Mussel Watch Pilot Expansion Study:

Toxic Contaminants in Nearshore Biota

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Funded by EPA's National Estuary Program

Presentation Overview

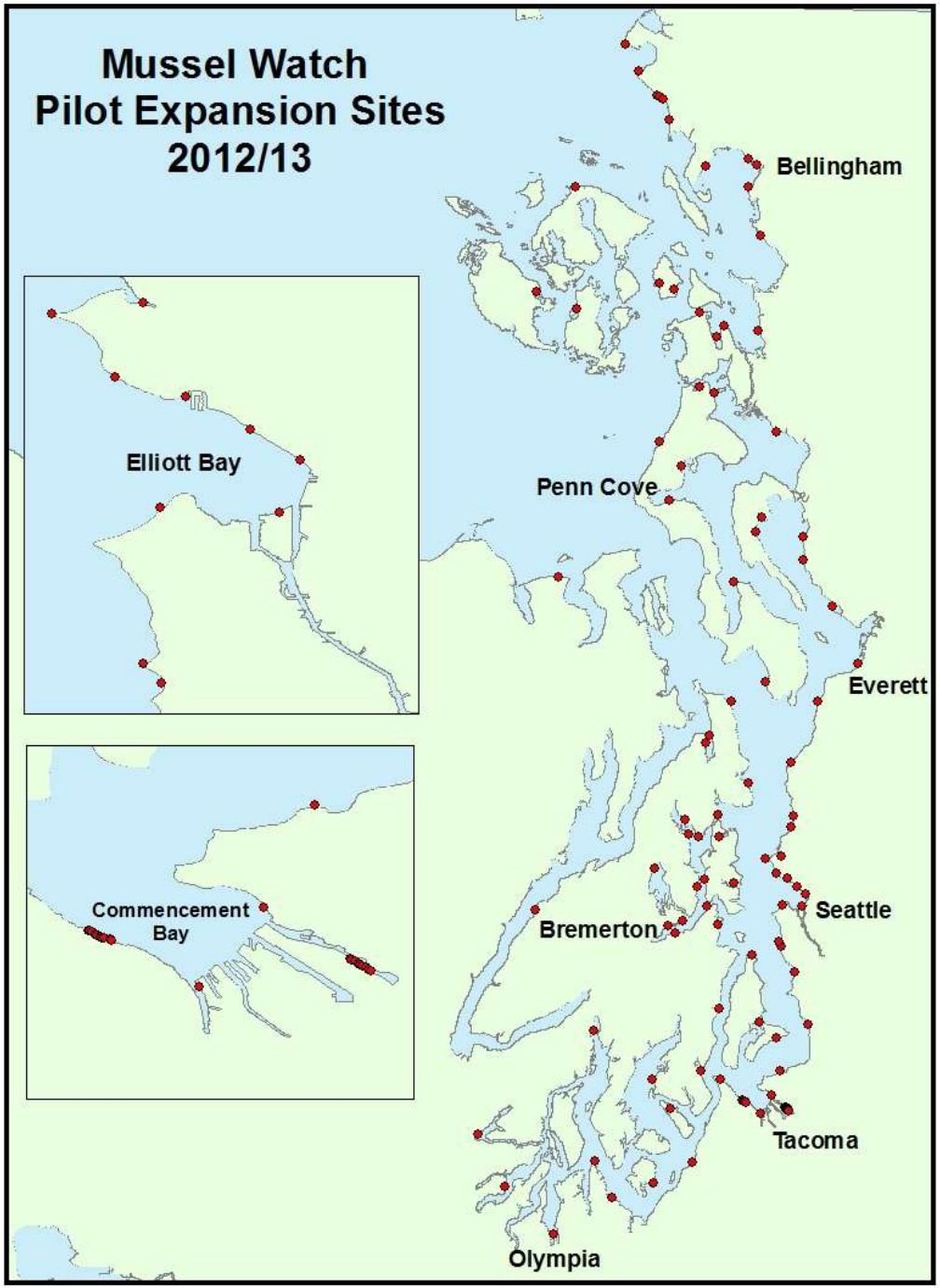
- Study parameters & map
- Success with partner groups and volunteers
- Why transplanted (caged) mussels?
- Preliminary chemistry results - 4 contaminants
- Limited comparison of caged vs. native mussels from the same locations
- Next steps in mussel data analysis

Successful cage deployment and retrieval during winter 2012/13

60 EPA-NEP funded sites +
48 additional sites funded by external partners

Numerous participants in this project: federal, state, county and city agencies, Marine Resource Committees (MRCs), tribes, universities and colleges, aquariums and nature centers, private business, NGOs (i.e. beach watchers)

Huge participation by citizen science volunteers in field and lab (100+ people)



Partners and volunteers in Mussel Watch Pilot Expansion (2012/13)

Bainbridge Beach Naturalists

City of Bellingham - Natural Resources Department

Evergreen State College

Harbor Wildwatch

Highline Community College - Marine Science & Technology Center (MaST)

King County Environmental Lab (KCEL)

King County - Natural Resources and Parks

Kitsap County Public Works - Surface & Storm Water Management Program

Lummi Nation

Nisqually Reach Nature Center

NOAA, Northwest Fisheries Science Center

Padilla Bay National Estuarine Research Reserve

Penn Cove Shellfish

Port Gamble S'Klallam Tribe

Port Madison Suquamish Tribe

Puget Creek Restoration Society

Puget Sound Partnership

Puget Soundkeeper Alliance

Samish Indian Nation

San Juan County Marine Resources Committee

Seattle Aquarium - Beach Naturalists

Skagit County Marine Resources Committee

Snohomish County Marine Resources Committee

SSA Marine

Stillaguamish River Clean Water District Advisory Board

Stillaguamish Tribe

Tacoma-Pierce County Health Department

Tulalip Tribes

US Navy - NW Space and Naval Warfare Systems Center

University of Puget Sound

UW-Tacoma

Washington Conservation Corps - Puget SoundCorps

Whatcom County Marine Resources Committee

Washington Department of Ecology

WDFW's Oil Spill Response Team

WDNR Aquatic Reserves Program

WDNR Nearshore Habitat Program

WSU Island County Beach Watchers

WSU Kitsap County Beach Watchers

WSU Skagit County Beach Watchers

WSU Snohomish County Beach Watchers

Why Transplanted (caged) Mussels?

Caged Mussels

Pros

- Unlimited locations
- Uniform starting population
- Known exposure period
- Bio-effects endpoints can be measured

Cons

- Possible loss of cages (storms/theft)
- Mismatch in methods for MW comparison

Native Mussels

Cons

- Natural populations limited/variable
- High individual variability
- Unknown exposure period

Pros

- Long-term MW data available
- Measure of “true condition”

Why Transplanted (caged) Mussels?

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- Unlimited locations
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Cons

- Very low loss of cages from storms (3 of 108), no theft
- Mismatch in methods for MW comparison

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Why Transplanted (caged) Mussels?

Caged Mussels

Pros

- Unlimited locations
- Uniform starting population
- Known exposure period
- Bio-effects endpoints can be measured

Cons

- Very low loss of cages from storms (3 of 108), no theft
- Limited matching caged-native data reveal no obvious pattern

Native Mussels

Cons

- Natural populations limited/variable
- High individual variability
- Unknown exposure period

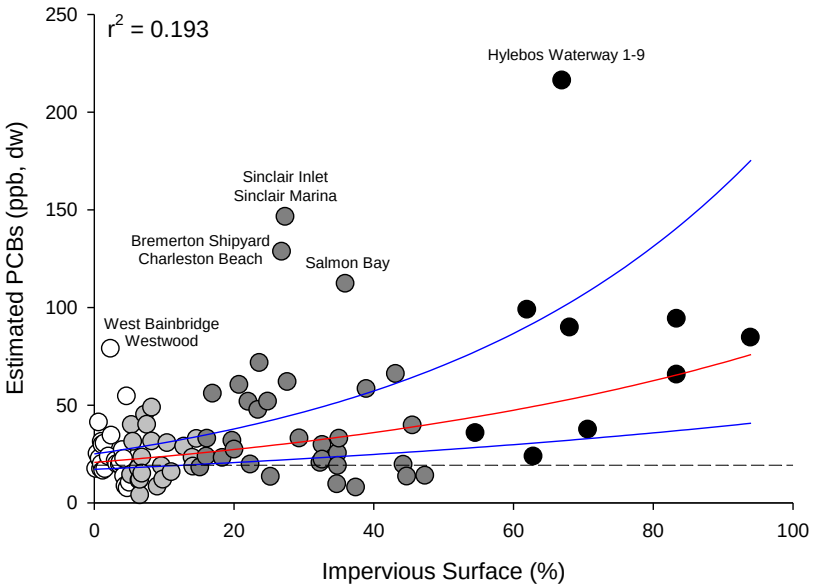
Pros

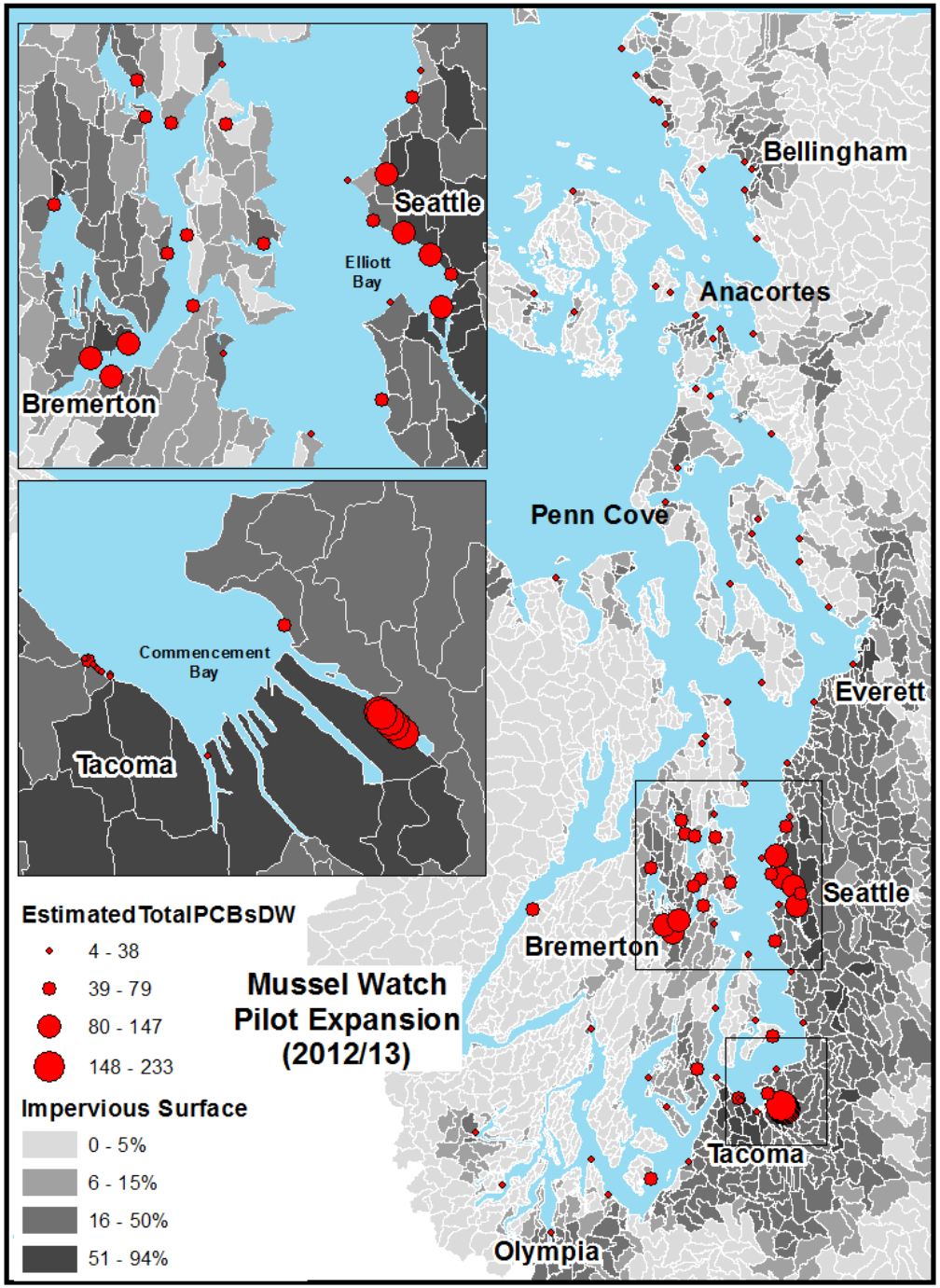
- Long-term MW data available
- Measure of “true condition”

Preliminary Chemistry Results

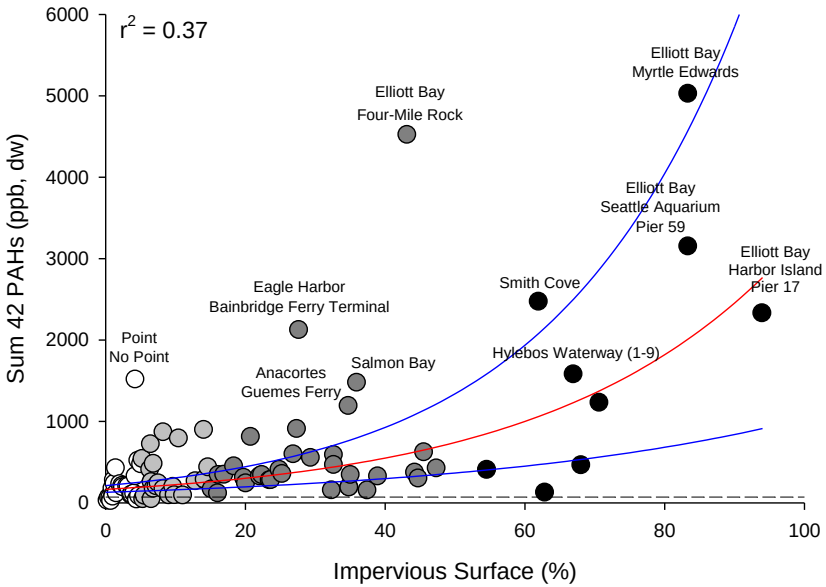
- **PAHs (hydrocarbons)**
- Organohalogens
  - **PCBs**
  - PBDEs
  - DDTs
  - Chlordanes
  - Other pesticides
- Metals
  - **Lead**
  - **Copper**
  - **Arsenic**
  - Zinc
  - Cadmium
  - Mercury

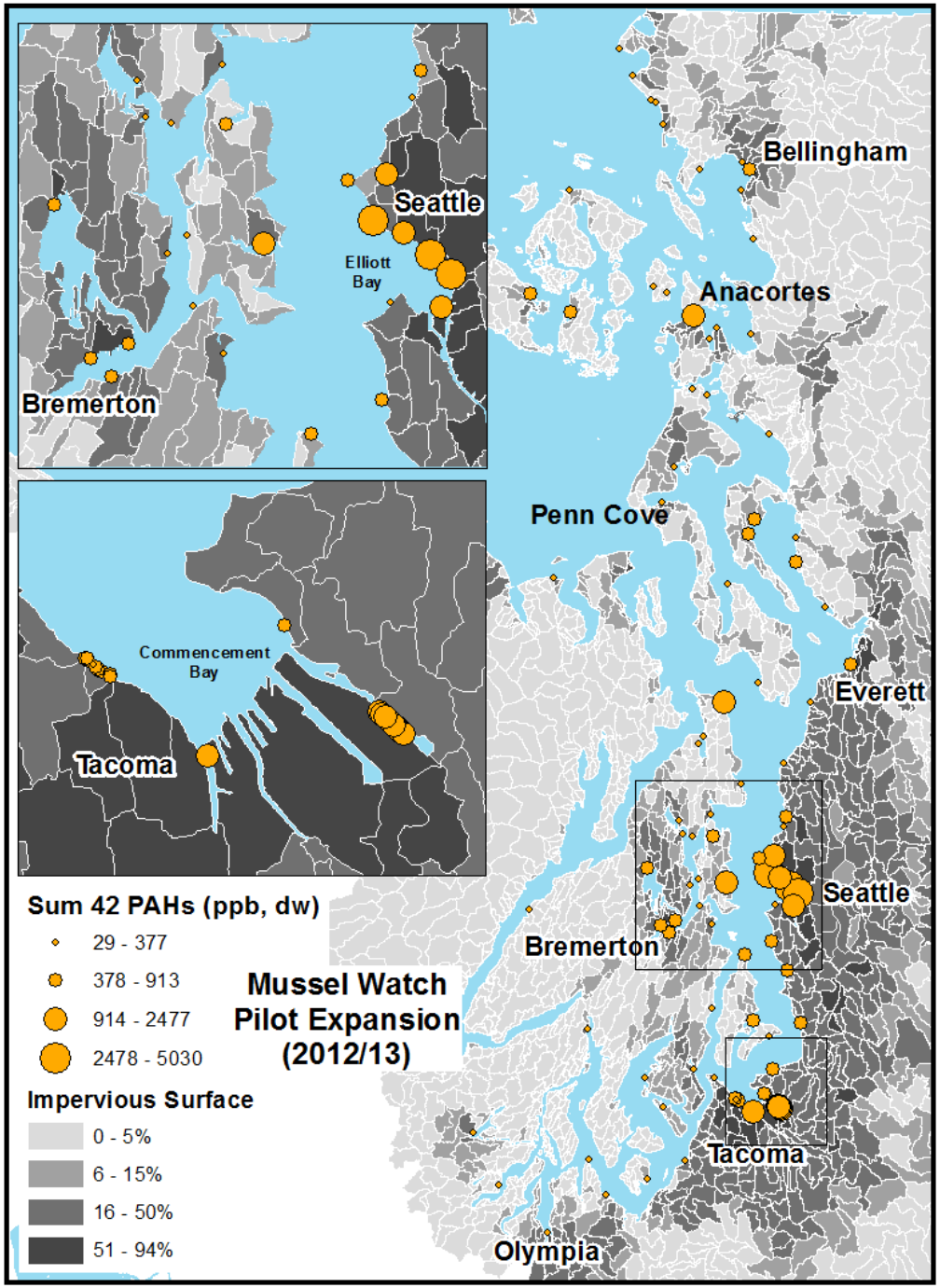
Estimated PCBs (ppb, dw)



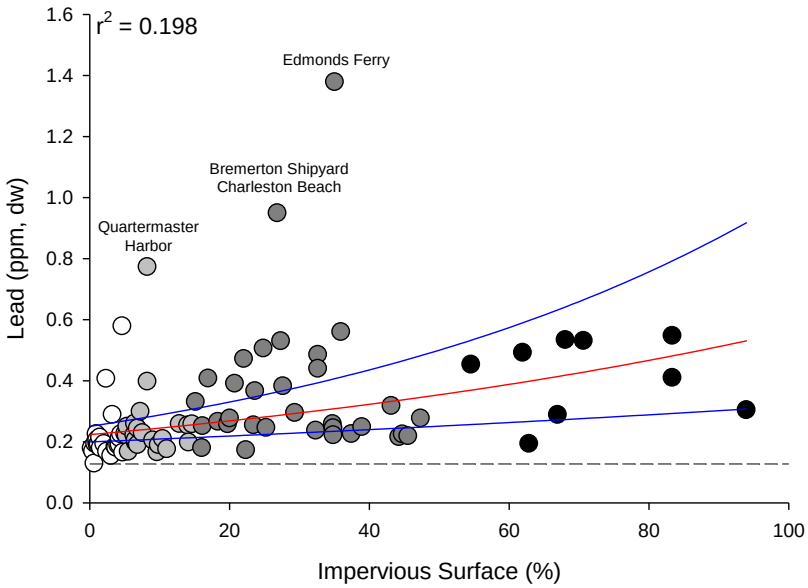


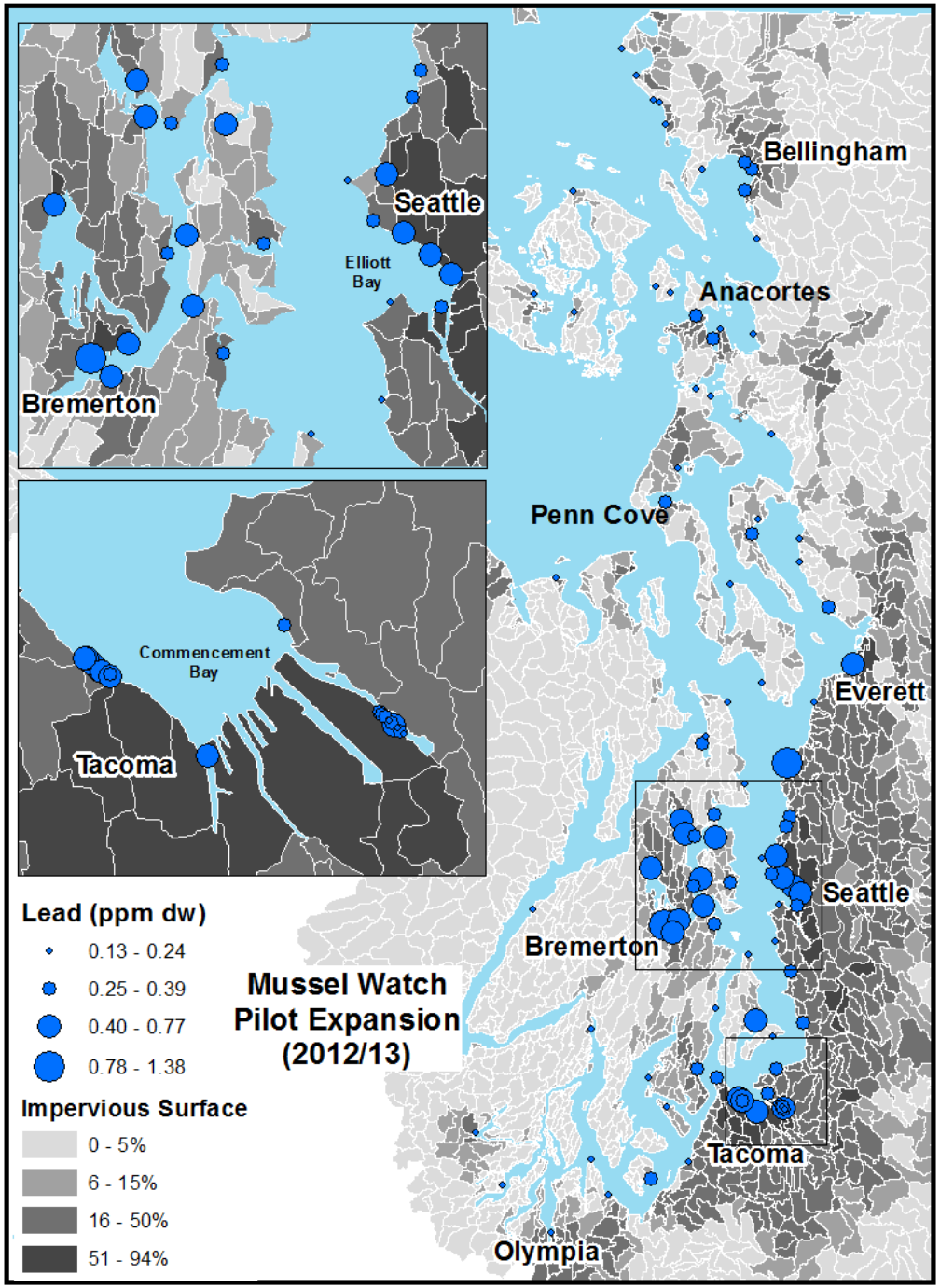
Sum 42 PAHs (ppb, dw)



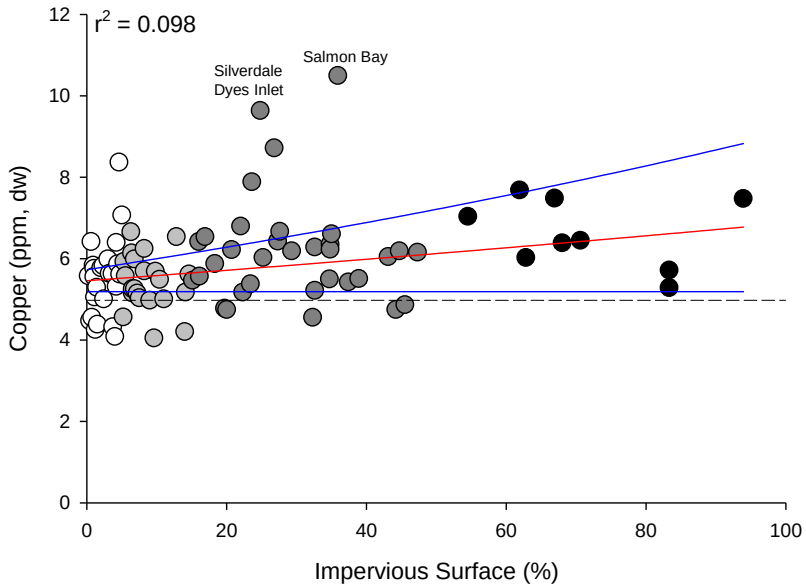


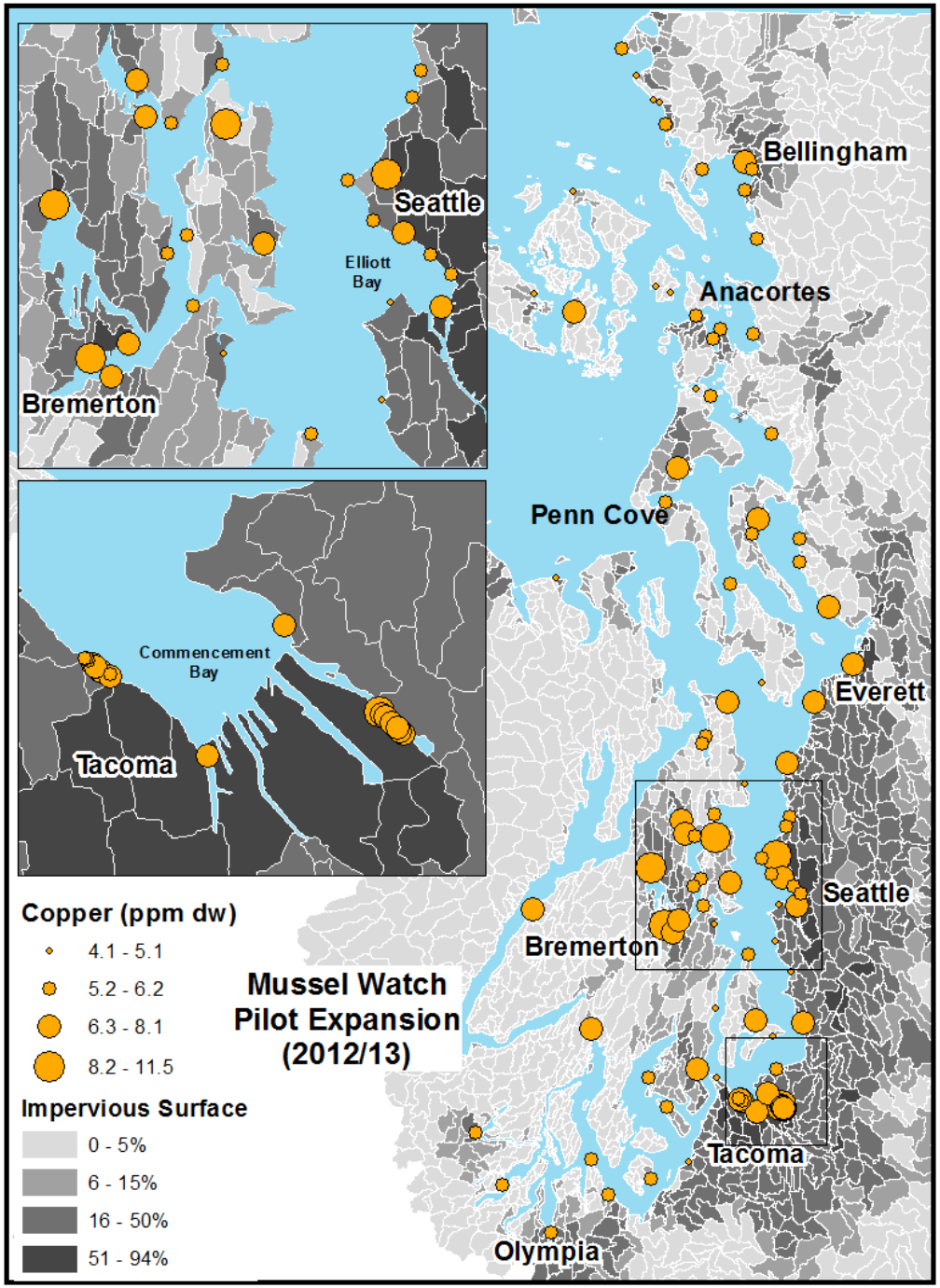
Lead (ppm, dw)


r^2 = 0.198
Edmonds Ferry
Bremerton Shipyard
Charleston Beach
Quartermaster
Harbor
Lead (ppm, dw)
Impervious Surface (%)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
20
40
60
80
100

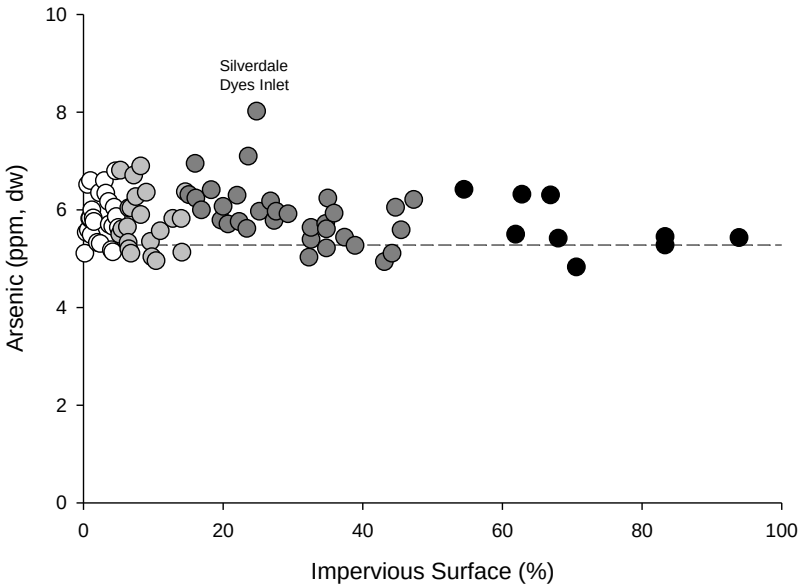

Seattle
Elliott
Bay
Bremerton
Commencement
Bay
Tacoma
Bellingham
Anacortes
Penn Cove
Everett
Seattle
Bremerton
Tacoma
Olympia
Lead (ppm dw)
0.13 - 0.24
0.25 - 0.39
0.40 - 0.77
0.78 - 1.38
Impervious Surface
0 - 5%
6 - 15%
16 - 50%
51 - 94%
Mussel Watch
Pilot Expansion
(2012/13)

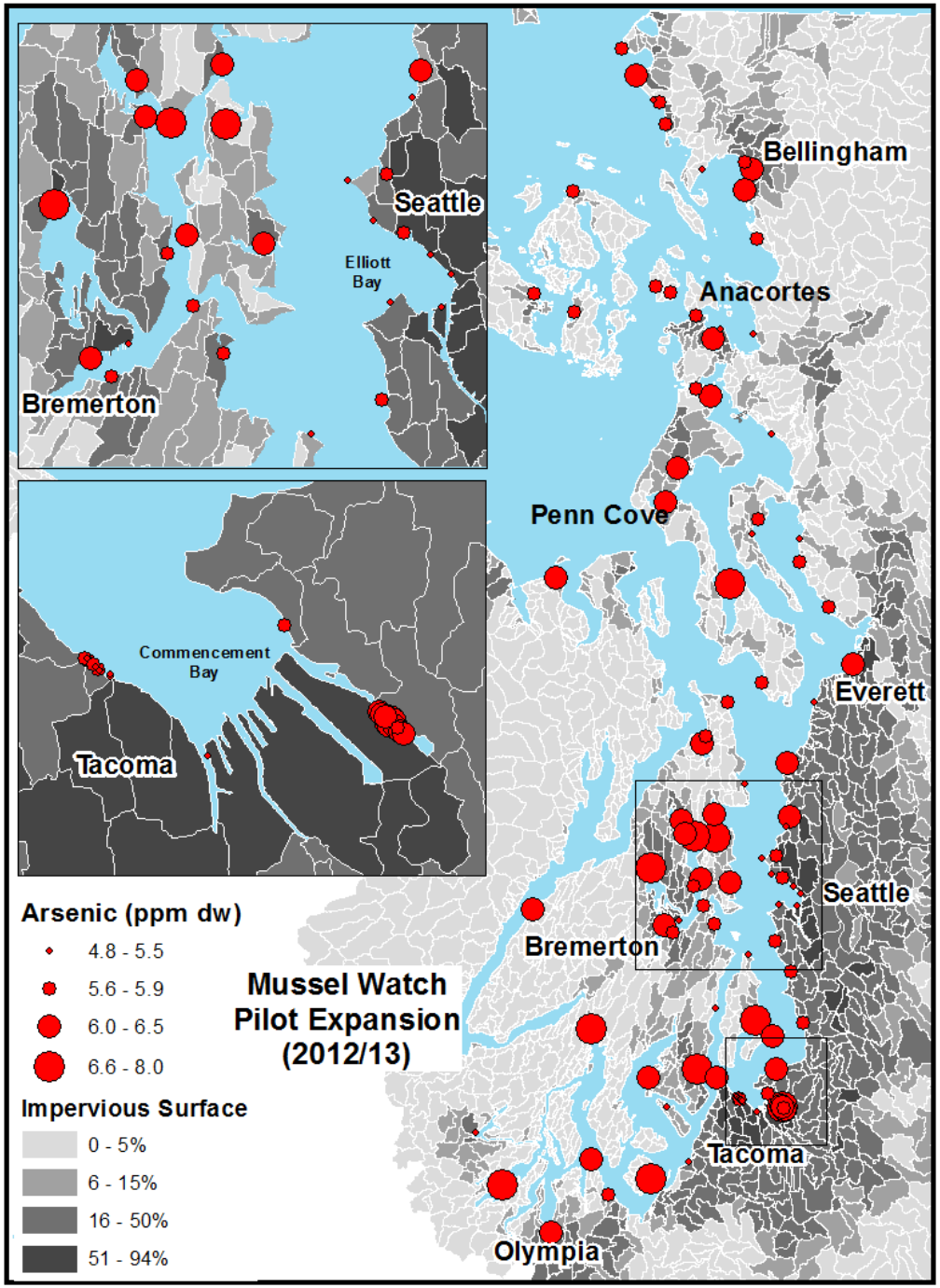
Copper (ppm, dw)





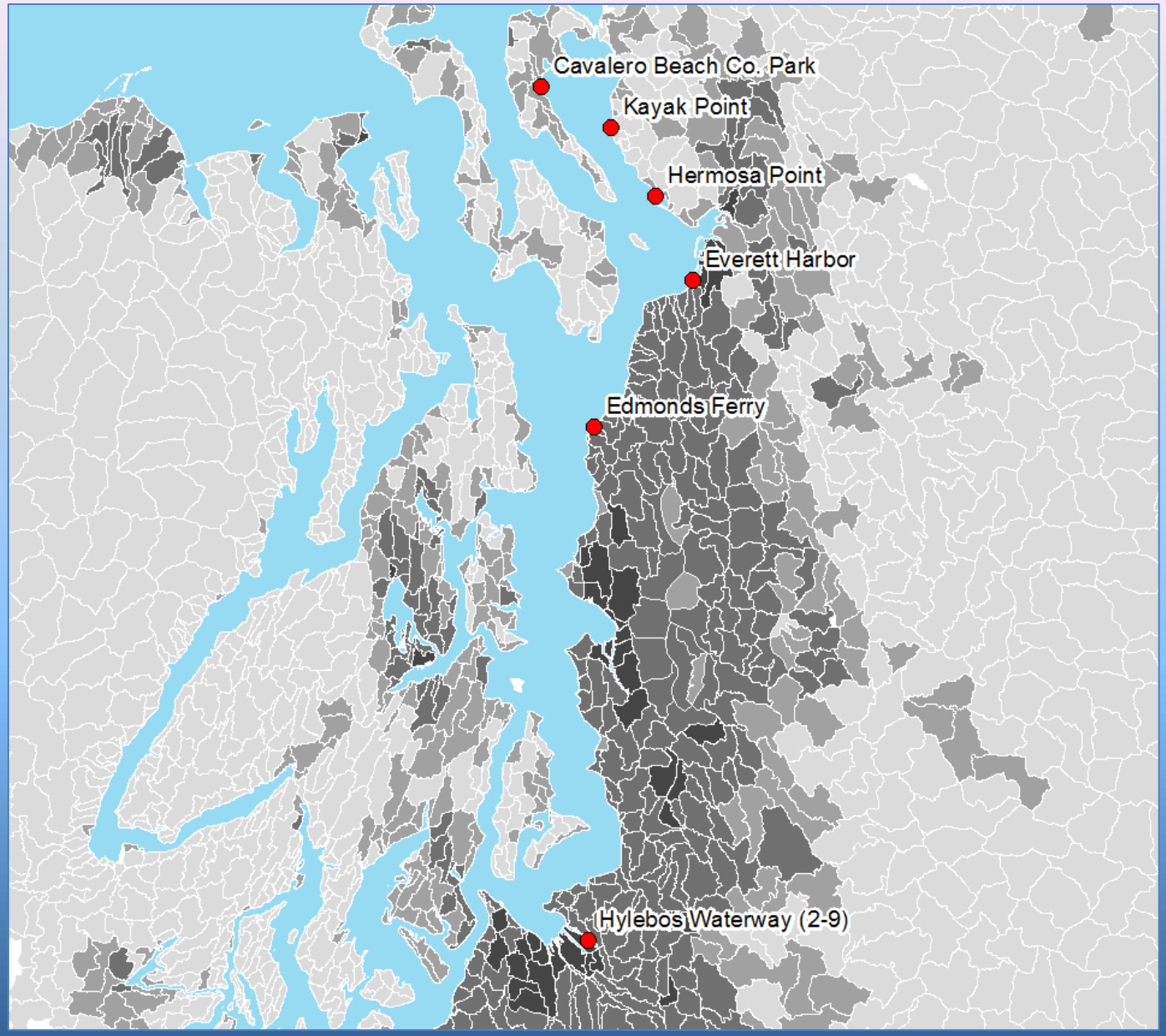
Arsenic (ppm, dw)

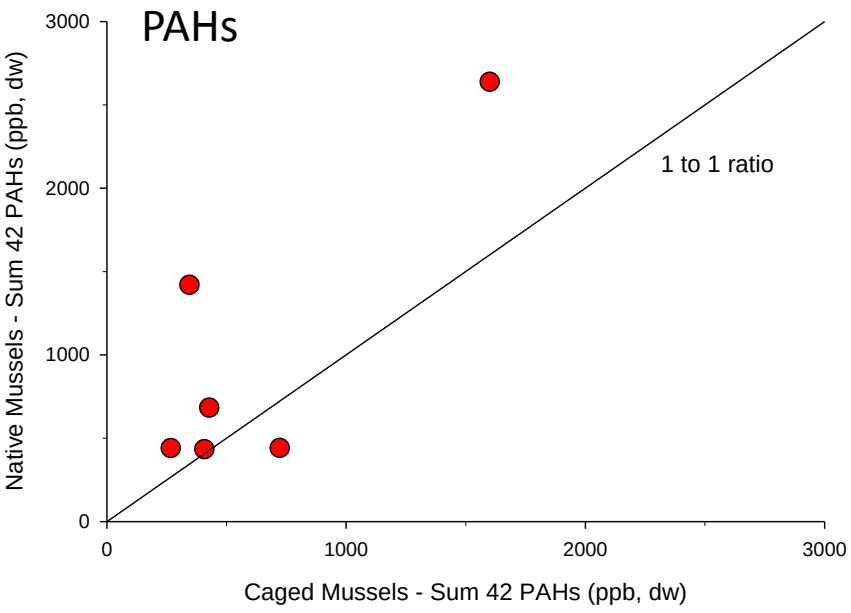


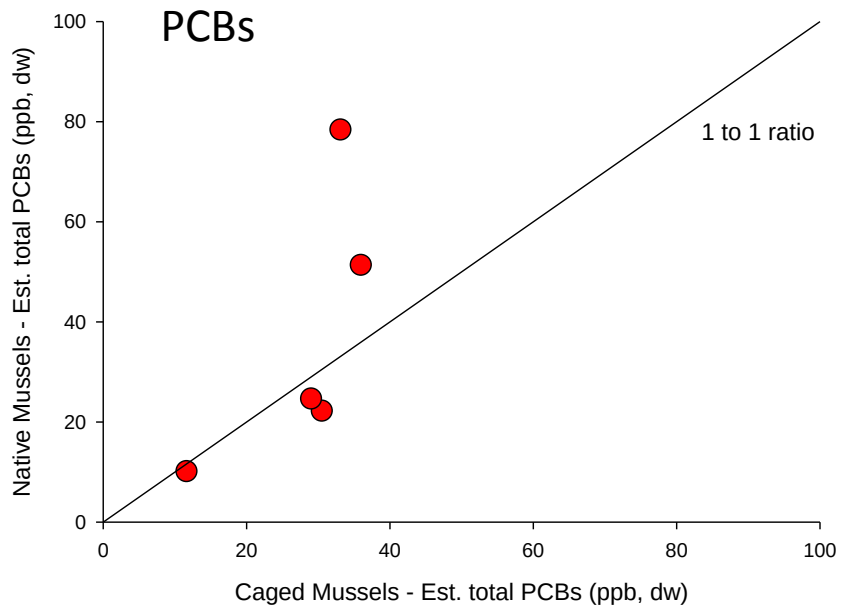


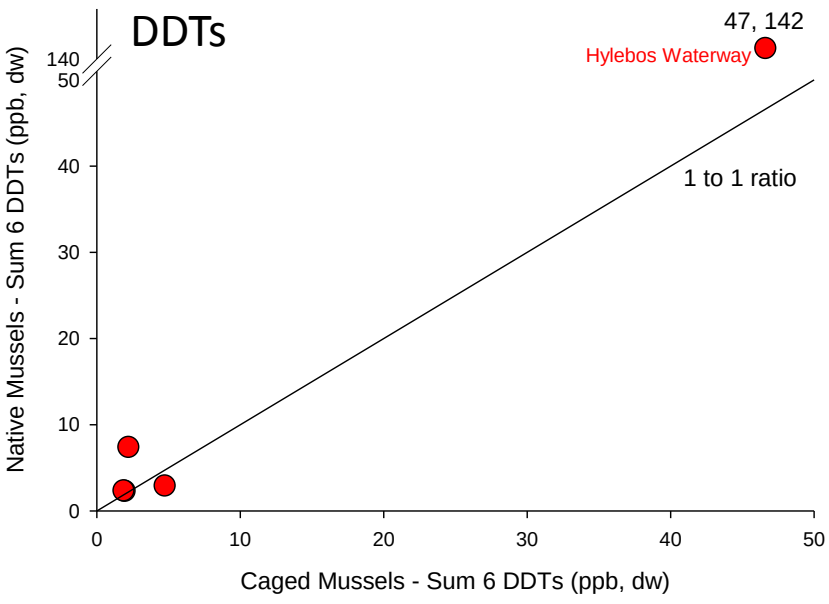
How do caged mussels compare to native mussels?

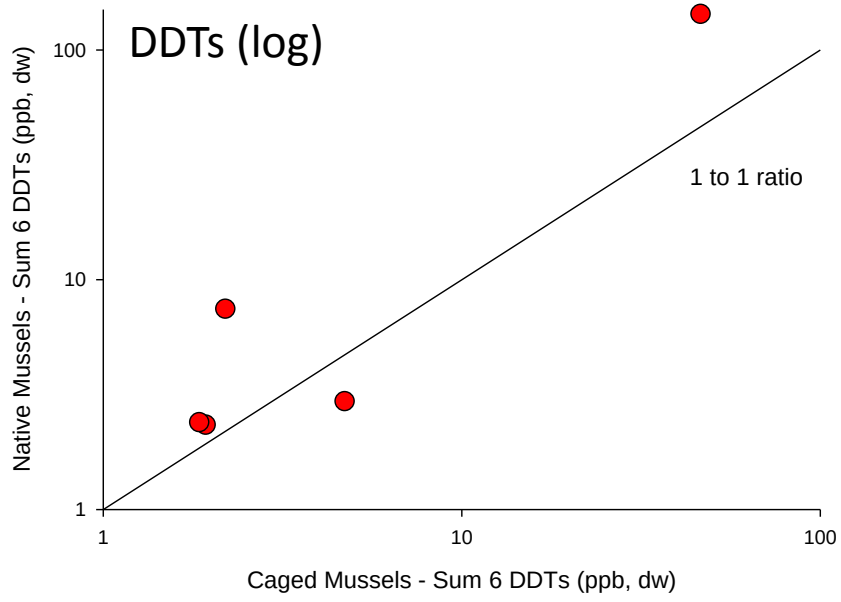
MWPE caged mussel sites where matching native mussels were collected…

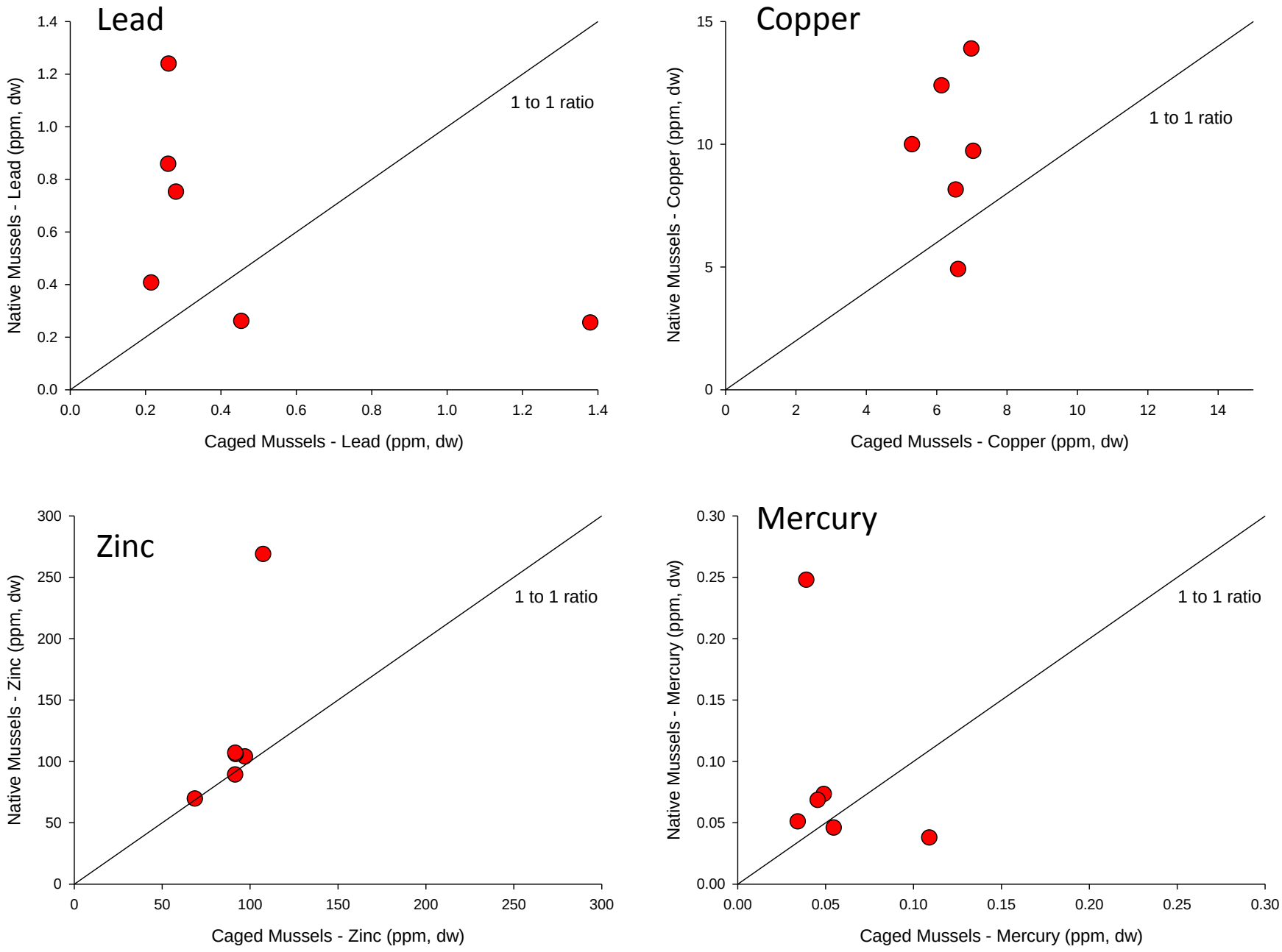


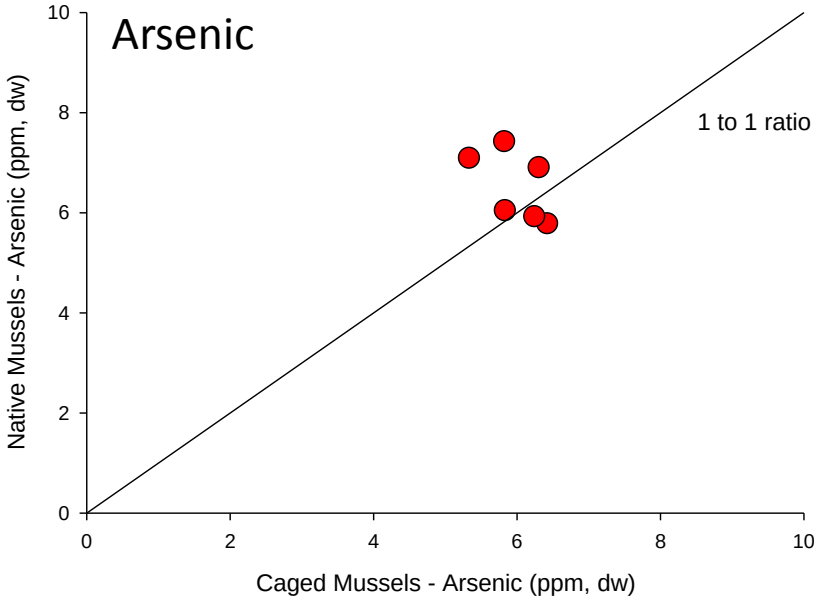

PAHs
1 to 1 ratio
Native Mussels - Sum 42 PAHs (ppb, dw)
Caged Mussels - Sum 42 PAHs (ppb, dw)
0
1000
2000
3000

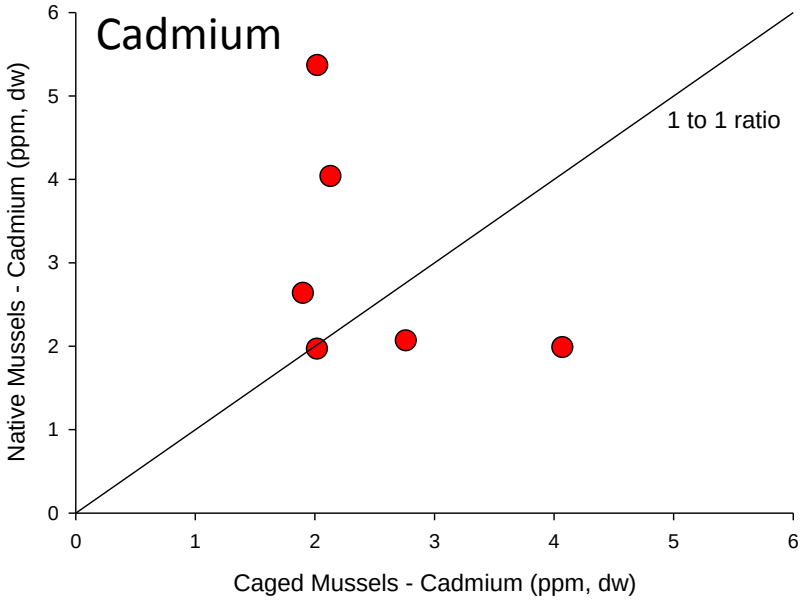

PCBs
1 to 1 ratio
Native Mussels - Est. total PCBs (ppb, dw)
Caged Mussels - Est. total PCBs (ppb, dw)
0
20
40
60
80
100


DDTs
47, 142
Hylebos Waterway
1 to 1 ratio
Native Mussels - Sum 6 DDTs (ppb, dw)
Caged Mussels - Sum 6 DDTs (ppb, dw)
140
50
0
10
20
30
40


DDTs (log)
1 to 1 ratio
Native Mussels - Sum 6 DDTs (ppb, dw)
Caged Mussels - Sum 6 DDTs (ppb, dw)
1
10
100


Lead
1 to 1 ratio
Native Mussels - Lead (ppm, dw)
Caged Mussels - Lead (ppm, dw)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
Copper
1 to 1 ratio
Native Mussels - Copper (ppm, dw)
Caged Mussels - Copper (ppm, dw)
0
5
10
15
0
2
4
6
8
10
12
14
Zinc
1 to 1 ratio
Native Mussels - Zinc (ppm, dw)
Caged Mussels - Zinc (ppm, dw)
0
50
100
150
200
250
300
Mercury
1 to 1 ratio
Native Mussels - Mercury (ppm, dw)
Caged Mussels - Mercury (ppm, dw)
0.00
0.05
0.10
0.15
0.20
0.25
0.30


Arsenic
1 to 1 ratio
Native Mussels - Arsenic (ppm, dw)
Caged Mussels - Arsenic (ppm, dw)
0
2
4
6
8
10

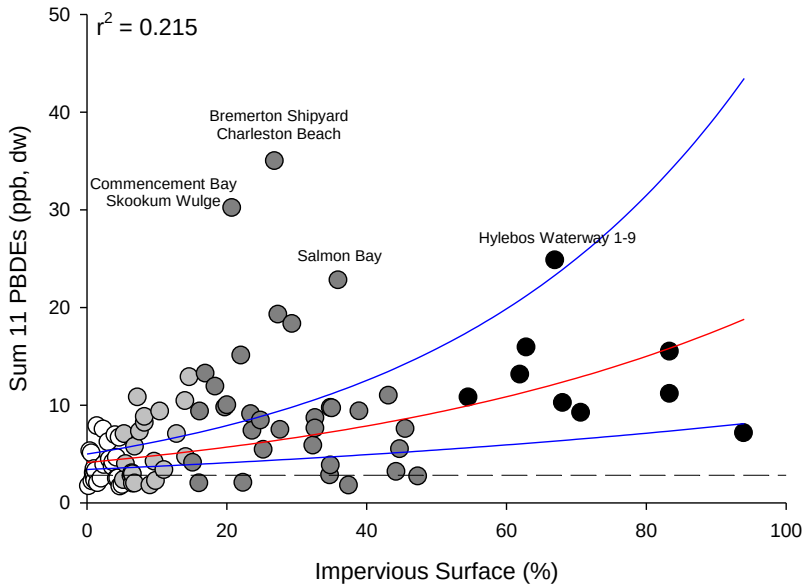

Cadmium
1 to 1 ratio
Native Mussels - Cadmium (ppm, dw)
Caged Mussels - Cadmium (ppm, dw)
0
1
2
3
4
5
6

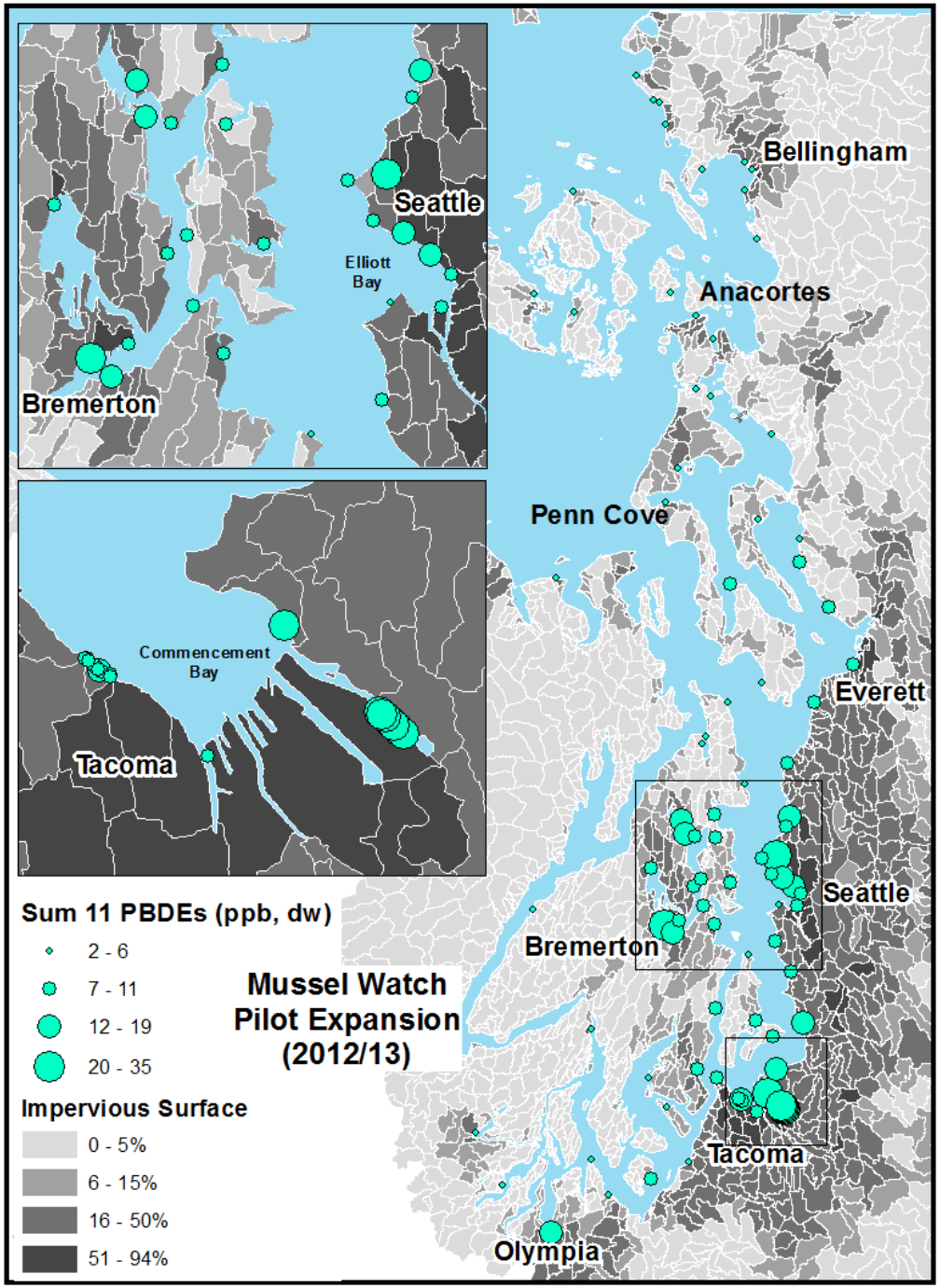
Next steps in analysis…

- Patterns in mussel contamination as related to:
  - Road density in adjacent uplands
  - Proximity to marinas
  - Proximity to ferry terminals
  - Proximity to river mouths
  - Embayments
  - CSOs or other large outfalls
- Multivariate dimensional scaling analysis of chemicals (i.e. fingerprinting using chemical ratios)
- Compare our results to other studies (Mussel Watch)

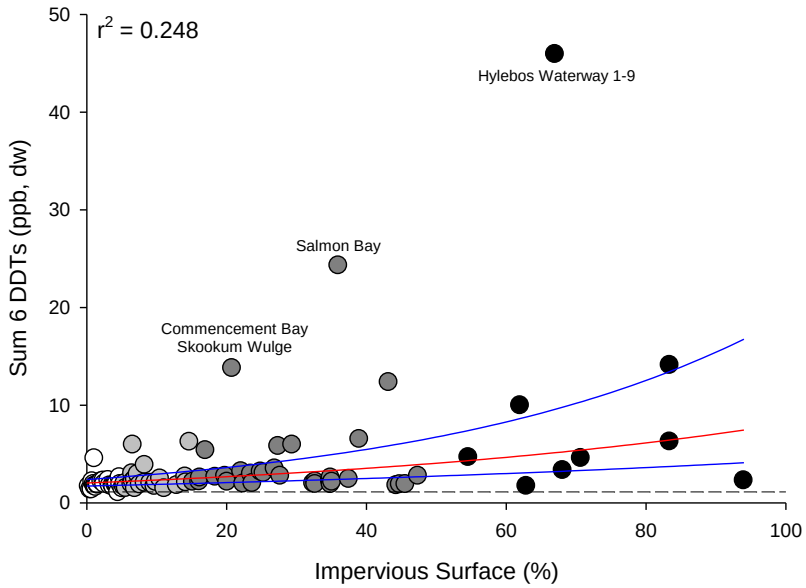
Thank you.

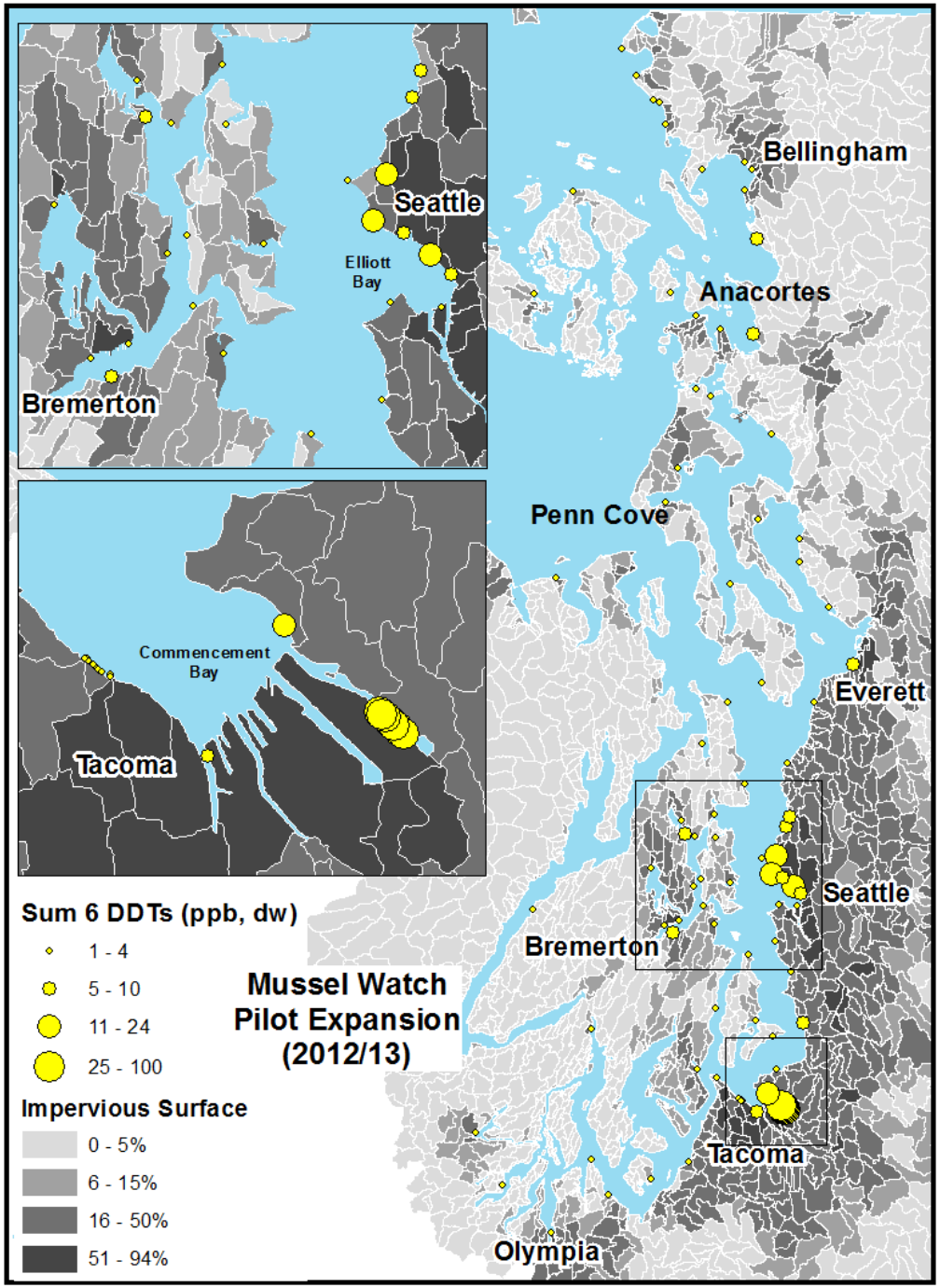
Sum 11 PBDEs (ppb, dw)



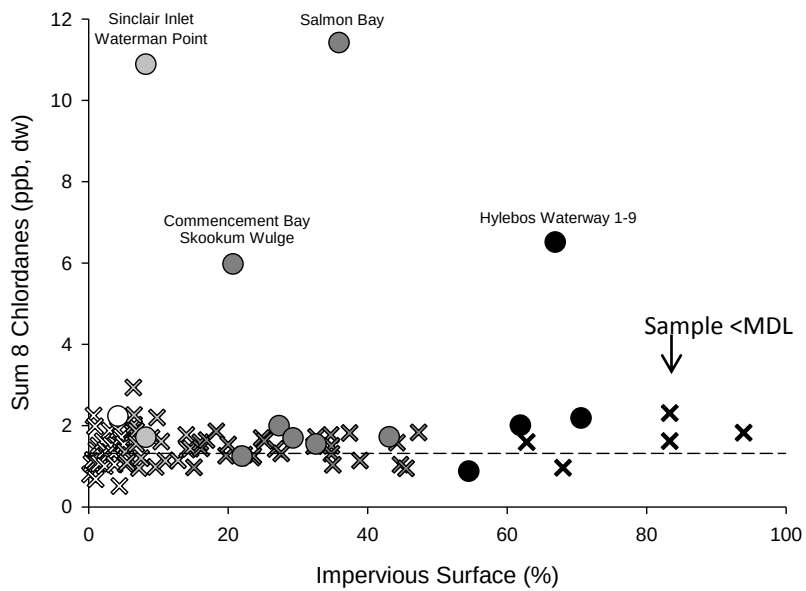


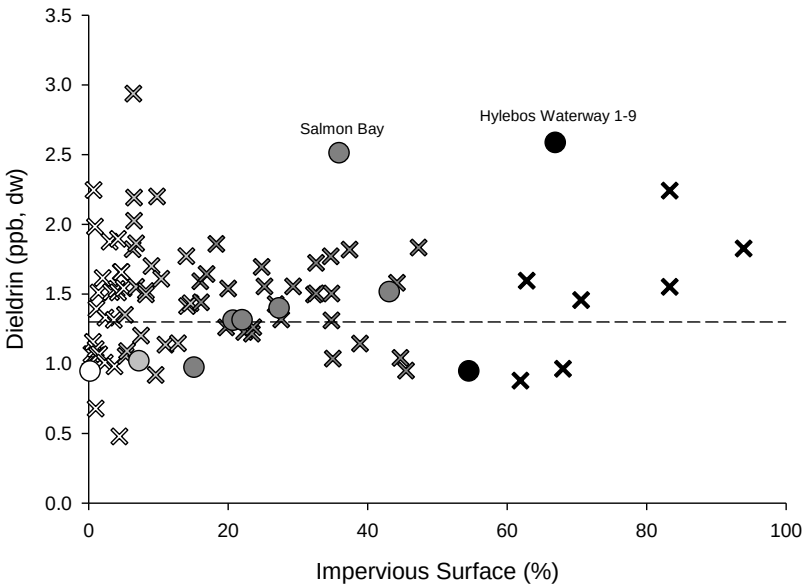
Sum 6 DDTs (ppb, dw)

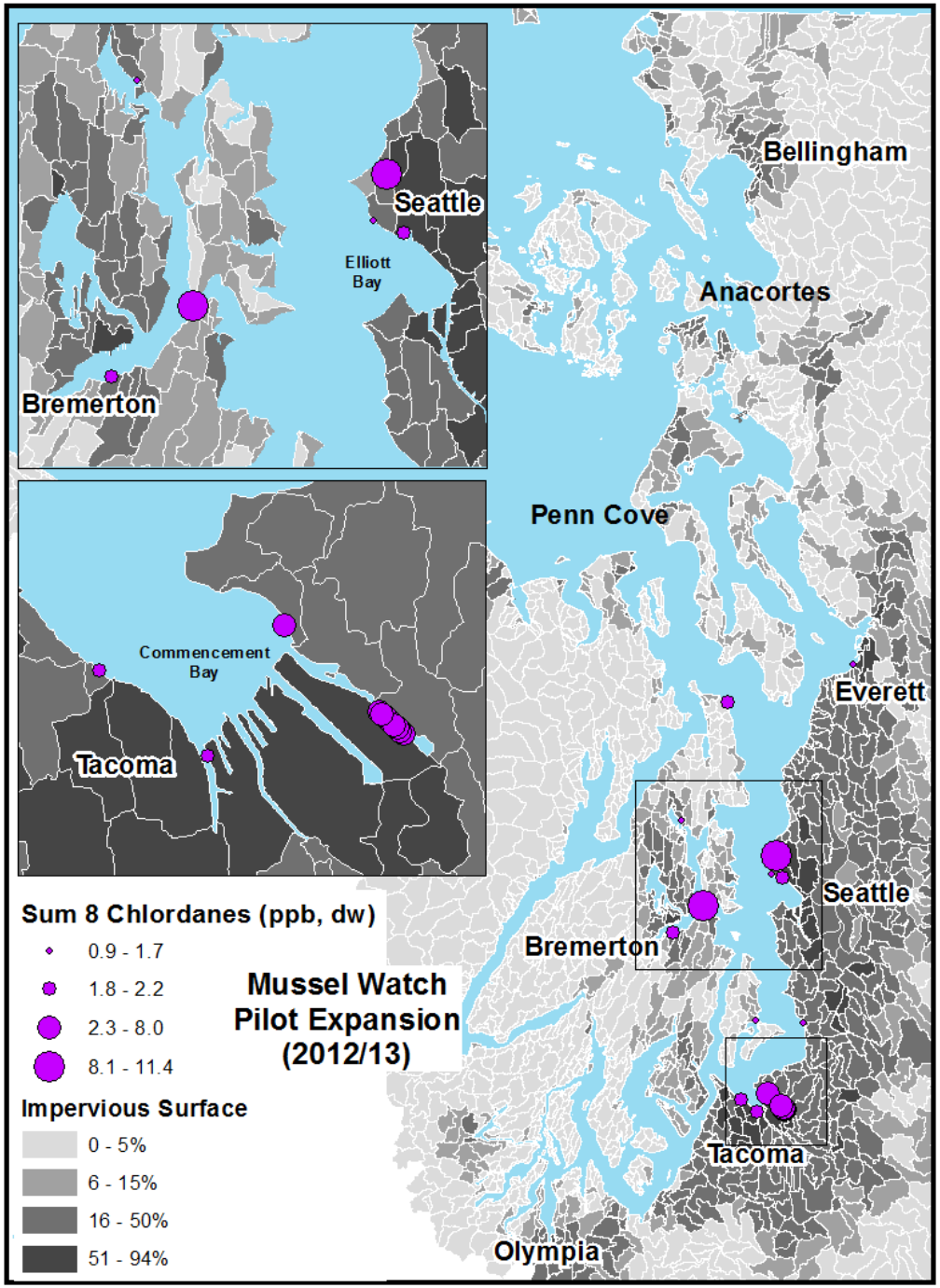




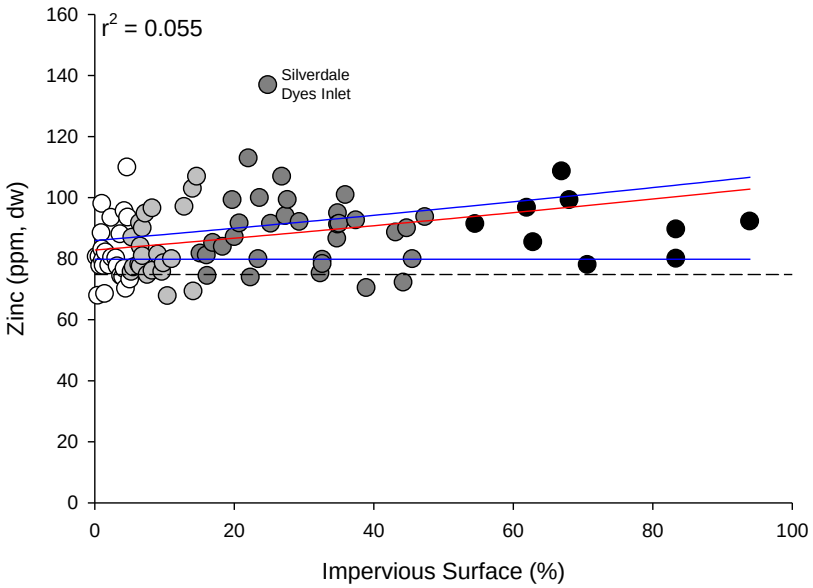
Sum 8 Chlordanes (ppb, dw)

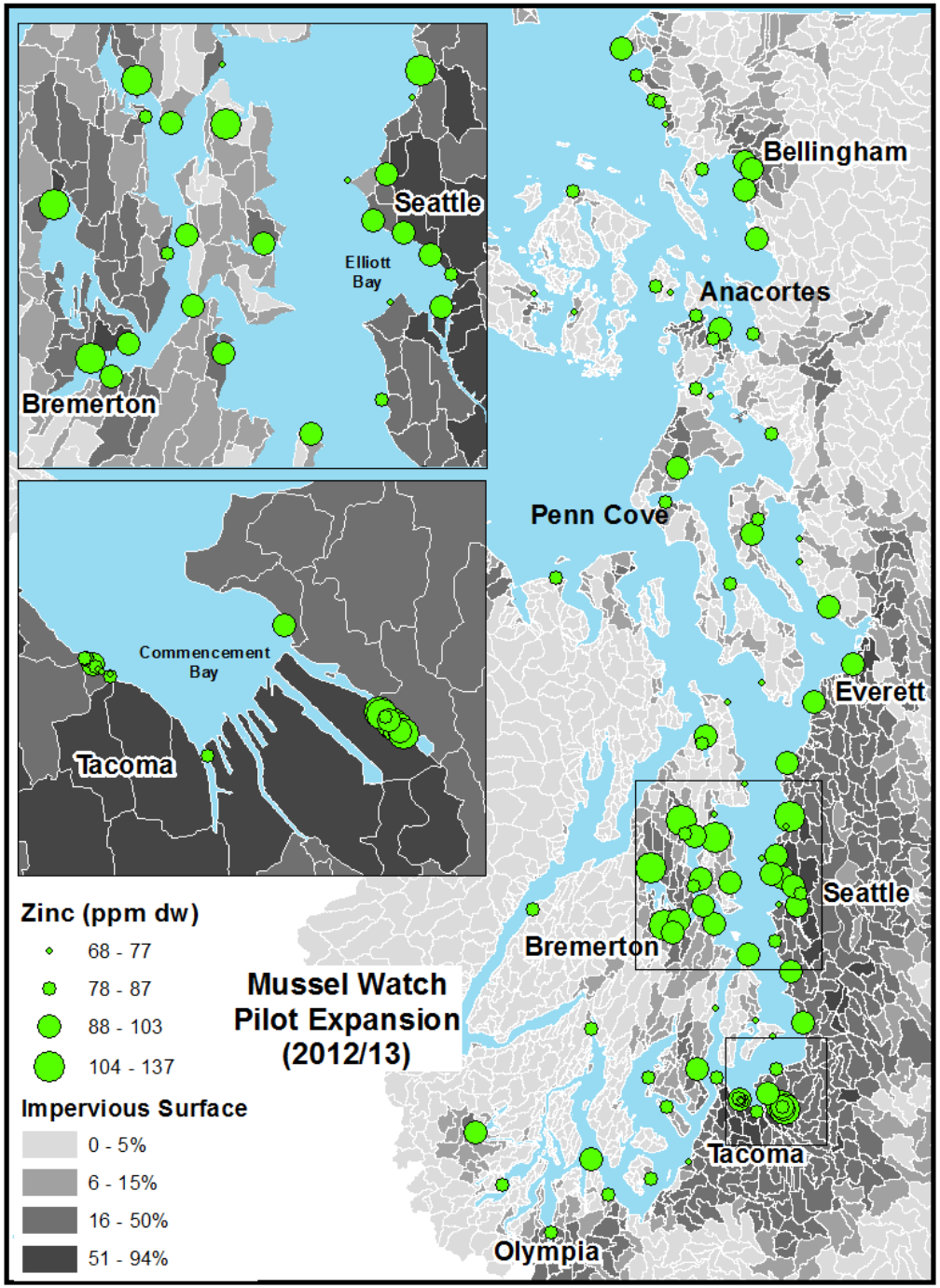




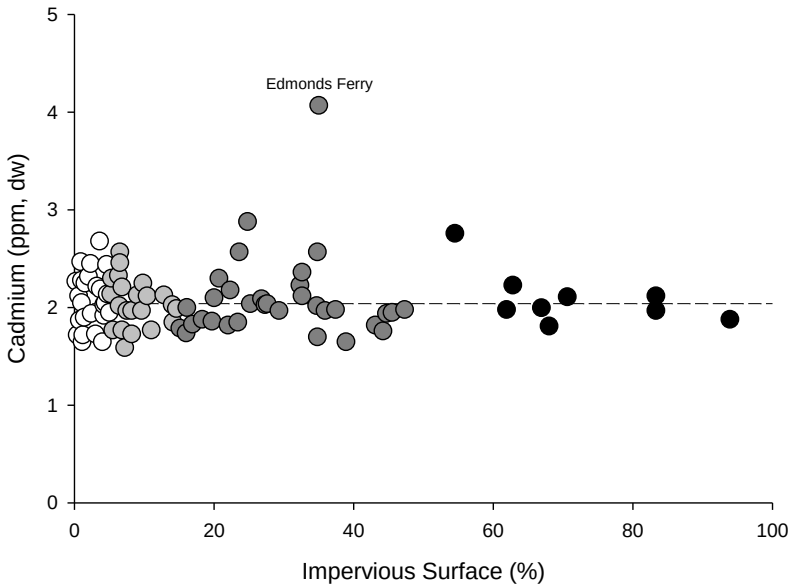


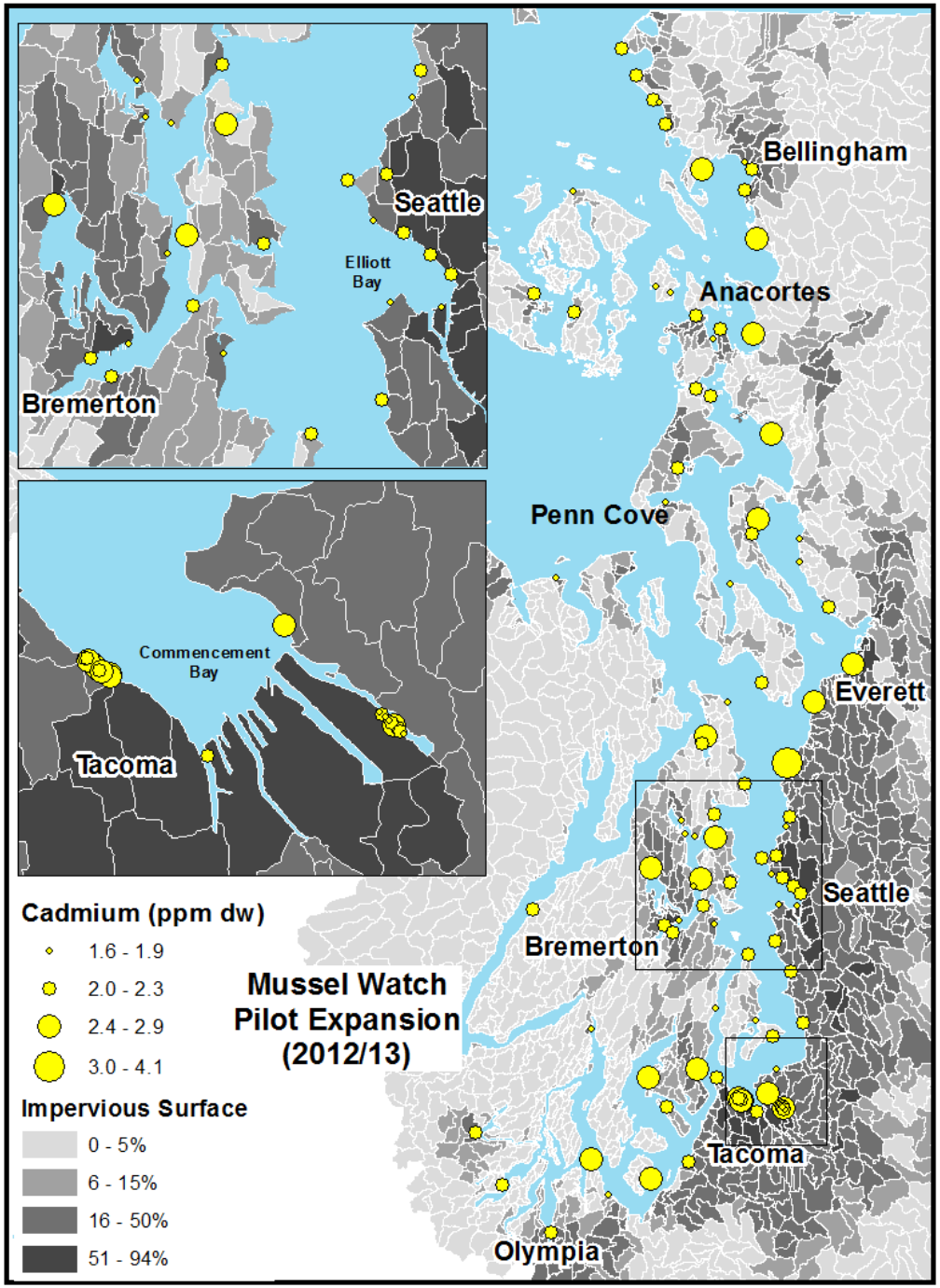
Zinc (ppm, dw)


r^2 = 0.055
Silverdale
Dyes Inlet
Zinc (ppm, dw)
Impervious Surface (%)
0
20
40
60
80
100
120
140
160

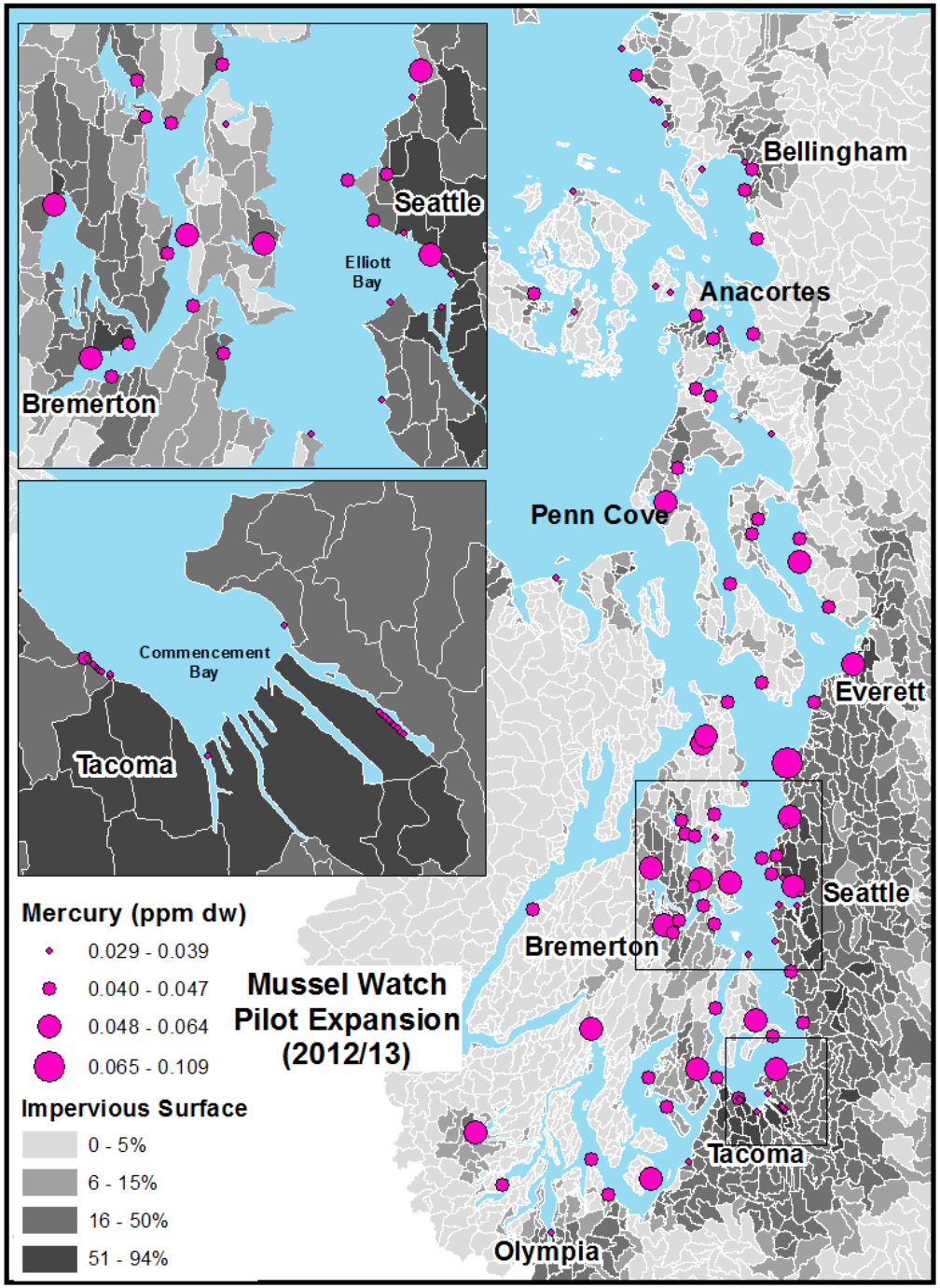
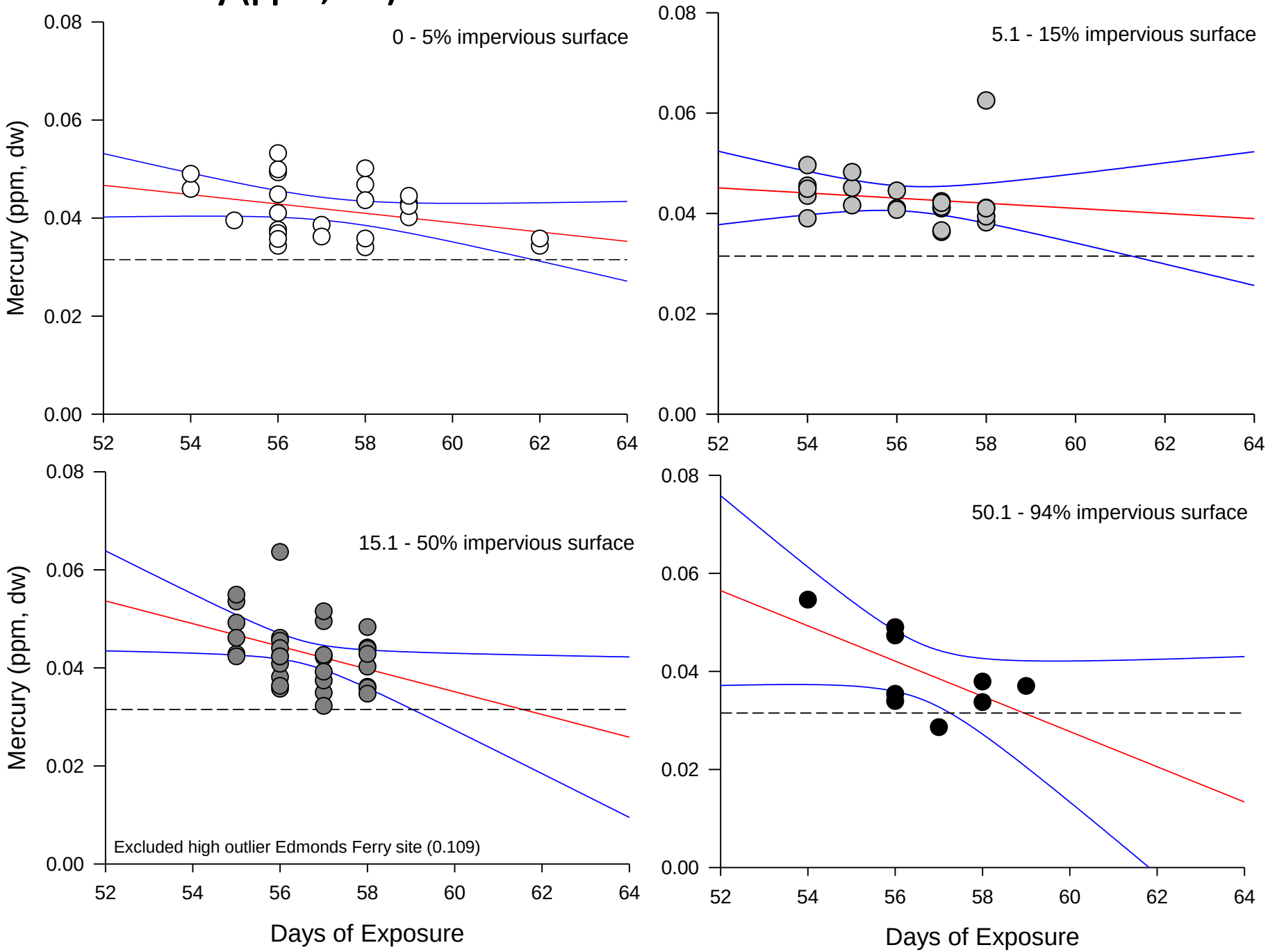

Seattle
Elliott Bay
Bremerton
Commencement Bay
Tacoma
Bellingham
Anacortes
Penn Cove
Everett
Seattle
Bremerton
Tacoma
Olympia
Mussel Watch Pilot Expansion (2012/13)
Zinc (ppm dw)
68 - 77
78 - 87
88 - 103
104 - 137
Impervious Surface
0 - 5%
6 - 15%
16 - 50%
51 - 94%

Cadmium (ppm, dw)





Mercury (ppm, dw)



Mercury (ppm, dw)