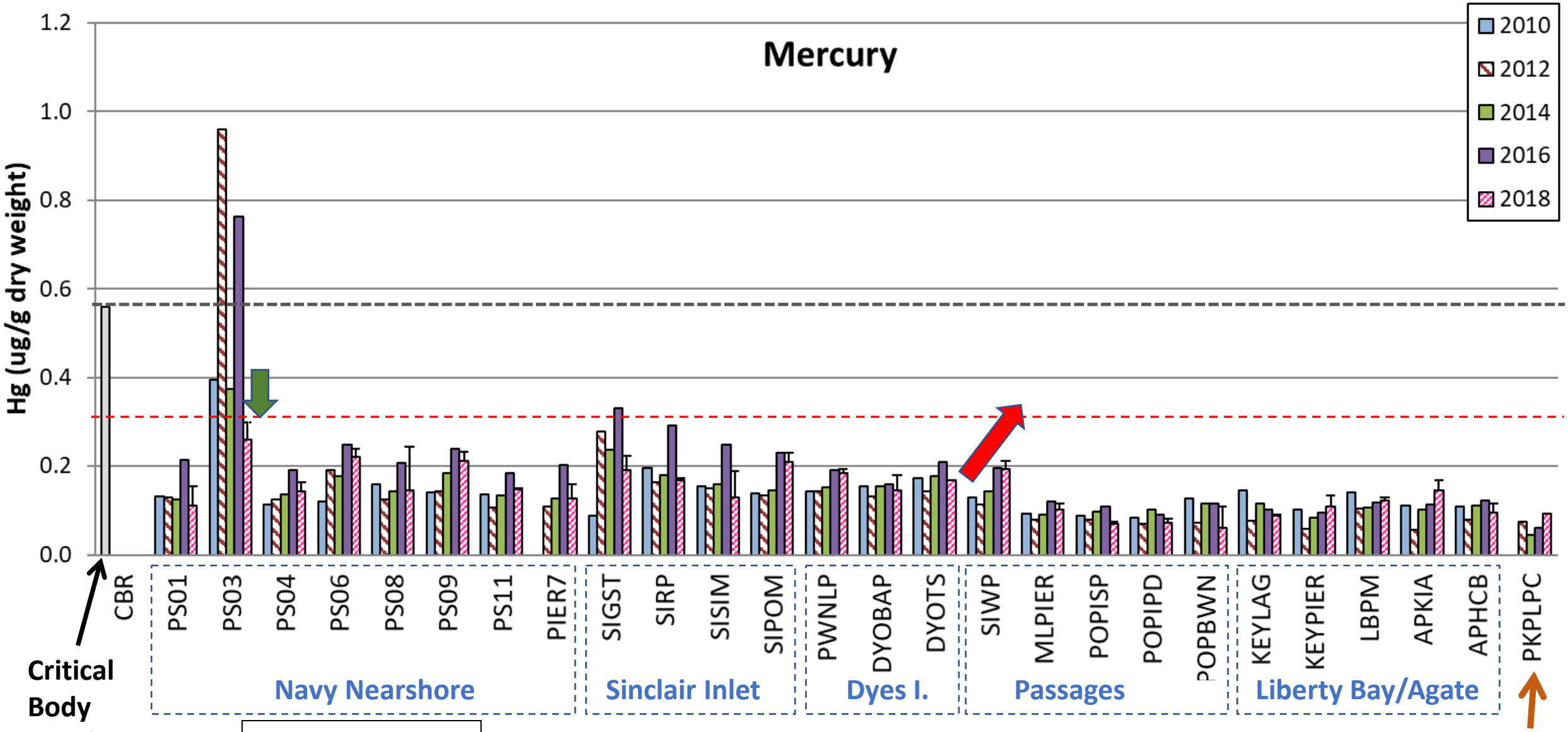

DO NOT EAT

ENVVEST Mussel Watch 2010-2018 Data Evaluation

- Possible Source

  higher than other stations (in upper 90th Percentile)

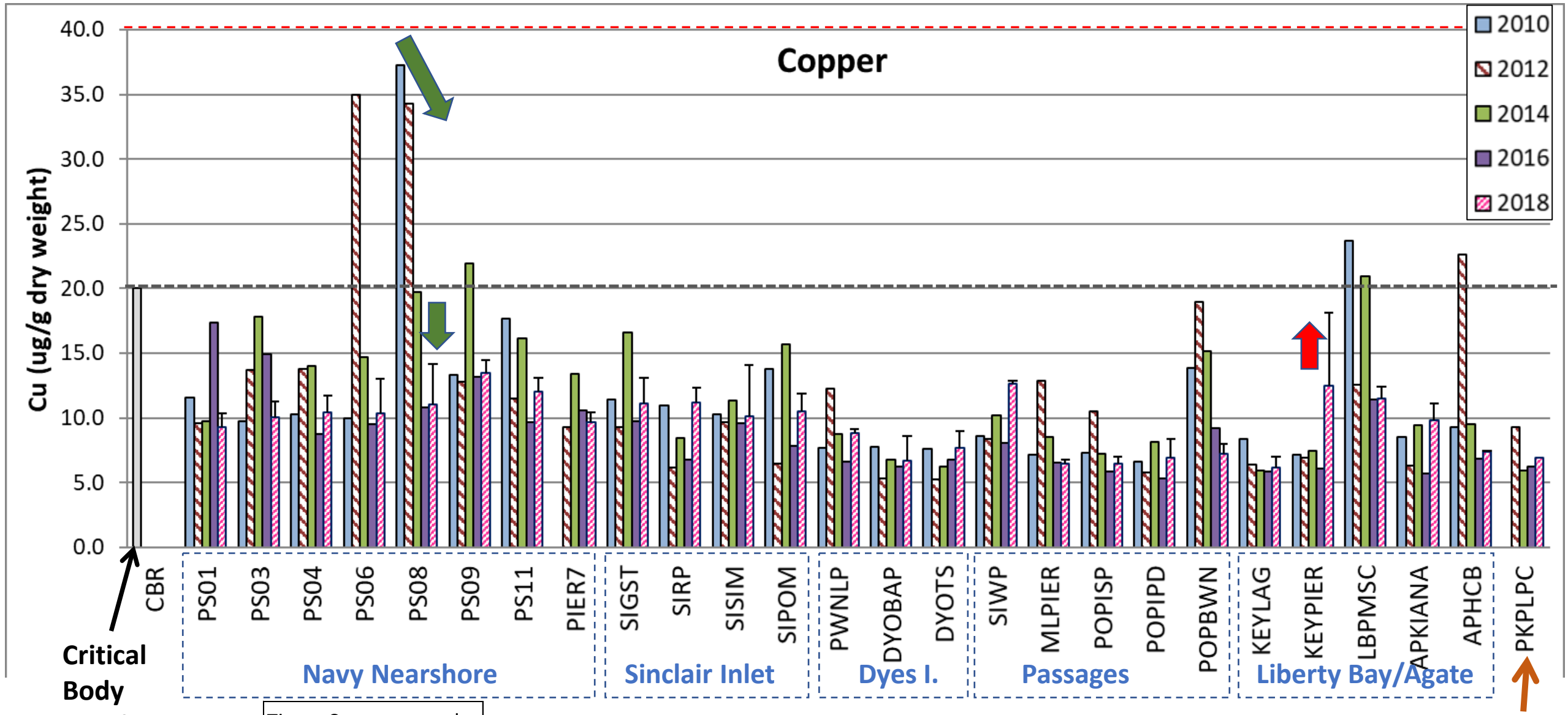
- Possible Trend
  - Recent Trend: 2018 data outside interquartile range of previous six years (2010, 2012, 2014, 2016) and more than 2x greater than average
  - Long Term Trend: Least squares linear regression over eight years with 5 sampling events
- Possible Ecological Effect – Critical Body Residue Benchmark
- Comparison to Seafood Market Sample (Penn Cove)
- Comparison to National Mussel Watch Data Set



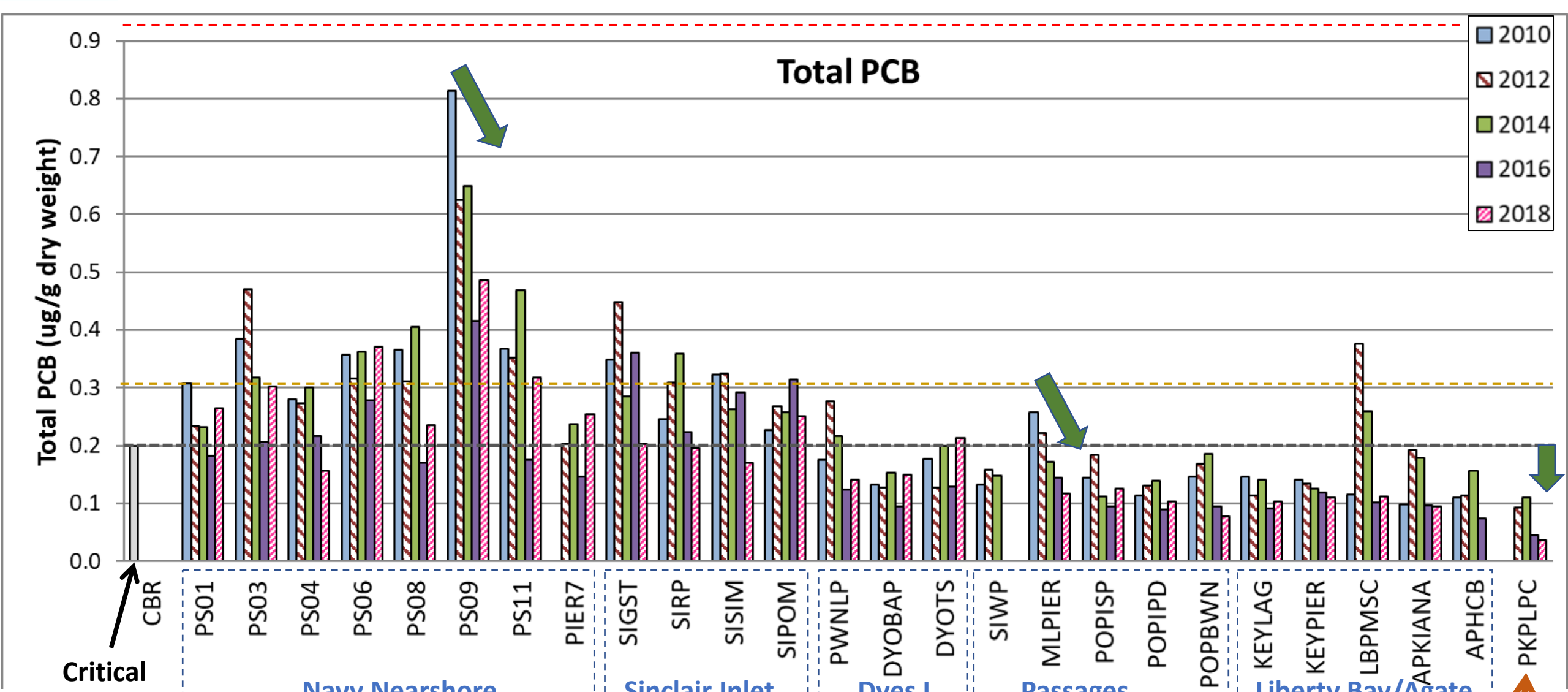
Critical Body Residue

Tissue Conc.	ppm dry
National MW	**Hg**
High	0.36 - 1.28
Medium	0.18 - 0.35
Low	0 - 0.17

Seafood Market (Penn Cove, Whidbey Island)



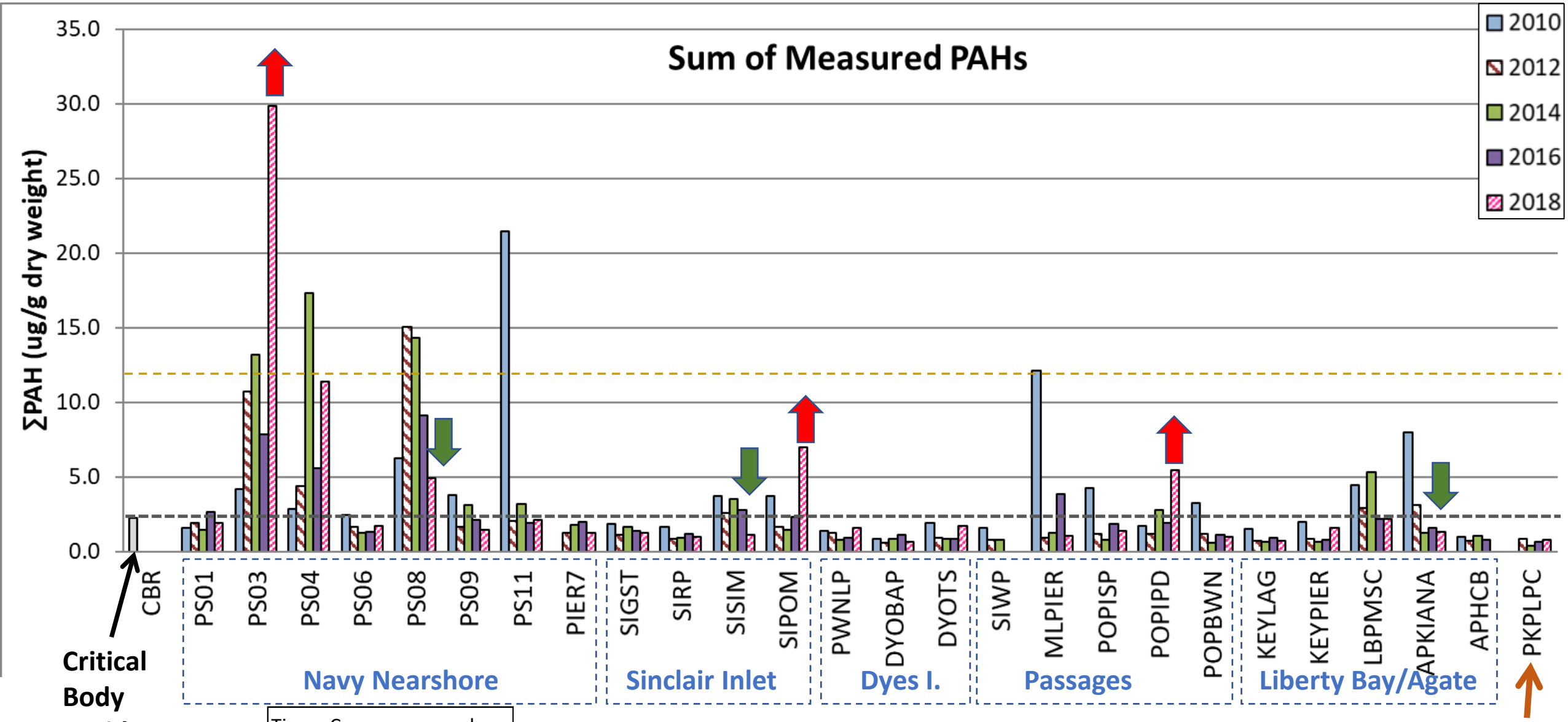
Tissue Conc.	ppm dry
National MW	**Cu**
High	40 - 857
Medium	17 - 39
Low	5 - 16



Critical Body Residue

Tissue Conc.	ppm dry
National MW	**TPCB**
High	0.958 - 2.826
Medium	0.308 - 0.956
Low	0.006 - 0.306

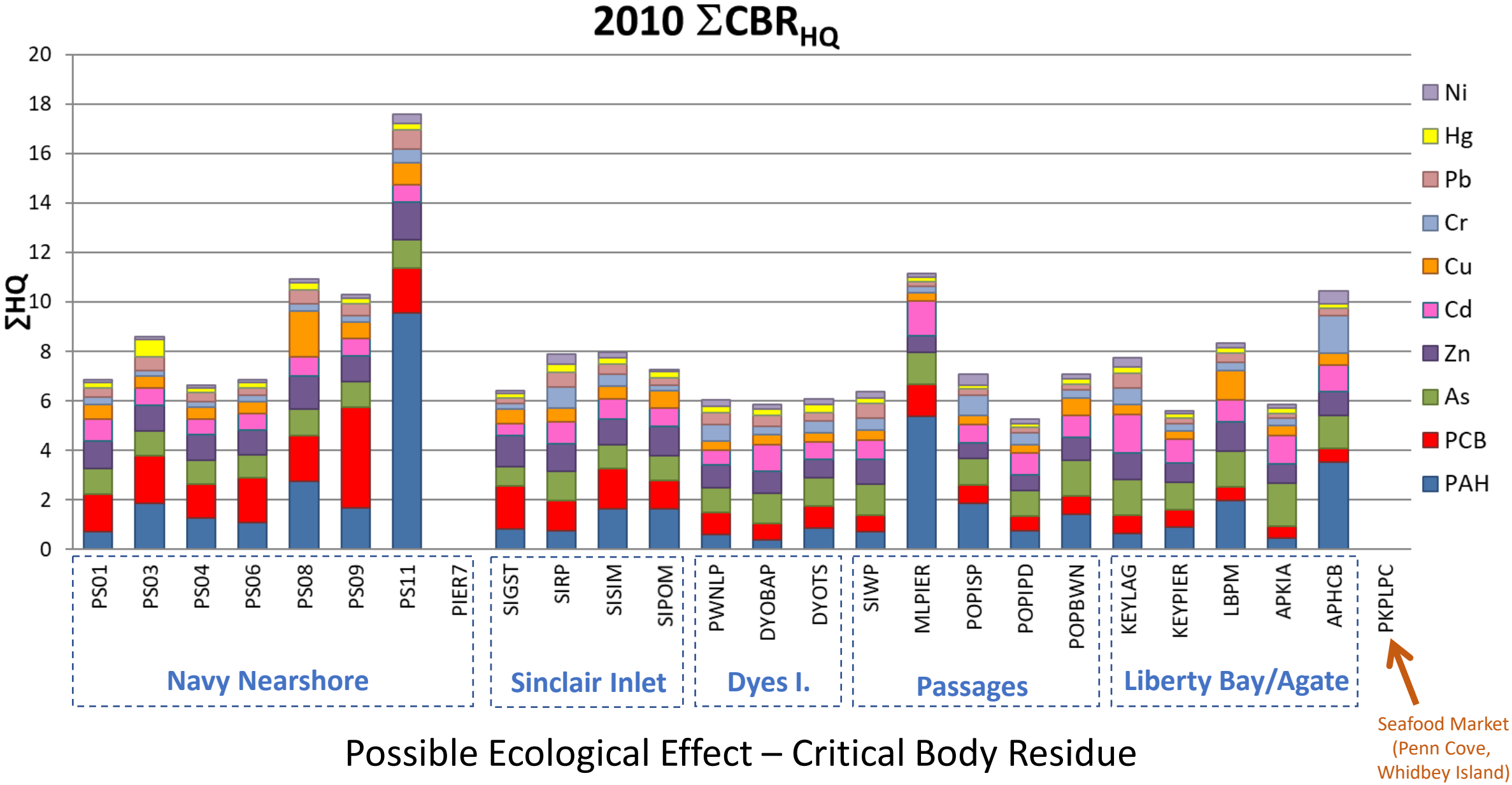
Seafood Market (Penn Cove, Whidbey Island)



Critical Body Residue

Tissue Conc.	ppm dry
National MW	**ΣPAH**
High	44 - 76
Medium	12 - 44
Low	0.6 - 12

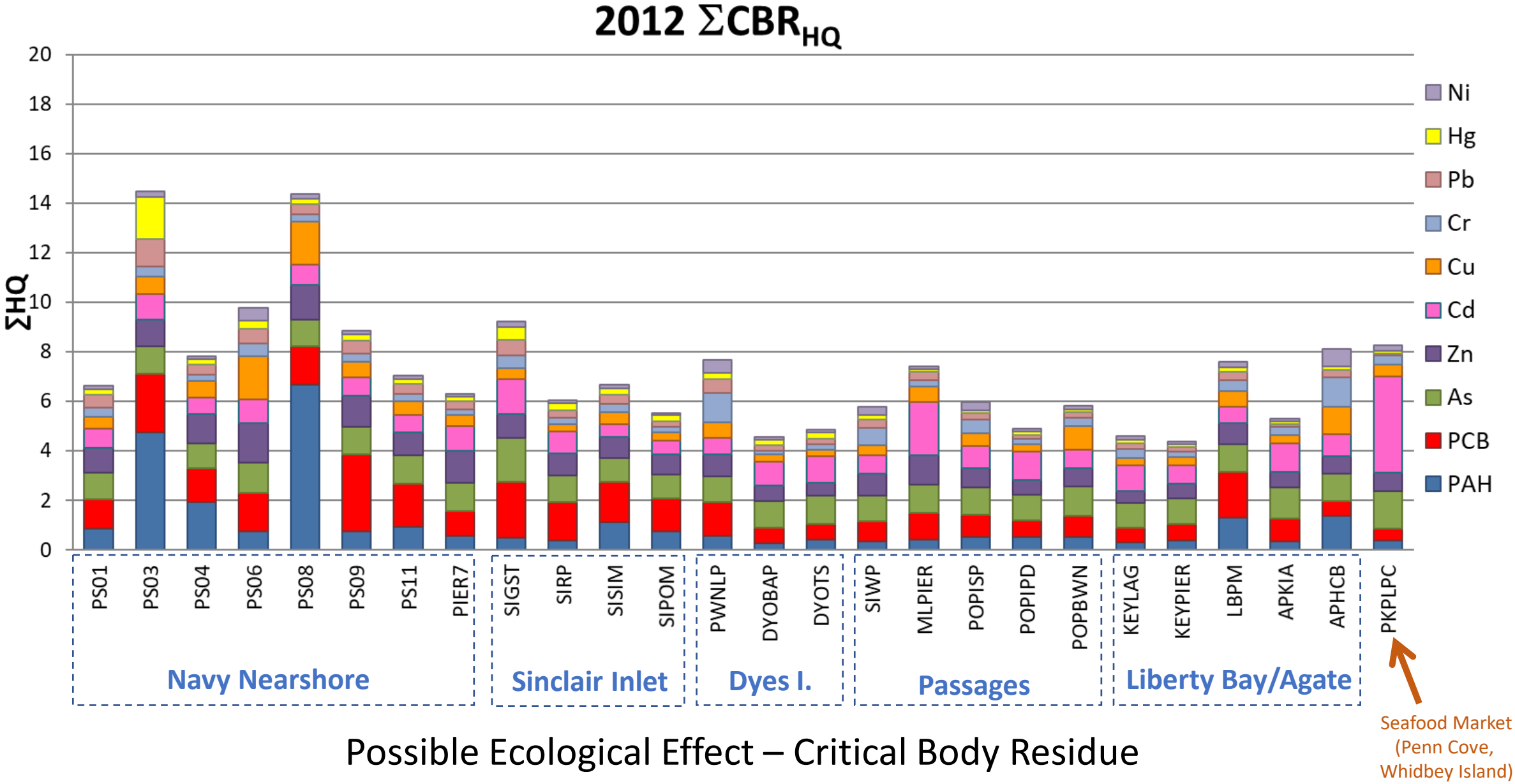
Seafood Market (Penn Cove, Whidbey Island)



Possible Ecological Effect – Critical Body Residue

$CBR_{HQi} > 2$; CBR_{HQi} = Concentration/CBR_i

$\Sigma CBR_{HQi} > 10$; where $i = 10$



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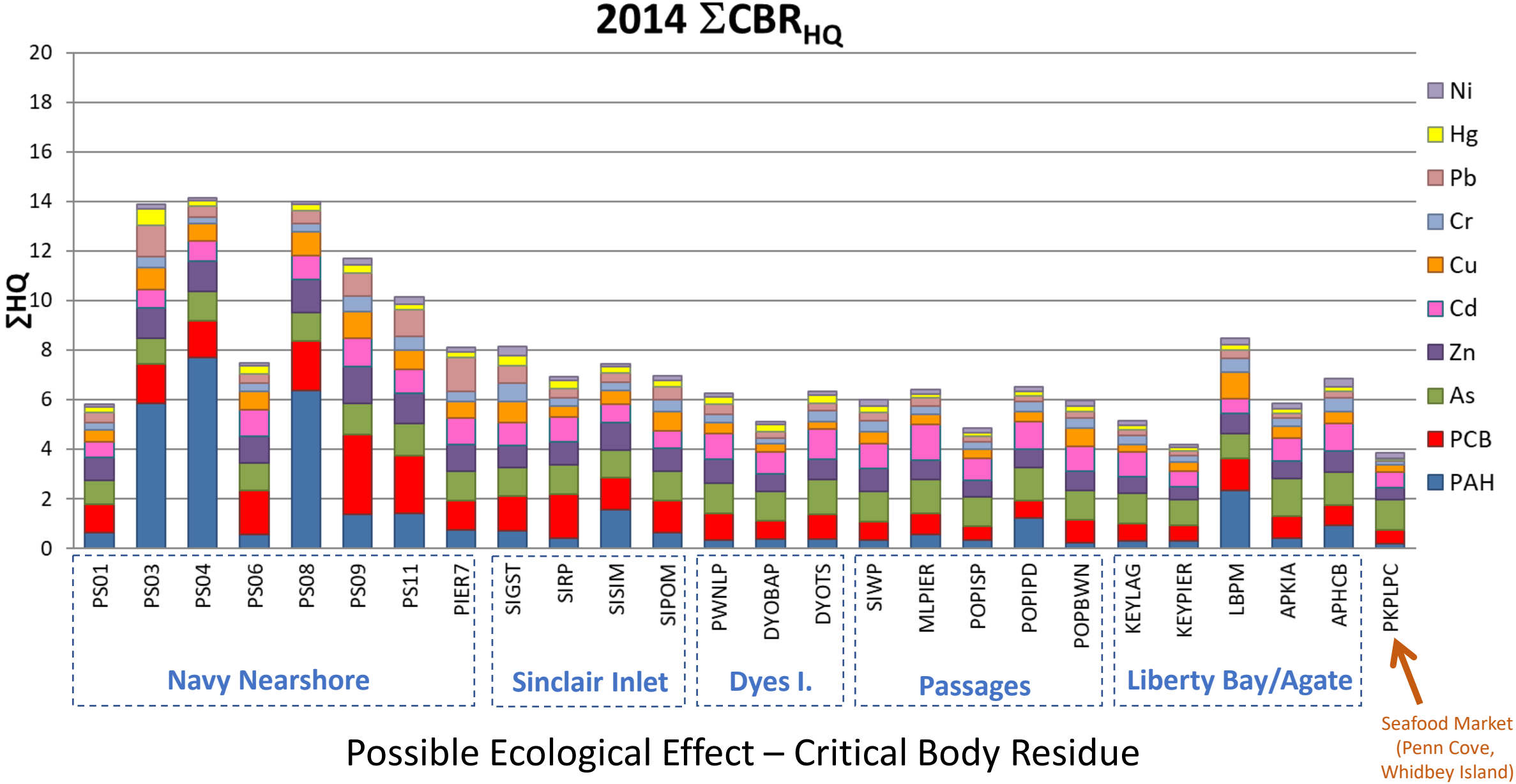

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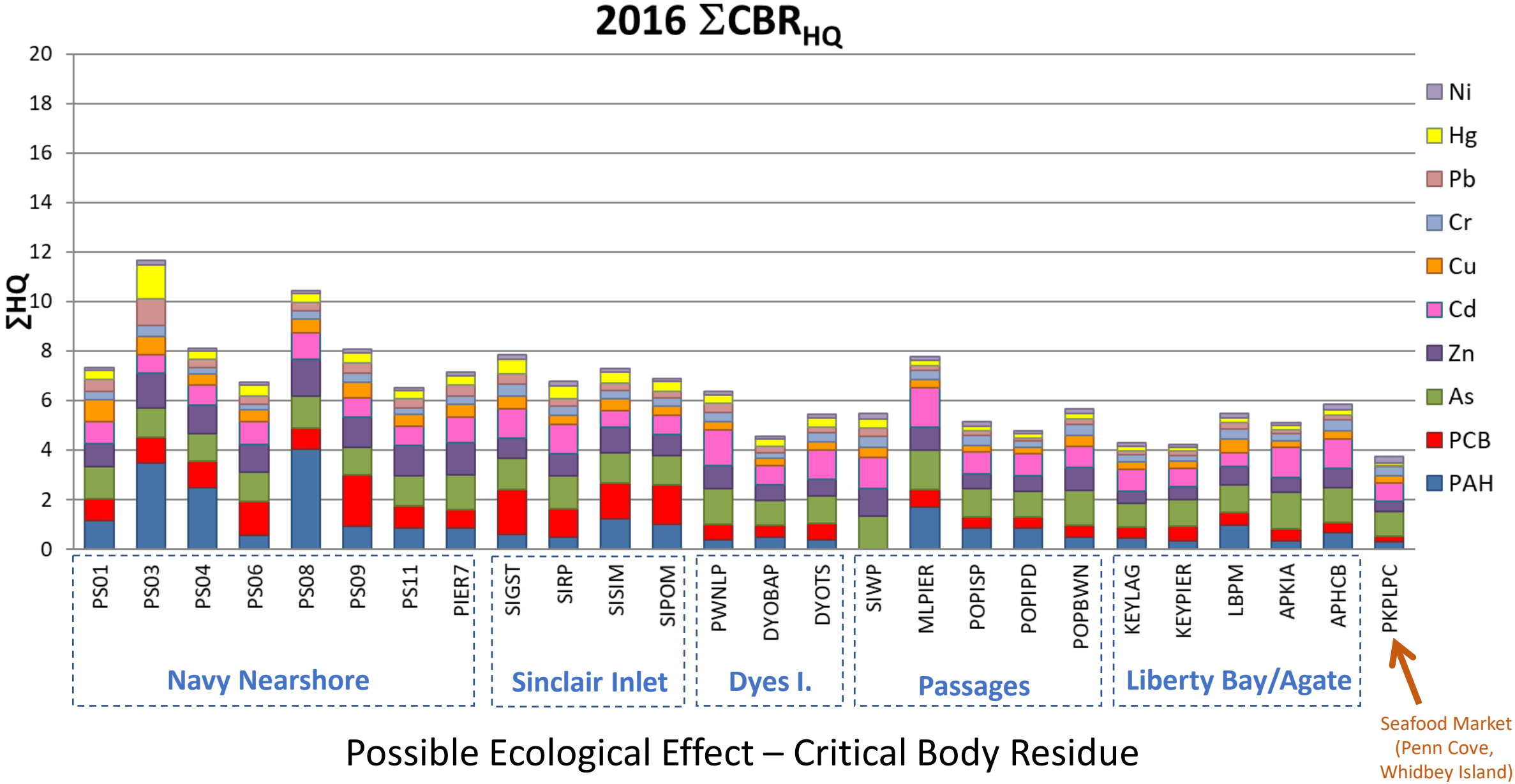

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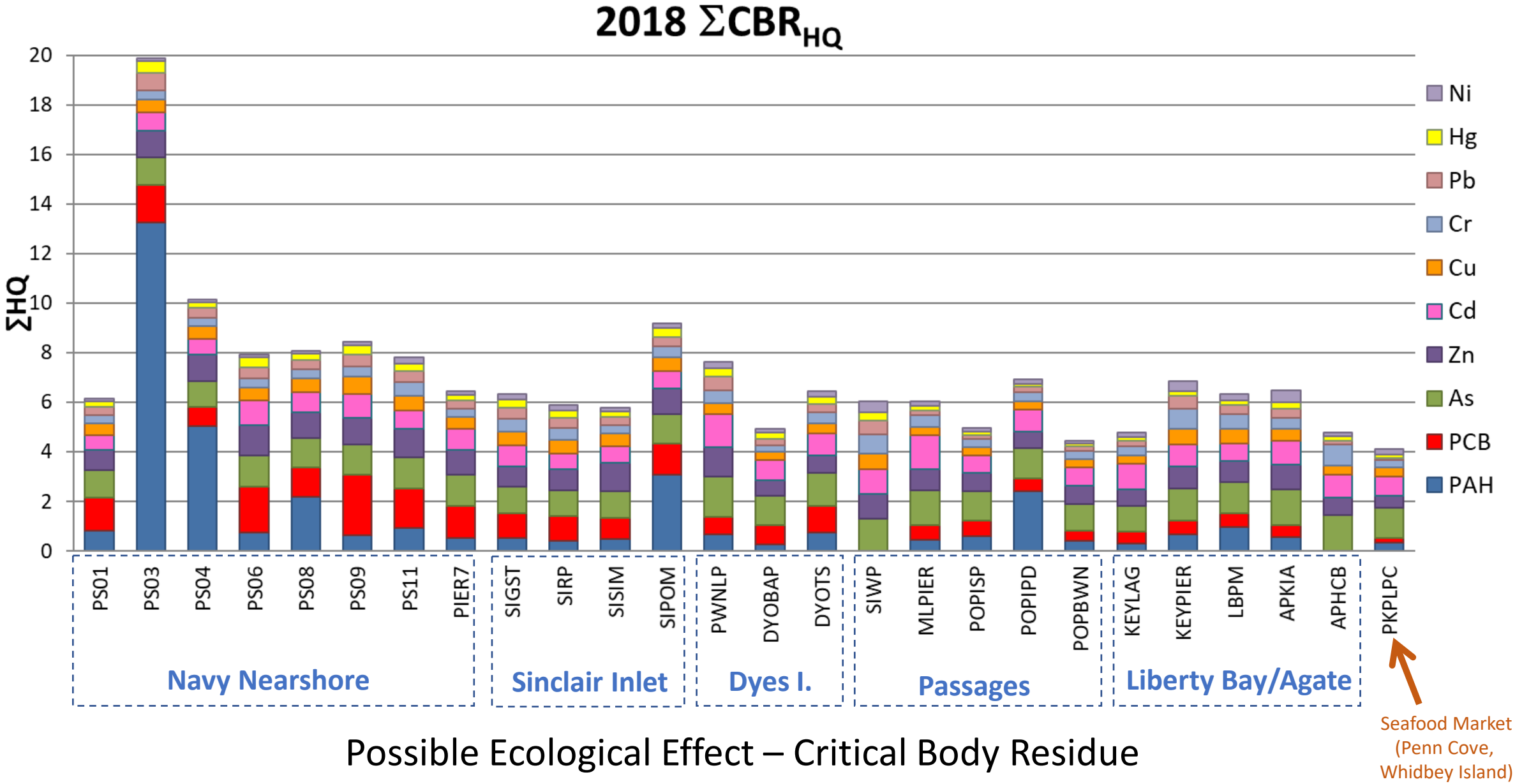

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Conclusions

- Monitoring Program is focused on tracking environmental quality in the Inlets
  - Can identify problems
  - Can evaluate effectiveness
- What are the Mussels Telling Us?
  - Some Areas were elevated with PAHs, PCBs, and metals
  - Increased risk of ecological effects
    - 2010-2014: 5 sites
    - 2016-2018: 2 sites
  - Contaminants of concern were PAHs (3 sites), PCBs (2 sites), Hg (1 site), and Cu (1 site ↓)
- Decreases in contaminant levels indicates Improving Environmental Quality
- Monitoring framework provides context for interpretation
  - Better information = better management

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