

Nutrient Bioextraction with Shellfish, A Viable Component of Water Quality Trading for the Puget Sound Region, Washington State

Bobbi Hudson, Aimee Christy and Andrew Suhrbier
A Community on Ecosystem Services, December 8-12, 2014
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Fostering sustainable shellfish resources & a healthy
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Outline

1. Pacific Shellfish Institute: Who we are
2. Nutrient bioextraction in concept
3. Fit with water quality trading
4. Our pilot research with mussels
5. 2013-2014 mussel growth
6. Growth and N content data
7. Conclusions



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Pacific Shellfish Institute (PSI): Who we are

1. Olympia, Washington based 501c(3)
2. Established in 1995 with strong linkages to the Pacific Coast Shellfish Growers Association (PCSGA)
3. In 2004, PSI Bylaws were changed to provide a clearer separation
4. PSI's funding source:
 - Largely competitive federal grants
 - Some private foundation grants
5. High level of industry cooperation and in-kind support
6. Partnerships are very important



Research Org.



Trade Assoc.



Funding & Partners

EPA's National Estuary Program (NEP) via WA Dept. of Ecology and The Russell Family Foundation

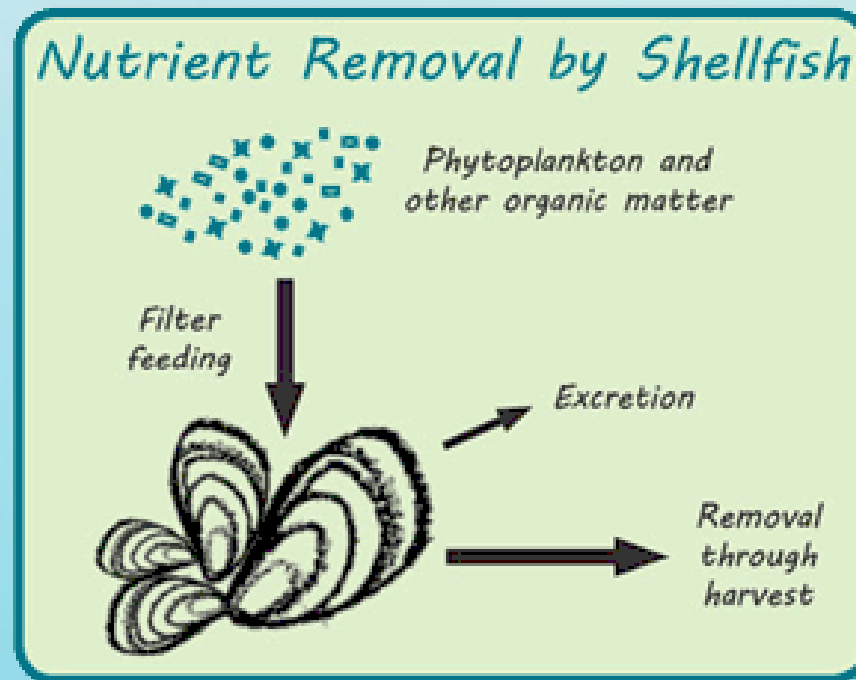
Partners:

- City of Olympia, Stream Team
- LOTT Cleanwater Alliance, WET Science Center
- Port of Olympia
- Puget Sound Restoration Fund
- Seaport Maritime Museum, Tacoma WA
- Squaxin Island Tribe
- The Evergreen State College
- Thurston County Conservation District, South Sound GREEN
- University of Washington - Tacoma
- WA Dept. of Corrections
- Washington State University (Puyallup Extension Facility)
- West Bay and Boston Harbor Marinas



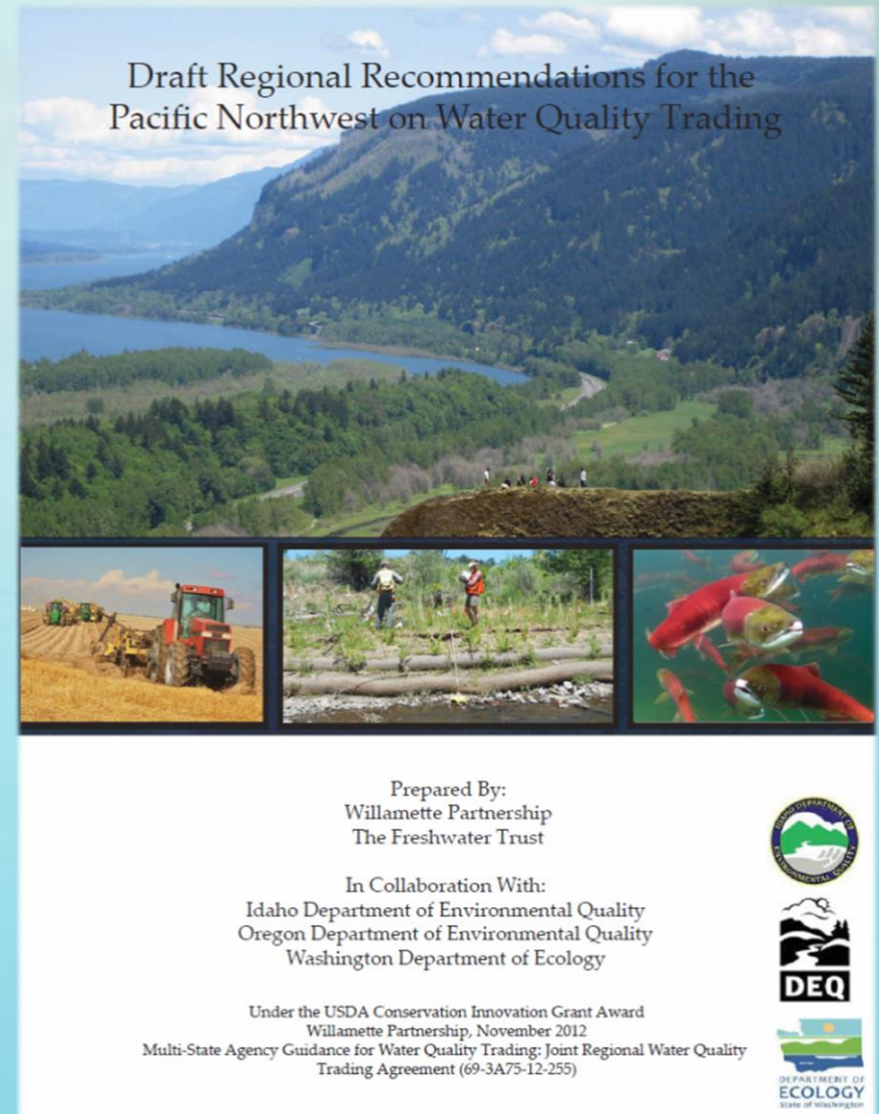
Nutrient bioextraction:

Growing and harvesting shellfish or seaweed to remove nutrients from natural water bodies.



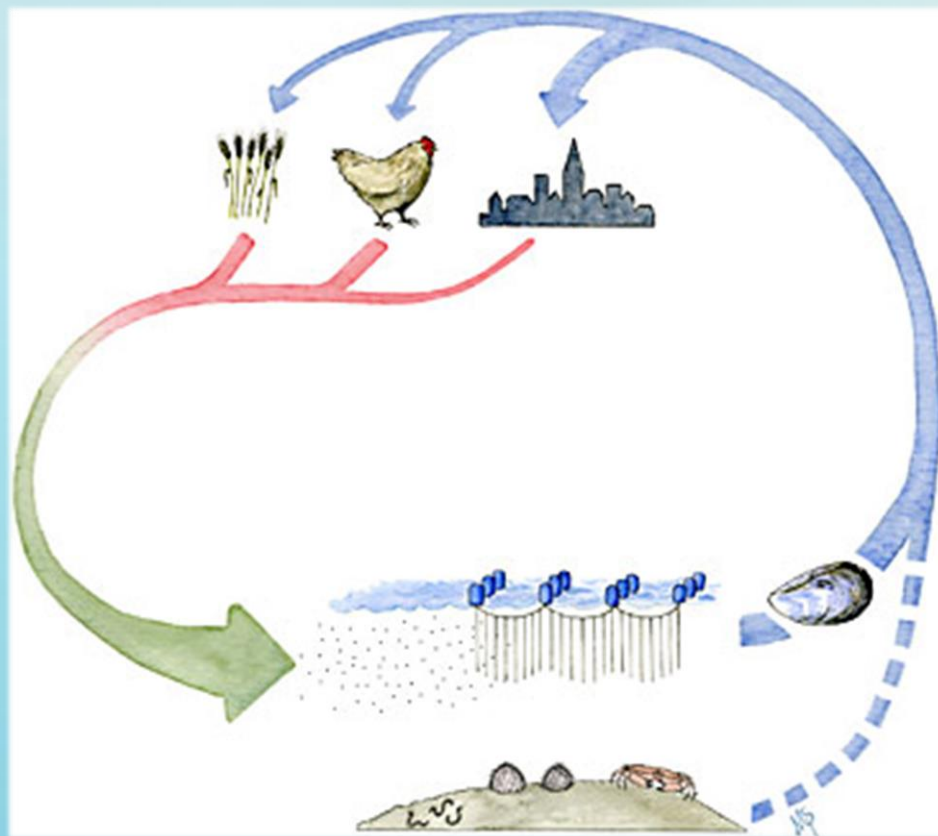
Water Quality Trading:

A voluntary market-based approach that, if used in certain watersheds, might achieve water quality standards more efficiently and at lower cost than traditional approaches.



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Where has this idea been applied?



One mussel contains:

0.8 - 1.2 % N

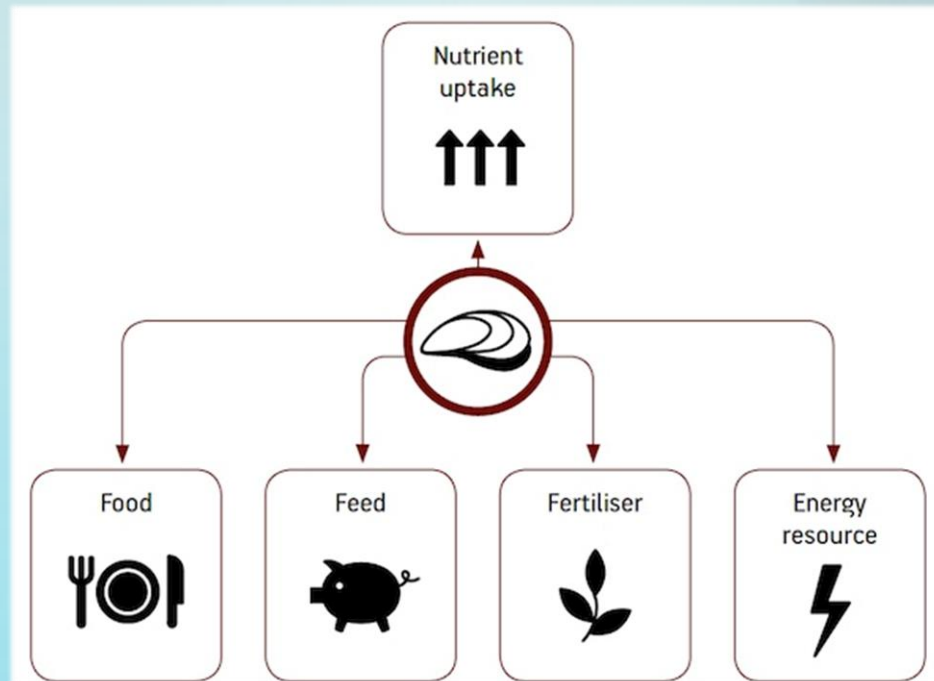
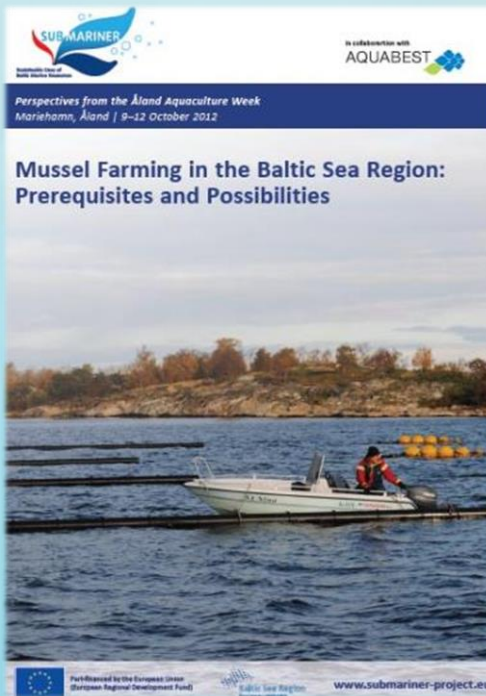
0.06 - 0.08 % P

Agro-Aqua recycling of nutrients using mussel farming as a recycling engine.

Odd Lindahl, 2008



SUBMARINER www.submariner-project.eu



100–150 t/ha mussel biomass harvested every 2nd year

1.2–1.8 t of N

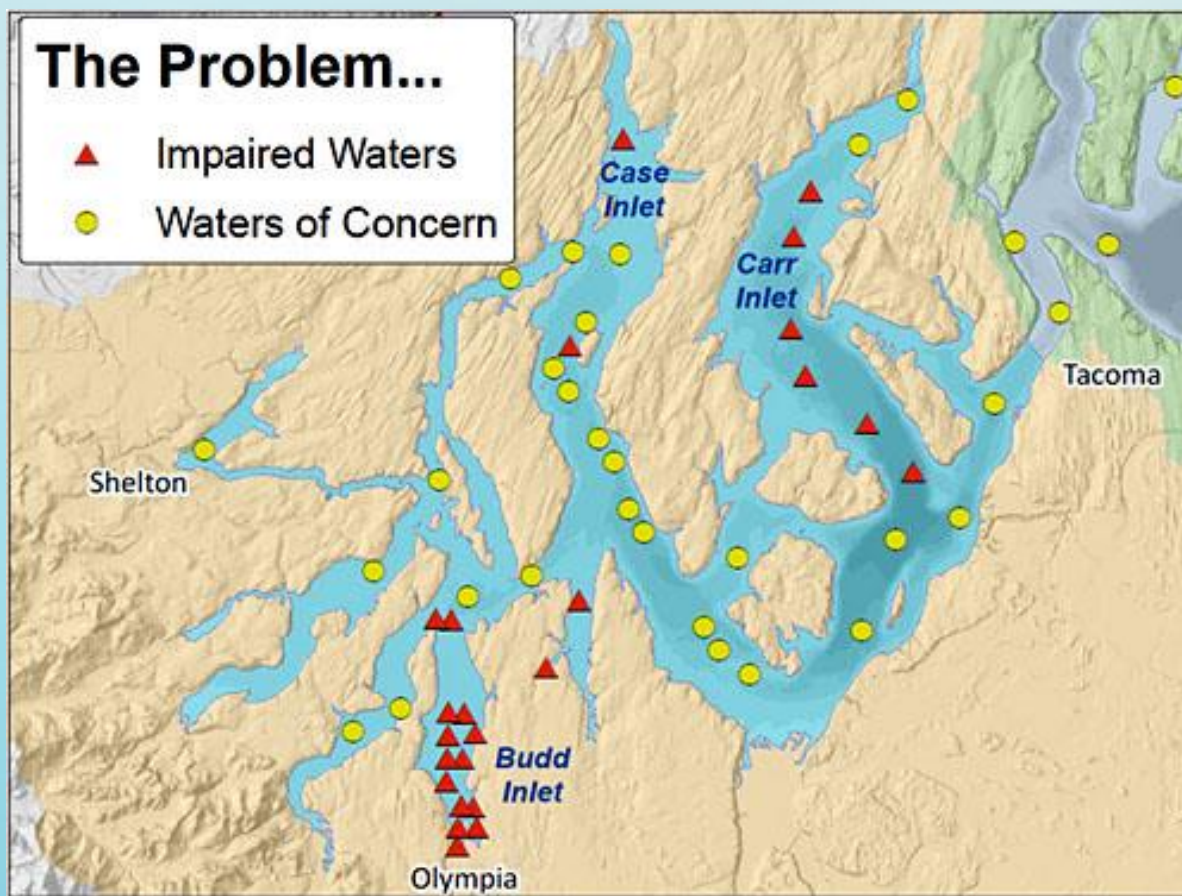
0.08–0.12 t of P

Baltic Sea Region Programme 2007-2013



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Budd Inlet Nutrient Reduction Study



WA Dept. of
Ecology 2008
Water Quality
Assessment

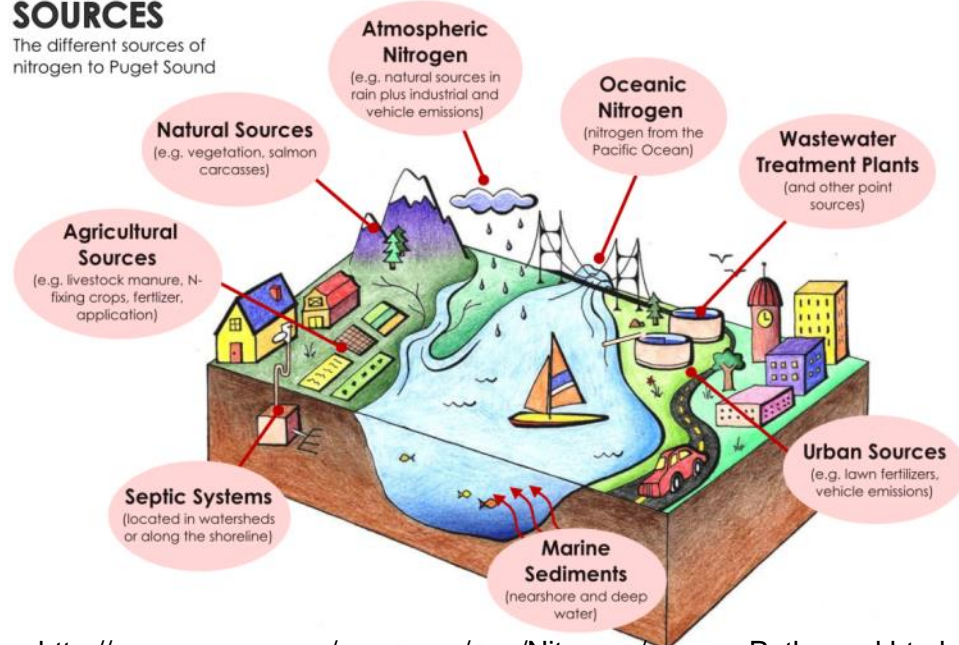


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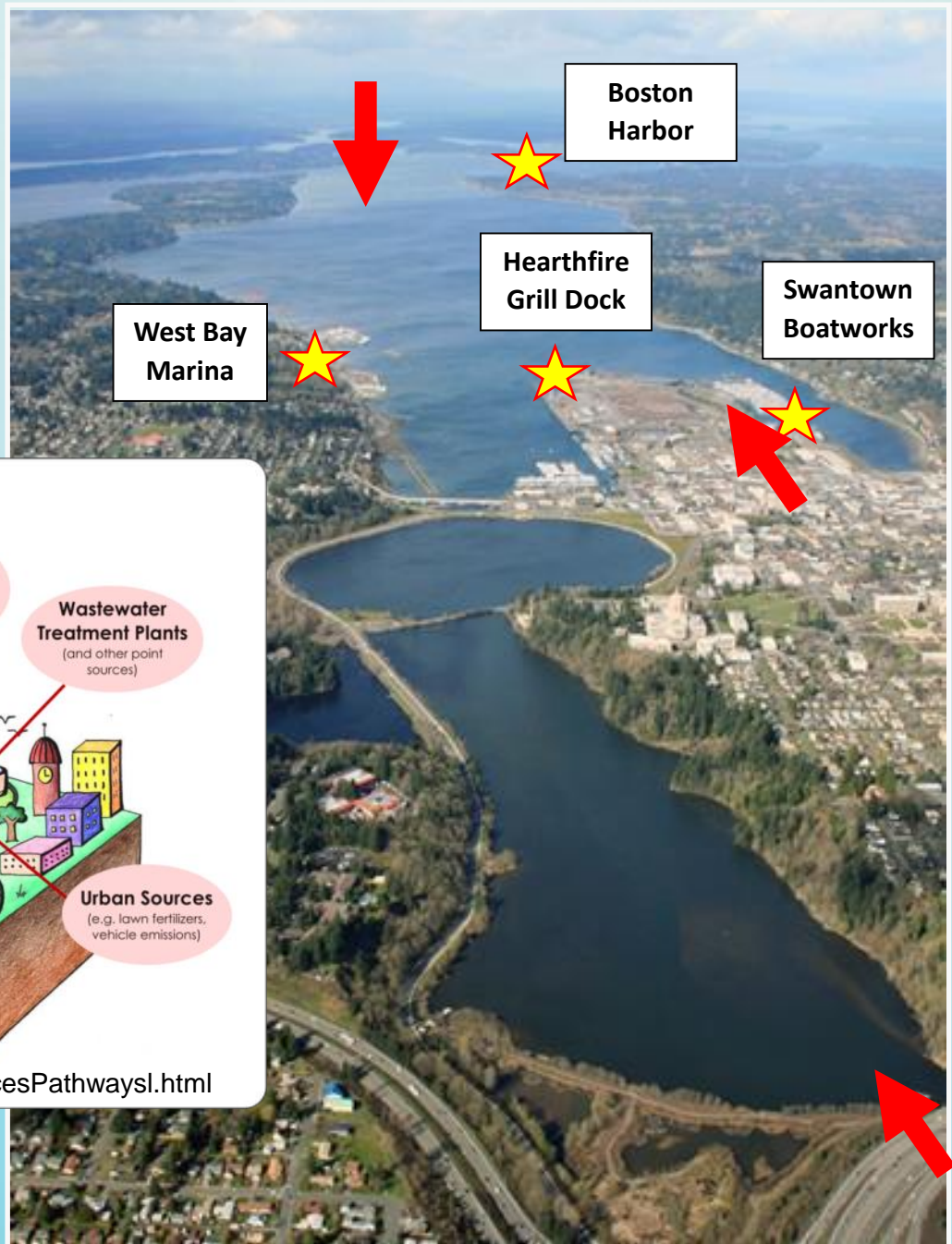
Budd Inlet

SOURCES

The different sources of nitrogen to Puget Sound

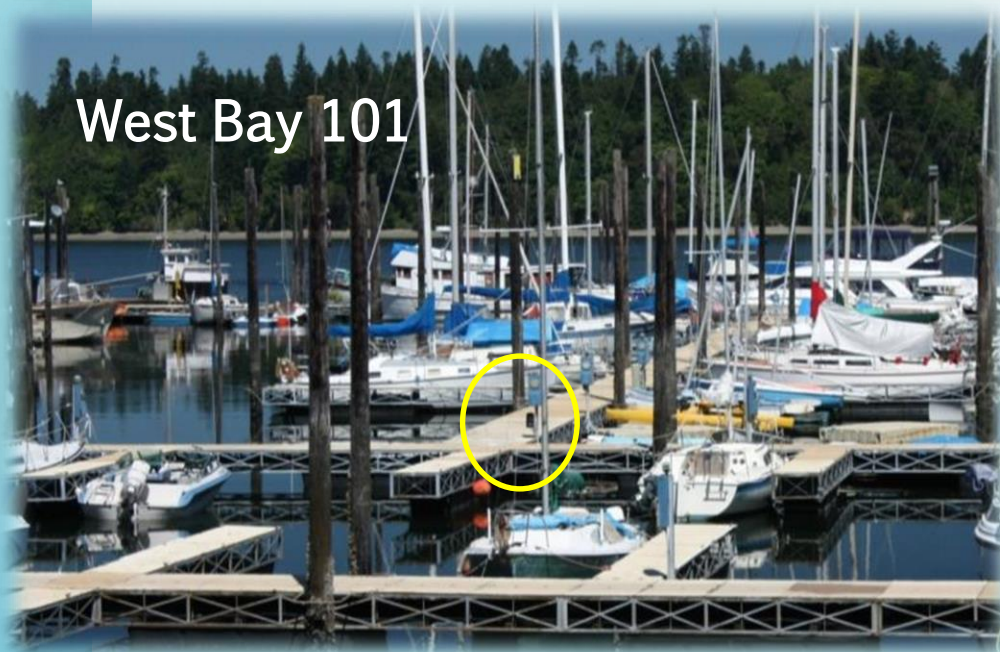


<http://www.ecy.wa.gov/programs/eap/Nitrogen/sourcesPathways1.html>



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West Bay 101



May 2013

314 3-5 ft
weighted nylon straps

Boatworks 76



Hearthfire 56

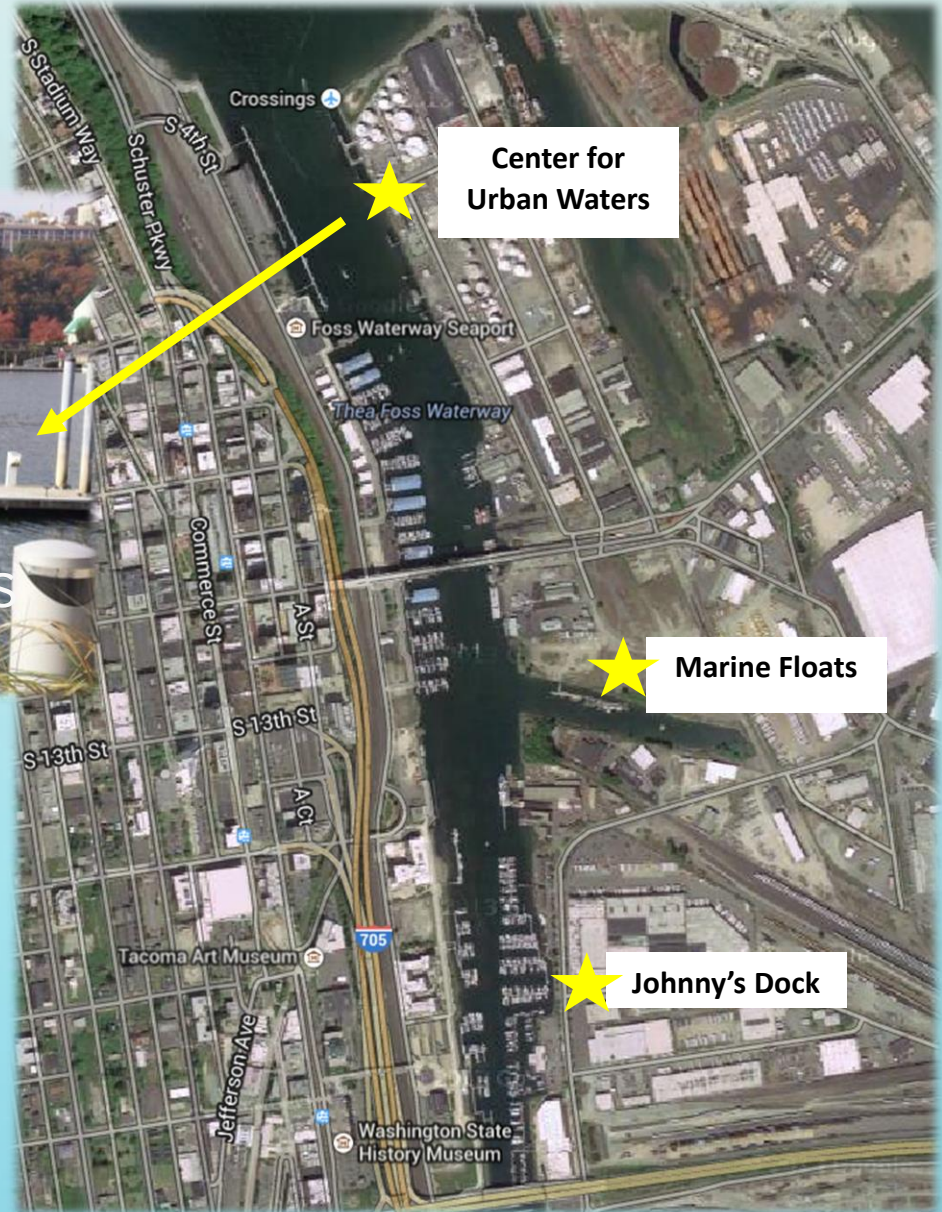


Boston Harbor 81



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Thea Foss Waterway



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Data Collection (June-October 2013)



Mussel Growth
Mussel Biomass
Temp, Salinity, pH
Dissolved oxygen
Phytoplankton/Secchi
Fouling/Diversity



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Community Outreach

Recording mussel lengths/weights
& community assemblages on lines



GoPro underwater video



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June

West Bay



Hearthfire



Boatworks



Boston Harbor



West Bay

Early July

Hearthfire

Boatworks



Boston Harbor



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Mid July

West Bay



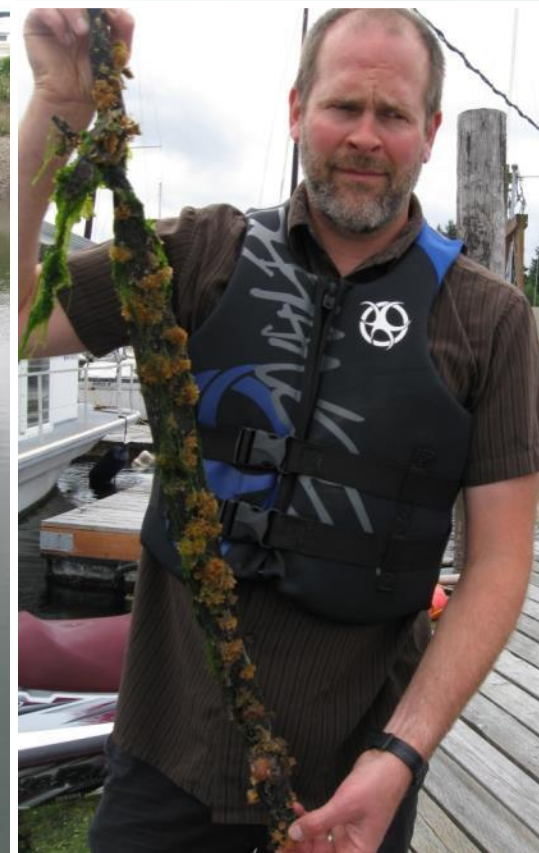
Hearthfire



Boatworks



Boston Harbor



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August

West Bay



Hearthfire



Boatworks



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September



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The Evergreen State College Composting Trial

Secret Recipe:

Mussels

Compost

Green Waste

Wood Chips



Evergreen – 1200 lbs

WSU – 500 lbs

WA Dept. Corrections – 1300 lbs

Yards, Classes, Labs – 1300 lbs

Total – 4300 lbs



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Washington State University (WSU)



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Dept. of Corrections - Cedar Creek Composting



In-Vessel Composting System
by DT-Environmental, Lynden, WA



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Surf-to-Turf Mussel Compost



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Soiltest Compost Results (triplicate averages)

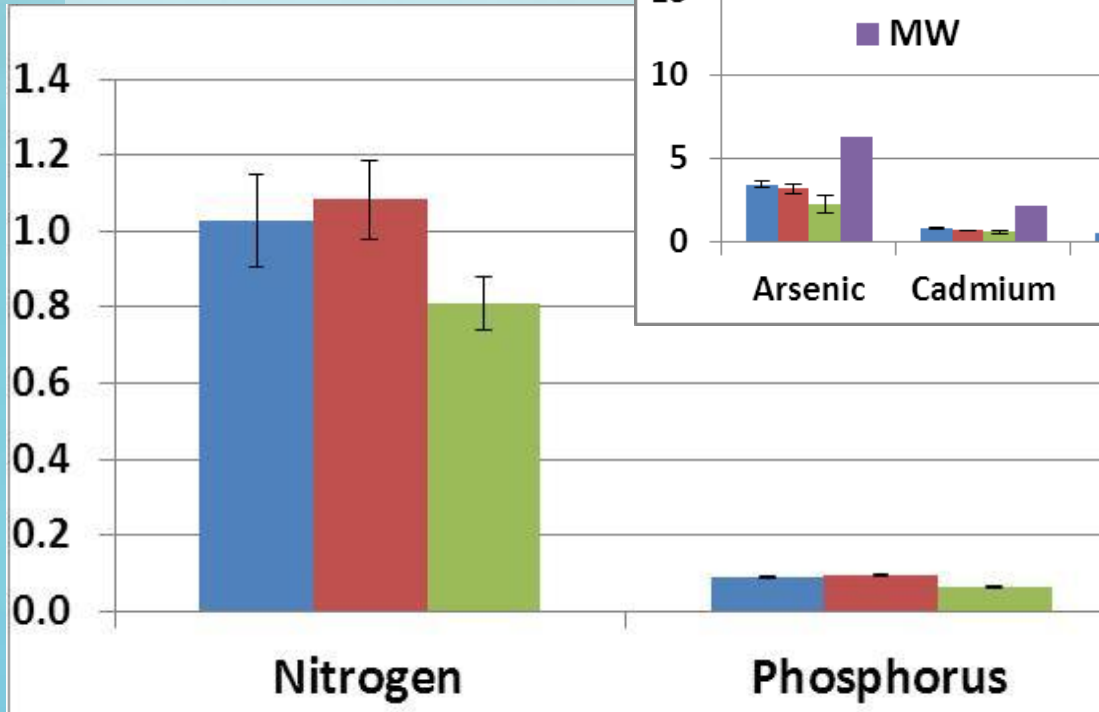
Element	TESC/WBM	Units	Typical Range	WAC limit
Calcium	13.3	%	0.5-10	
Sodium	0.48	%	0.05-0.7	
Copper	29	mg/kg-dry	100-500	750
Arsenic	0.4	mg/kg-dry		20
C/N	22	ratio	18-24	



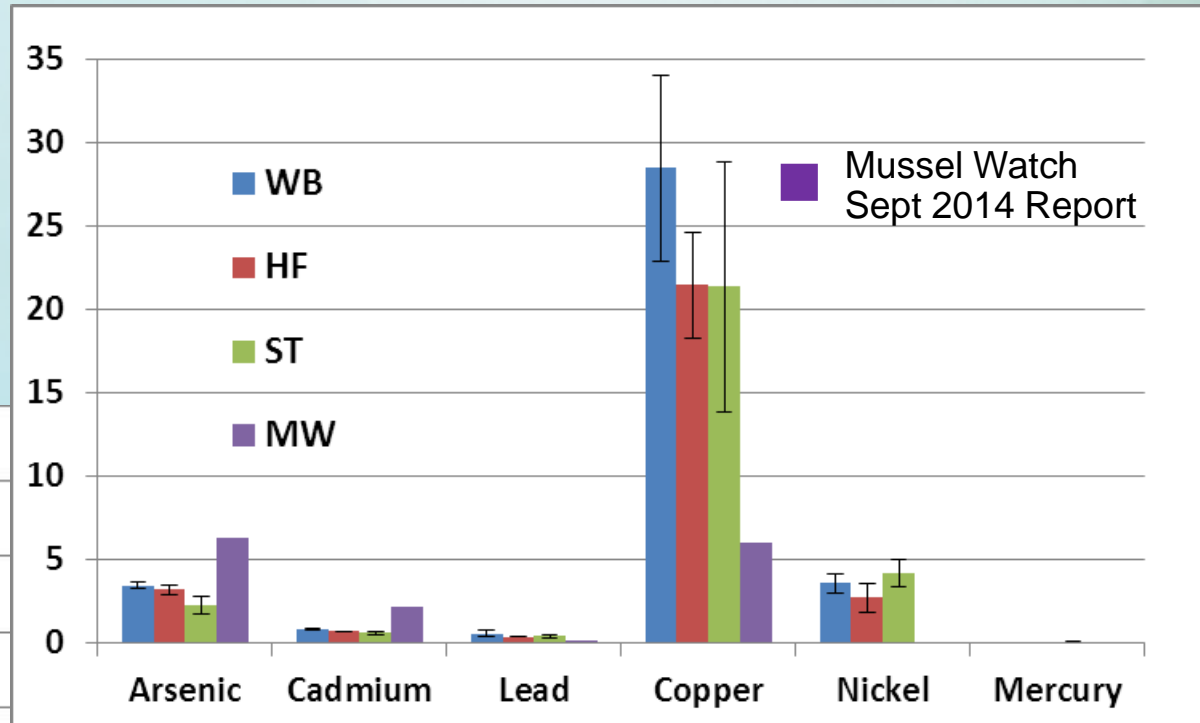
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AmTest Results Tissue + Shell

Nutrients (% - wet wt)



Metals ($\mu\text{g/g}$ - dry wt)



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Nutrient Removal Results

3 pilot sites at maximum yield:



8,000 lbs mussels

X 1% N

X .08% P

=

80 lbs N removed

6.4 lbs P removed



Scaling up....



West Bay pilot:
120 straps

Entire marina
concept:
16,810 straps
=
605,000 lbs
mussels

1% N = 6,050 lbs N
=
N output of
~600 people
(4.5 kg/yr or 10 lbs/yr)



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Conclusions

1. The community learned about local water quality issues
2. Nutrients were removed through nutrient bioextraction and possibly source control
3. The project generated a marketable product: Surf-to-Turf compost
4. Results may be used to provide a framework for a potential nutrient-trading concept
5. More research is needed to better understand localized nutrient dynamics:
 - biodeposition
 - seston depletion
 - dissolved oxygen (DO)



Questions?

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