Ambient monitoring to inform the protection of beneficial uses and achieve water quality goals in Sinclair and Dyes Inlets, Puget Sound, WA

Salish Sea Ecosystems Conference SSE3-260, Seattle, WA

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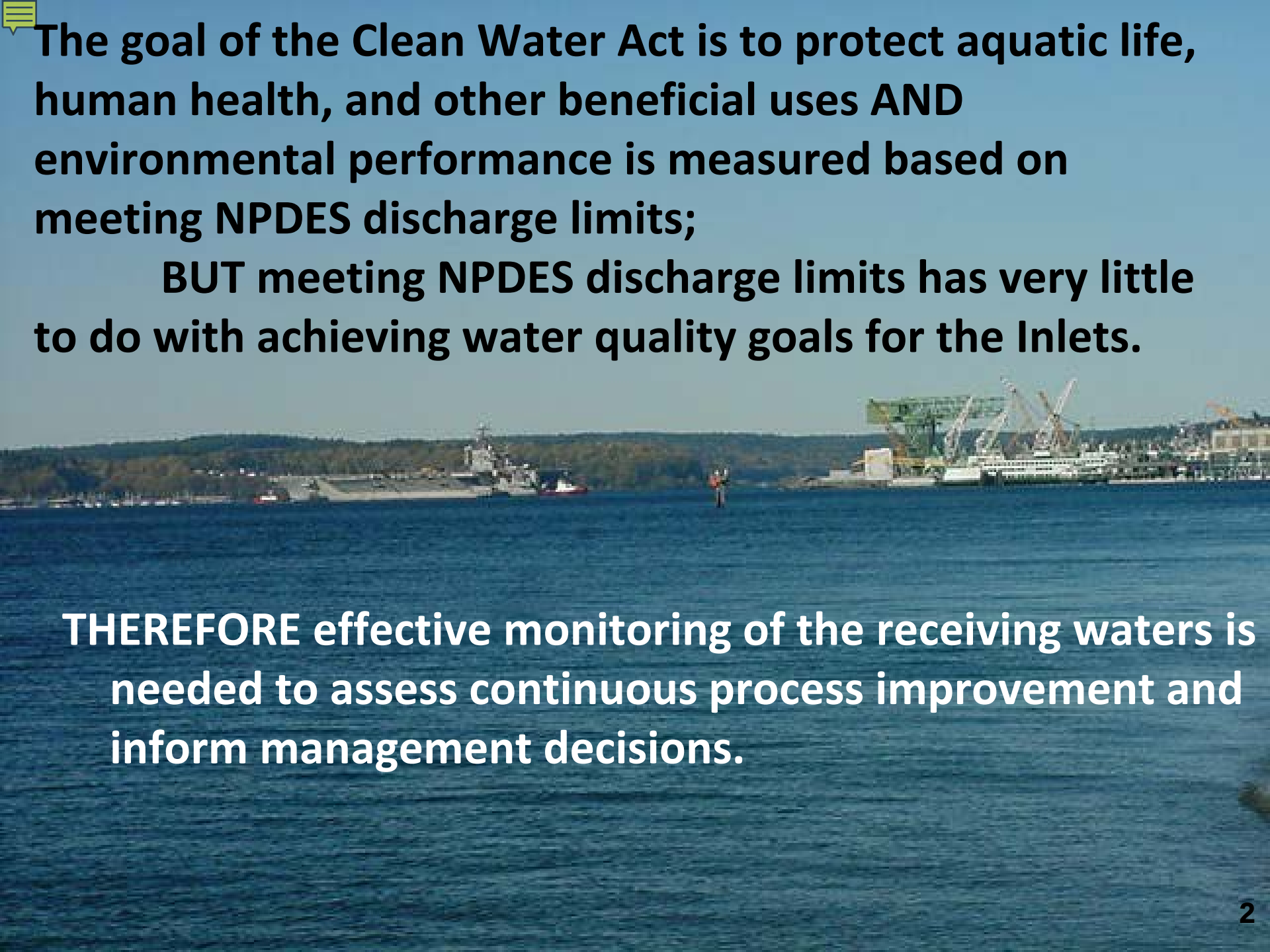
Outline of Talk

- Bottom Line
- Background
- Partnering on the Watershed Scale
- Improved Monitoring to Achieve Water Quality Goals
  - Ambient Monitoring and Toxicity Assessment
  - Mussel Watch
- Conclusions

This presentation reflects the personal views of the authors and does not suggest or reflect the official policy, practices, programs, or doctrine of the U.S. Navy or any other governmental agency.



The goal of the Clean Water Act is to protect aquatic life, human health, and other beneficial uses AND environmental performance is measured based on meeting NPDES discharge limits;

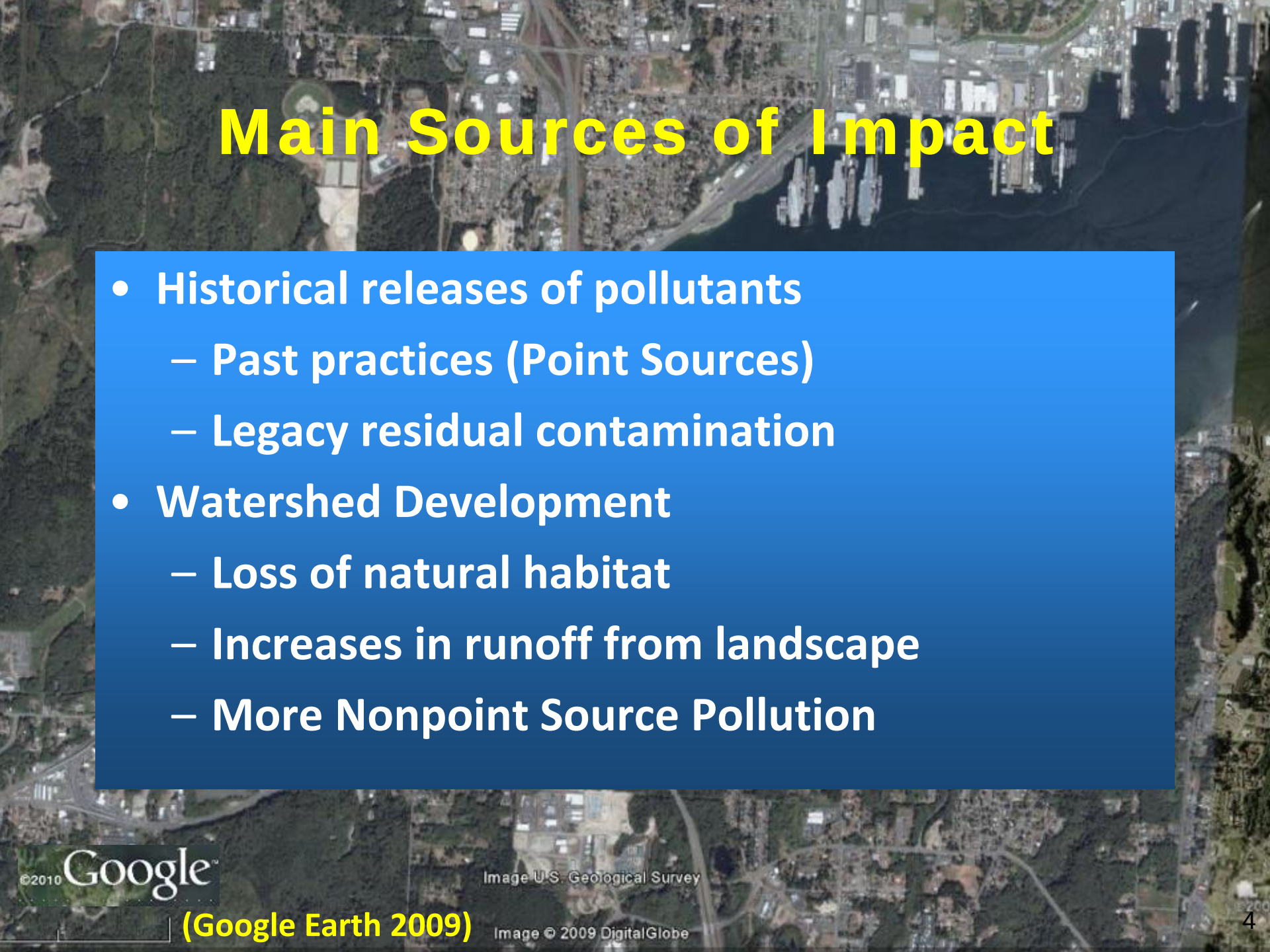
BUT meeting NPDES discharge limits has very little to do with achieving water quality goals for the Inlets.

THEREFORE effective monitoring of the receiving waters is needed to assess continuous process improvement and inform management decisions.


Pacific Ocean
Sinclair and Dyes Inlets
You Are Here

Main Sources of Impact

- Historical releases of pollutants
  - Past practices (Point Sources)
  - Legacy residual contamination
- Watershed Development
  - Loss of natural habitat
  - Increases in runoff from landscape
  - More Nonpoint Source Pollution

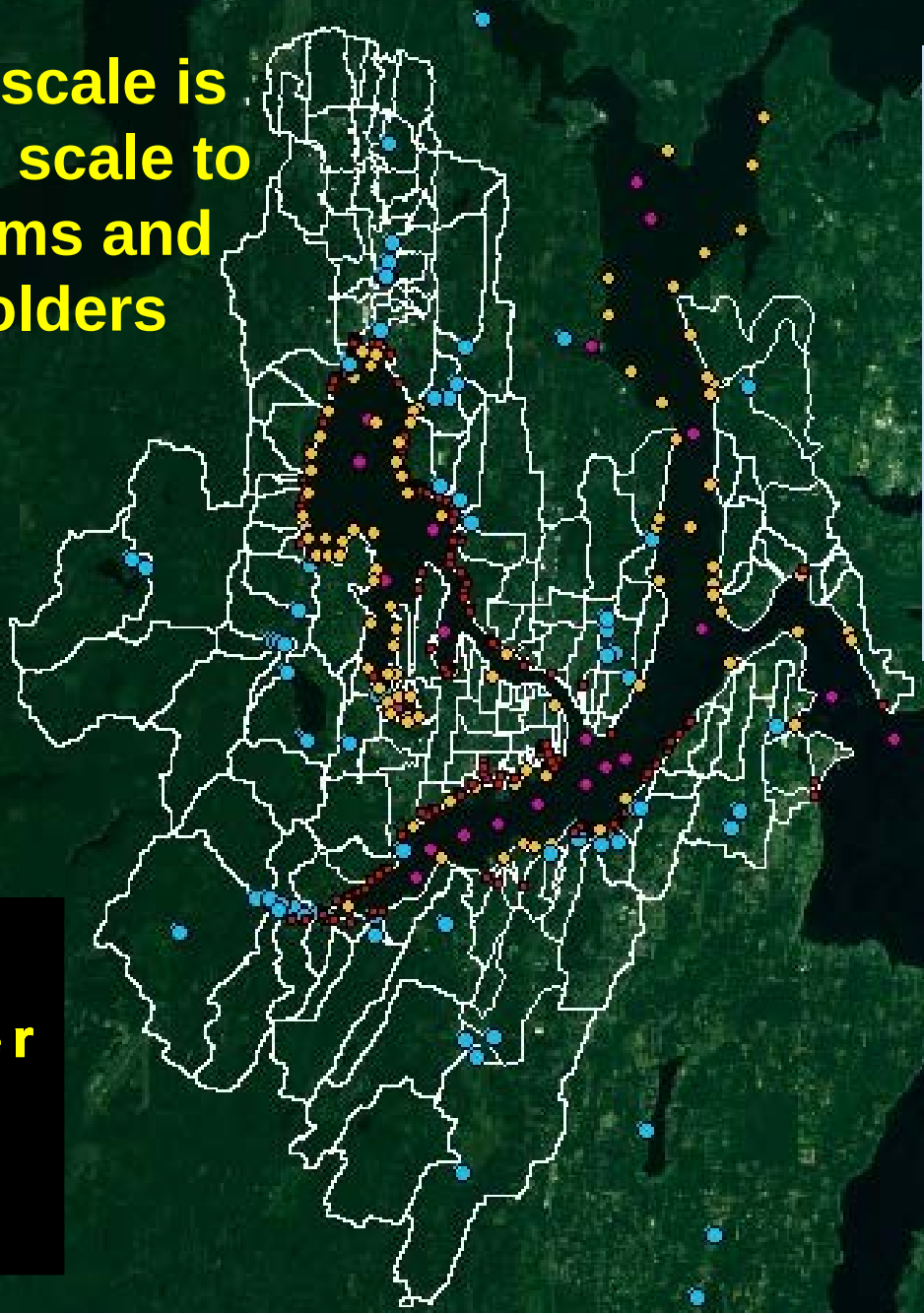


(Google Earth 2009)

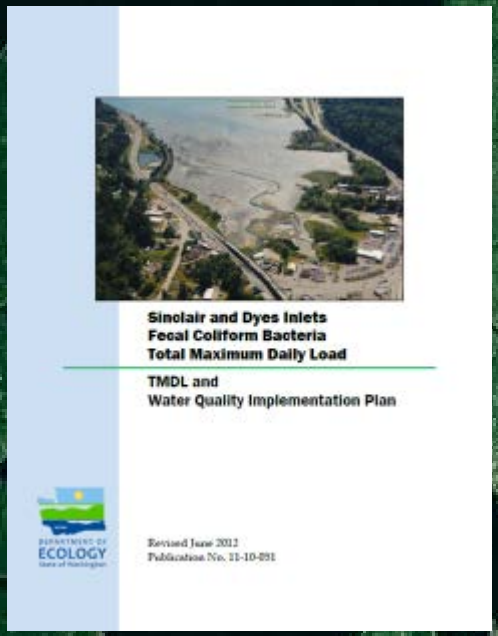
Partnering at the Watershed Scale

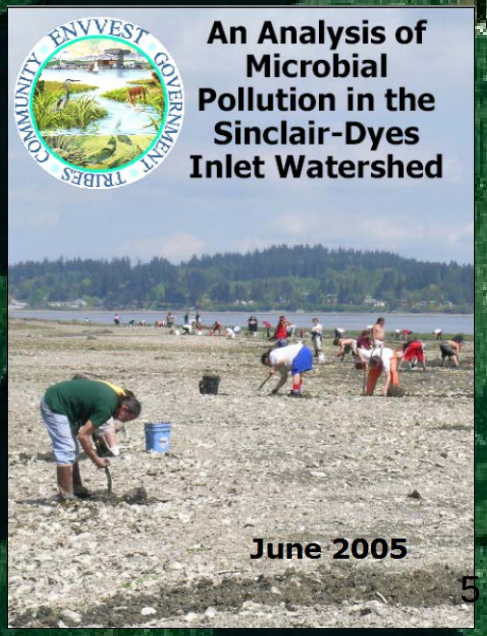
The watershed scale is the appropriate scale to address problems and engage stakeholders ENVironmental InVESTtment (ENVVEST)

- Navy
- EPA
- Ecology
- Stakeholders



- Stream
- Stormwater
- Nearshore
- Marine





ENVVEST Partnership Modeling

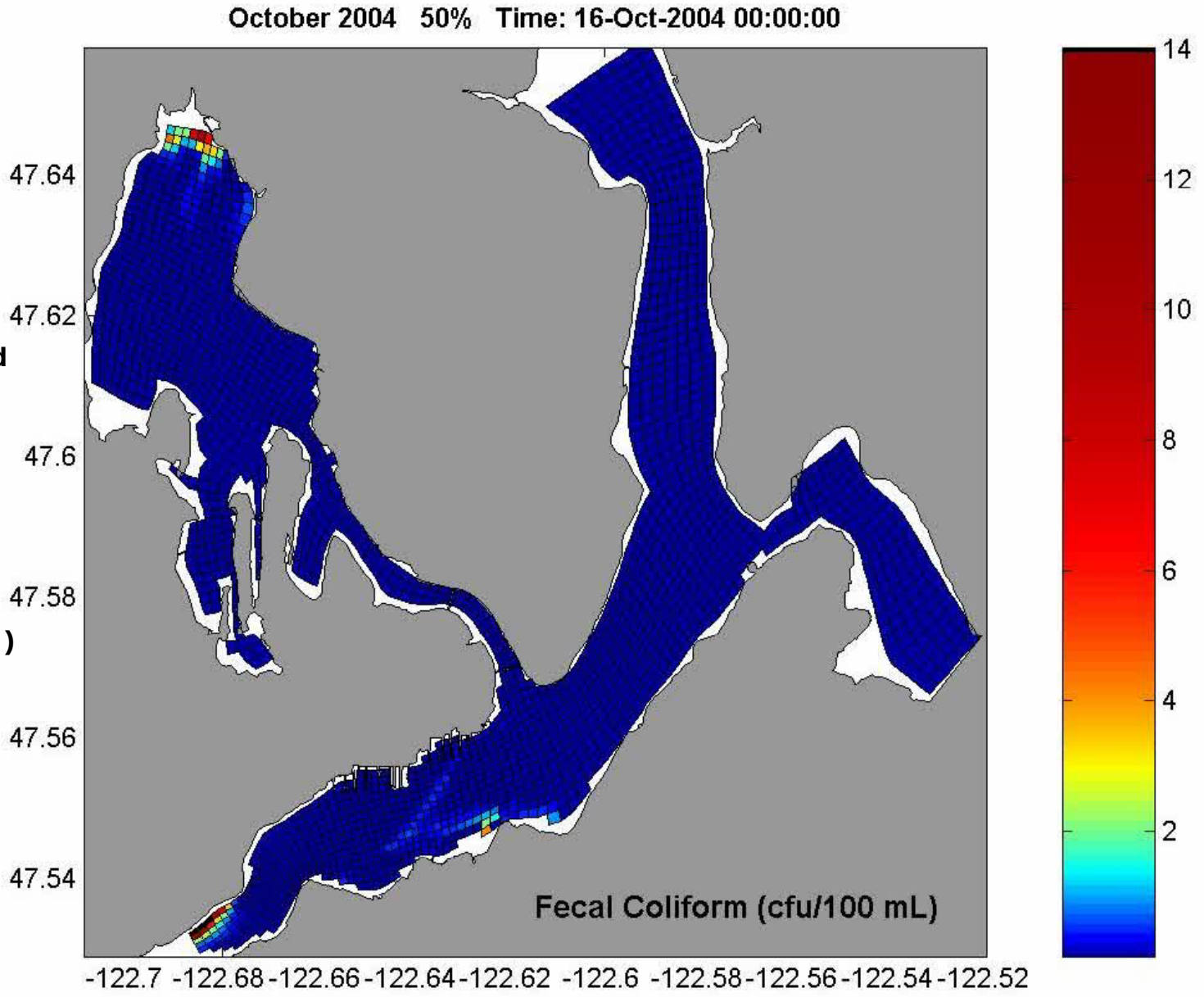
Simulation of Oct 2004 Storm Event

Color scale shows build up of contamination near creek mouths and nearshore areas with limited flushing

Upset condition occurred at Port Orchard treatment plant (10/19/04 10:00)

Effect of upset evident throughout Inlets

Short term effect as contamination is reduced by dispersion, mixing, and die off of harmful bacteria



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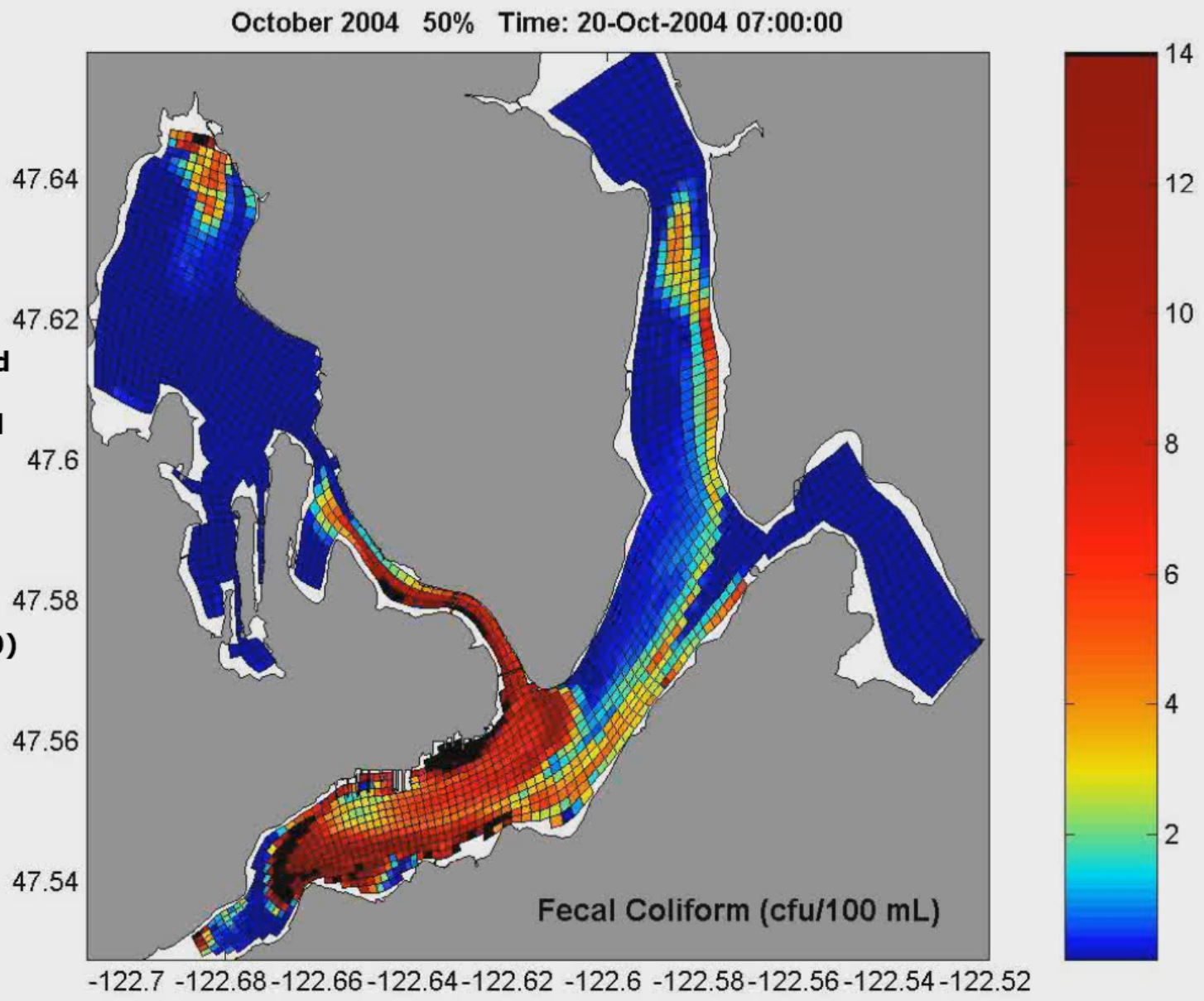


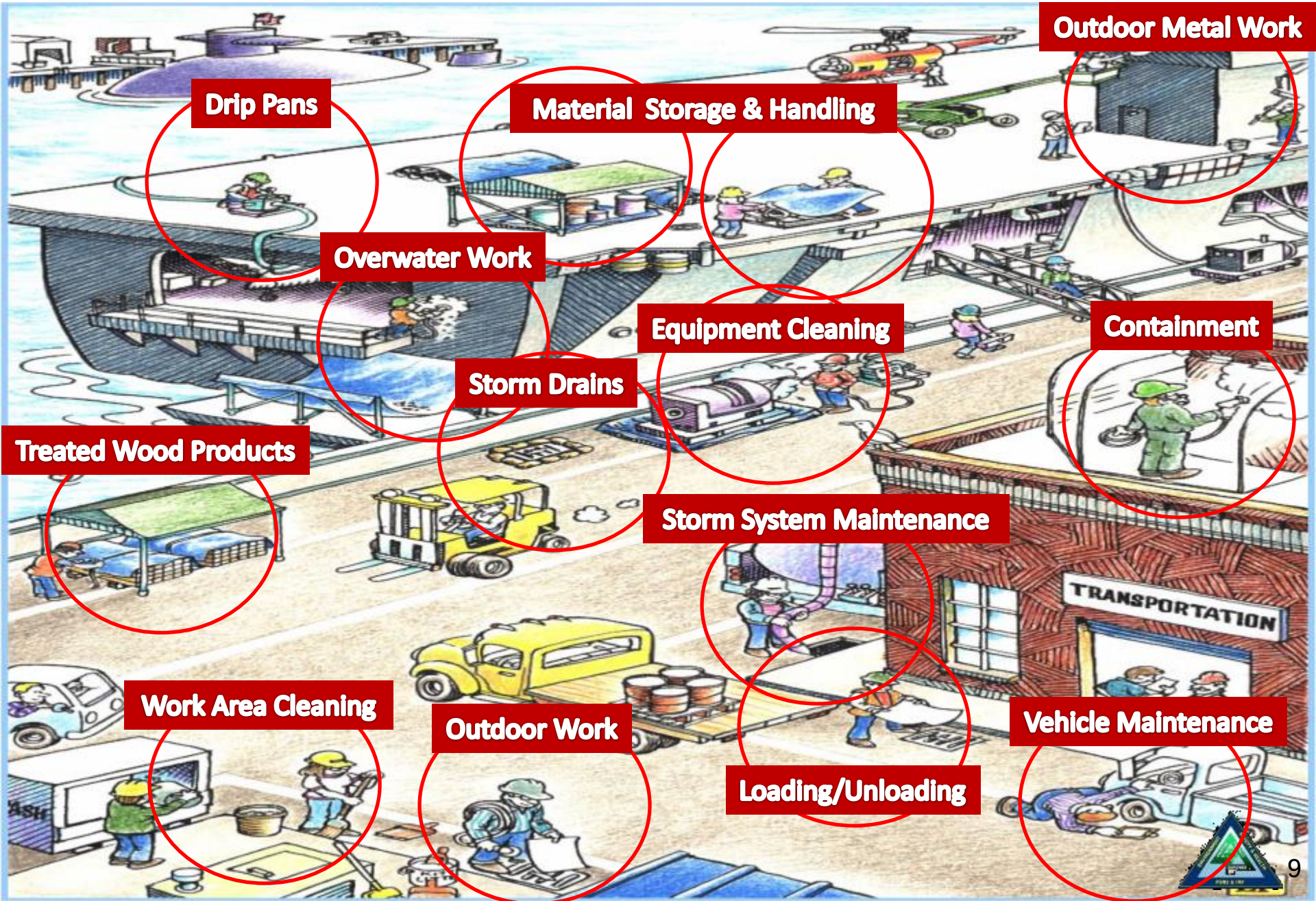
PSNS & IMF (Bremerton)

Shipyard Operation May 1992

(WA Dept. of Ecology Shoreline Photo)

Continuous Process Improvement!

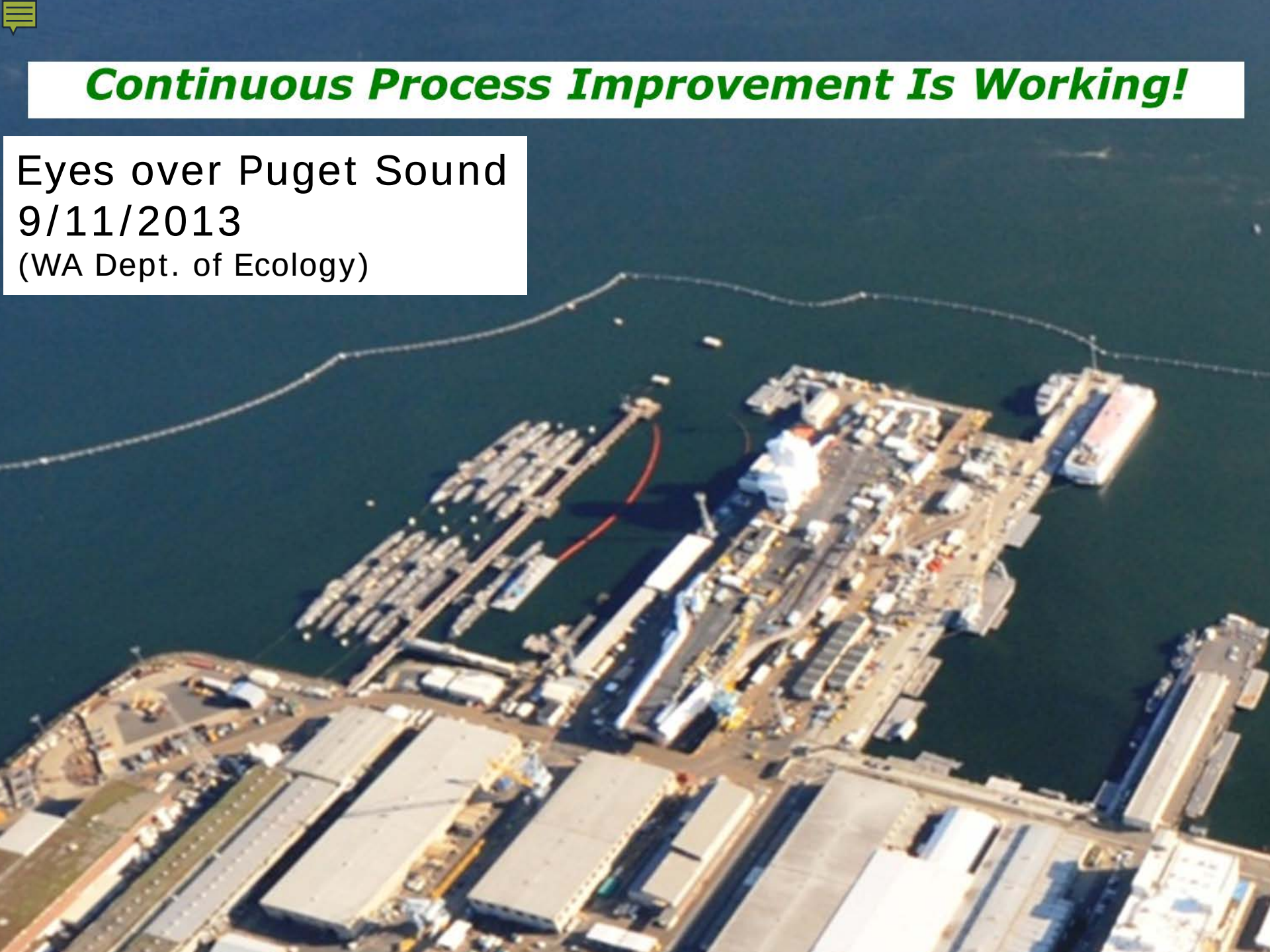
WATER POLLUTION PREVENTION BMPs



Continuous Process Improvement Is Working!

Continuous Process Improvement Is Working!

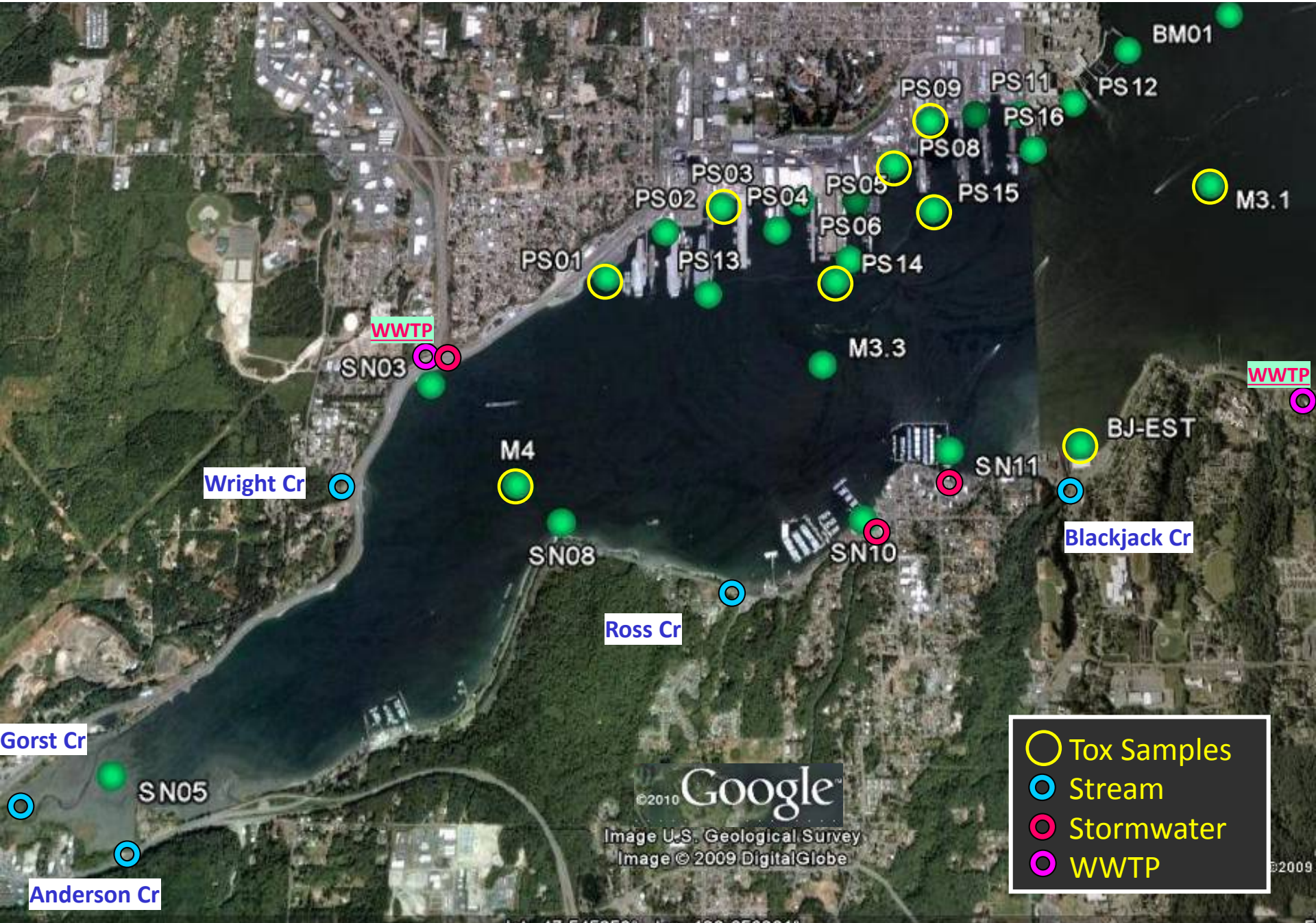
Eyes over Puget Sound
9/11/2013
(WA Dept. of Ecology)



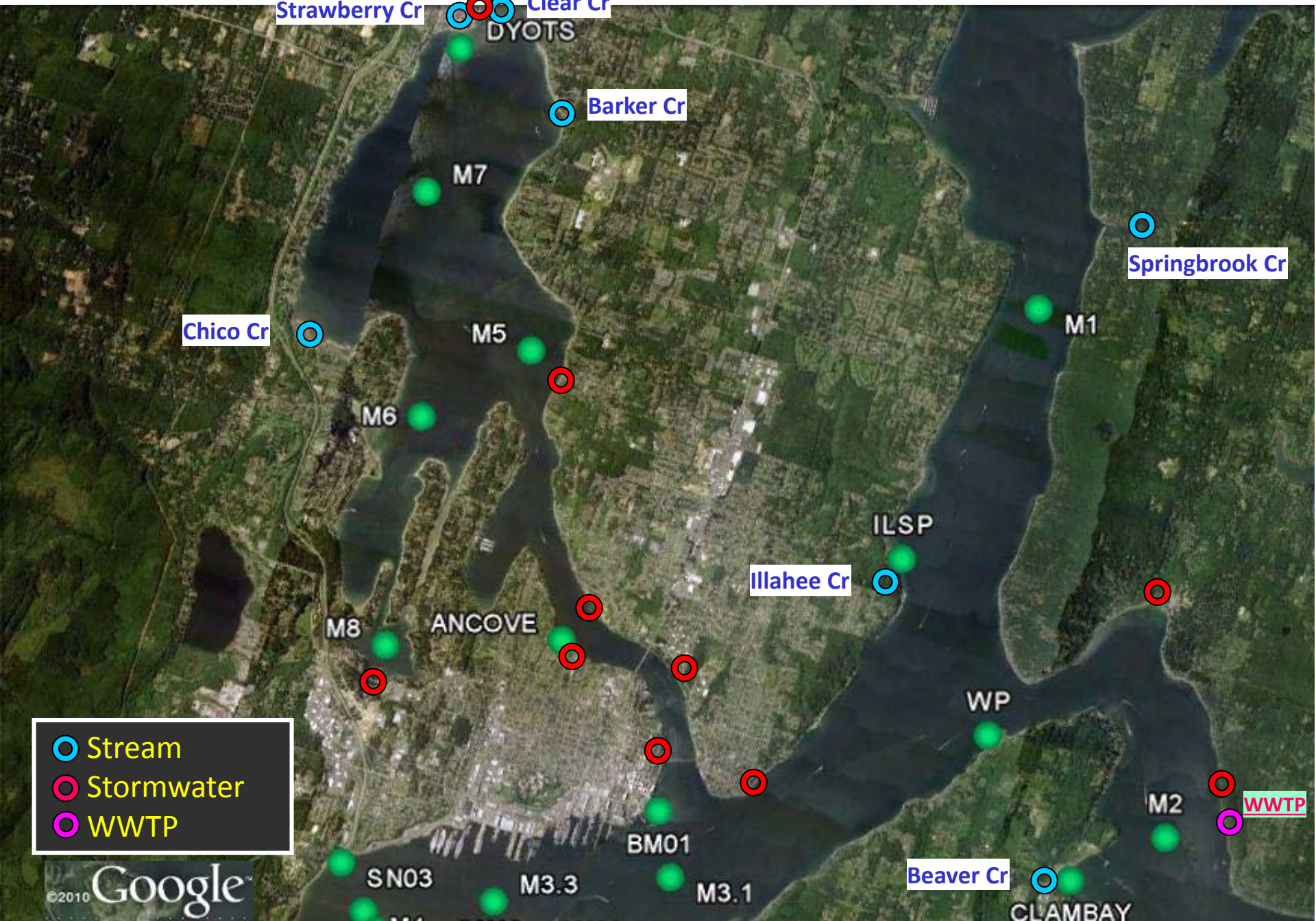
Ambient Monitoring and Toxicity Testing

What - Monthly and storm event sampling for fecals; seasonal sampling for metals and toxicity; Mussel sampling on even years

Ambient Marine Stations – Sinclair Inlet

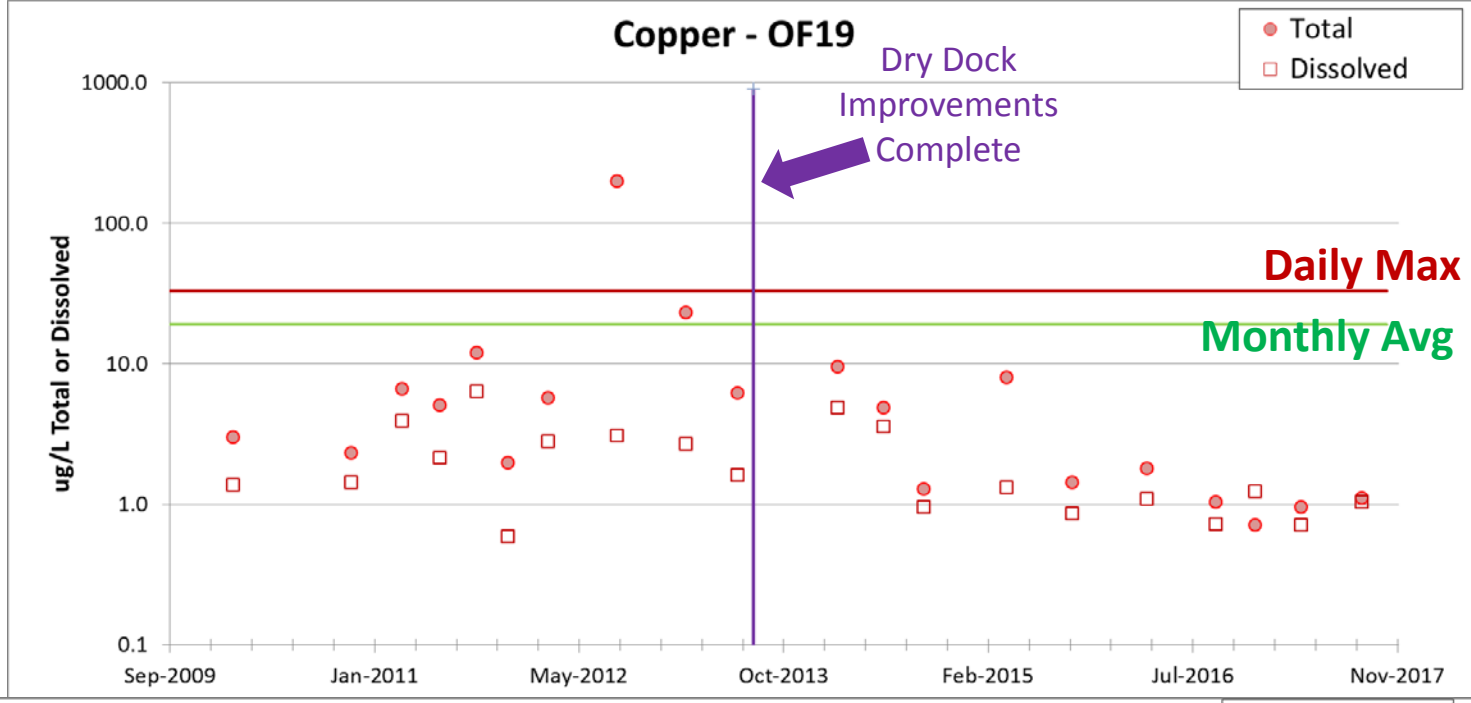


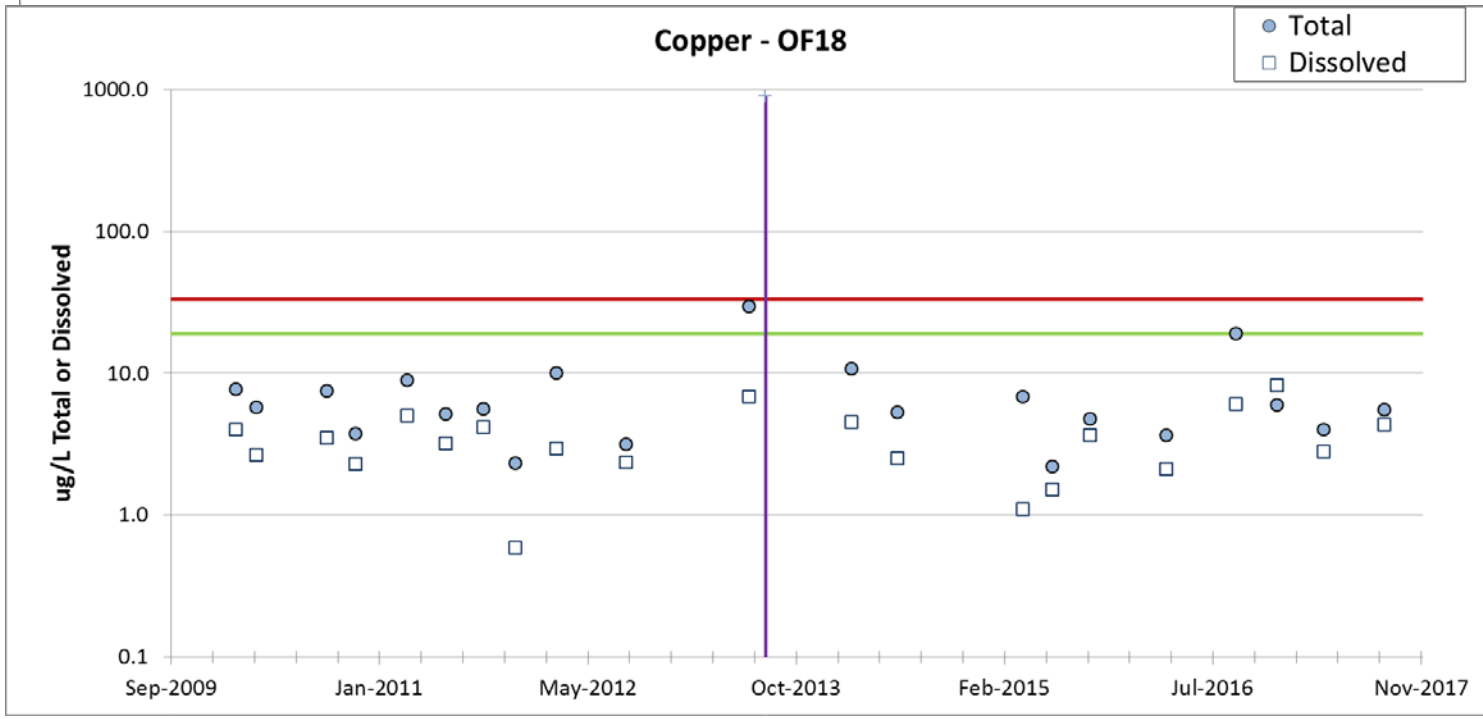
Ambient Marine Stations – Dyes Inlet and Passages



Effluent Monitoring

- 24 hr Composite
- Trace Metal Analysis using ultra clean seawater methods
- Whole Effluent Toxicity (WET) Testing



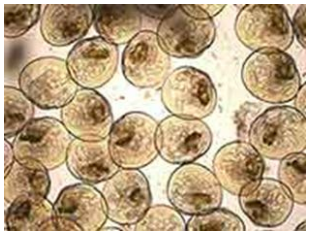


Toxicity Testing

- Acute Toxicity Test:
  - 96 hr Mysid Survival


wikipedia/commons

- Chronic Toxicity Tests:
  - 48 hr Mussel Larvae Development**
  - 96 hr Sea Urchin Larvae Development
  - 24 hr QwikLite (Bioluminescence Response)
  - 48 hr Giant Kelp Germination and Growth


NOAA Fisheries/Renee Mercaldo-Allen


Wikipeida/commons


Bioluminescent dinoflagellate, Pyrocystis lunula (actual size approximately 0.1 mm).
Photo Sharing PhotoPost


Steve Lonhart
Monterey Bay National Marine Sanctuary

**Driver for national saltwater WQC for copper

	AMB17	AMB18	AMB19	AMB20
	NPDES18			
MysidSurv	0.00	0.00	5.00	0.00
SeaUrchin	9.27	**67.01**	**93.63**	**85.66**
QwikLite	11.11	19.59	**26.94**	**41.22**
MusDev				
MusNorSur				

	AMB17	AMB18	AMB19	AMB20
	PS08			
MysidSurv	0.00	15.00	0.00	0.00
SeaUrchin	0.00	0.00	4.26	1.62
QwikLite	0.00	0.00		0.00
MusDev		0.00		
MusNorSur		7.44		

	AMB17	AMB18	AMB19	AMB20
	M4			
MysidSurv	0.00	5.00	0.00	0.00
SeaUrchin	0.20	0.00	0.60	0.00
QwikLite	0.00	0.00	0.00	22.22
MusDev		0.31		
MusNorSur		0.00		

	AMB17	AMB18	AMB19	AMB20
	NPDES19			
MysidSurv	0.00	0.00	0.00	0.00
SeaUrchin	0.00	1.09	**14.93**	0.00
QwikLite	**36.92**	0.00	0.00	0.00
MusDev		7.97		
MusNorSur		8.24		

	AMB17	AMB18	AMB19	AMB20
	PS09			
MysidSurv	0.00	0.00	5.00	0.00
SeaUrchin	0.00	0.73	0.81	0.81
QwikLite	0.00	0.00	0.00	13.78
MusDev		0.00		
MusNorSur		6.60		

	AMB17	AMB18	AMB19	AMB20
	BJ-EST			
MysidSurv	0.00	0.00	0.00	0.00
SeaUrchin	1.00	0.45	0.60	0.00
QwikLite	0.00	0.00	7.53	18.06
MusDev		0.00		
MusNorSur		0.00		

	AMB17	AMB18	AMB19	AMB20
	NPDES21			
MysidSurv	0.00	10.00	10.00	0.00
SeaUrchin	0.20	1.64	0.00	0.00
QwikLite	**25.84**	4.31	1.85	0.63
MusDev		0.64		
MusNorSur		3.04		

	AMB17	AMB18	AMB19	AMB20
	PS14			
MysidSurv	0.00	5.00	0.00	0.00
SeaUrchin	0.00	1.04	0.00	0.00
QwikLite	0.00	0.00	0.25	17.86
MusDev		0.00		
MusNorSur		1.26		

	AMB17	AMB18	AMB19	AMB20
	PS01			
MysidSurv	0.00	0.00	0.00	0.00
SeaUrchin	0.00	0.00	0.00	0.00
QwikLite	0.00	0.00	0.00	0.00
MusDev		0.00		
MusNorSur		10.48		

	AMB17	AMB18	AMB19	AMB20
	PS15			
MysidSurv	0.00	5.00	5.00	0.00
SeaUrchin	0.20	2.49	0.80	0.00
QwikLite	10.84	0.00	0.00	0.00
MusDev		0.00		
MusNorSur		0.00		

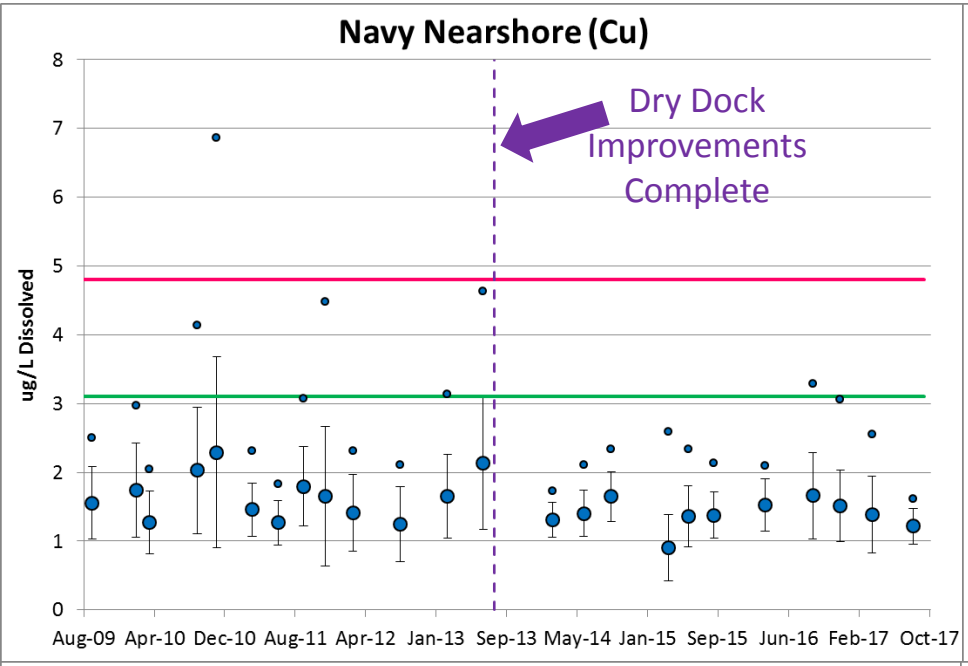
	AMB17	AMB18	AMB19	AMB20
	PS03			
MysidSurv	0.00	0.00	5.00	0.00
SeaUrchin	0.00	0.21	0.00	0.00
QwikLite	0.00	0.00	0.71	0.00
MusDev		0.00		
MusNorSur		6.50		

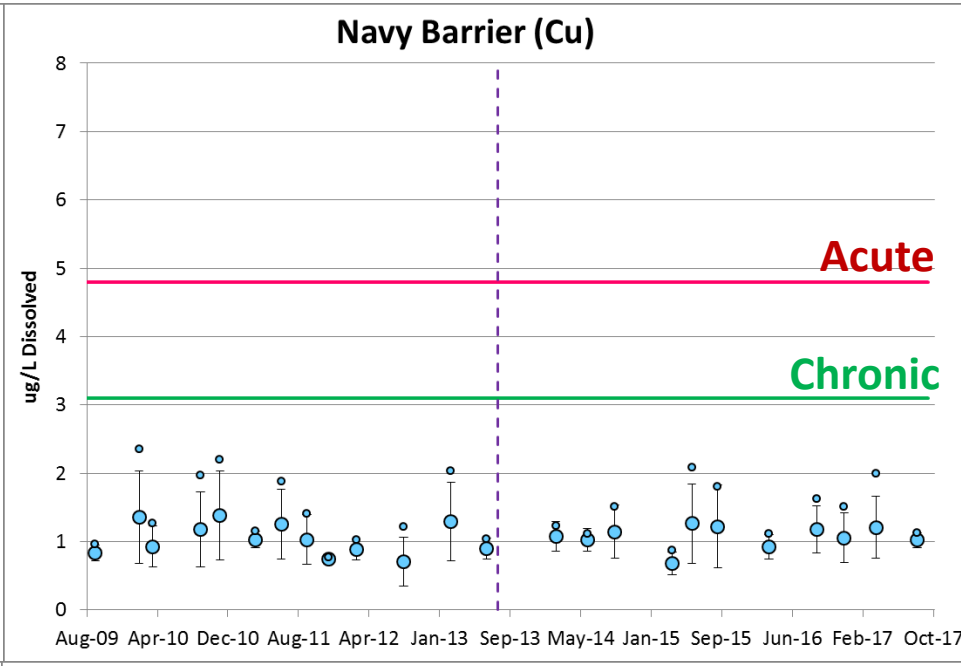
	AMB17	AMB18	AMB19	AMB20
	M3.1			
MysidSurv	0.00	10.00	5.00	0.00
SeaUrchin	1.20	8.65	0.60	0.00
QwikLite	0.00	0.00	0.00	19.44
MusDev		0.00		
MusNorSur		0.00		

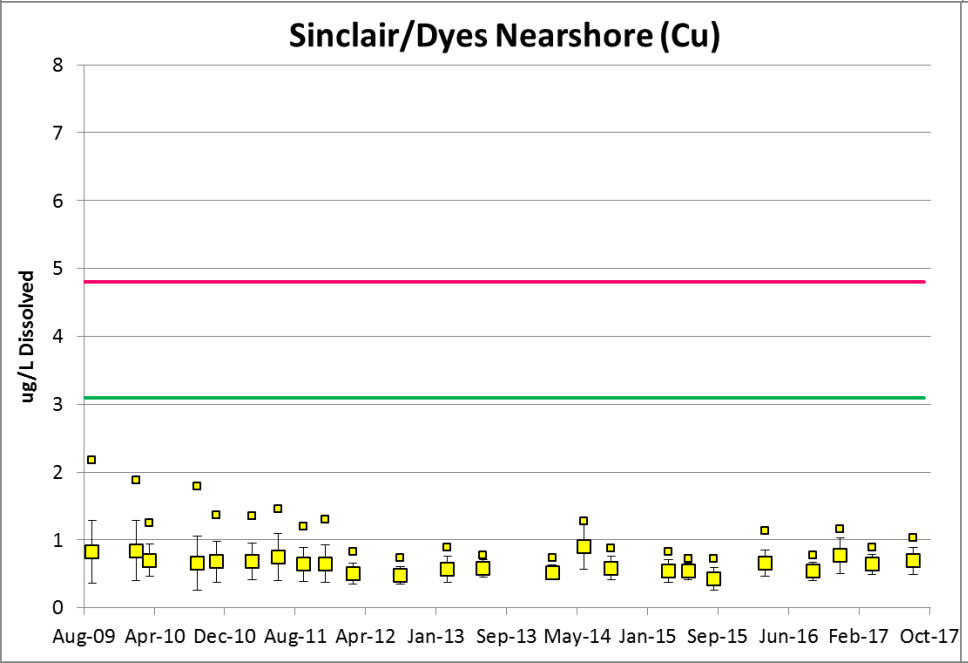
Relatively low toxicity observed for 2015-2016 events

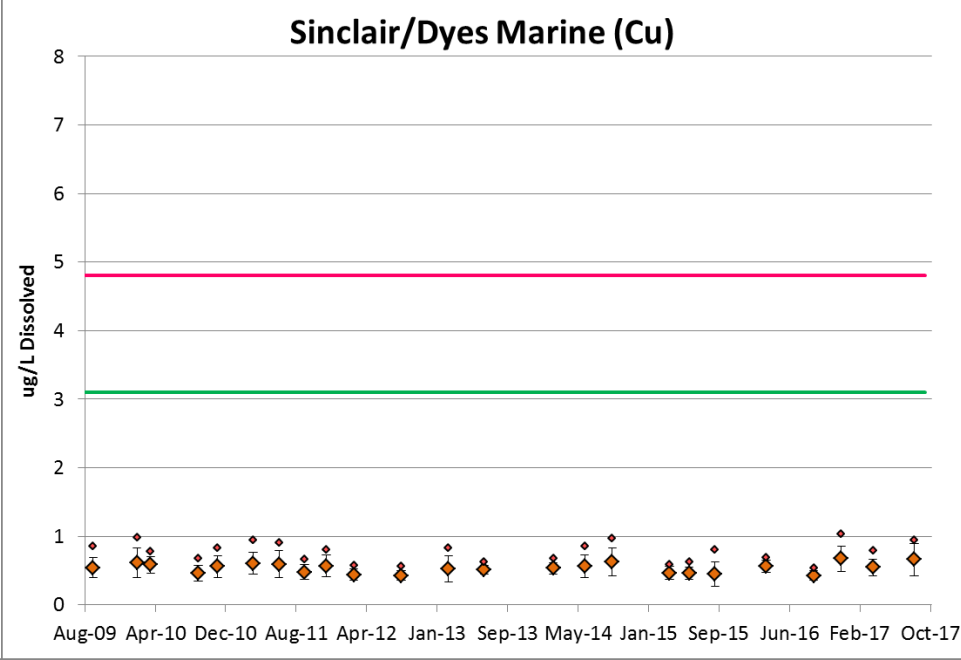
OF18 has majority of significant hits in the urchin development test and the QL test

Ambient Monitoring Dissolved Copper

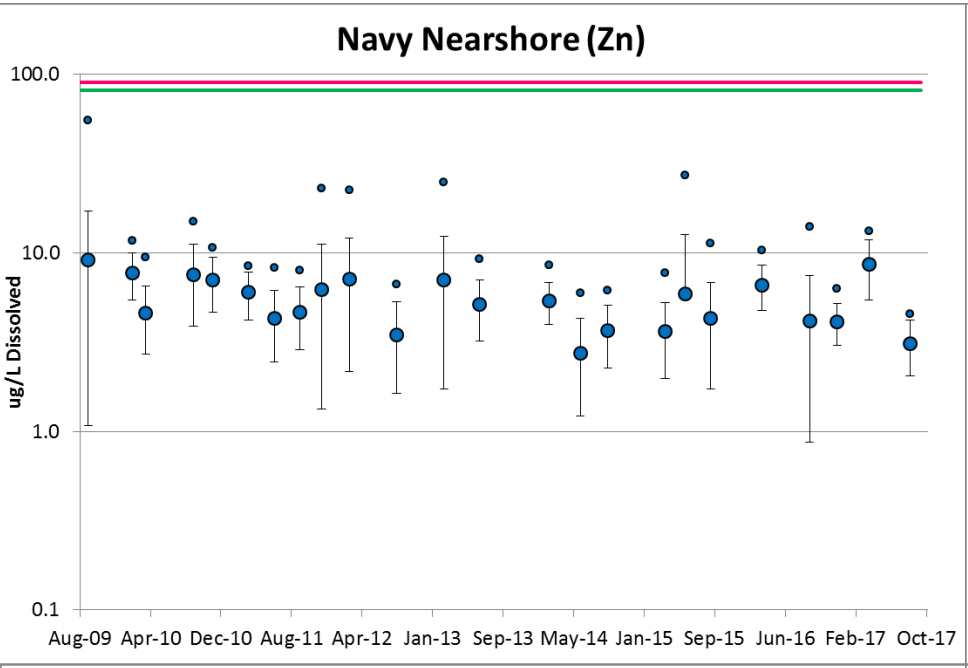


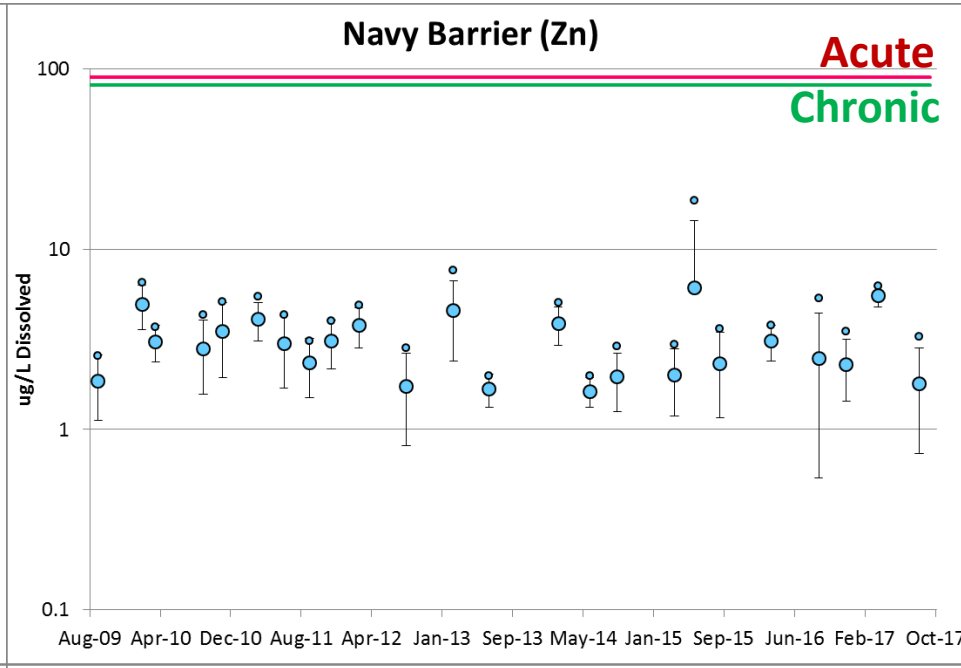


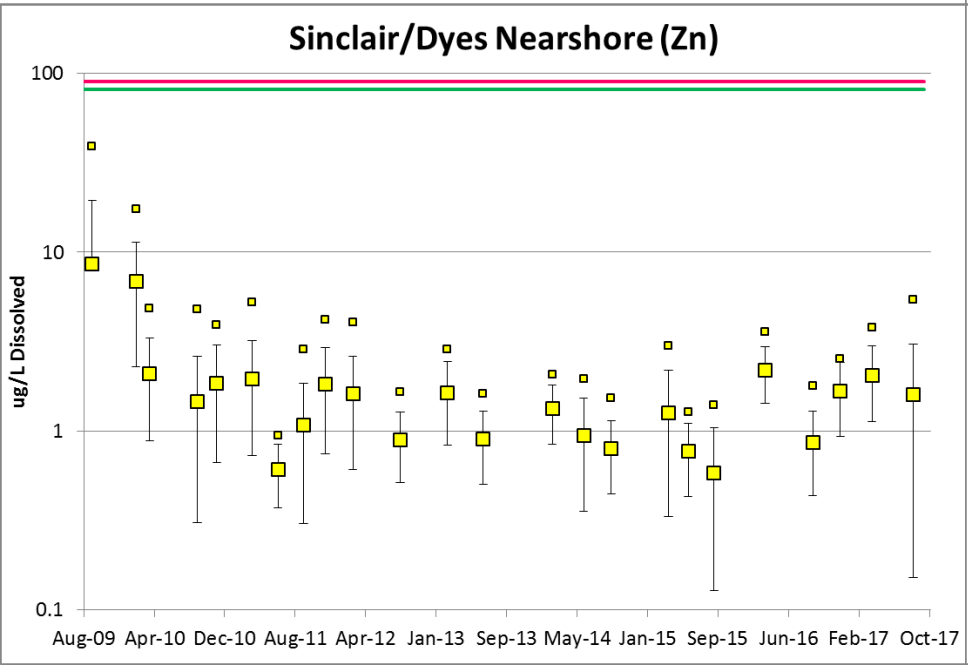


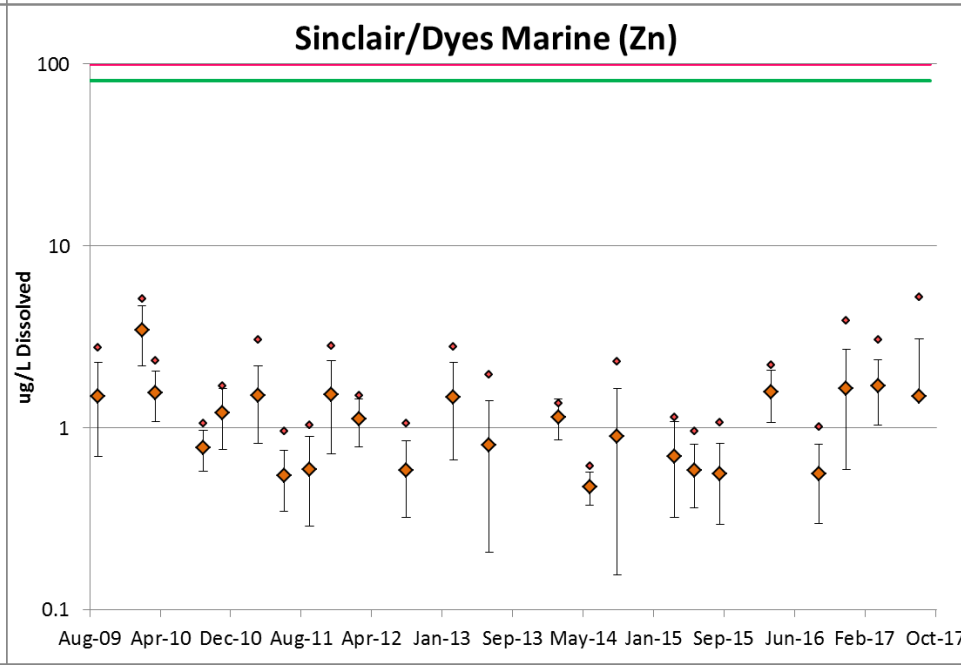


Ambient Monitoring Dissolved Zinc

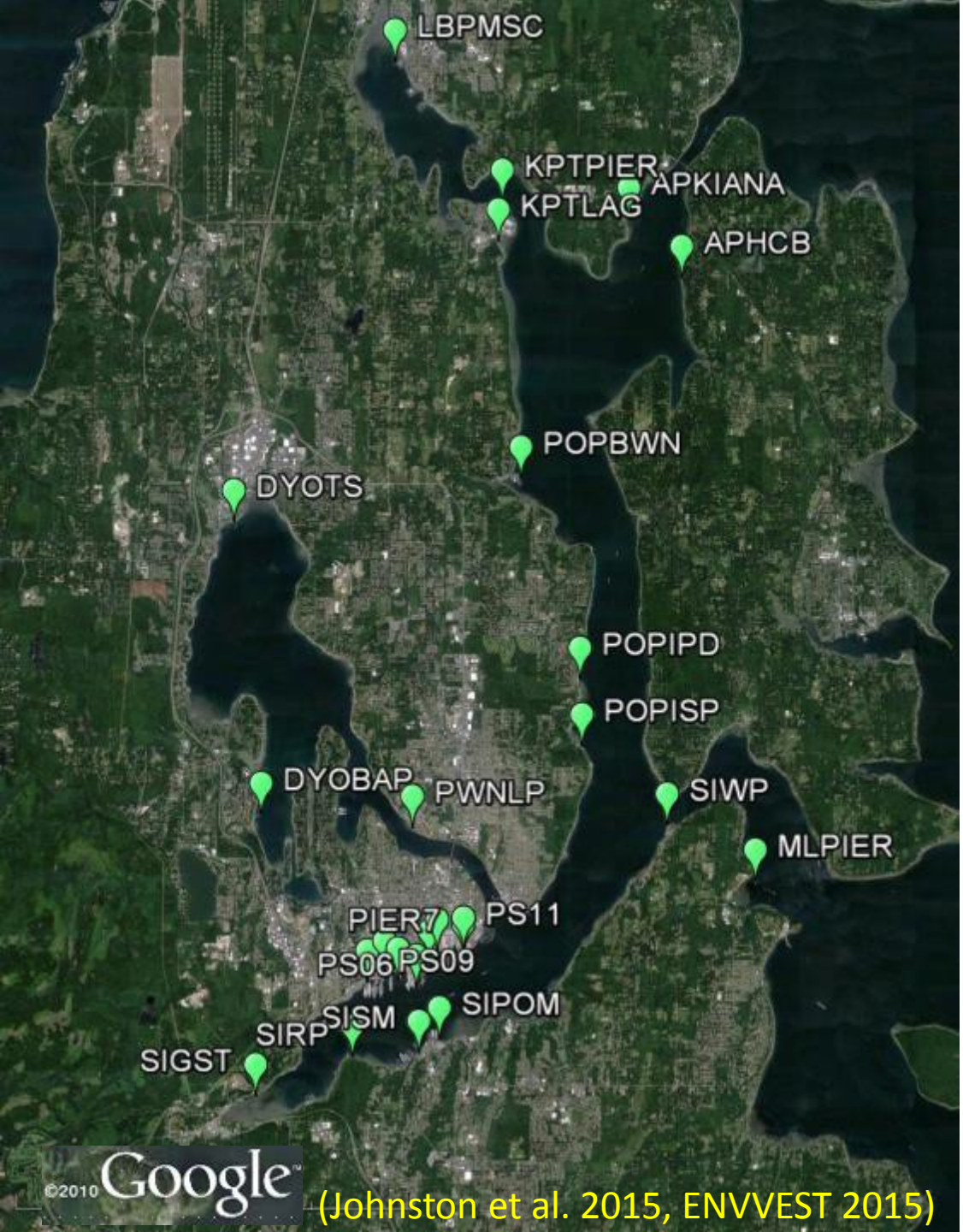




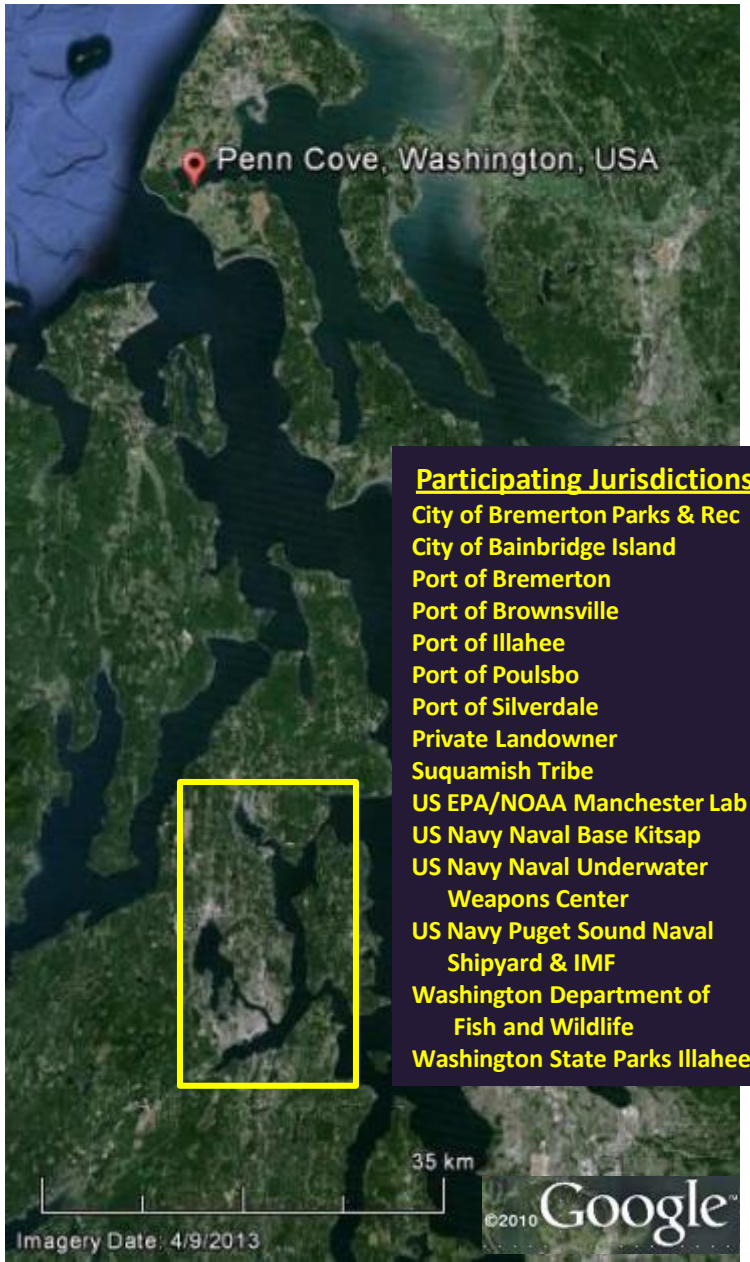




ENVVEST Mussel Watch Stations 2010 - 2016



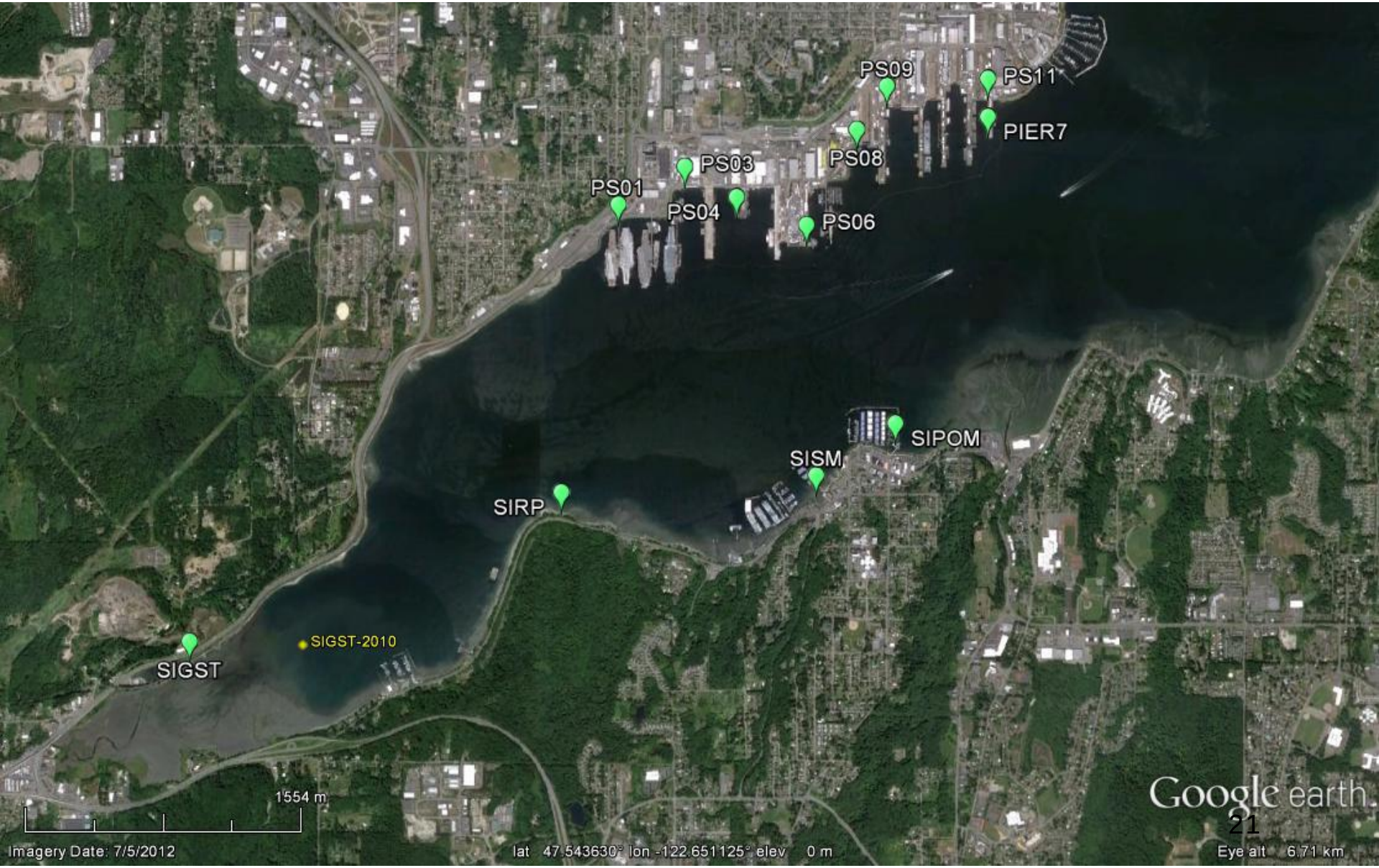
(Johnston et al. 2015, ENVVEST 2015)



Participating Jurisdictions

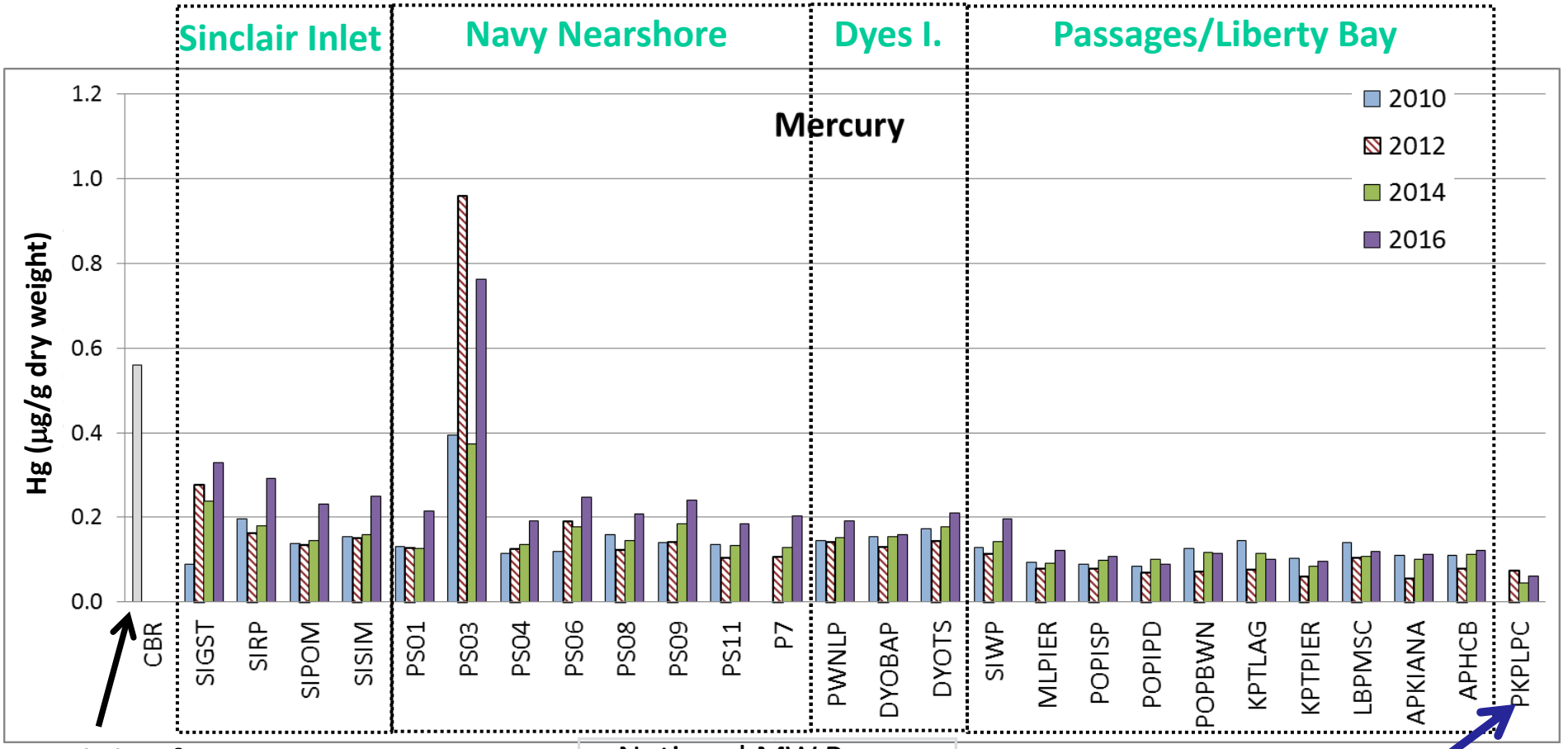
- City of Bremerton Parks & Rec
- City of Bainbridge Island
- Port of Bremerton
- Port of Brownsville
- Port of Illahee
- Port of Poulsbo
- Port of Silverdale
- Private Landowner
- Suquamish Tribe
- US EPA/NOAA Manchester Lab
- US Navy Naval Base Kitsap
- US Navy Naval Underwater Weapons Center
- US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

Mussel Watch Sinclair Inlet



Mussel Watch Sampling

Mercury in Mussel Tissue



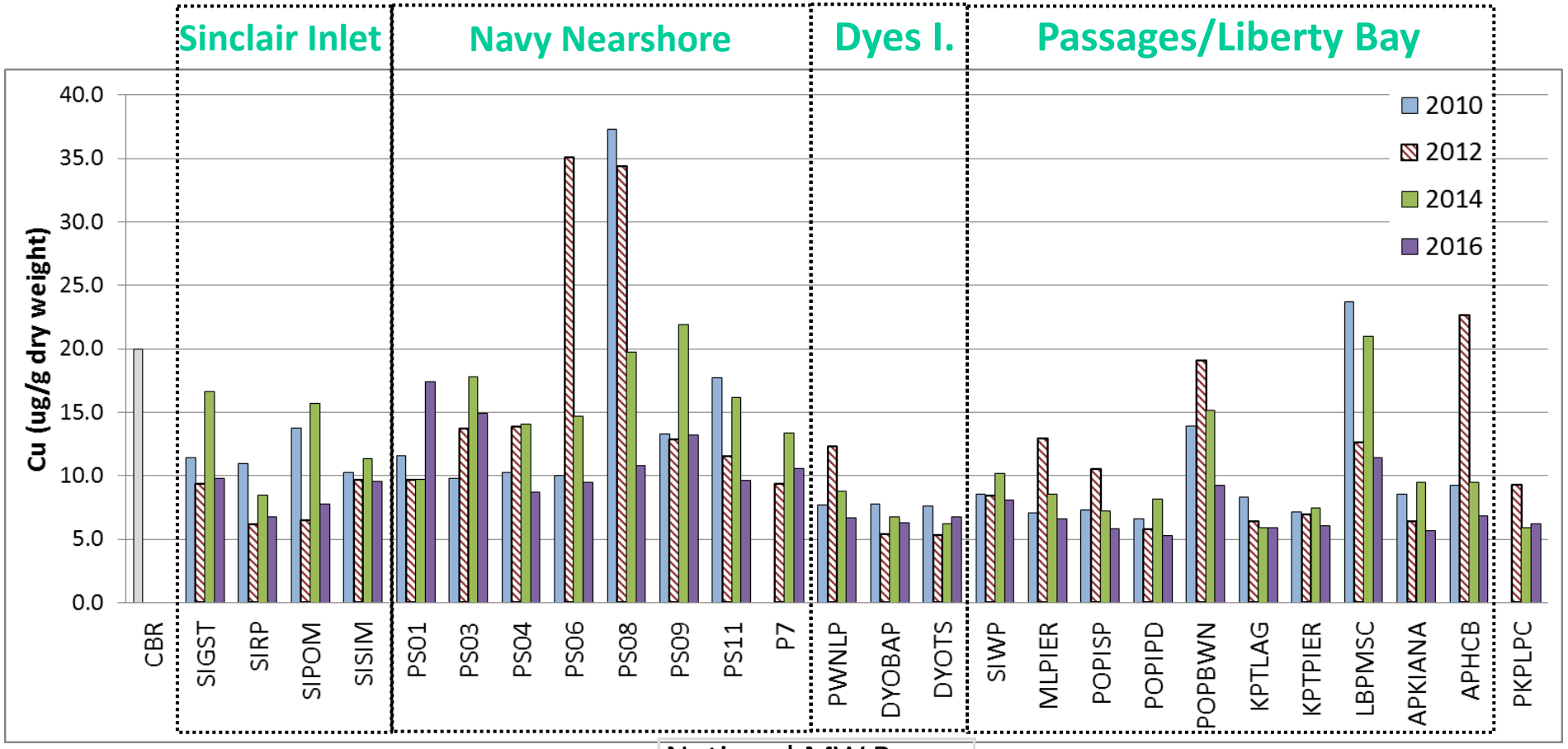
Critical Body Residue

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)

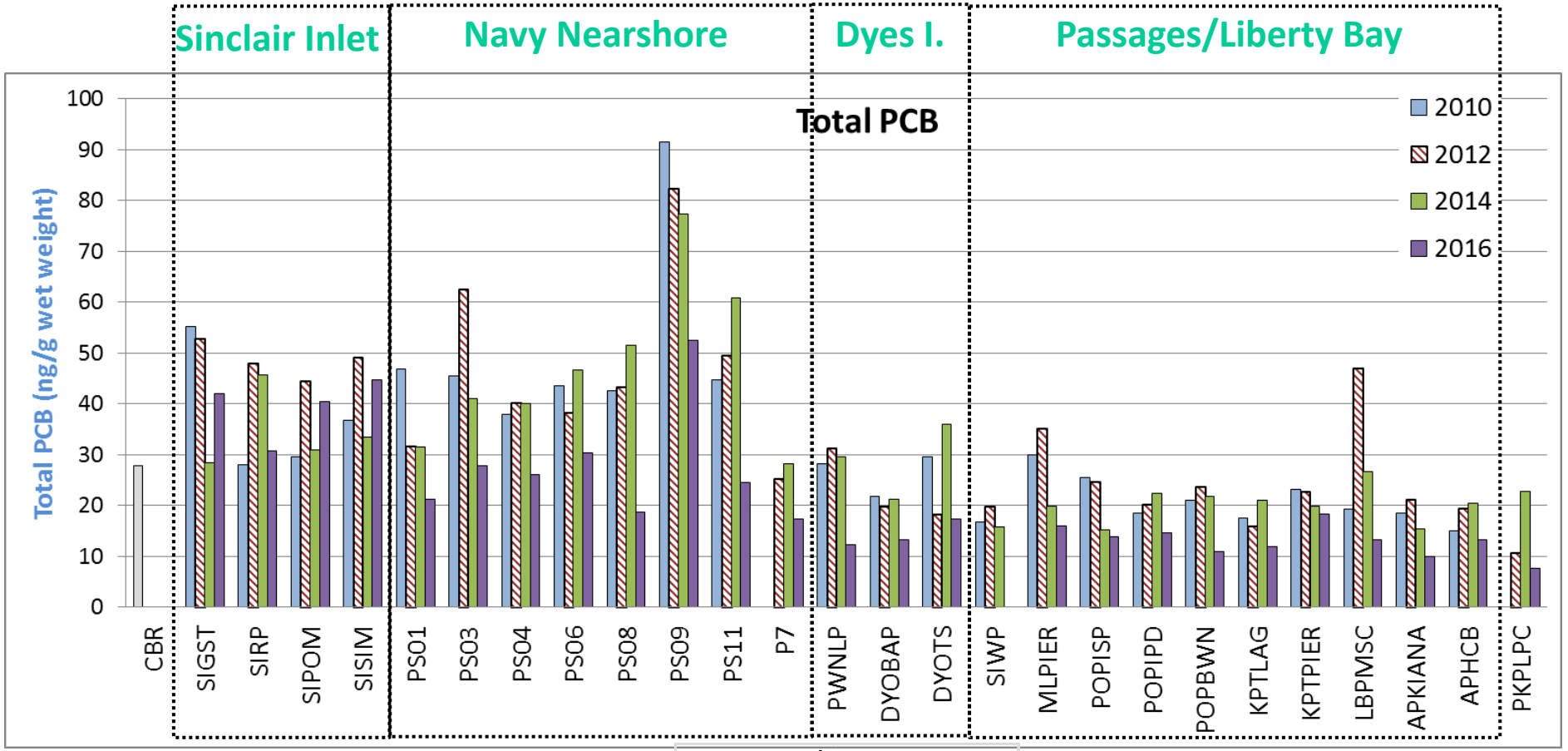
Copper in Mussel Tissues



National MW Range
ppm dry weight

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

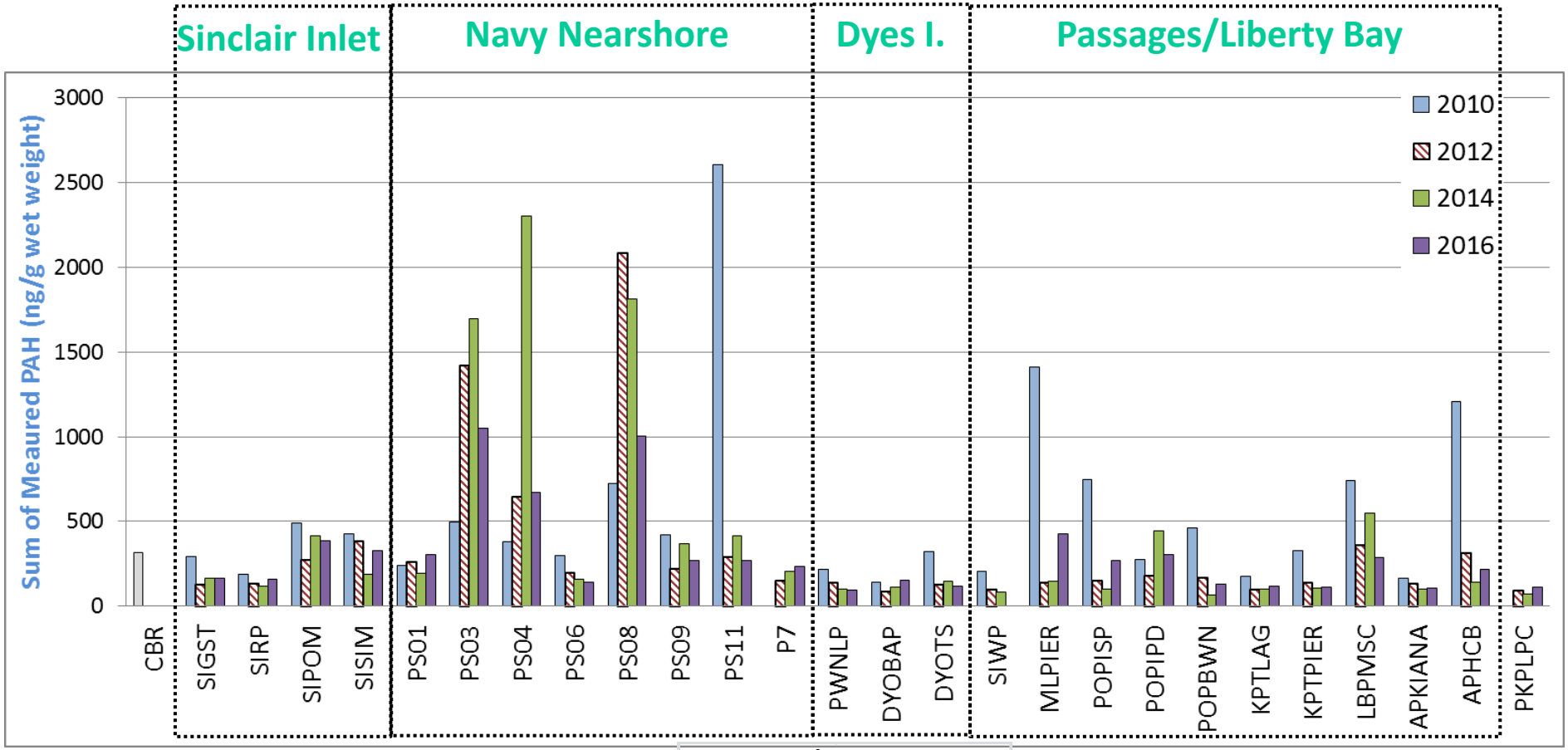
Total PCBs – Polychlorinated Biphenyls



National MW Range
ppb wet weight

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

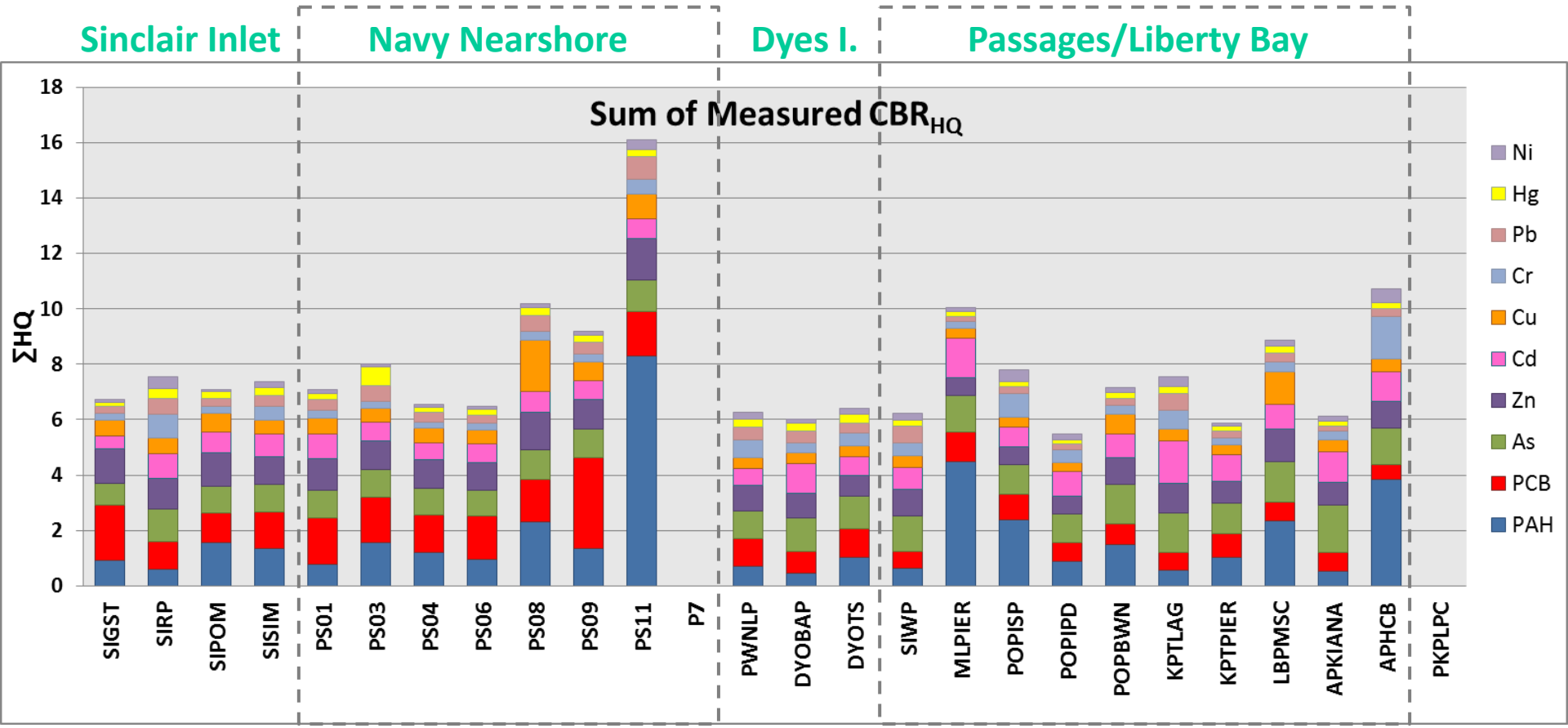
Sum PAHs – Polycyclic Aromatic Hydrocarbons



National MW Range
ppb wet weight

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

Hazard Index for Critical Body Residues
2010

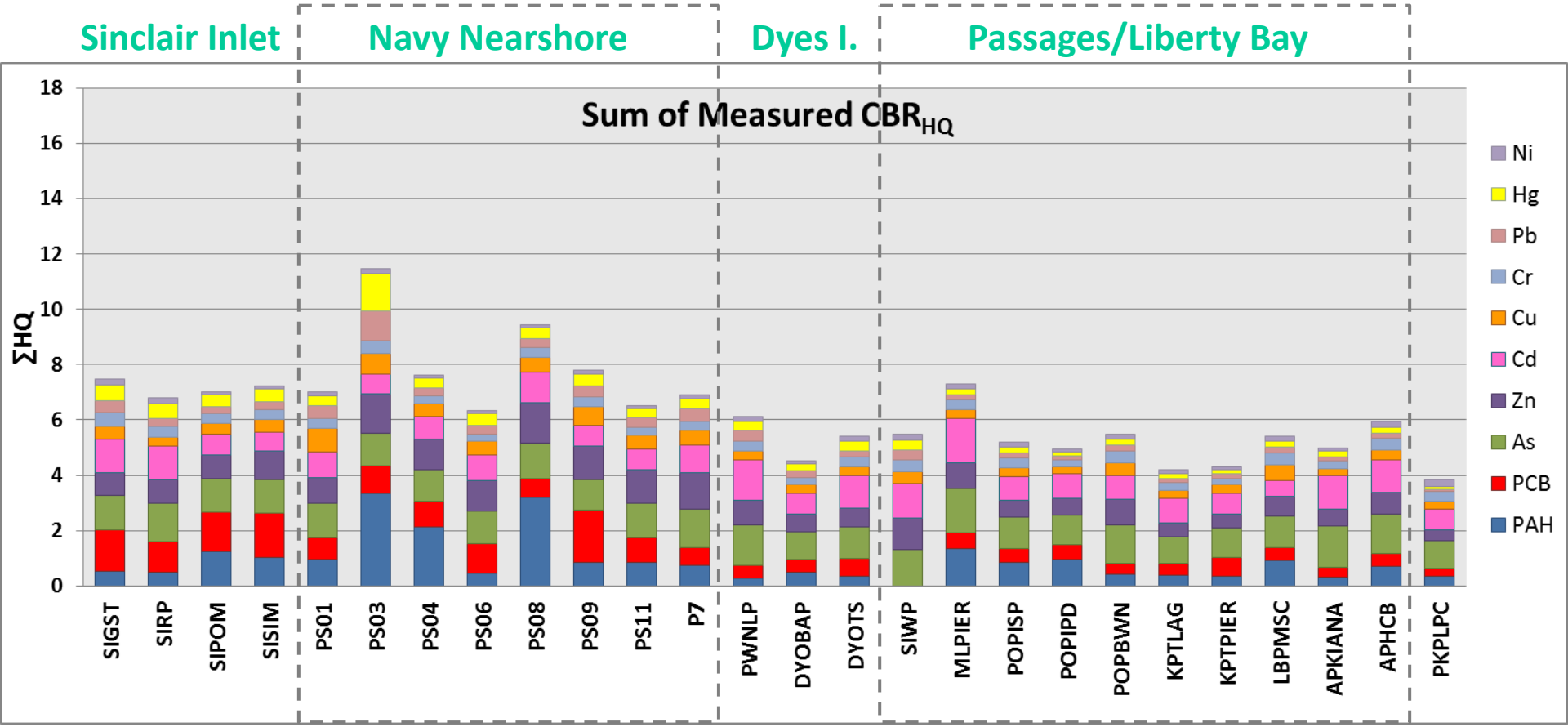


Possible Ecological Effect – Critical Body Residue

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

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

Hazard Index for Critical Body Residues 2016



Possible Ecological Effect – Critical Body Residue

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

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

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
- Ambient Monitoring and Toxicity Testing Status and Trends
  - Effluent quality is improving
  - Receiving Waters Not Toxic and Protective of Beneficial Uses
- What are the Biota Telling Us?
  - Some Areas Elevated with PAHs, PCBs, Hg, and Cu
- Overall decrease in contaminant levels indicates Improving Environmental Quality
- Monitoring framework provides context for interpretation
  - Better information = Better management