



# 2015-2020 Puget Sound Nearshore Mussel Monitoring

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Washington  
Department of  
**FISH** and  
**WILDLIFE**

# Mussel Monitoring

## SAM Status & Trends Objectives:

### Status:

Characterize the spatial extent of contamination to which nearshore biota residing inside the UGA sampling frame may be exposed, using mussels (*Mytilus* sp.) as the primary indicator organism. (*answered each year*)

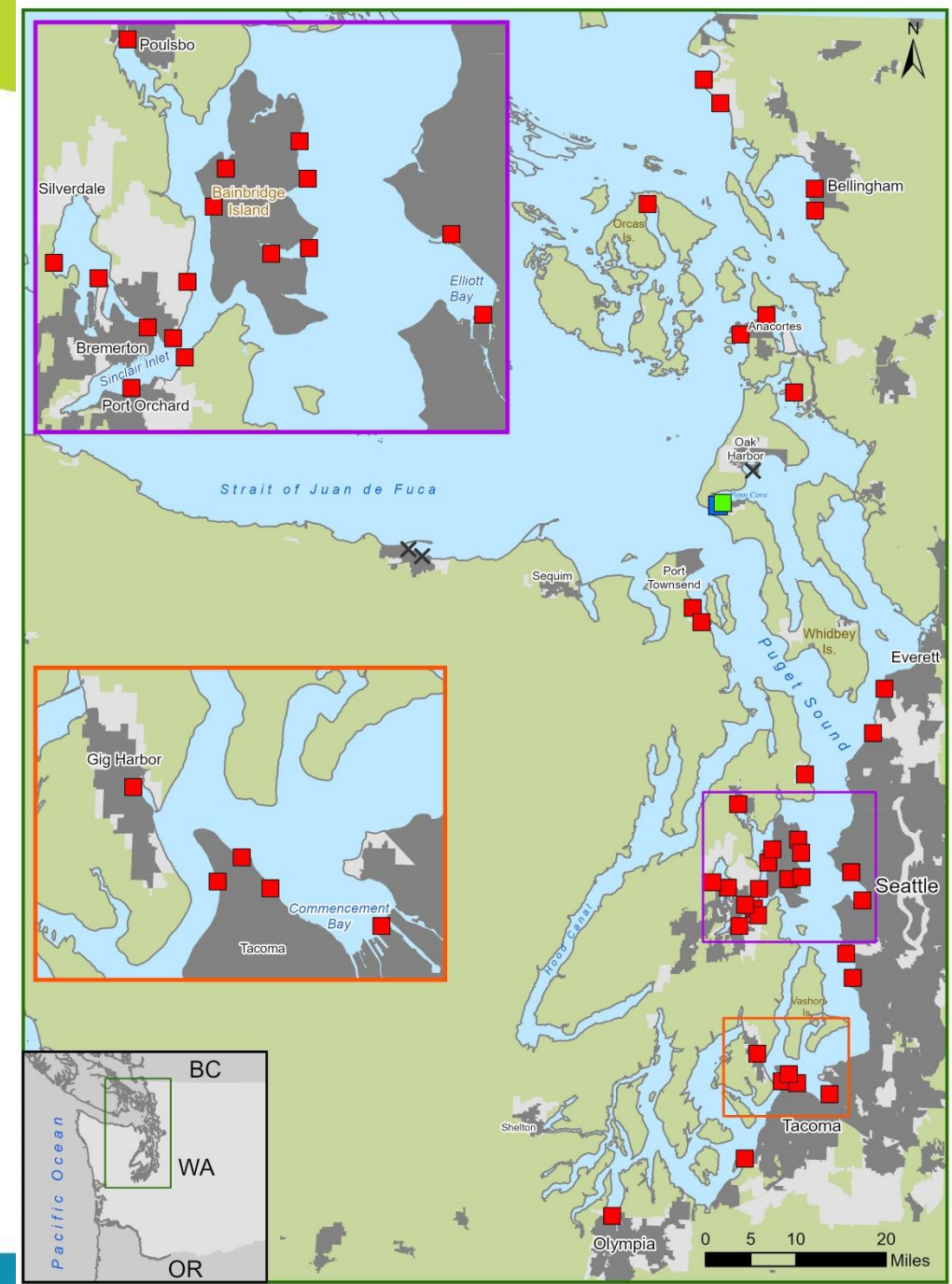
- detection frequency and concentration range of contaminants
- spatial extent of key contaminants present inside the UGA sampling frame

### Trends:

Track changes in mussel tissue contamination over time inside the UGA sampling frame to determine if the health of the biota in the urban nearshore is improving, deteriorating, or remaining the same related to stormwater management and urban population growth in Puget Sound. (*answered over time*)

## 2019/20 SAM Nearshore Monitoring Survey:

- 42 SAM Sites Visited: 41 random (GRTS) and 1 Reference
- Cages retrieved from 39 sites: 38 GRTS and 1 Reference, lost cages at 3 sites
- Urban Growth Areas (UGA) in Puget Sound sampling frame
- Native bay mussels (*Mytilus trossulus*)
- Transplanted in anti-predator cages to nearshore



# Chemical Analyses

- **Organic contaminants:**

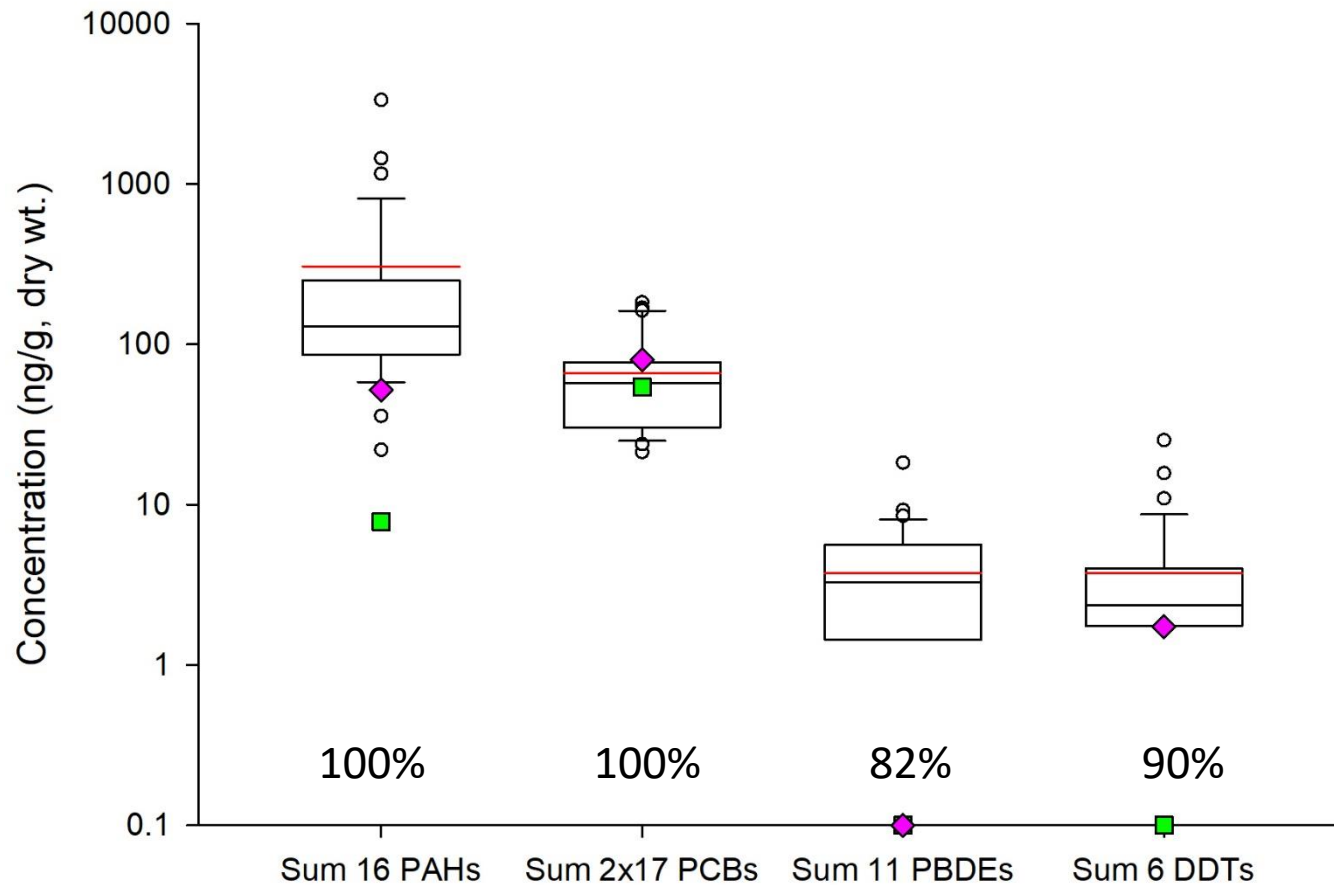
- **PAHs** - Polycyclic Aromatic Hydrocarbons
- **PCBs** - Polychlorinated biphenyls
- **PBDEs** - Polybrominated diphenylethers
- **DDTs** - Dichloro-diphenyl-trichloroethanes
- Other pesticides - chlordanes, HCB, aldrin, dieldrin, HCHs, endosulfan 1, Mirex

- **Metals:**

- Arsenic, Cadmium, Copper, Lead, Mercury, Zinc



# 2019-2020 Status: Detection Frequency and Concentration Range



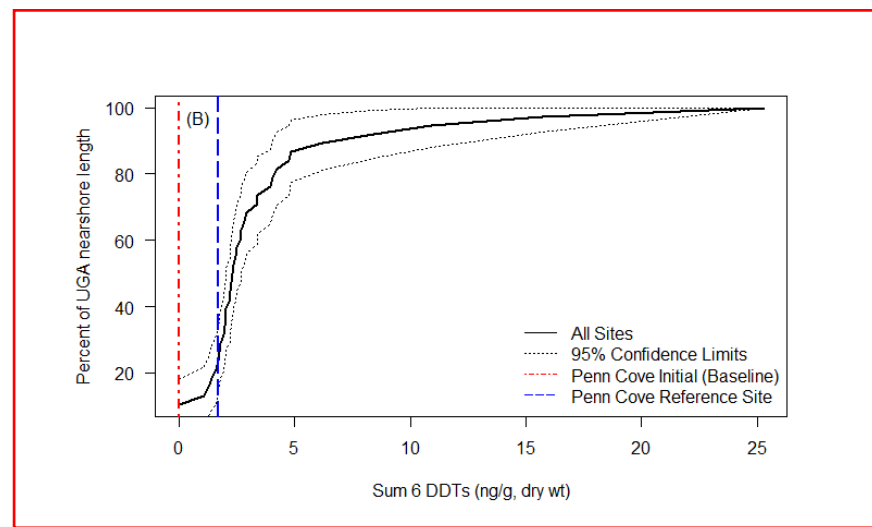
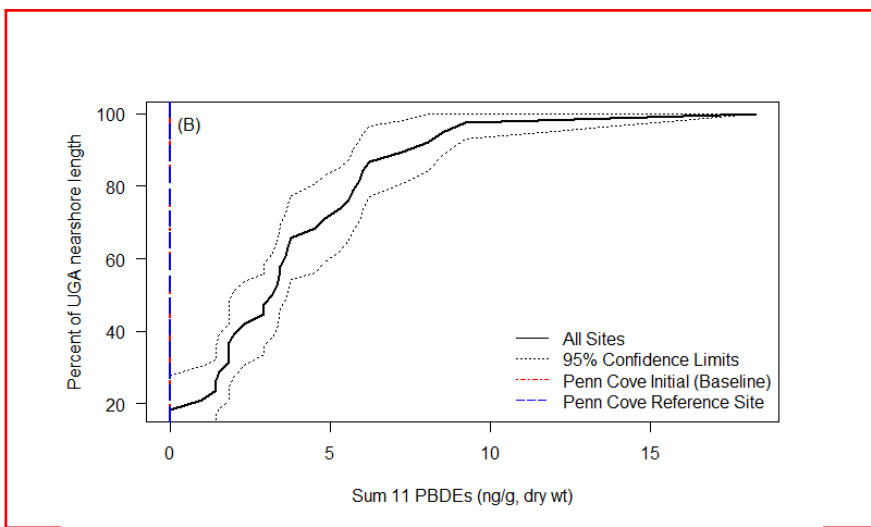
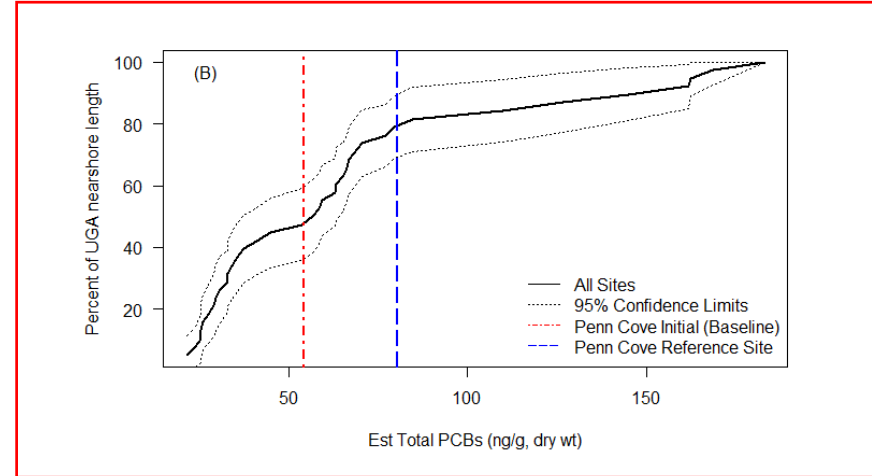
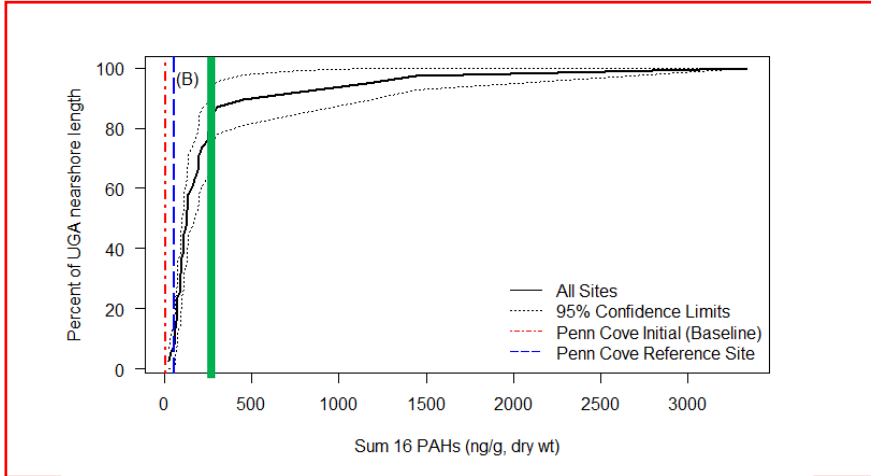
PAHs: 22 – 3300 ppb dry wt.

PCBs: 21 – 180 ppb dry wt.

PBDEs: Not detected – 18 ppb dry wt.

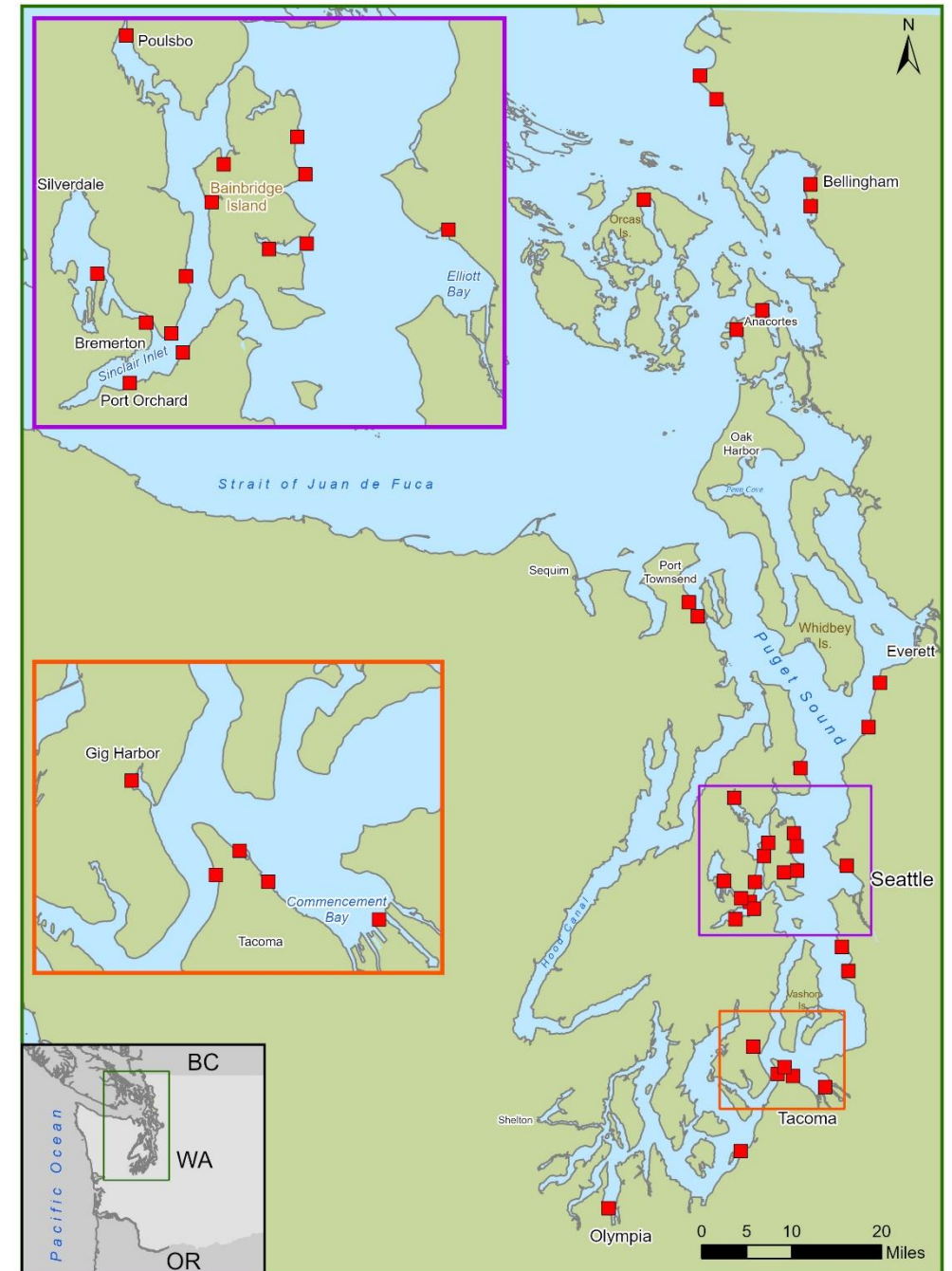
DDTs: Not detected – 25 ppb dry wt.

# 2019-2020 Status: Cumulative Distribution of Contaminants in Mussels Along the Puget Sound Nearshore UGA



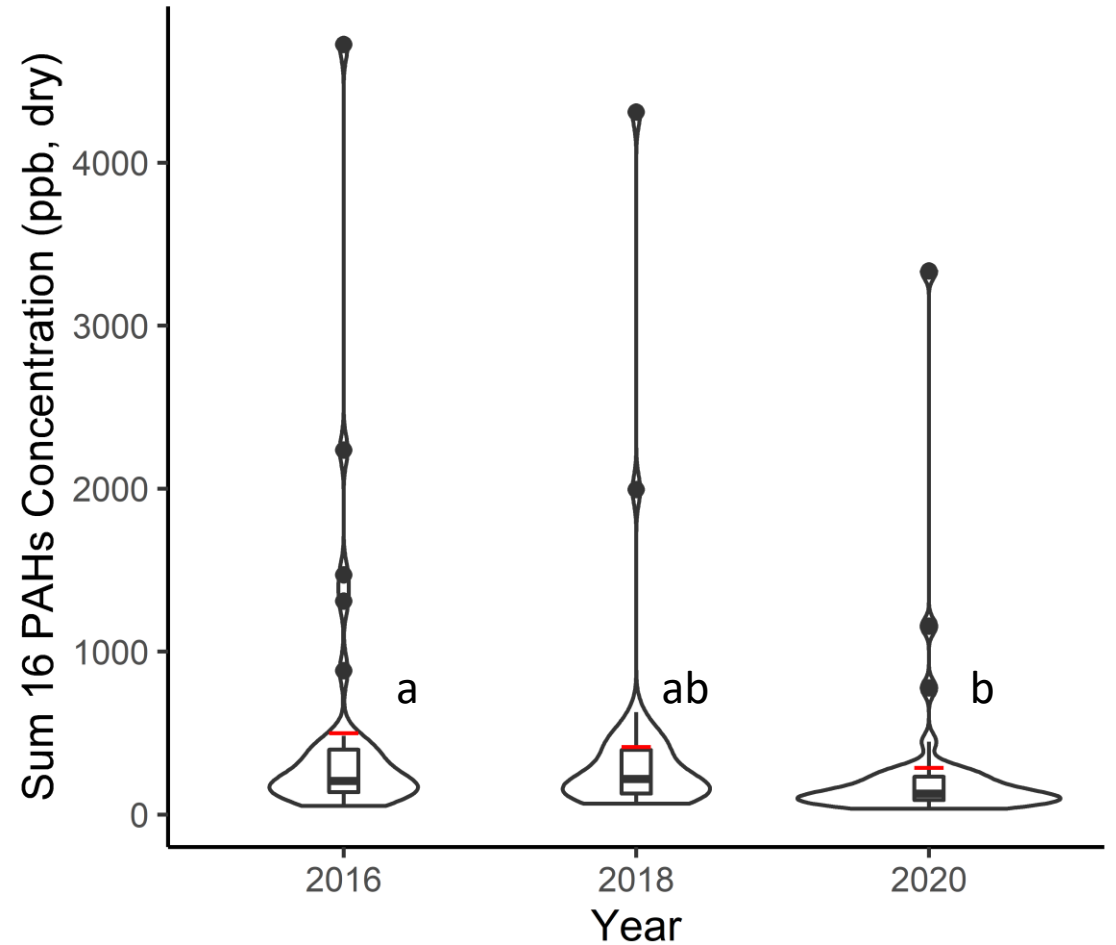
## Trends?: 2016 – 2018 – 2020 Surveys

- Total # of sites with mussel cages recovered:
  - 2016: 36 sites
  - 2018: 40 sites
  - 2020: 38 sites
- 35 sites were visited in all 3 survey years
- Coverage as far north as Cherry Point and as far south as Budd Inlet
- Pairwise comparison between survey years, additional survey years/data needed to determine a robust trend.



## Trend?: PAHs

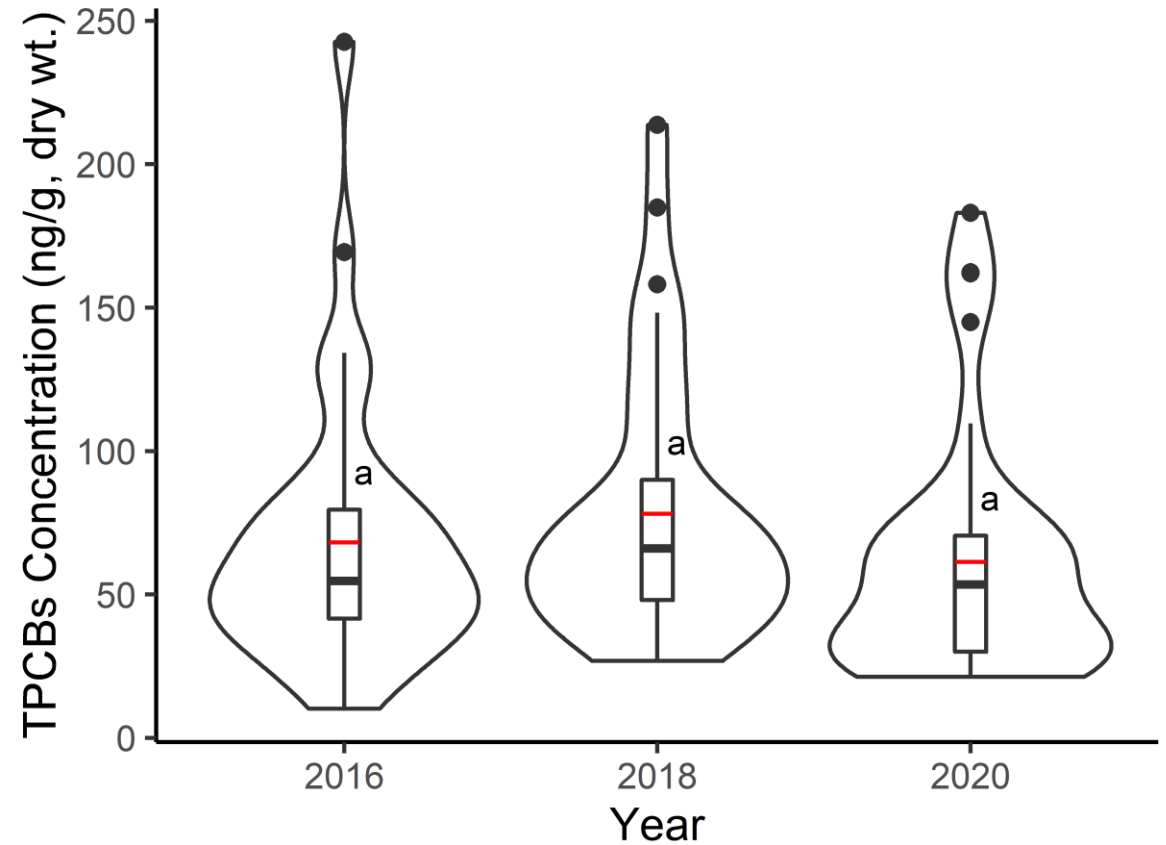
- Significant difference between 2016 and 2020 survey
- Mean Concentrations (ppb, dry wt.)
  - 2016: 500
  - 2018: 416
  - 2020: 286





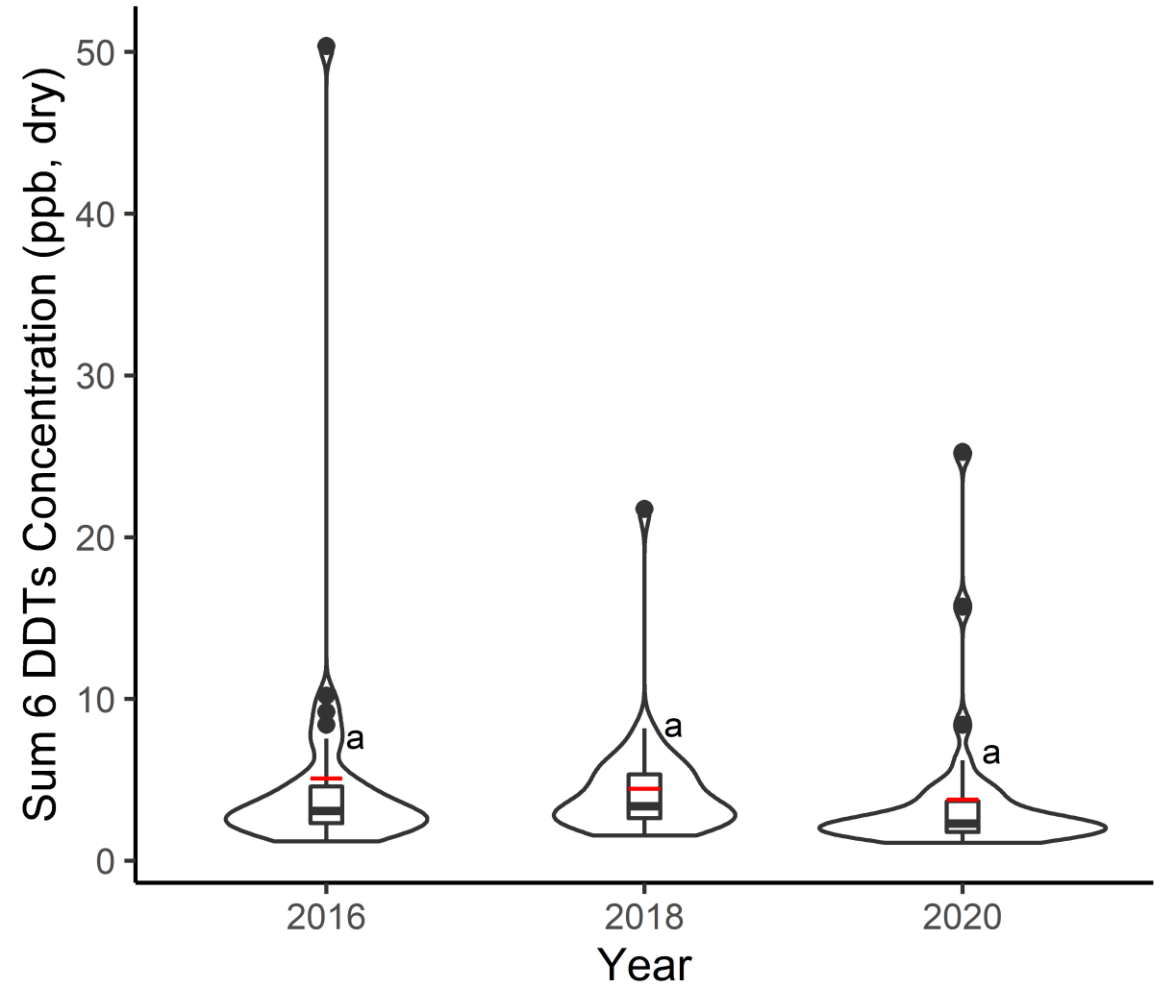
## Trend?: PCBs

- No significant differences between survey years
- Mean Concentrations (ppb, dry wt.)
  - 2016: 68.1
  - 2018: 78.1
  - 2020: 61.4



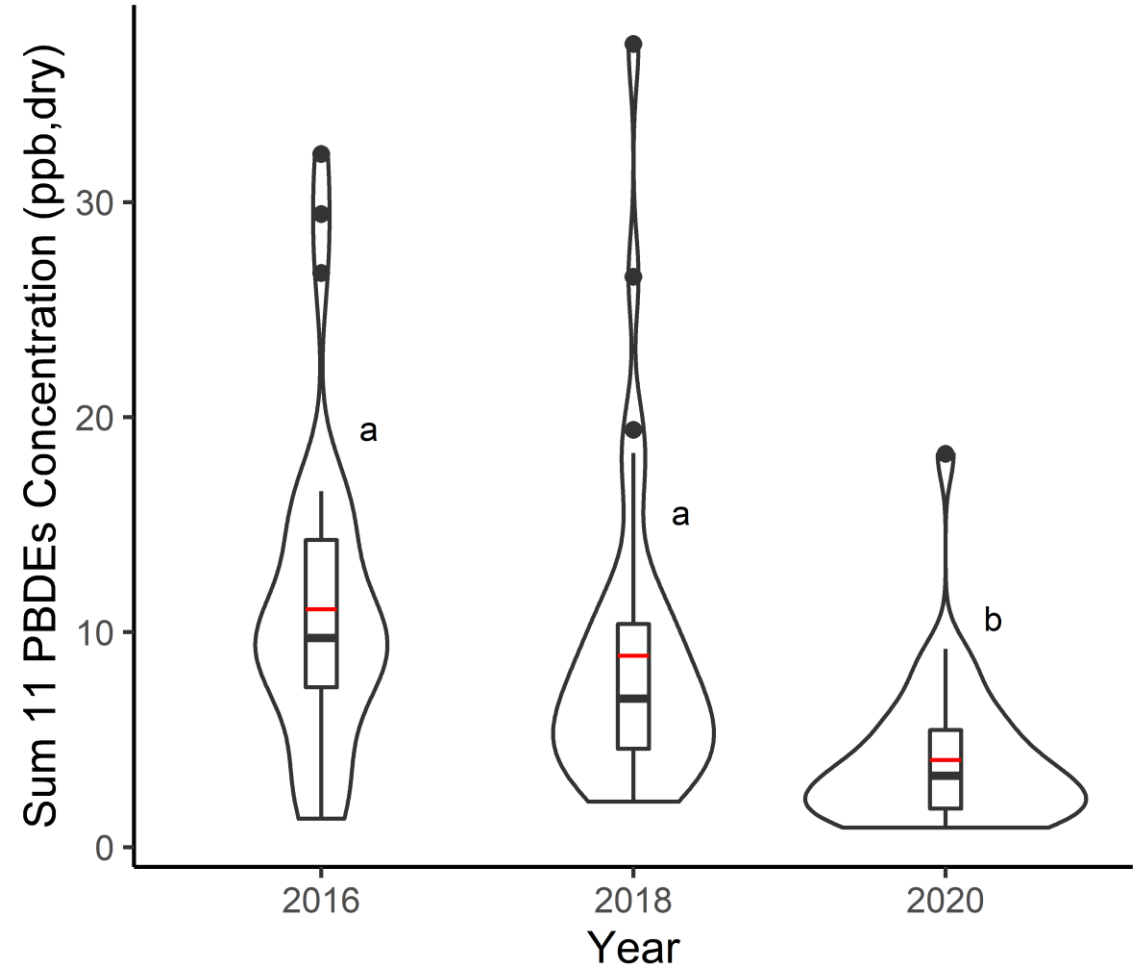
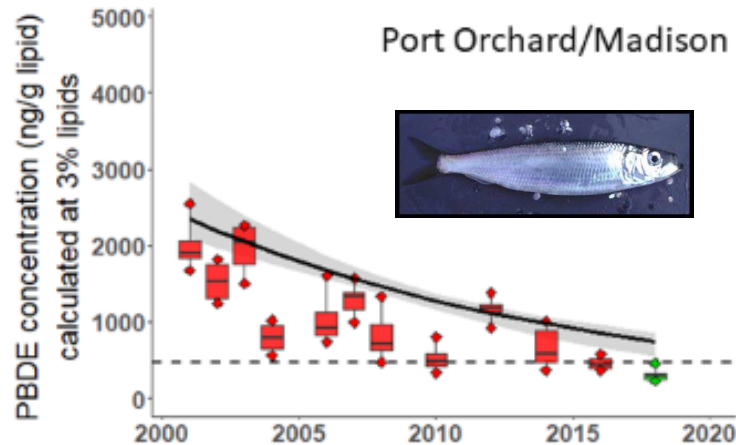
## Trend?: DDTs

- No significant differences between survey years
- Mean Concentrations (ppb, dry wt.)
  - 2016: 5.09
  - 2018: 4.44
  - 2020: 3.78

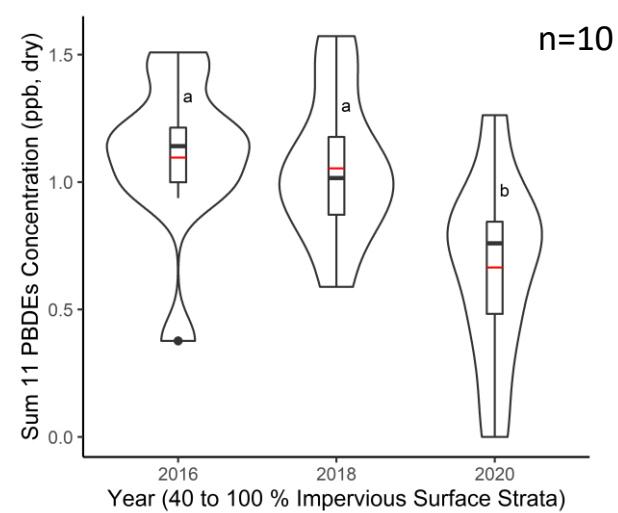
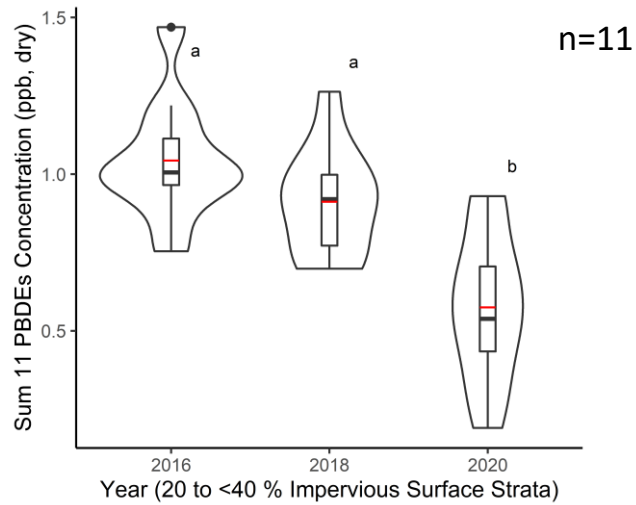
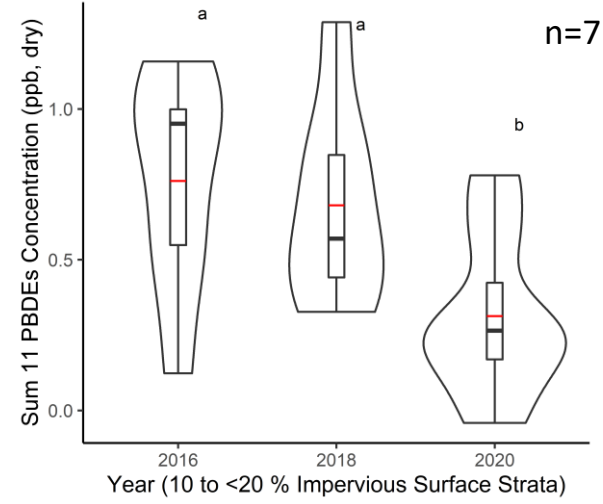
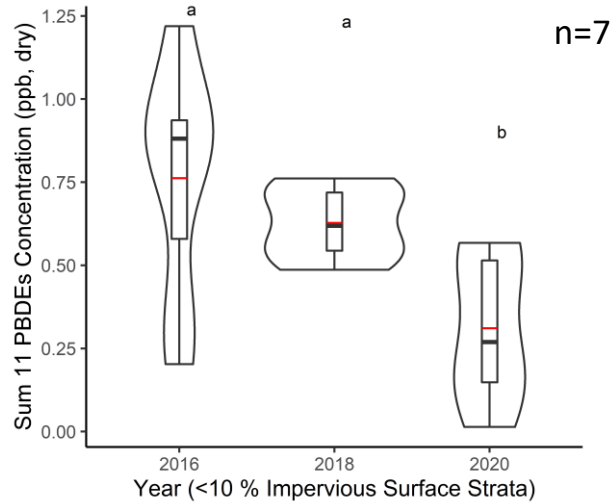


# Trend?: PBDEs

- Significant decline in mean concentration of PBDEs in 2020 survey
- Mean Concentrations (ppb, dry wt.)
  - 2016: 11.1
  - 2018: 8.91
  - 2020: 4.06



# Trend: PBDE concentration and sites by average % impervious surface strata



**Strata for impervious surface cover:**

Least: <10%

Low: 10 to <20%

Medium: 20 to <40%

High: 40 to 100%

# Conclusions

## 2019/20 Status:

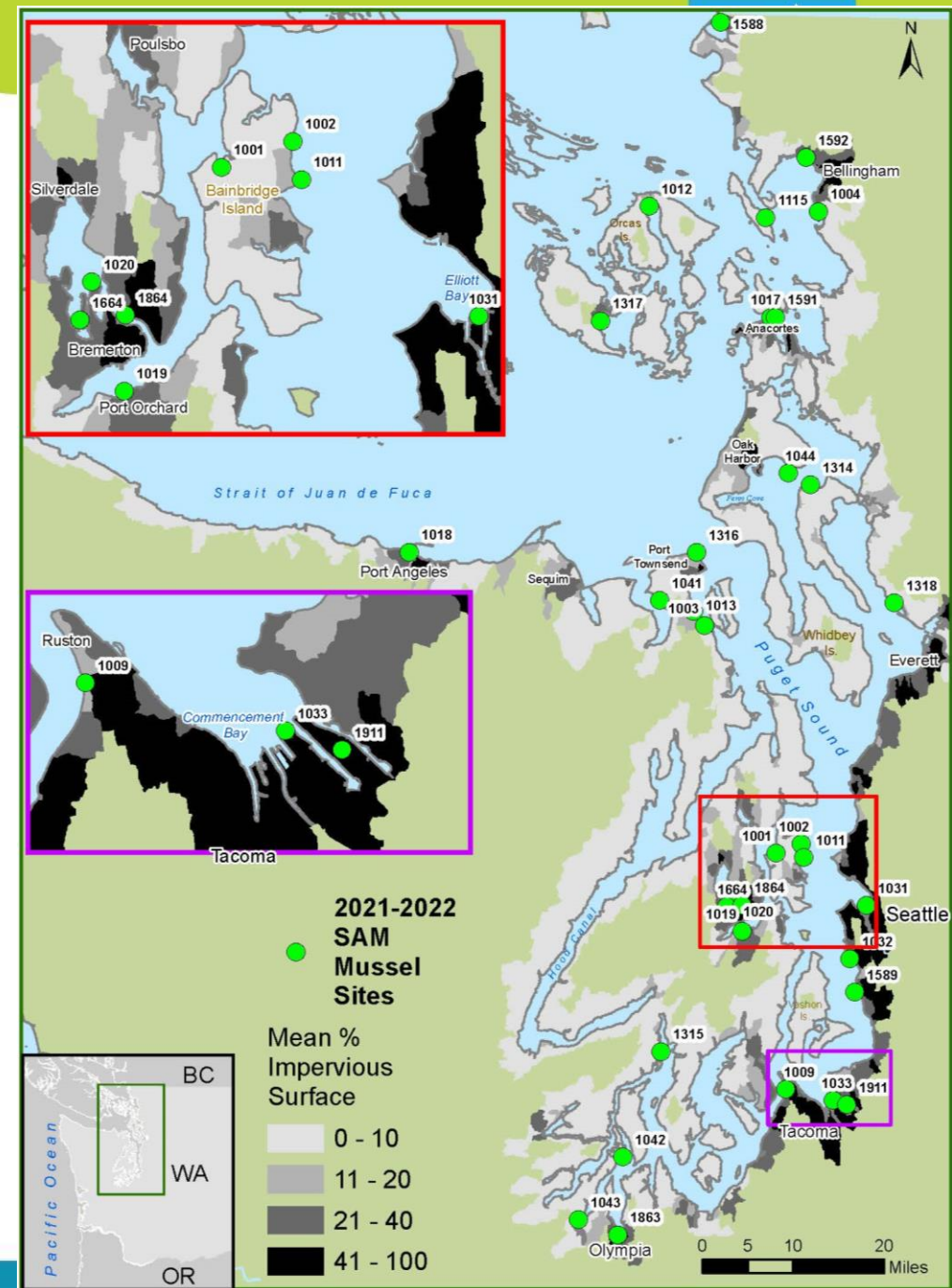
- PAHs , PCBs, PBDEs , and DDTs continue to be the most abundant organic contaminants detected in mussels of the Puget Sound nearshore. The highest organic chemical concentration observed was for PAHs.
- The CFD patterns for PAHs and DDTs were similar in that they all were more skewed toward the low end of the concentration range, suggesting that the majority of the Puget Sound UGA shoreline covered by the SAM study design, have lower concentrations of these contaminants (relative to the range of concentrations for each chemical) and that only a few sites have much higher concentrations, perhaps from site specific point sources.
- The CFD pattern for PCBs and PBDEs had a more gradual contaminant accumulation as the cumulative percentage of UGA shoreline length increased, suggesting a full range of concentrations (low to high) are observed across the UGA.

## 2016-2018-2020 Comparison (Early Trends):

- Mean concentrations of PCBs and DDTs in SAM site mussels showed no significant differences between the first three survey years (2016, 2018, 2020), indicating contamination in the Puget Sound nearshore (within the UGA sampling frame) by these chemicals has not changed appreciably.
- Mean concentrations of PAHs and PBDEs in SAM site mussels showed a significant decline in the 2019/2020 survey, indicating contamination by these chemicals in the Puget Sound nearshore (UGA) have declined during this three-year survey period. Additional sampling years will allow us to determine a more robust trend.
- The significant decline in PBDE concentrations in the 2020 survey year occurred in all four % impervious surface in nearshore watershed strata, indicating the decline in concentrations is occurring across the entire UGA sampling frame and changes were not driven by nearshore development.

# 2021-2022 Survey

- First survey under the new SAM study design: sampling the entire Puget Sound Lowland areas and distributed by four %IS strata
- Evaluated 40 sites in summer 2021 and confirmed 33 sites with suitable locations to anchor a mussel cage.
- Cages deployed in November 2021 and retrieved January/February 2022. Retrieved cages from 31 sites.
- Tissue composite samples prepared and ready to be submitted to labs for chemical analyses.

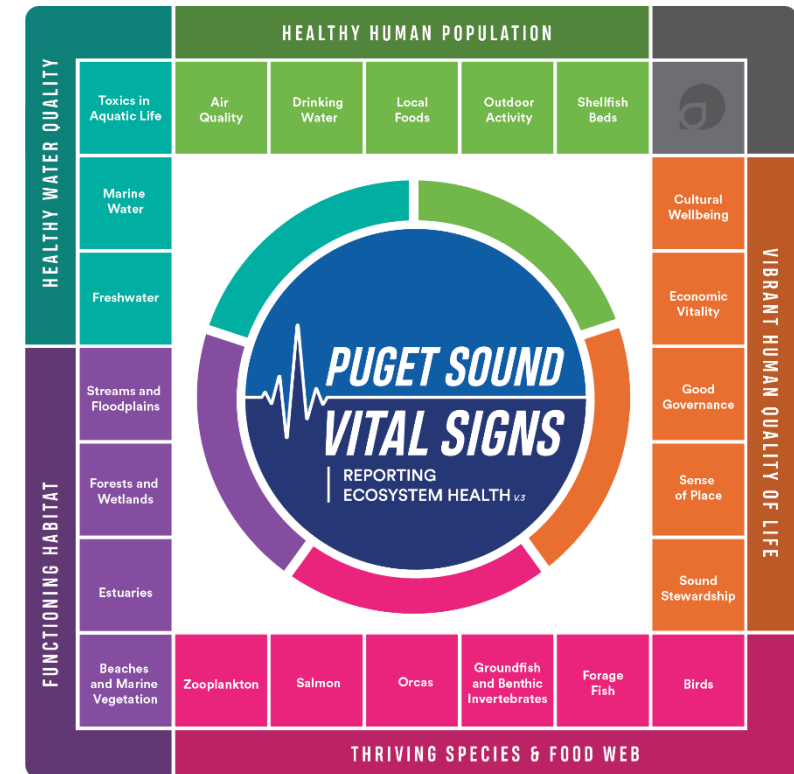


## Additional Work:


- WDFW Mussel Monitoring Program (SAM/WDFW/Sponsor sites) and development of the nearshore Toxics in Aquatic Life Vital Sign indicator with the Washington Cooperative Fish and Wildlife Research Unit at UW-SAFS.
- Partnership with NOAA National Mussel Watch Program to conduct an assessment of the presence, distribution, and concentrations of contaminants of emerging concern in mussels in WA coastal waters. Twenty of the 2019/20 SAM sites contributed to the study.



Toxics in Aquatic Life		
Contaminants in adult salmon	INSUFFICIENT OR NO DATA	BELOW TARGET
Contaminants in caged mussels	INSUFFICIENT OR NO DATA	INSUFFICIENT OR NO DATA
Contaminants in English sole	MIXED RESULTS	BELOW TARGET
Contaminants in juvenile salmon	INSUFFICIENT OR NO DATA	BELOW TARGET
Contaminants in Pacific herring	MIXED RESULTS	BELOW TARGET



# Reports now available online:




Puget Sound Ecosystem Monitoring Program (PSEMP)


**Toxic Contaminants in Puget Sound's Nearshore Biota:  
A Large-Scale Synoptic Survey Using  
Transplanted Mussels (*Mytilus trossulus*)**

**Final Report  
September 4, 2014**

Jennifer A. Lanksbury, Laurie A. Niewolny, Andrea J. Carey and James E. West



WDFW Report Number FPT 14-08




Toxics-focused Biological Observation System (T-BIOS),  
Puget Sound Ecosystem Monitoring Program (PSEMP)

**Stormwater Action Monitoring  
2015/16 Mussel Monitoring Survey**

**Final Report  
August 9, 2017**

Jennifer Lanksbury, Brandi Lubliner, Mariko  
Langness, and James West



WDFW Report Number FPT 17-06




Toxics Biological Observation System (TBIOS),  
Puget Sound Ecosystem Monitoring Program (PSEMP)

**Stormwater Action Monitoring  
2017/18 Mussel Monitoring Survey**

**Final Report  
October 2020**

Mariko Langness and James West



WDFW Report Number FPT 20-13



# Acknowledgments

## 2019/20 WDFW Partners:

WA Department of Natural Resources – Aquatic Reserves

Bainbridge Beach Naturalists

City of Bellingham

Jamestown S’Klallam Tribe

King County

Kitsap County

Port of Tacoma

NOAA National Mussel Watch Program

## WDFW Volunteers:

100+ Citizen Science Volunteers

WA Conservation Corps

