Mussel Watch monitoring to assess status, trends, and continuous process improvement of environmental protection and restoration initiatives for Sinclair and Dyes Inlets, Liberty Bay, and Port Orchard, Rich and Agate Passages of the Puget Sound, WA

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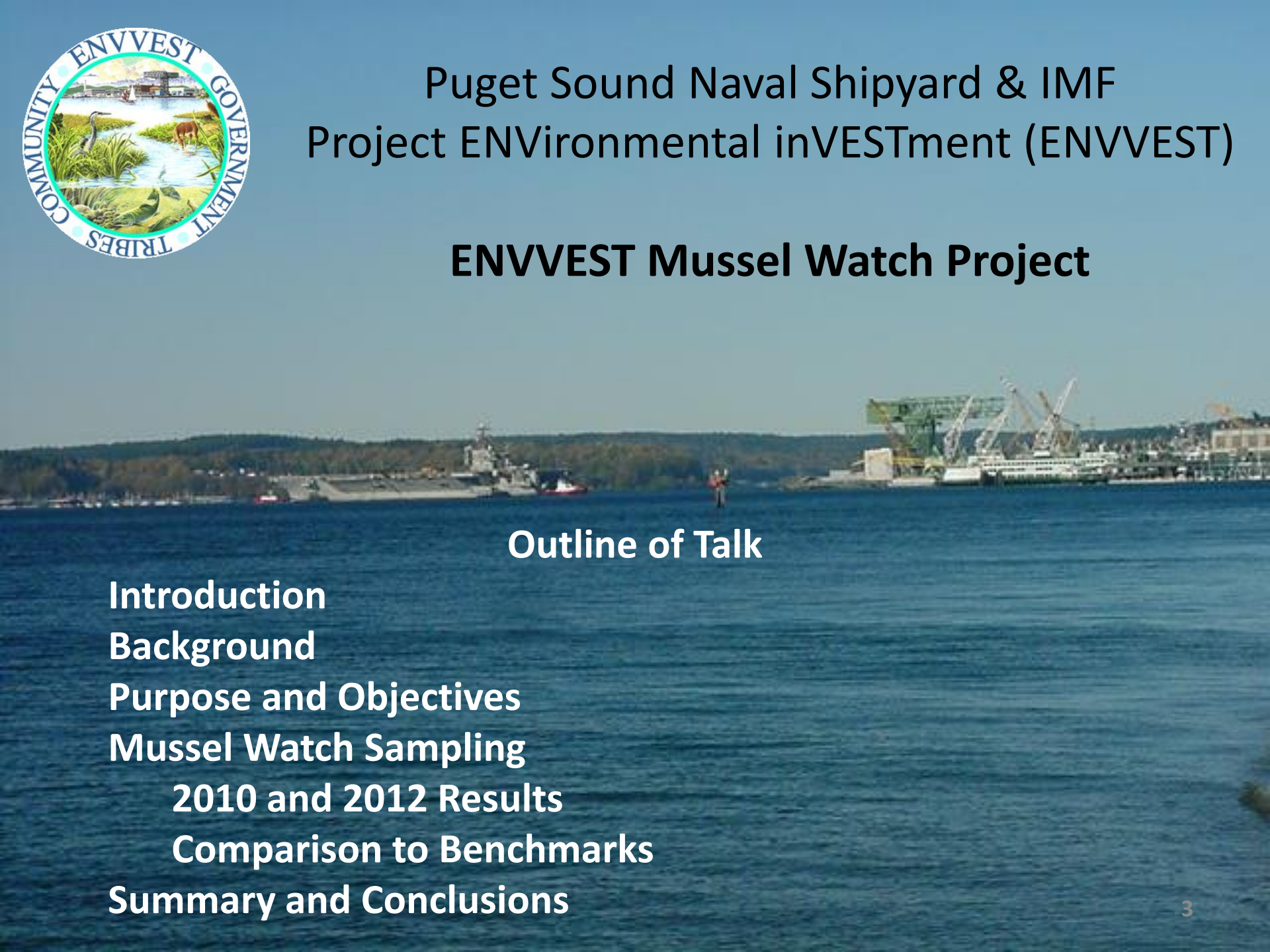
East Kitsap Inlets
Pacific Ocean



Puget Sound Naval Shipyard & IMF
Project ENVironmental inVESTment (ENVVEST)

ENVVEST Mussel Watch Project

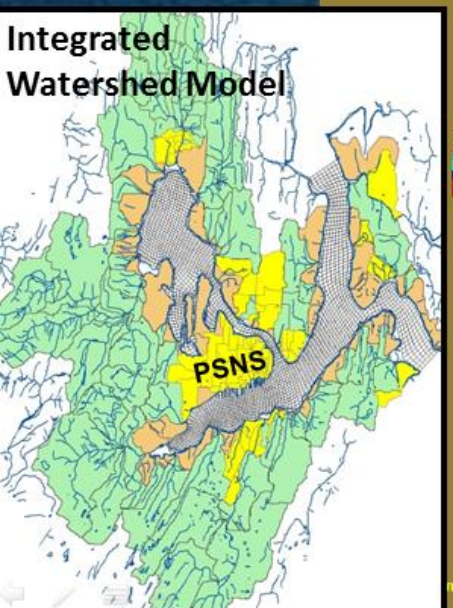
Outline of Talk

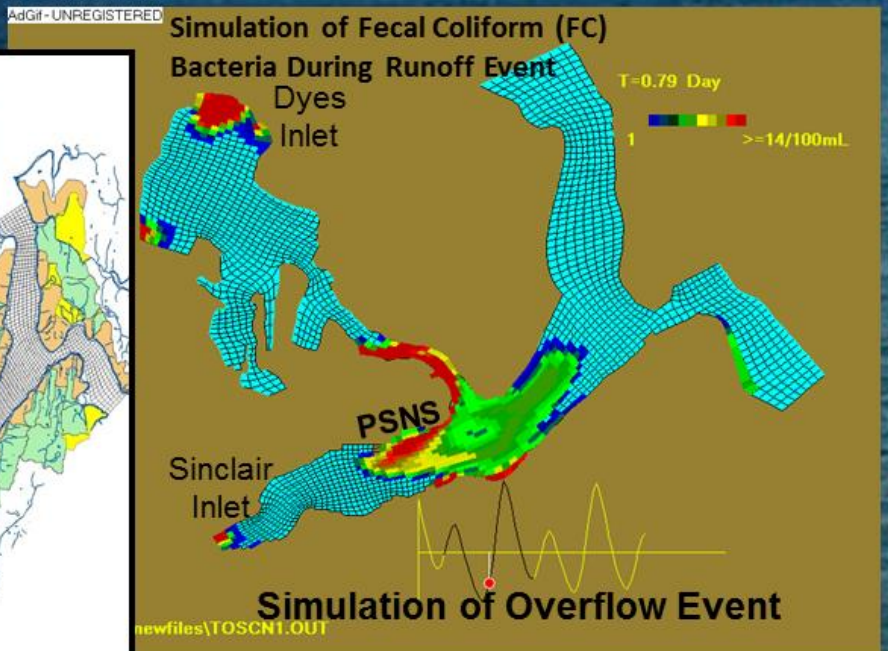
- Introduction
- Background
- Purpose and Objectives
- Mussel Watch Sampling
  - 2010 and 2012 Results
  - Comparison to Benchmarks
- Summary and Conclusions

Puget Sound Naval Shipyard & IMF (PSNS&IMF)
Project ENVVEST

- 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





Major Accomplishments

- Developed model of watershed and Inlets
- Assessed contaminant loading from storm events and runoff
- Contributed to reopening of 1500 acres of shellfish beds in Dyes Inlet
- Technical Support for FC TMDL
- Providing science to inform NPDES permitting process

Current NPDES limits are focused on the discharges at the end of the pipe **AND** environmental performance is measured based on meeting the discharge limits;

BUT meeting discharge limits has very little to do with achieving water quality goals for the Inlets.

THEREFORE an effective monitoring and assessment program is needed to assess continuous process improvement and inform management decisions.

Key Questions

1. Are beneficial uses of Sinclair Inlet being protected?
2. Are discharges from all sources of contamination into Sinclair and Dyes Inlets impacting the quality of water, sediment, and biota in the Inlets?
3. What is the status and trend of water, stormwater, sediment, and biota residue quality in Sinclair and Dyes Inlets?

Sampling and Analysis Plan for Ambient Monitoring and Toxicity Testing for Sinclair and Dyes Inlets, Puget Sound, Washington

Objectives

1. Develop procedures needed to meet ambient monitoring requirements
    a) Water
        a) Receiving Water
        b) Effluents
        c) Stormwater
    b) Sediment
    c) <u>Biota (Mussel Watch)</u>
    d) Bacteria (FC)
2. Coordinate with other regional monitoring programs

ENVVEST Mussel Watch Sampling

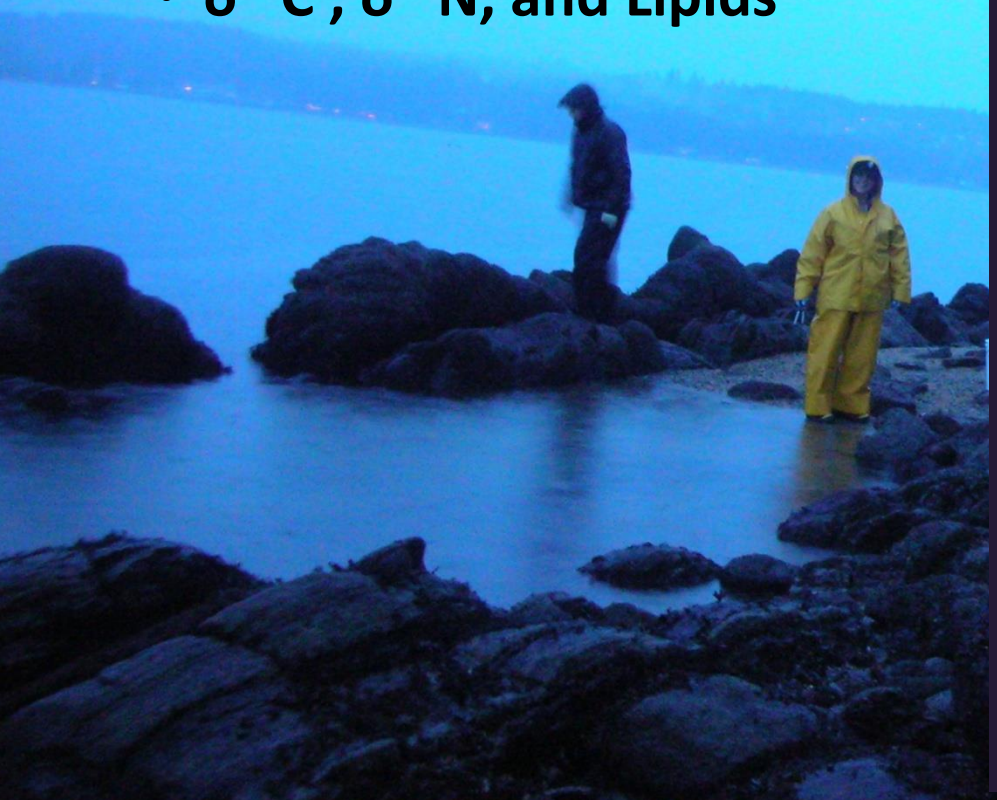
Partnering with WDFW and Local Stakeholders

Coordinated with National Mussel Watch Program

West Coast Sampling Winter of Even Years (Winter 2010 and 2012)

Representative Sampling Site Locations

- **3 Stations/Site, Size Distribution**
- **Composite Sample for Chemistry**
  - **Metals, PAHs, PCBs**
  - **$\delta^{13}C$, $\delta^{15}N$, and Lipids**



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
US Navy Puget Sound Naval Shipyard & IMF
Washington Department of Fish and Wildlife
Washington State Parks Illahee

National Mussel Watch Program

PROGRAM DESIGN

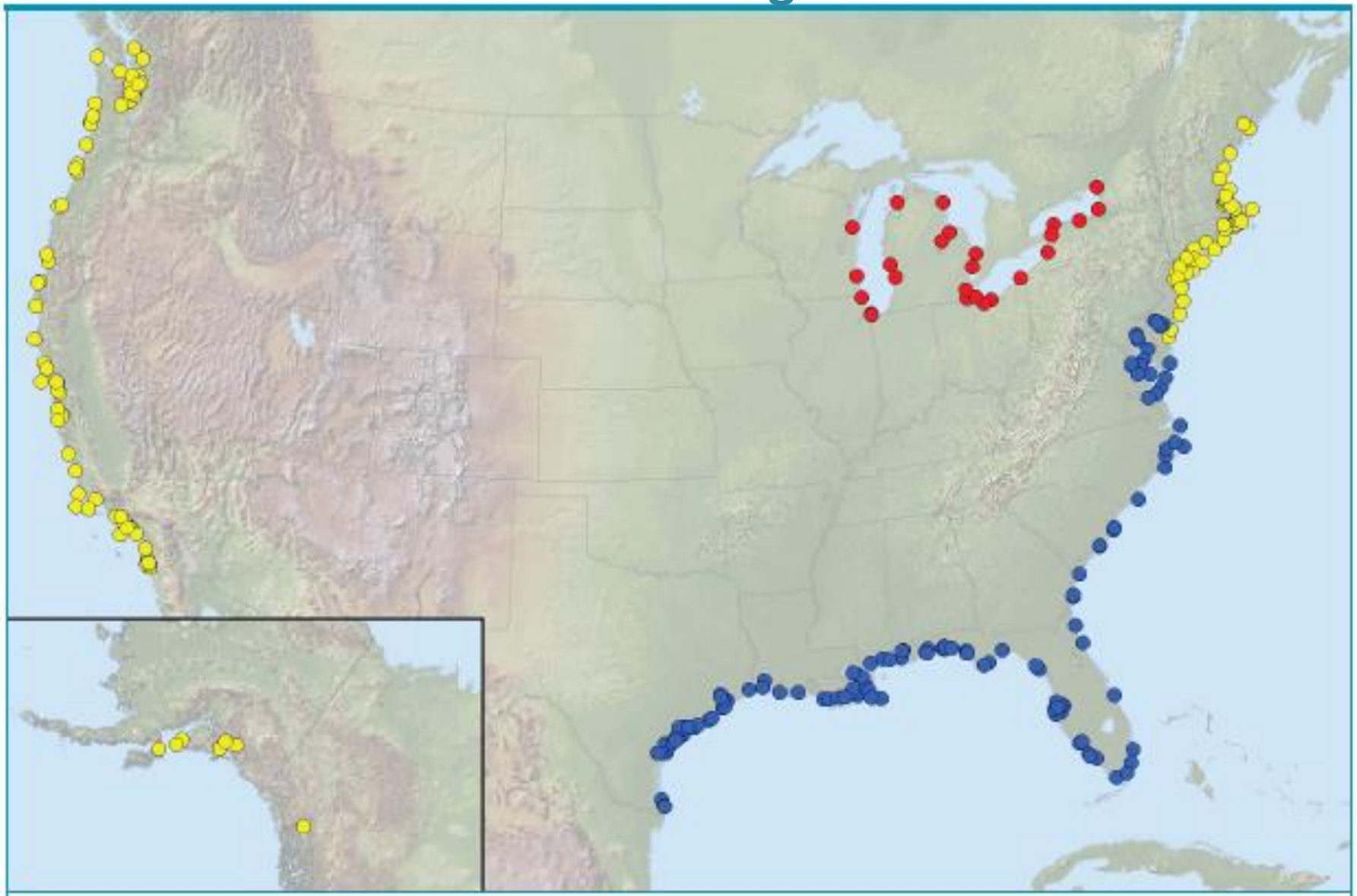
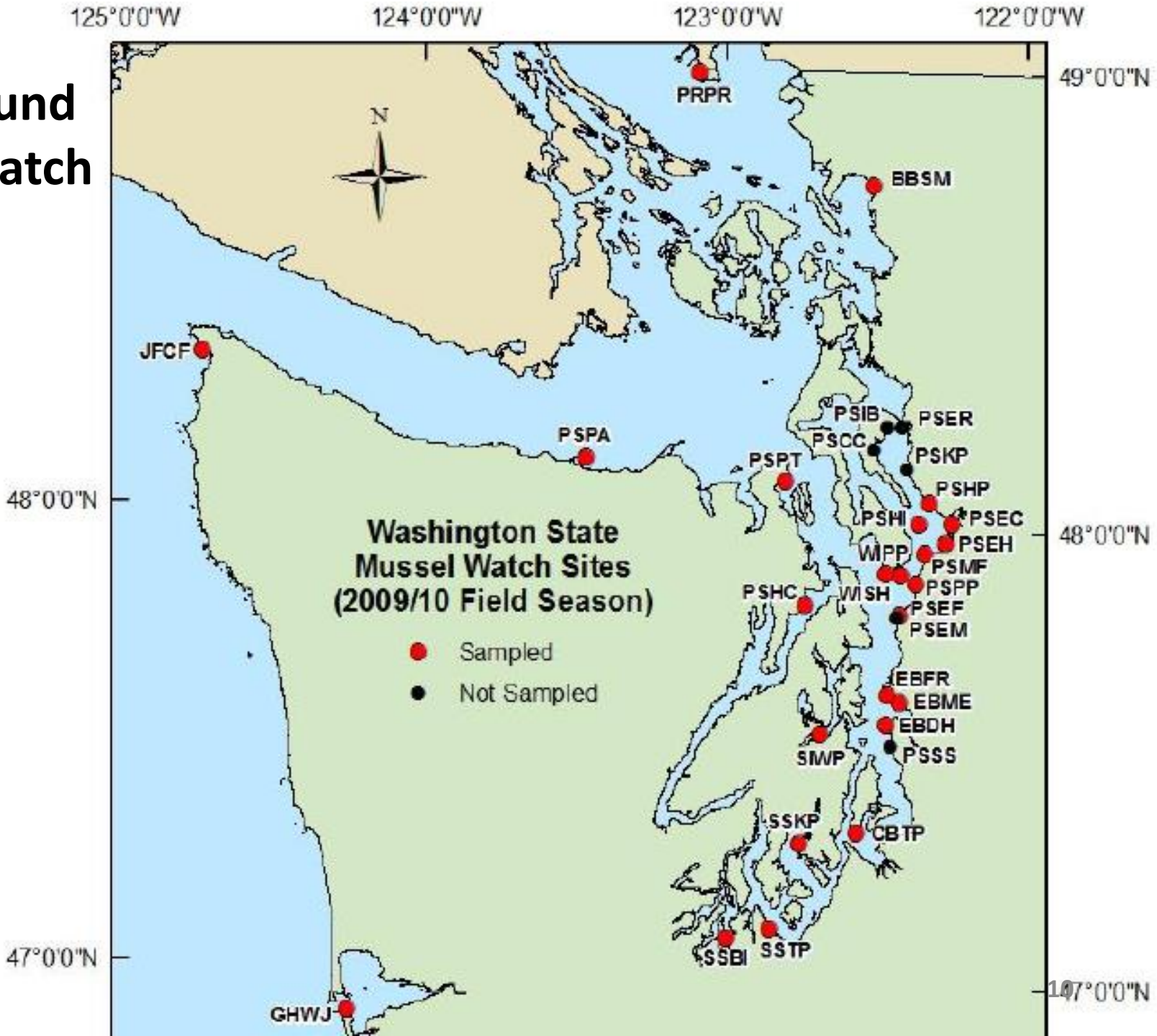
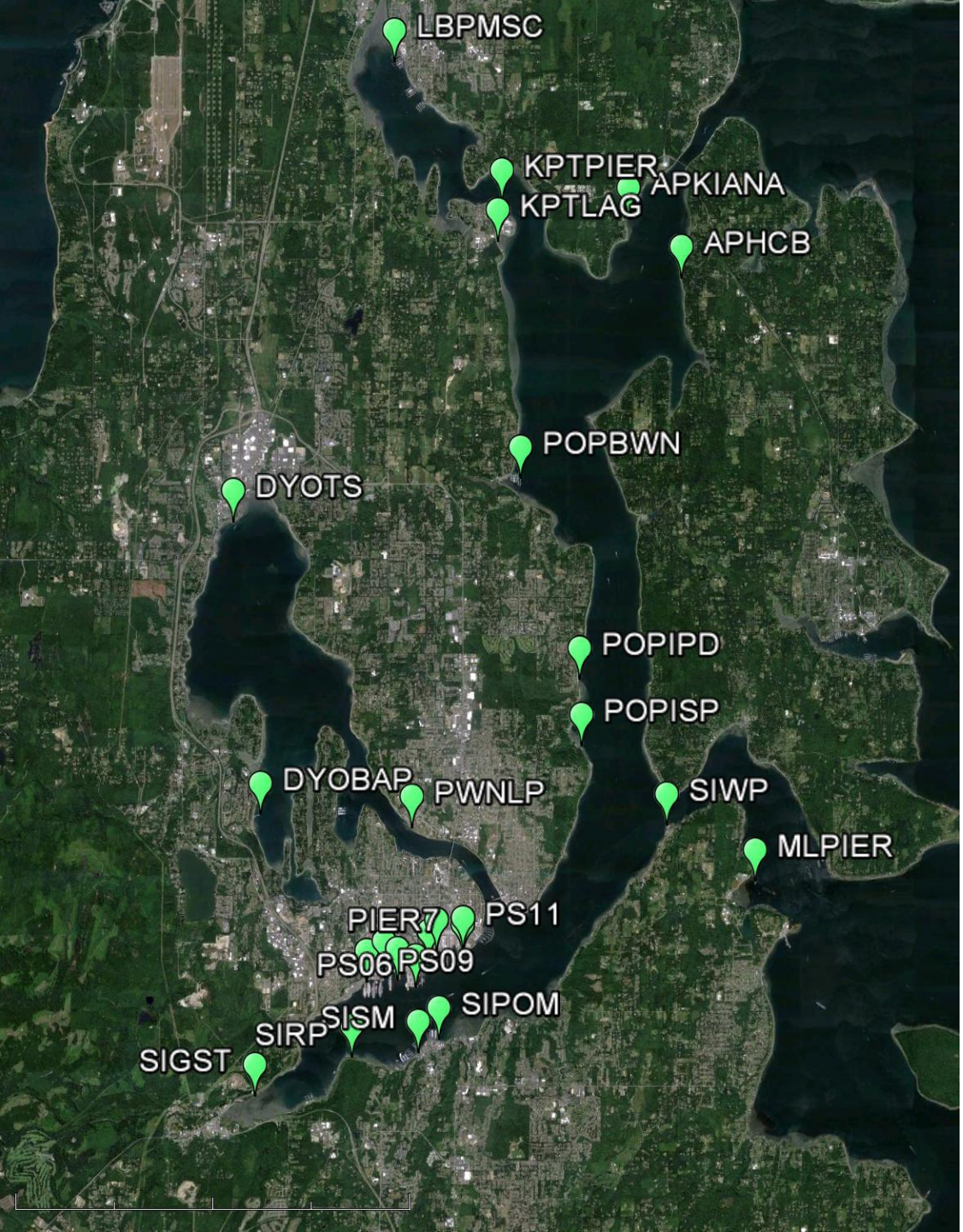


FIGURE 1. Distribution of oysters (*Crassostrea virginica*), mussels (*Mytilus species*), and zebra mussels (*Dreissena species*) collected and measured as part of the Mussel Watch Program.

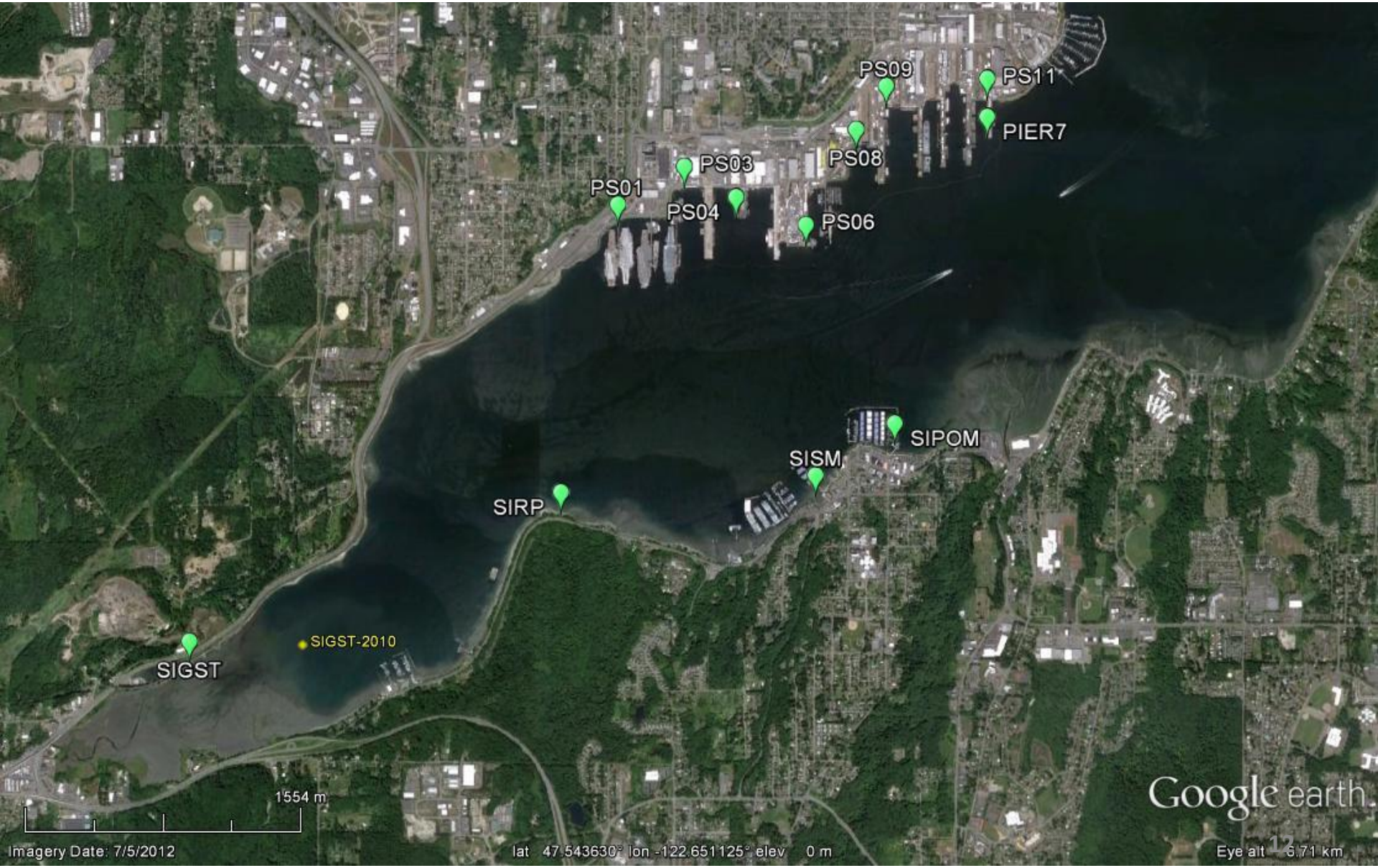
Puget Sound Mussel Watch



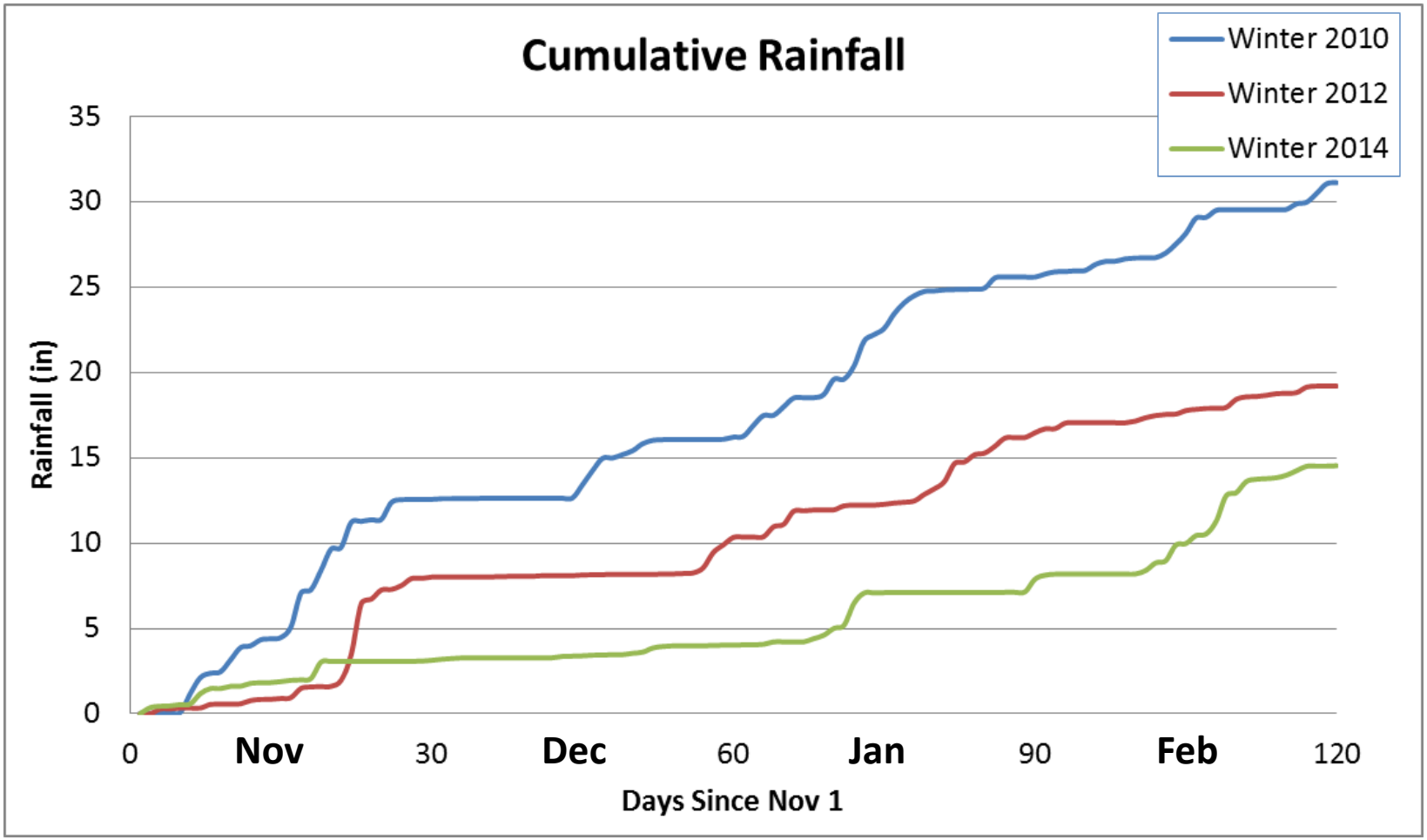
ENVVEST Mussel Watch Stations 2010 and 2012



Mussel Watch Sinclair Inlet



Winter Sampling Nov - Feb

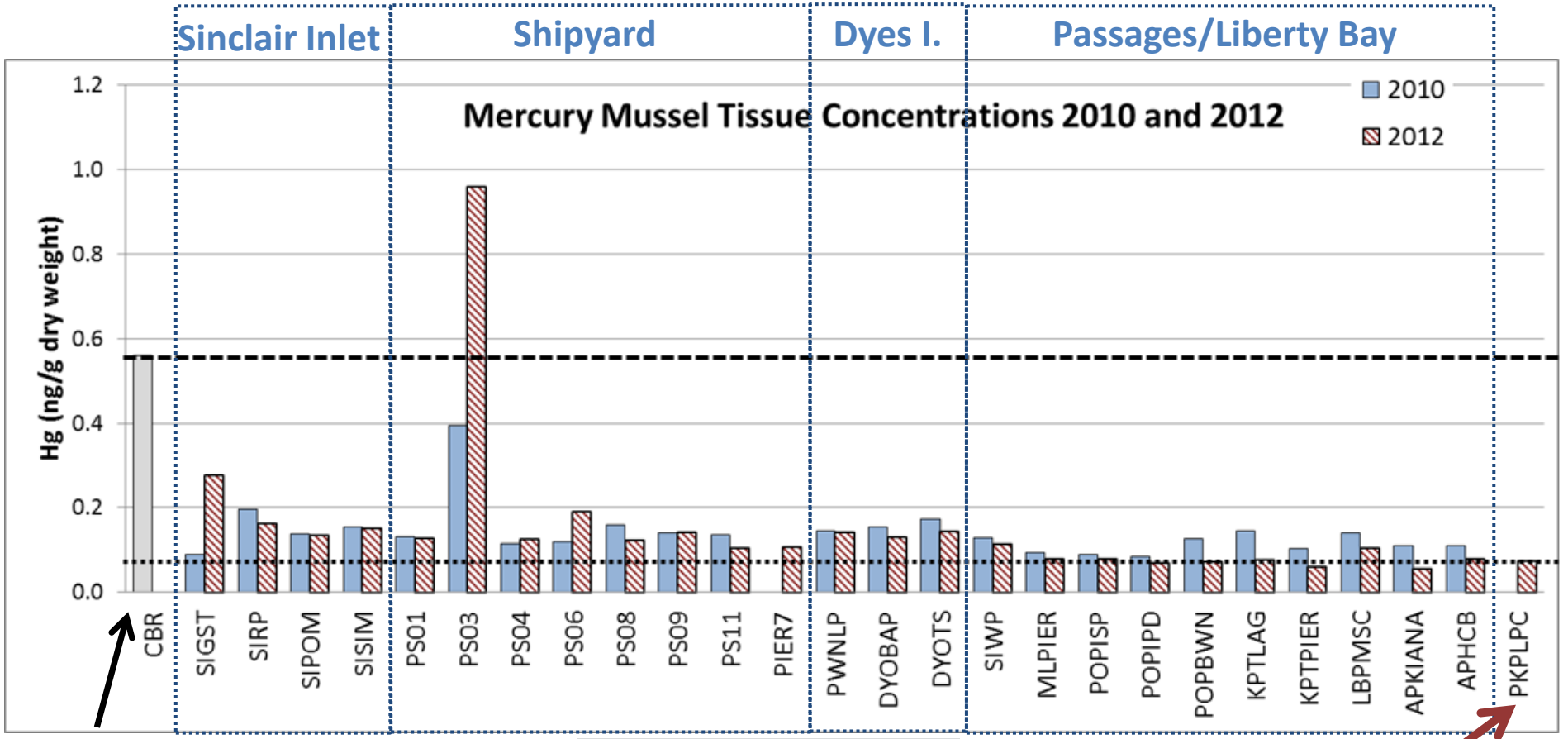


Sum of average daily rainfall reported from Kitsap County rain gauges (CoCoRaHS 2014)

ENVVEST Mussel Watch 2010 and 2012 Data Evaluation

- Possible Trend
  > 3x difference between 2010 and 2012
- Possible Source
  > 3x higher than other stations
- Possible Ecological Effect – Critical Body Residue
  $CBR_{HQ} > 2$; $CBR_{HQ} = Concentration/CBR_i$
  $CBR_{HI} > 10$; $CBR_{HI} = \Sigma CBR_{HQi}$ where i = 10
- Comparison to Seafood Market Sample
- Comparison to National Data Set
  - Low, Medium, and High Ranges

Hg



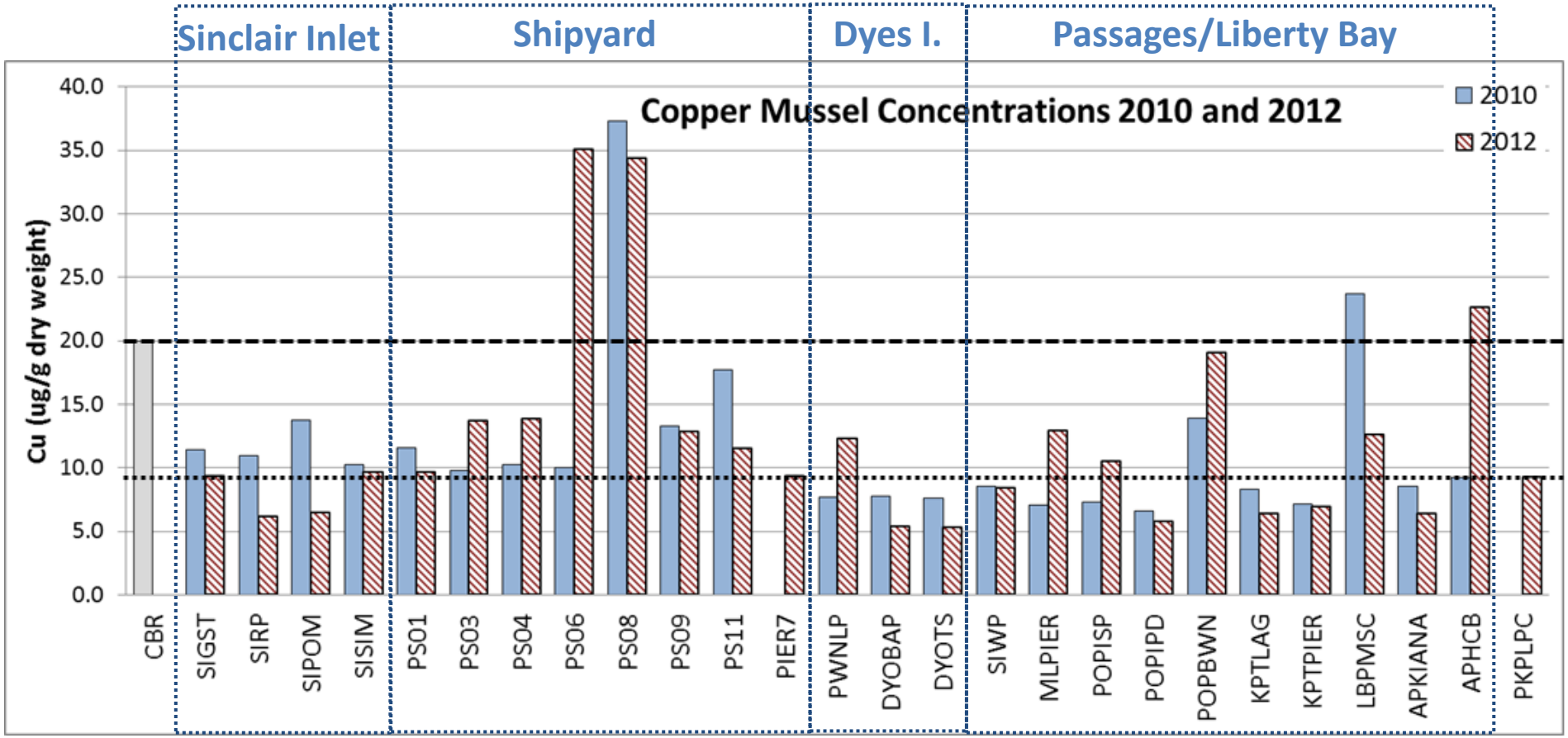
Critical Body Residue

National MW Range
ppm dry weight

	Hg
Low	0.00 - 0.17
Medium	0.18 - 0.35
High	0.36 - 1.28

Seafood Market (Penn Cove, Whidbey Island)

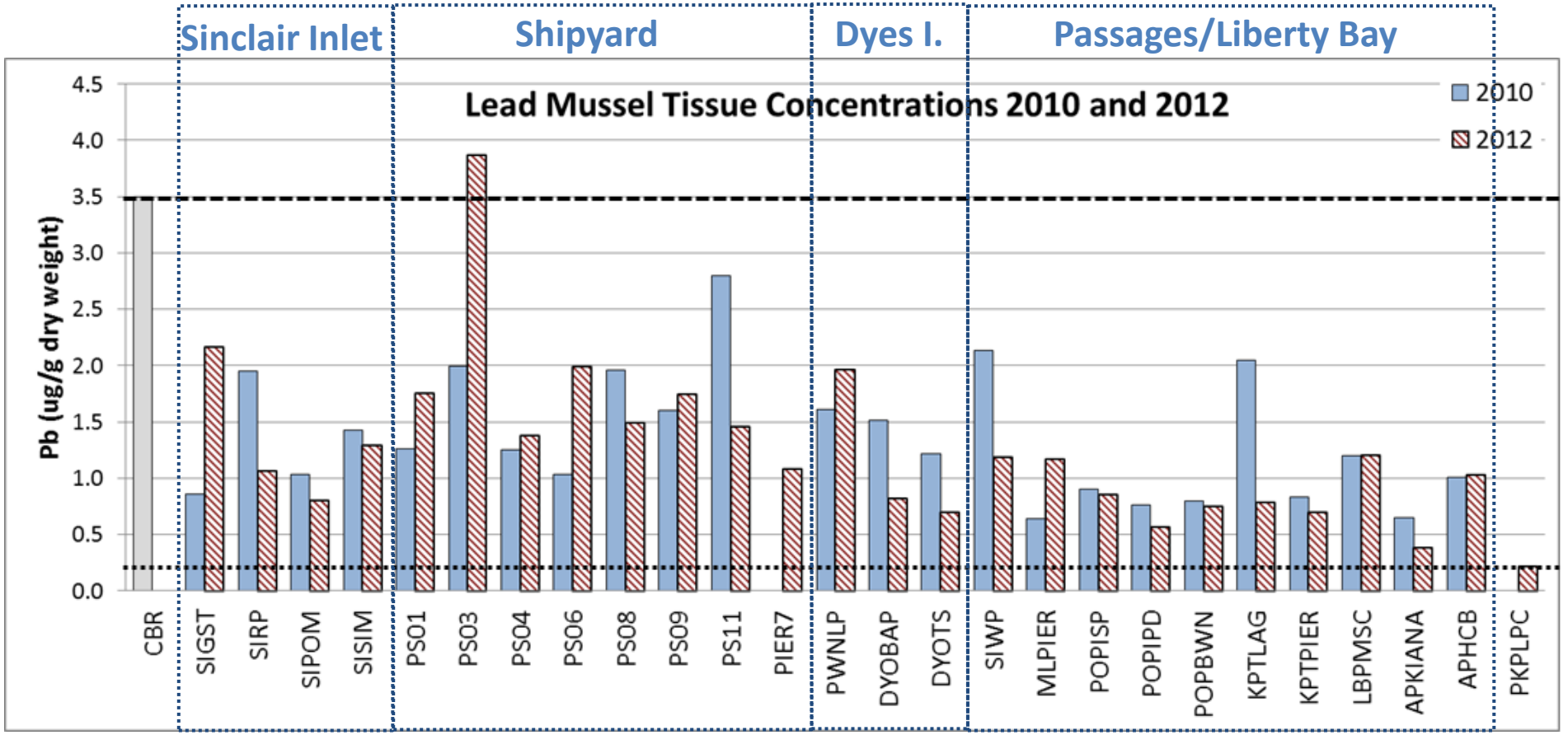
Cu



National MW Range
ppm dry weight

	Cu
Low	5 - 16
Medium	17 - 39
High	40 - 857

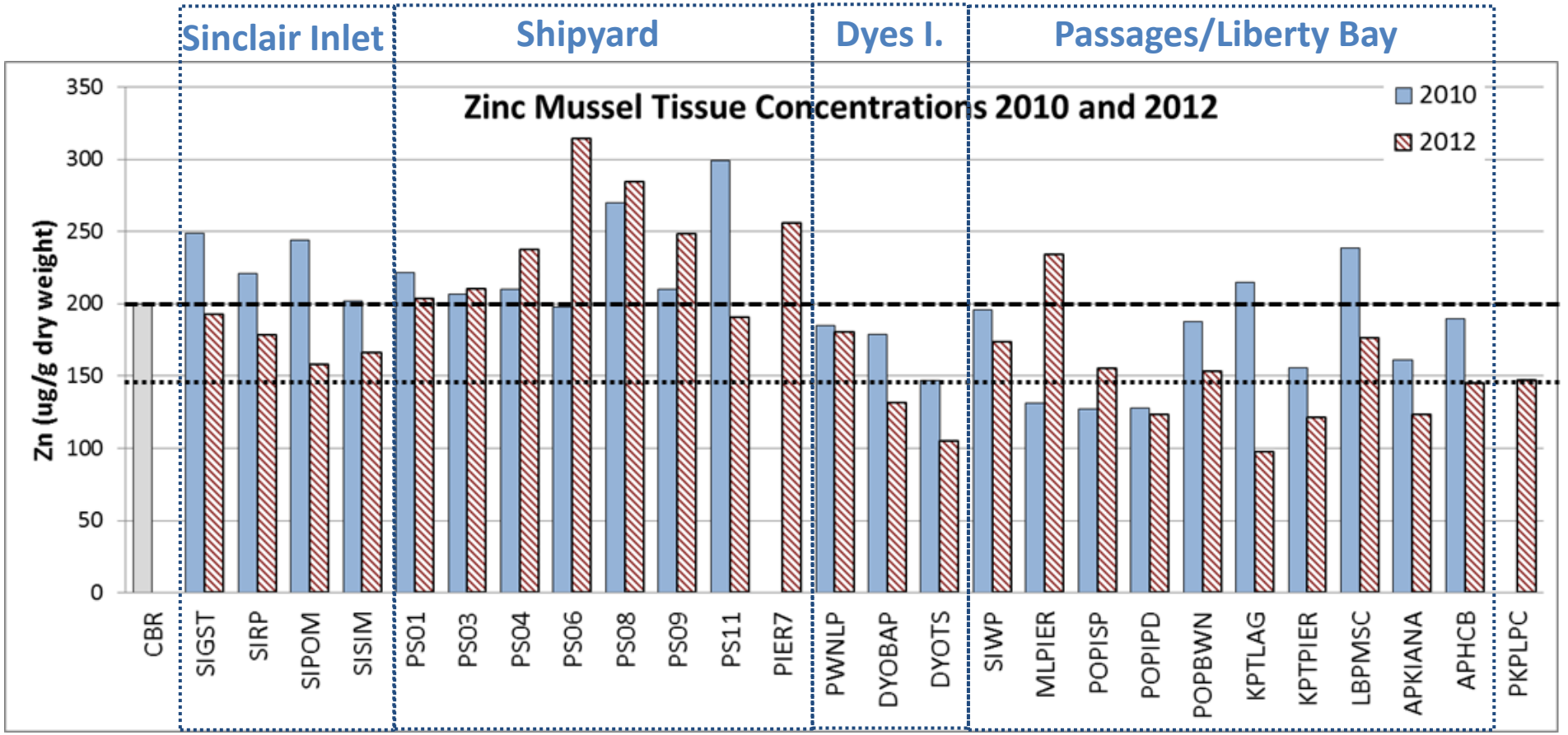
Pb



National MW Range
ppm dry weight

	Pb
Low	0 - 3
Medium	4 - 6
High	7 - 13

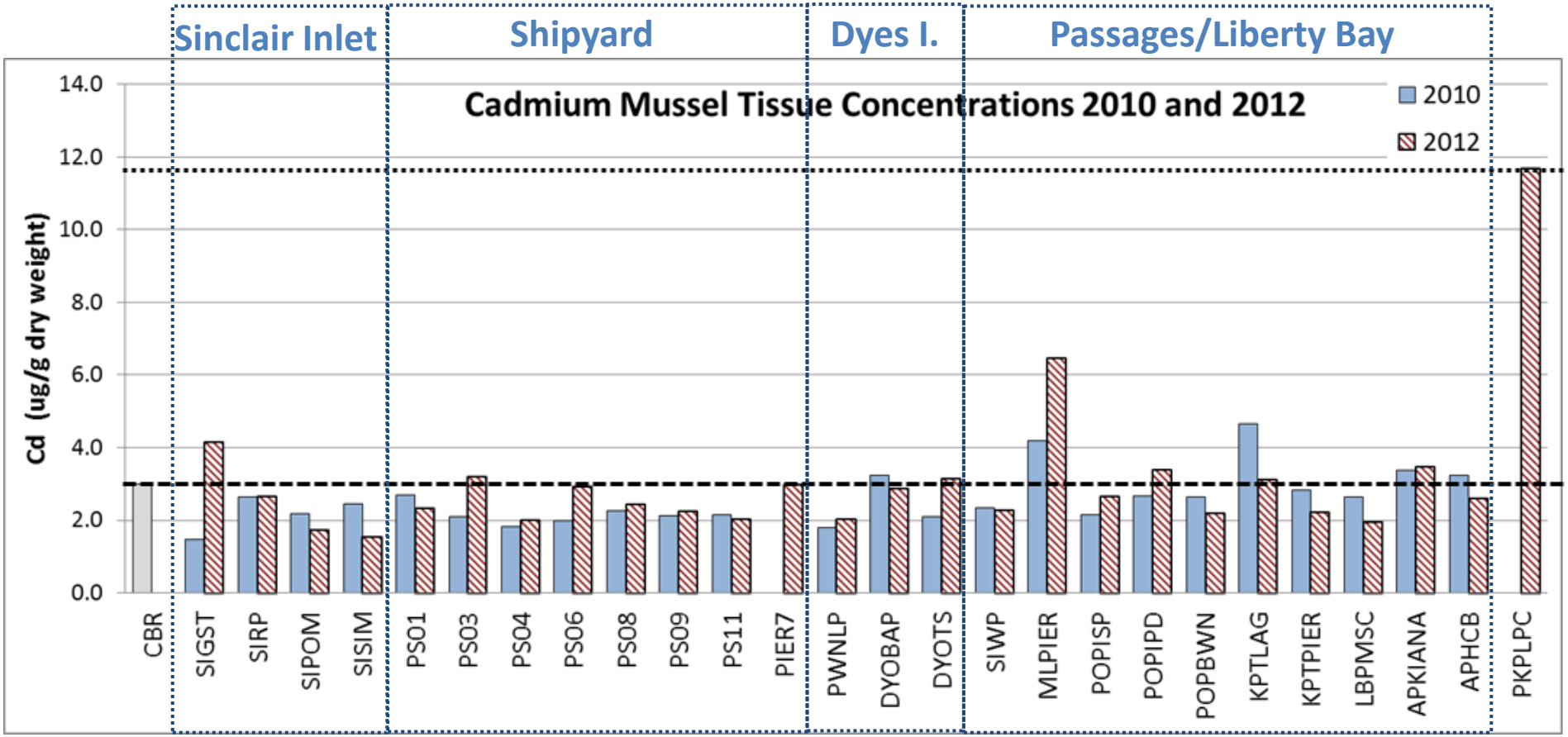
Zn



National MW Range
ppm dry weight

	Zn
Low	48 - 139
Medium	140 - 320
High	321 - 11500

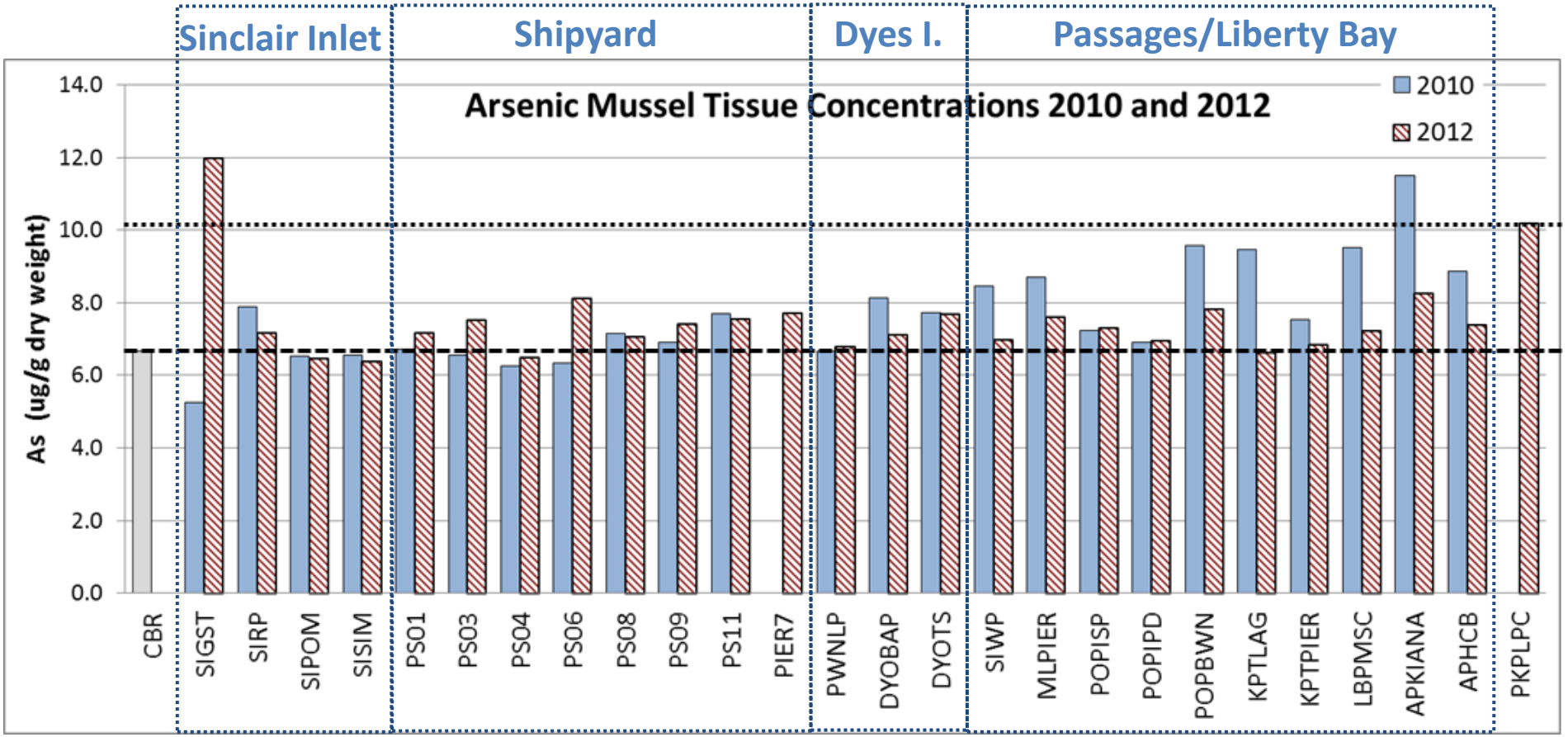
Cd



National MW Range
ppm dry weight

	Cd
Low	0 - 3
Medium	4 - 9
High	10 - 12

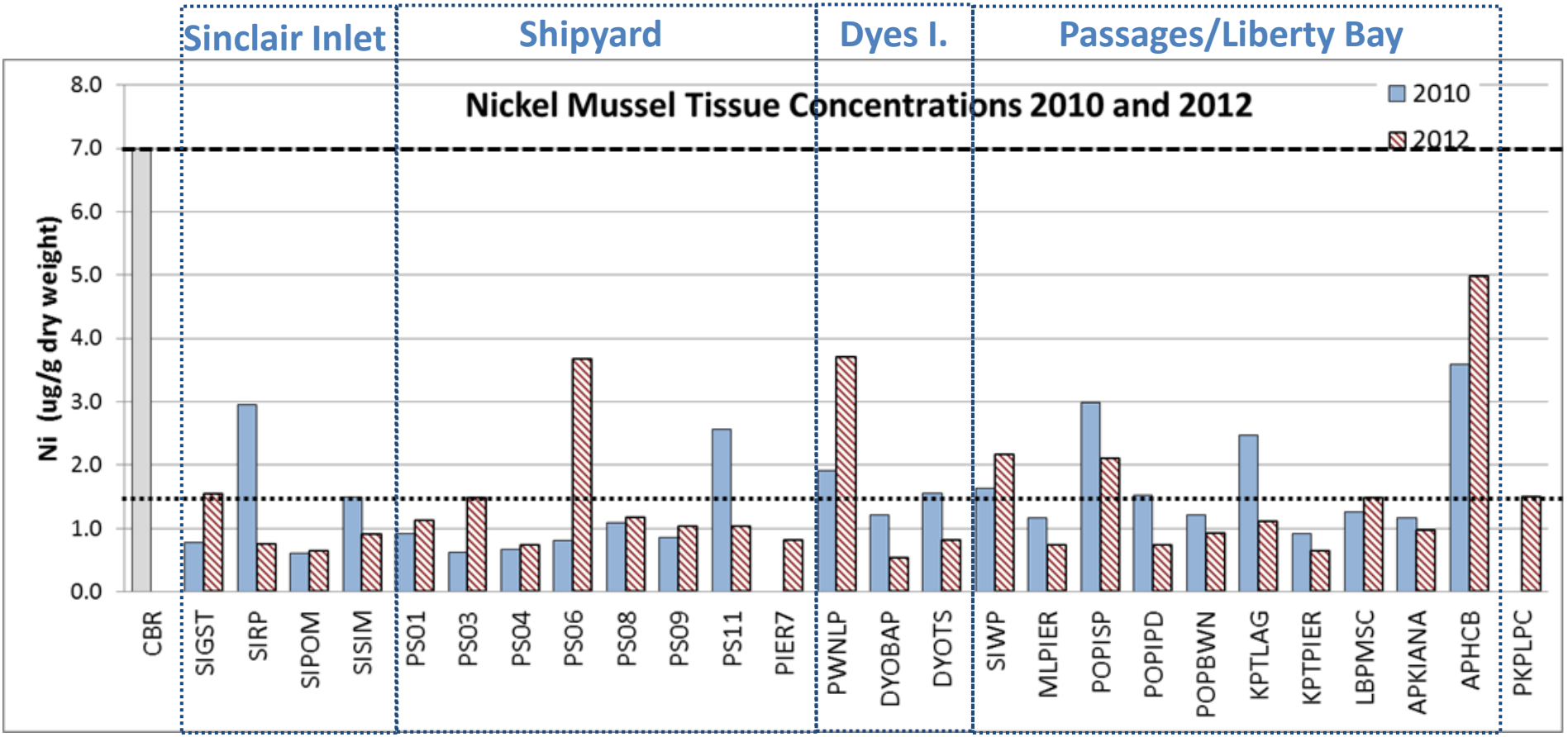
As



National MW Range
ppm dry weight

	As
Low	5 - 11
Medium	12 - 22
High	23 - 41

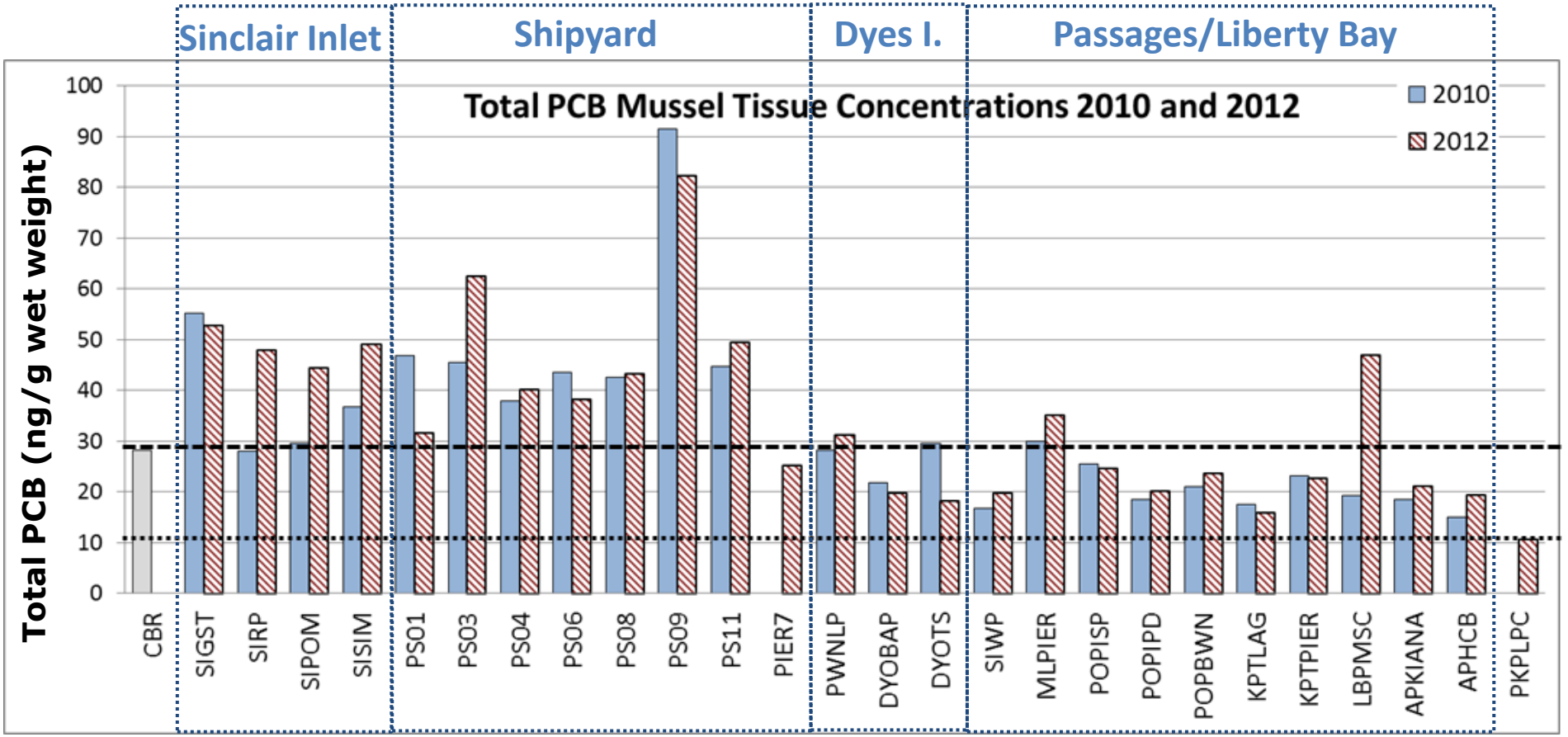
Ni



National MW Range
ppm dry weight

	Ni
Low	0 - 5
Medium	6 - 14
High	15 - 44

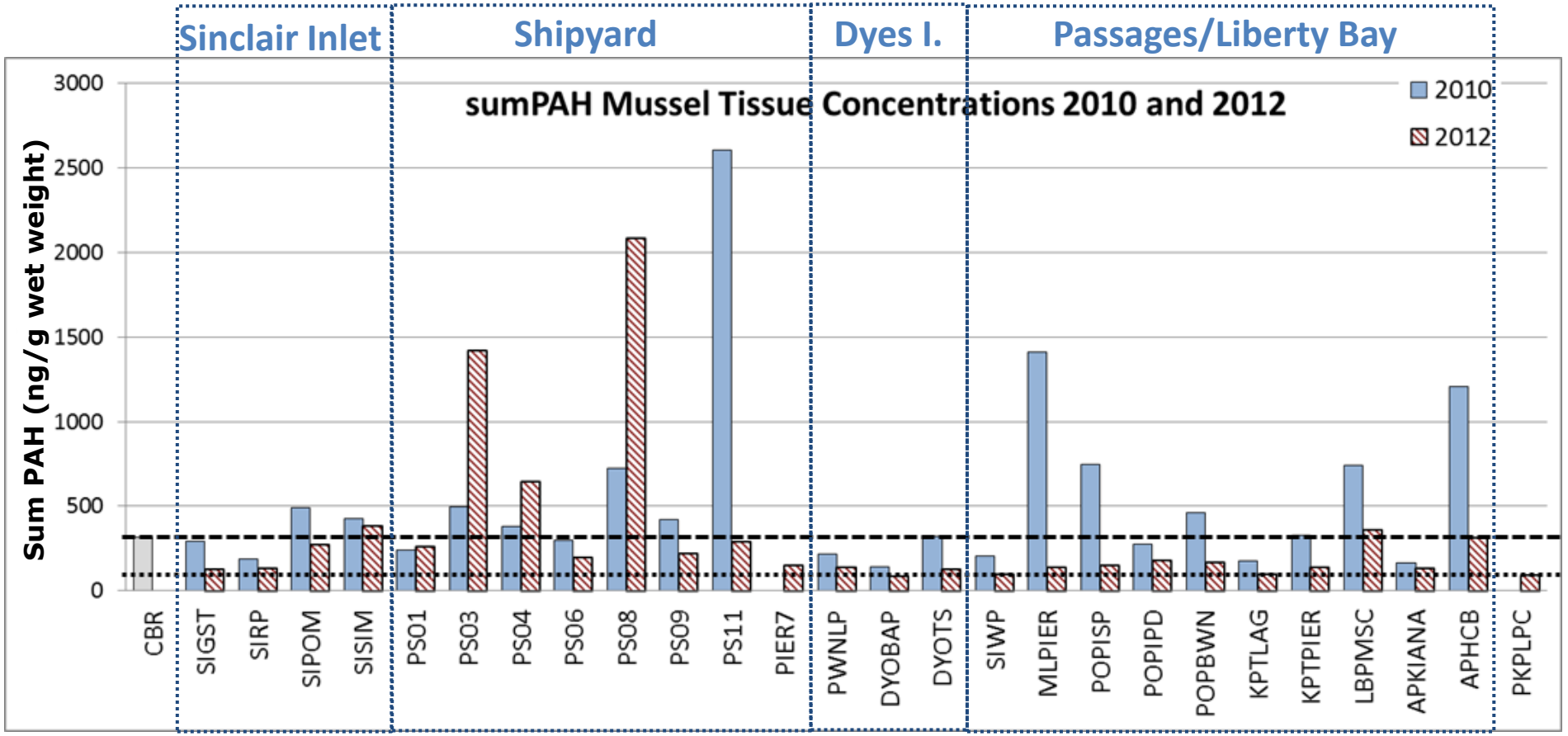
Total PCB



National MW Range
ppb wet weight

	PCBs
Low	0.4 - 21.3
Medium	21.5 - 66.6
High	66.8 - 197

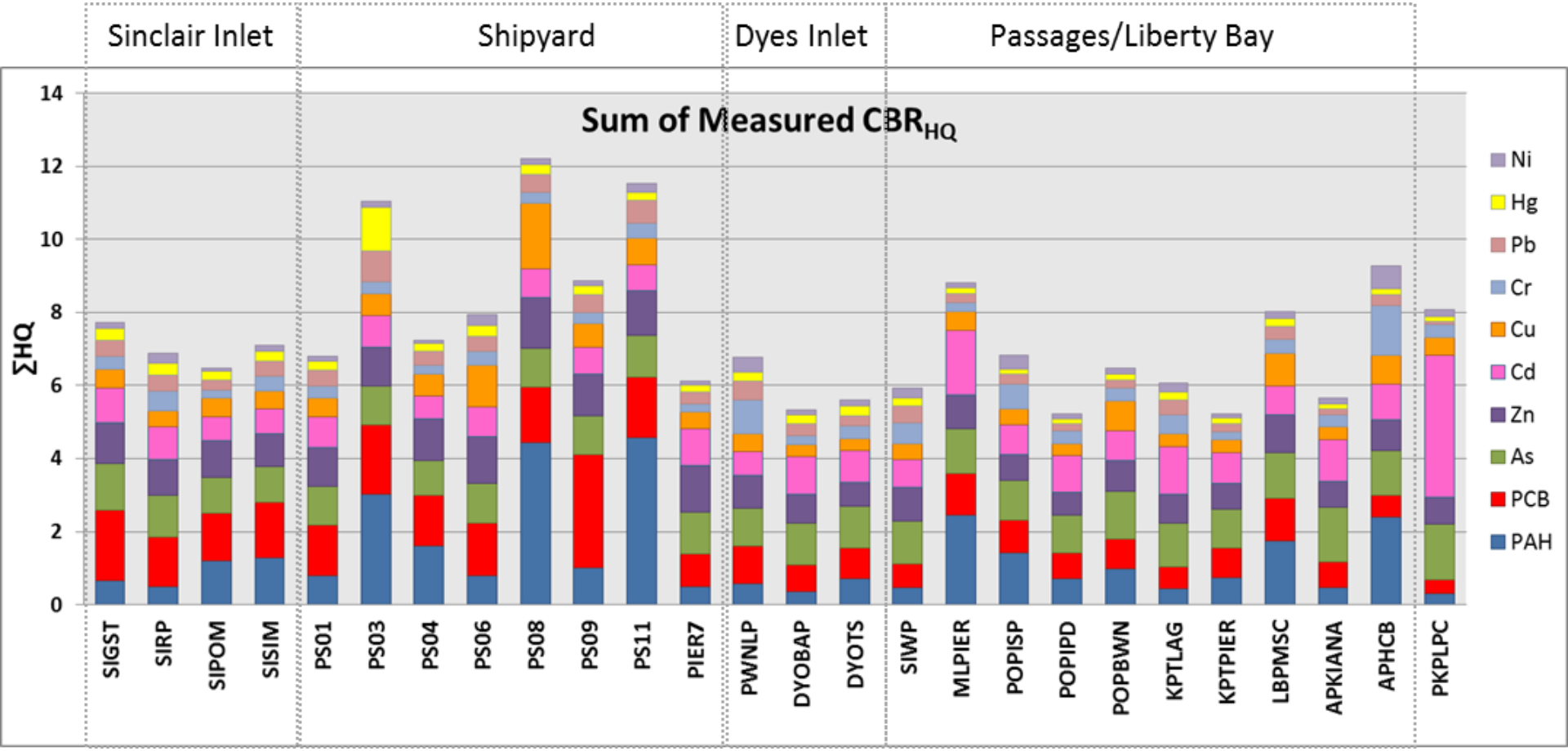
Sum PAH



National MW Range
ppb wet weight

	PAHs
Low	9 - 165
Medium	166 - 618
High	618 - 1054

Hazard Index for Critical Body Residues



Possible Ecological Effect – Critical Body Residue

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

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

Summary of ENVVEST Mussel Watch 2010-2012 Findings

Possible Trend

Hg increasing at two sites (Sinclair Inlet and Shipyard)

PAHs decreasing (creosote piling removal and better sampling technique)

Possible Source

One site for Hg and one site for Cu (Shipyard)

PAHs - two sites in Shipyard and one in Port Orchard Passage

Possible Ecological Effect – Critical Body Residue

Three sites within the Shipyard (driven by PAHs, Hg, and Cu)

Comparison to Seafood Market Sample

Cd higher in market sample

Hg and PCBs higher in Shipyard; Cu and PAHs higher in Shipyard and Marinas; Pb higher in East Kitsap

Comparison to National Data Set

Low to Medium Ranges for most contaminants except for:

High Range for Hg at one site and PCBs for two sites in Shipyard and PAHs associated with creosote

Conclusions

- Monitoring Program is focused on tracking environmental quality in the Inlets
  - Can identify problems for further investigation and correction
  - Can be used to evaluate effectiveness of corrective actions
- What are the Biota Telling Us?
  - Some Areas were elevated with PAHs, PCBs, and metals
  - 3 of 24 sites had increased risk of ecological effects
  - Contaminants of concern were PAHs (3 sites), PCBs (2 sites), Hg (1 site), and Cu (1 site)
- Monitoring framework provides context for interpretation
  - Better information = better management

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