## Source Control, Toxic Chemicals, and Biological Improvements

**Tracy Collier** 

Ex-NOAA Fisheries
Ex-Puget Sound Partnership

2014 Toxics Reduction Conference Seattle, WA

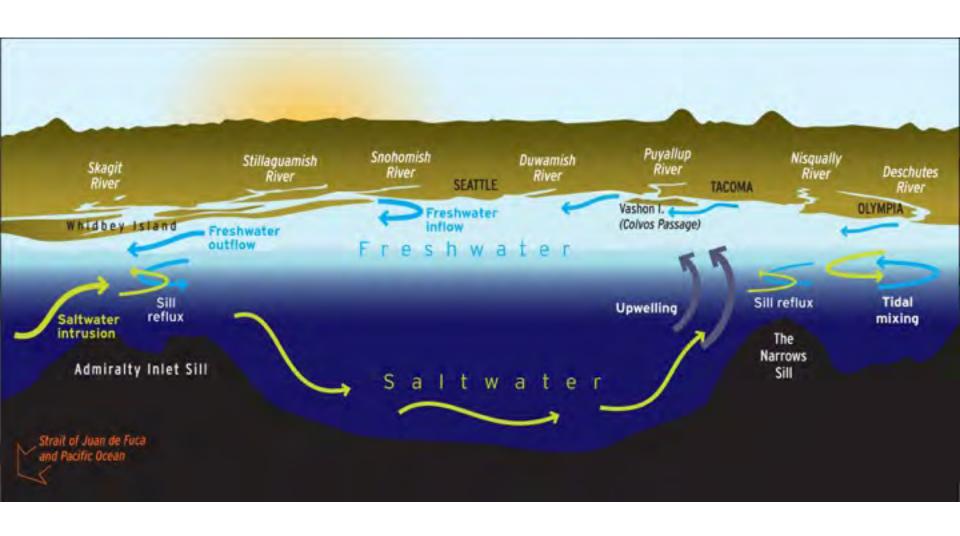
November 17, 2014

#### Toxic Chemical Contaminants and Puget Sound

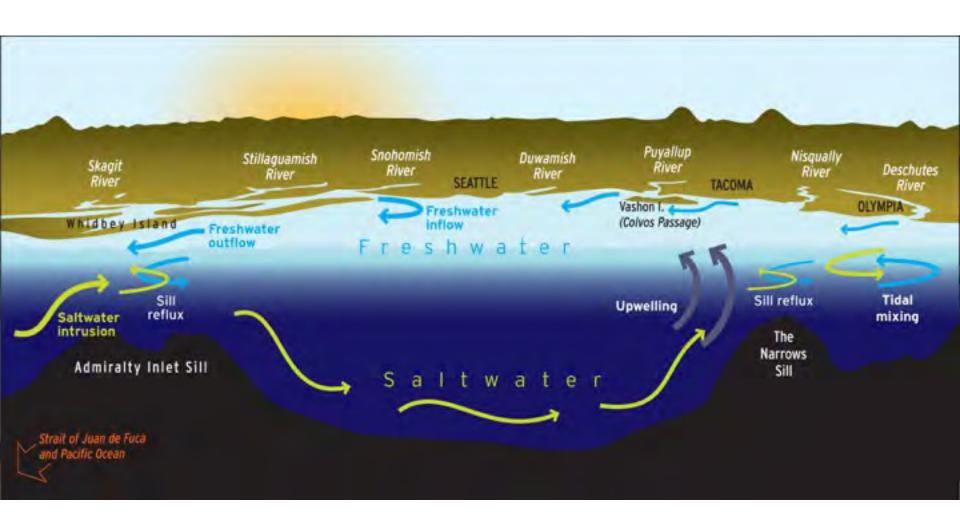
Tracy K. Collier<sup>1</sup>, Sandra M. O'Neill<sup>2</sup>, James E. West<sup>2</sup>, and Nathaniel L. Scholz<sup>1</sup>

<sup>1</sup>NOAA Fisheries\*, Northwest Fisheries Science Center, Environmental Conservation Division, Seattle WA and <sup>2</sup>WA Department of Fish and Wildlife\*, Fish Program, Marine Resources, Olympia WA

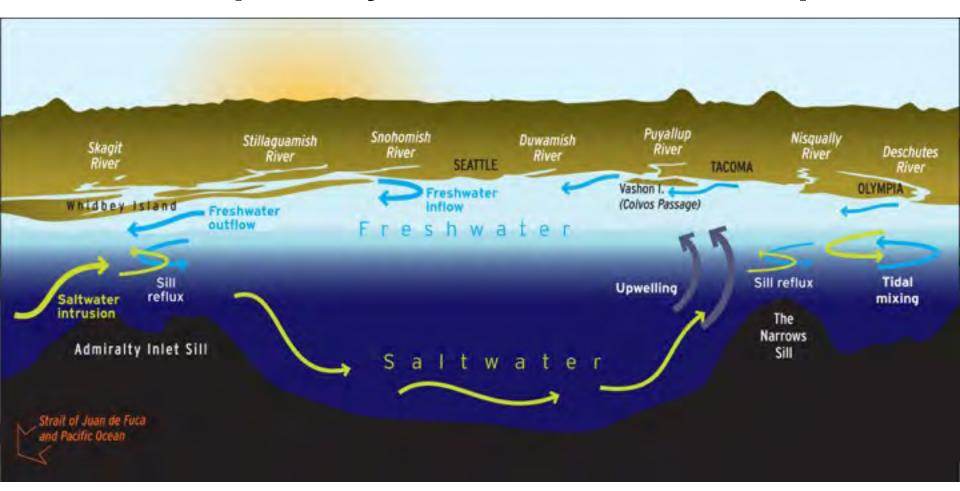
#### Puget Sound is isolated hydrologically



### Puget Sound is isolated hydrologically and biologically



# This combination, of biological and hydrological isolation, renders Puget Sound biota especially sensitive to toxic inputs



Three specific types of actions are needed if we hope to reverse the current state of degradation in Puget Sound and protect the Sound's ecosystem from harmful effects of toxic chemical contaminants in the future:

- Define the sources, and estimate the amounts, of chemical contaminants entering Puget Sound (loadings estimates);
- Determine what reductions can be realistically achieved for the major classes of contaminants entering Puget Sound (source control);
- Mandate institutional support for biologically based monitoring and assessment (adaptive management).

# A detailed management framework for protecting complex ecosystems from human-induced damages to ecosystem services

—Reduce pressures

—Monitor outcomes

Toxics loading project—report 12/07, led by WA Dept Ecology (Jim Maroncelli)

- 15 "chemicals" (12 + 3)
- PCBs, dioxins/furans, PAHs, DDT, Pb, Hg, As,
   Cd, Cu, DEHP, triclopyr, oil/petroleum (dirty dozen)
- PBDEs, nonylphenol, Zn (possibly harmful)

# Biota Can Tell Us Where the Problems Are



Endocrine Disrupting Compounds (EDCs) in English sole



Persistent bioaccumulative contaminants in juvenile salmon



Toxics in the Nearshore



Long term time trends

#### Bottomfish are affected by Endocrine Disrupting Chemicals

# Endocrine Disrupting Chemicals; a joint study on *xenoestrogens* by NOAA Fisheries and WDFW



Contents Bits available at ScienceDirect

#### **Aquatic Toxicology**

journal homepage: www.eisevier.com/locate/aquatox



Xenoestrogen exposure and effects in English sole (Parophrys vetulus) from Puget Sound, WA

Lyndal L. Johnson<sup>a,\*</sup>, Daniel P. Lomax<sup>a</sup>, Mark S. Myers<sup>a</sup>, O. Paul Olson<sup>a</sup>, Sean Y. Sol<sup>a</sup>, Sandra M. O'Neill<sup>b</sup>, James West<sup>b</sup>, Tracy K. Collier<sup>a</sup>

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#### ARTICLE INFO

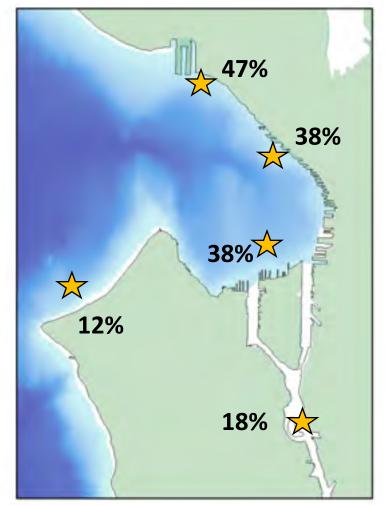
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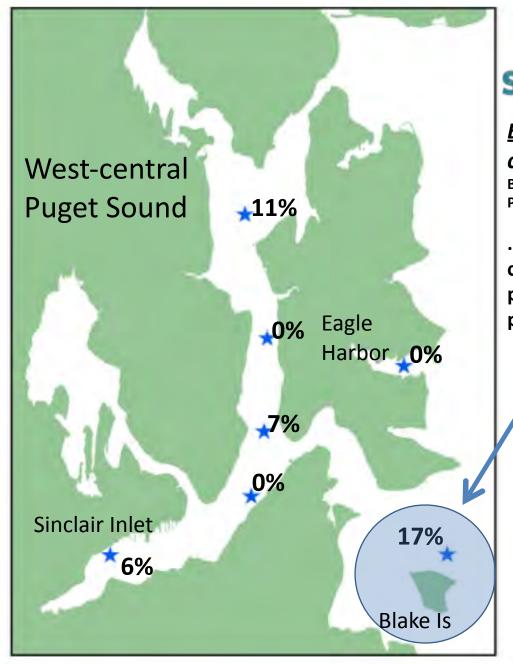
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#### ABSTRACT

Vitellogenin, a yolk protein produced in the liver of oviparous animals in response to extragent, normall occurs only in sexually nature females with developing eggs. However, males can spinhester visiologenis when exposed to environmental entogens, making the absorbing an exposed to environmental entogens, making the absorbing and of the Winhington State's Page Sound Assentinent and Monitoring Program, we surveyed English sole from a number of titing for evidenc of xetocetrogen exposure, using viteflogenin production in males as an indicator. Significant levels of viteflogenin were found in male flub from several urban sizes, with expectably high numbers of fish affects in Effect Ray, along the Seattle Waterfront. Interest fish were rare, comprising only two fish out of mor than 2900 examined. Other ovarian and testicular lesions, including occyte attests, were also observed but their prevalence did not appear to be related to sensestrogen exposure. However, at the Efficien flashes where absorbing viteflingenin production was observed in male sole, the liming of spawning in bot male and female English sole appeared altered. Sources of sensestrogens and types of sensestrogen present in Efficit Ray are poorly documented, but the compounds are likely associated with industris discharges, ourface nanol, and combined sewer ourfalls.

Published by Eisevier II.V.







#### <u>Blake Island</u>'s wastewater system ripe for change

By LISA STIFFLER, SEATTLE POST-INTELLIGENCER REPORTER Published 9:00 pm, Sunday, March 14, 2004

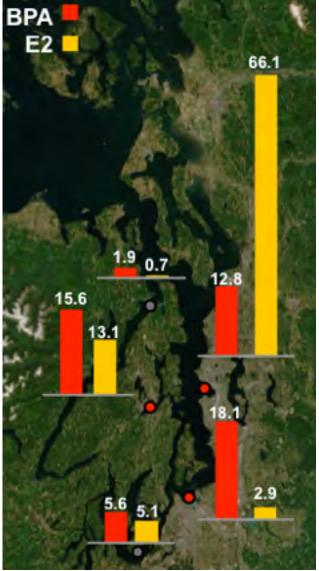
....It is one of Puget Sound's most notorious culprits. The park's wastewater treatment plant has frequently run afoul of its operating permit.....



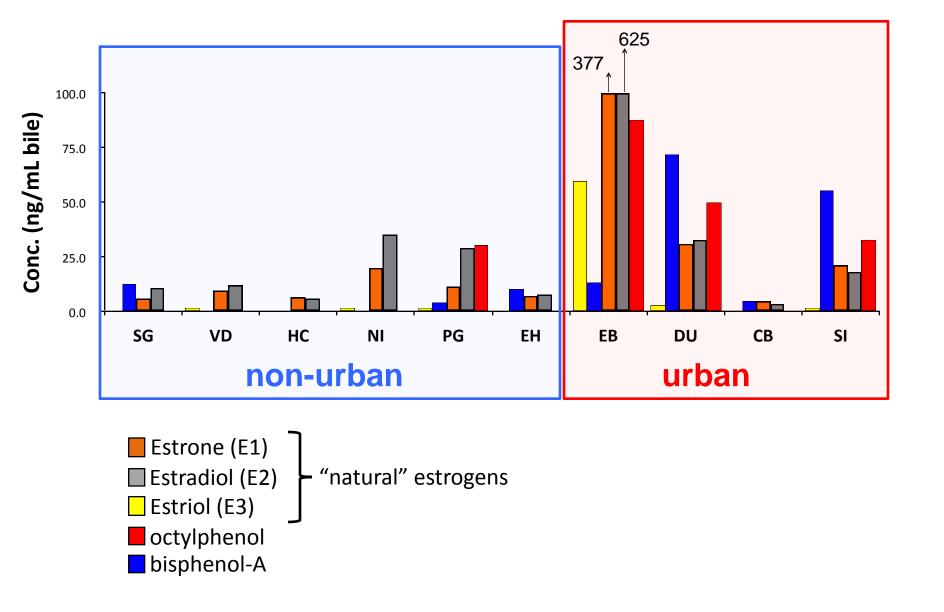
http://www.seattlepi.com/local/article/Blake-Island-s-wastewater-system-ripe-for-change-1139570.php

### Need for a method to measure EDCs in English sole (bile)





#### New Results: more EDCs in male English sole bile



# Assessing the threat of toxic contamination to early marine survival of Chinook salmon in the Salish Sea



Sandie O'Neill<sup>1</sup>, James West<sup>1</sup>, Gina Ylitalo<sup>2</sup>, Andrea Carey<sup>1</sup>, Laurie Niewolny<sup>1</sup>, Jennifer Lanksbury<sup>1</sup>, and Lyndal Johnson<sup>2</sup>



<sup>1</sup>Washington Department of Fish & Wildlife <sup>2</sup>Northwest Fisheries Science Center funded by USEPA/NEP/Ecology



#### Study Objectives



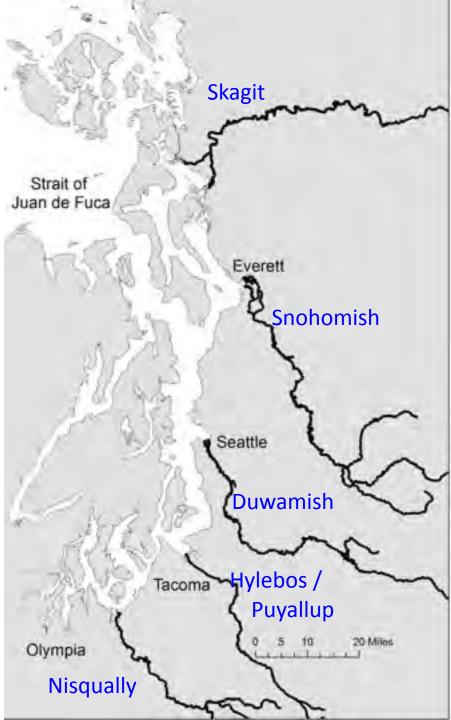
- Quantify contaminant levels in out-migrant Puget Sound Chinook salmon.
- Evaluate potential effects on marine survival (compare body burdens w/ effects thresholds)
- <u>Determine "sources"</u> of contaminant inputs
  - freshwater habitat?
  - marine habitat?
  - freshwater and marine?





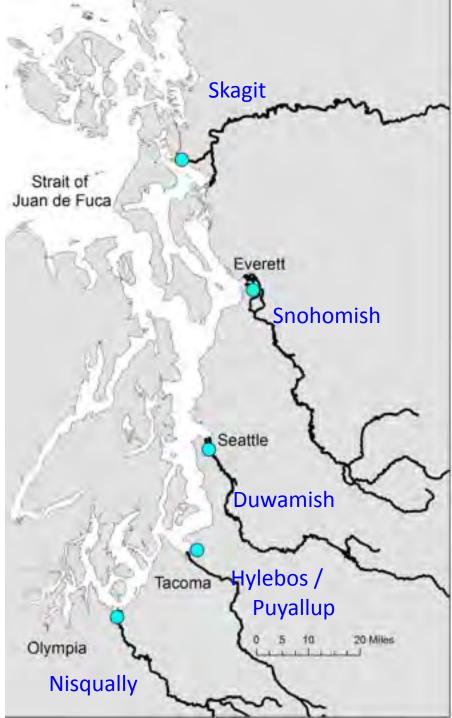
• 5 major river/estuary systems



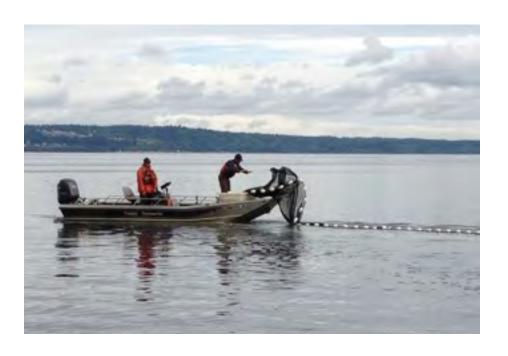


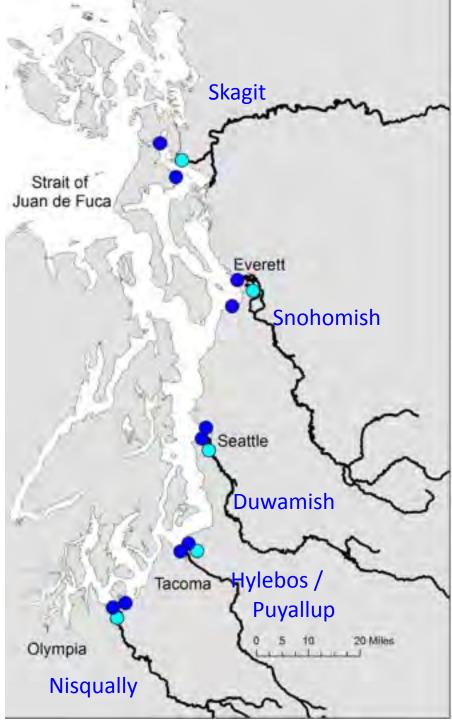
- 5 major river/estuary systems
  - lower river (May)



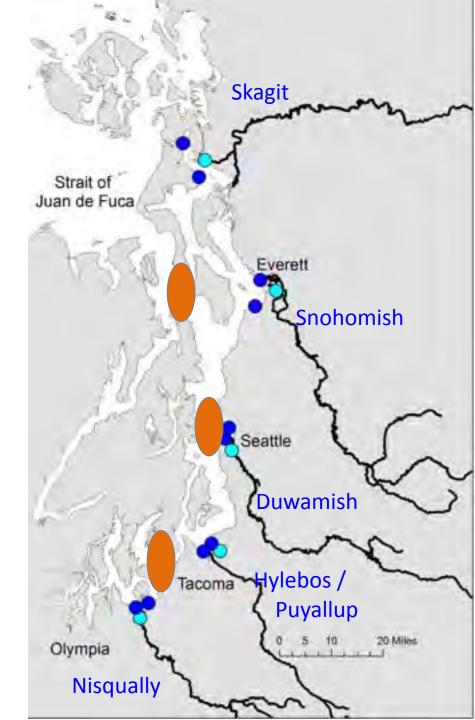


- 5 major river/estuary systems
  - lower river (May)
  - marine estuary (June)





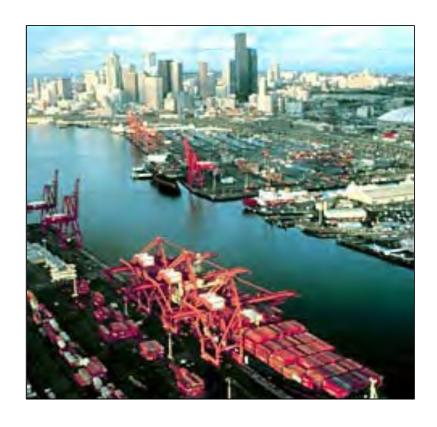
- 5 major river/estuary systems
  - lower river (May)
  - marine nearshore (June)
- 3 marine basins
  - Admiralty Inlet (July)
  - Central Sound (July, Sept.)
  - South Sound (July, Sept.)



# Juvenile Chinook salmon are exposed to harmful chemicals as they migrate down rivers in the Pacific Northwest

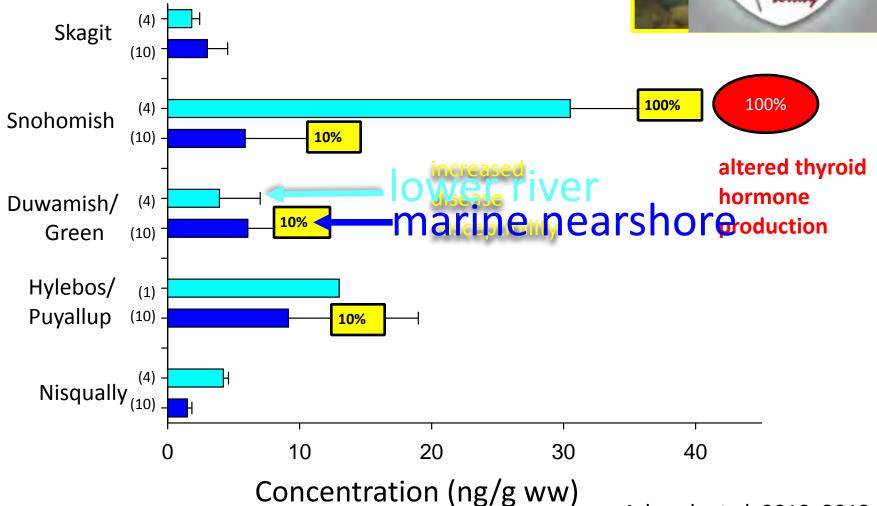
Flame retardants (PBDEs) in juvenile Chinook salmon





### Flame Retardants ( $\sum_{11}$ PBDEs)

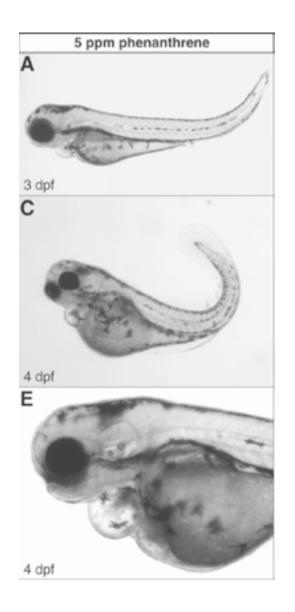




Arkoosh et al. 2010, 2013.

#### Oil and PAHs induce developmental defects in fish embryos and larvae

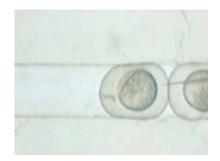




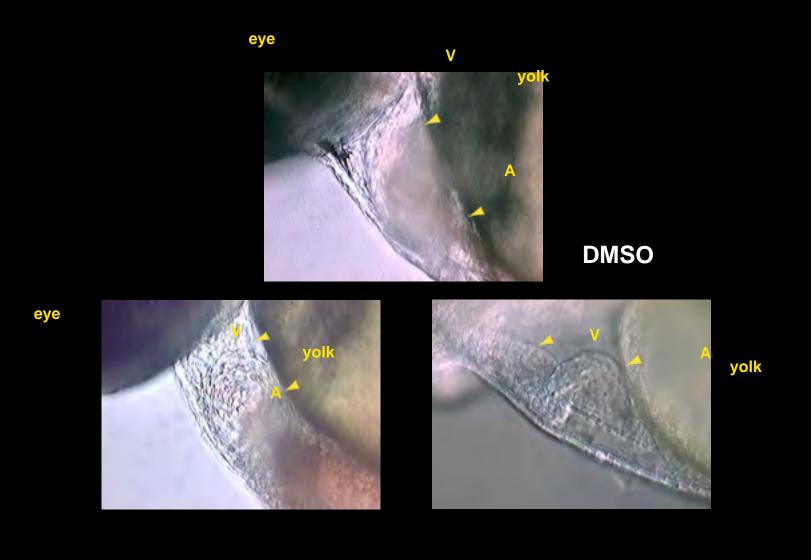


Targeted genetic "knock-down" of cardiac function induces the same suite of defects induced by PAH exposure:

Malformations are secondary to loss of circulation



#### **PAH-specific effects on cardiac function in zebrafish**



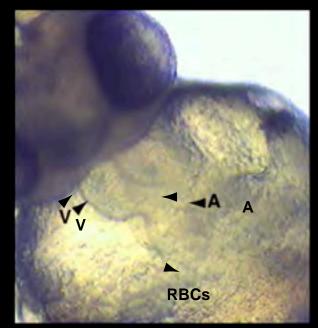
phenanthrene2:1 partial AV block arrhythmia

benz(a)anthracene poorly looped, small ventricle, normal rhythm

### Embryonic cardiac dysfunction from weathered crude oil exposure



control 39 hpf



weathered ANS crude 39 hpf

HR @ 56 hpf =  $143 \pm 12$ , p <  $10^{-8}$ 

# PAHs in the nearshore may be high enough to impact fish embryos.... even in non-urban areas

- Petroleum or combustion sources
- Some chemicals highly toxic
- Stormwater (non-point sources) is a key conveyor
- Nearshore organisms may be at high risk

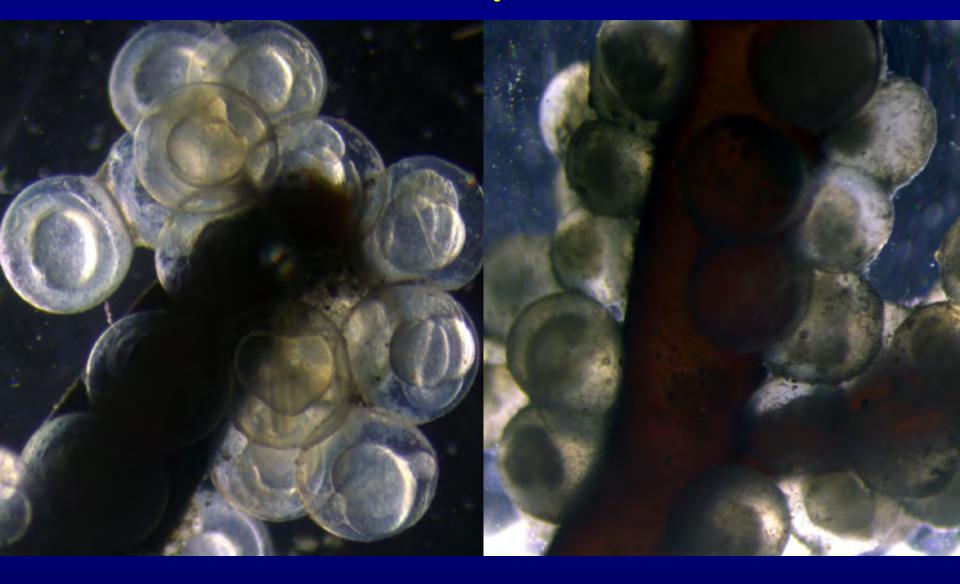




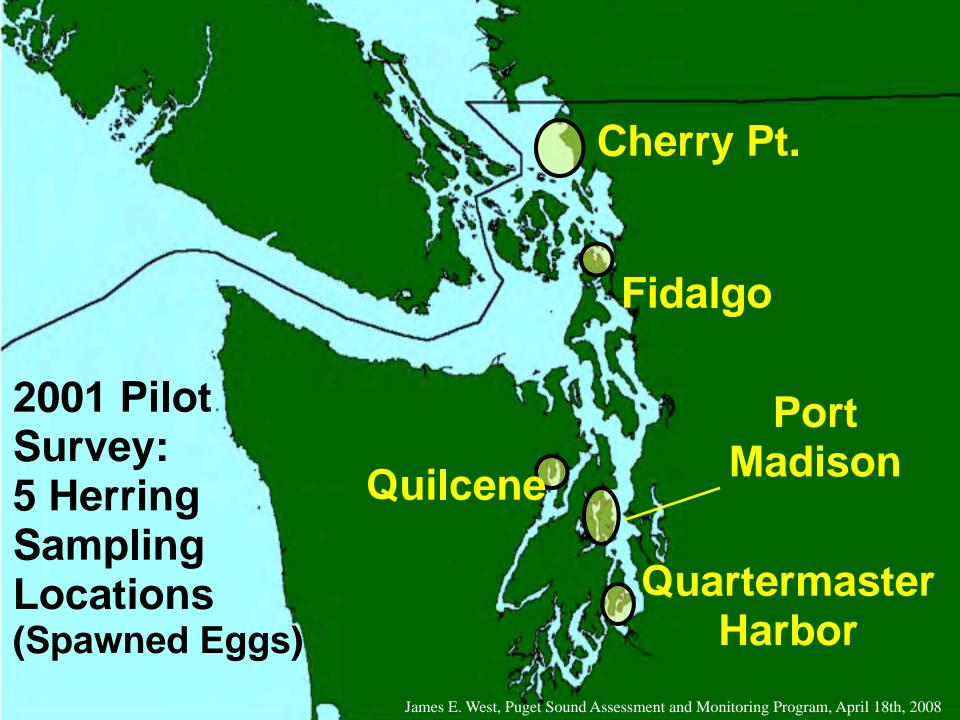


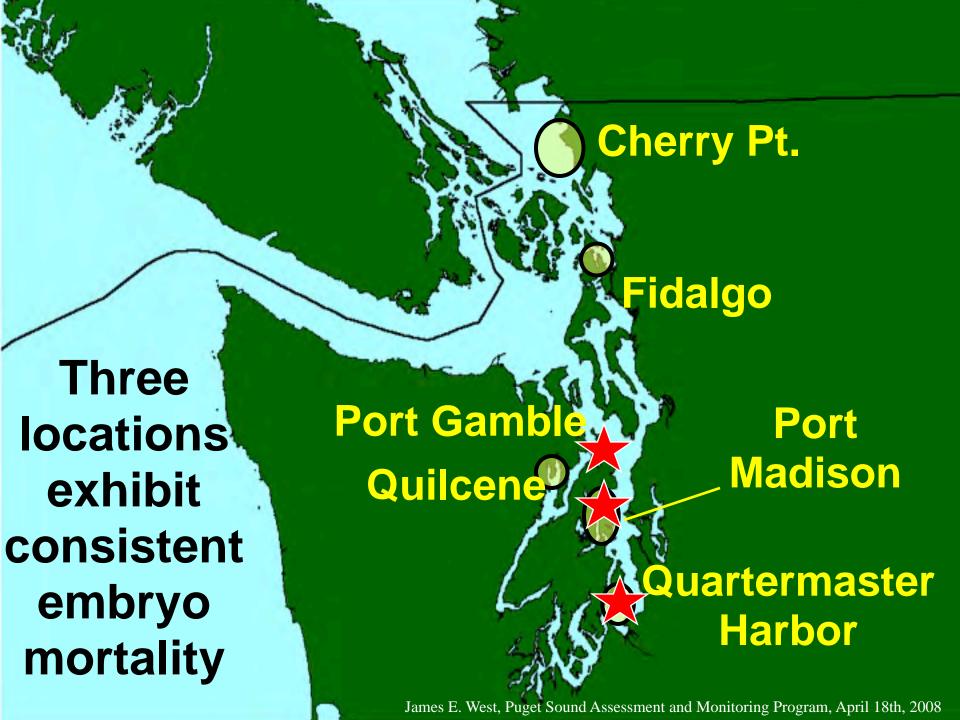


# Is herring embryo health/mortality in the nearshore affected by PAHs?

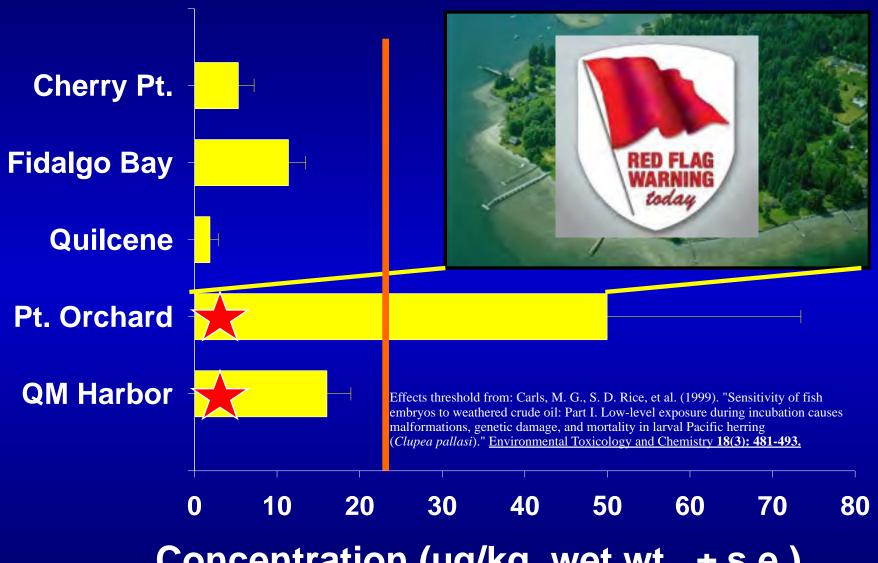




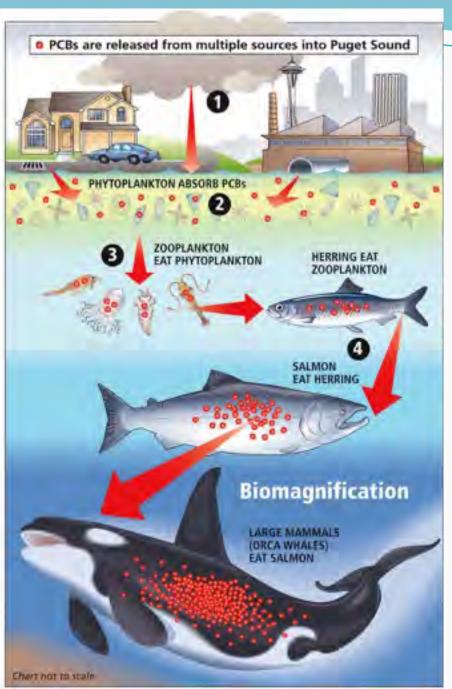




#### TPAH in Spawned Herring Eggs



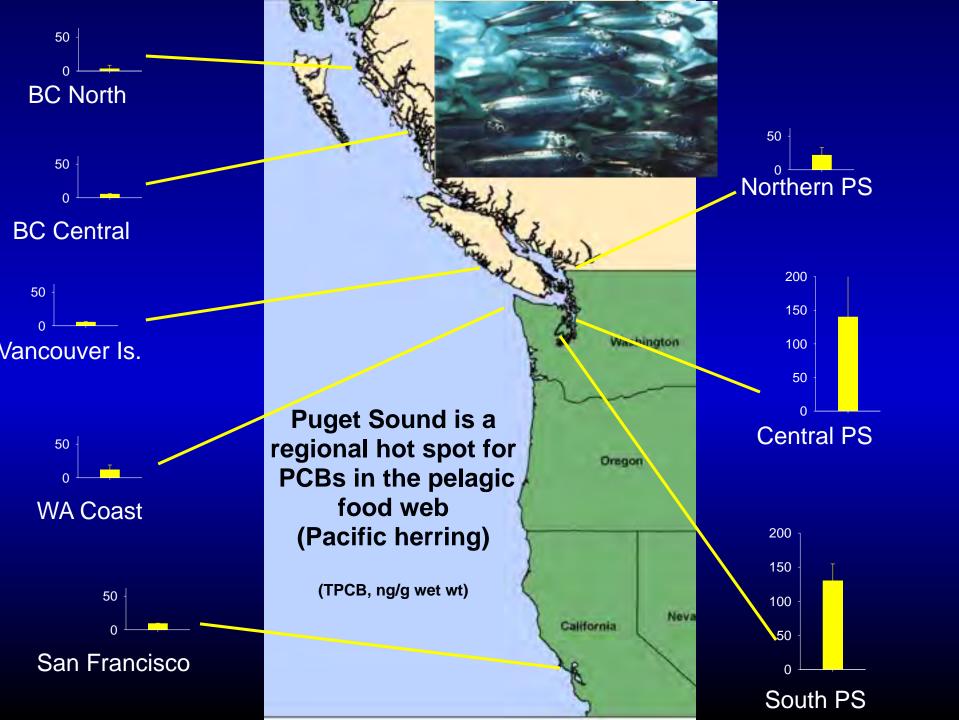
Concentration (µg/kg, wet wt., ± s.e.)

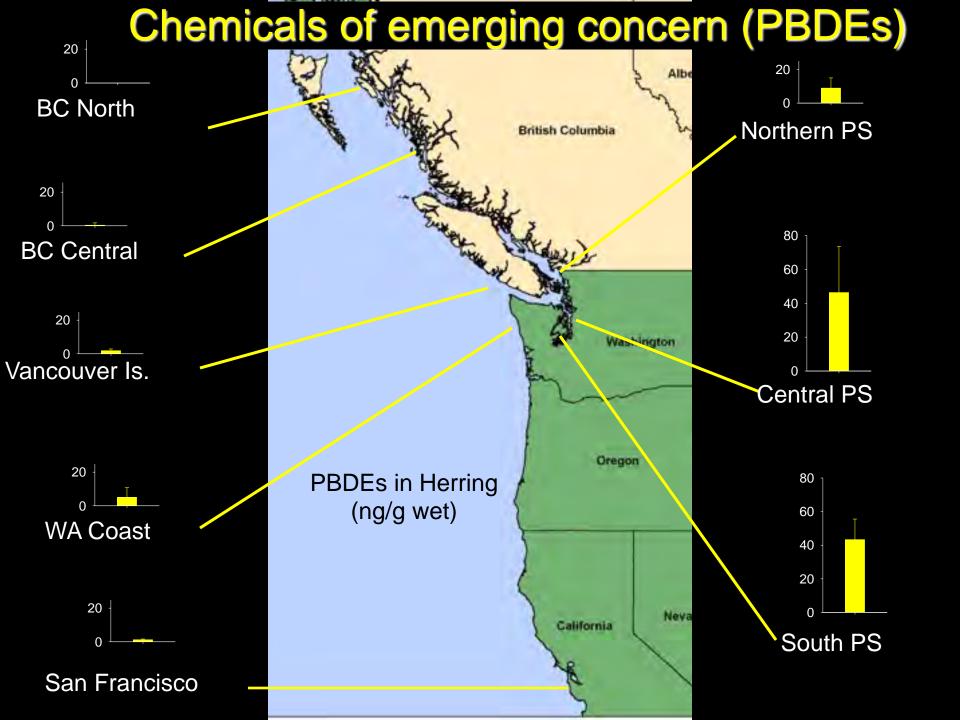


# Are conditions getting better or worse?

PCBs and Flame retardants (PBDEs) biomagnify in the pelagic food web

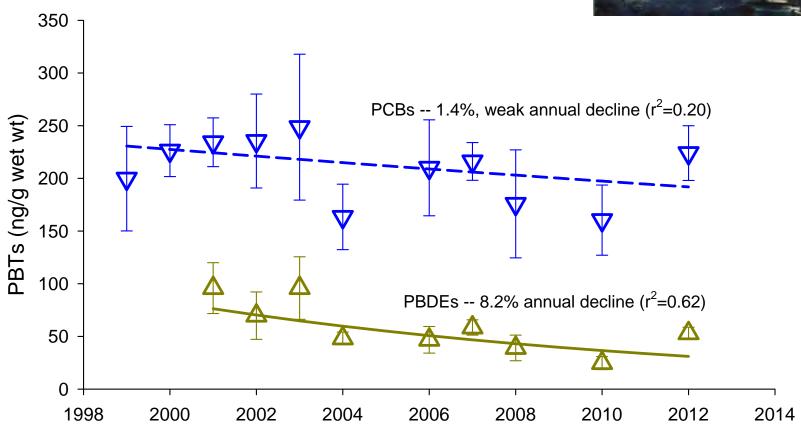
Are they declining after chemicals were banned?



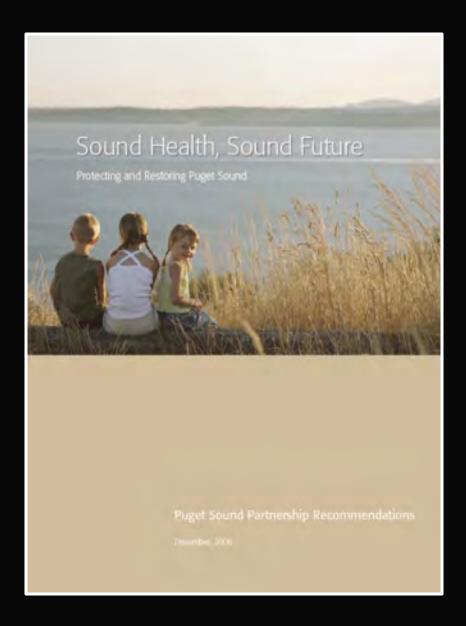




#### **Central Puget Sound Herring**



#### The Puget Sound Partnership called for...



.... renewed efforts to identify and reduce the impacts of toxic contaminants on Puget Sound's living resources...

How do we better incorporate biologically based assessment of toxics to guide pollution reduction strategies in Puget Sound?

... Toxics-based Biological Observing System (TBiOS)

# A toxics-based biologically integrated observing system (TBiOS) for Puget Sound

Lyndal Johnson<sup>1</sup>, Sandra O'Neill<sup>1</sup>, James West<sup>2</sup>, Claudia Bravo<sup>1</sup>, Mark Myers<sup>1</sup>, Carla Stehr<sup>1</sup>, Gina Ylitalo<sup>1</sup>, Nathaniel Scholz<sup>1</sup>, and Tracy Collier<sup>1</sup>

<sup>1</sup>Northwest Fisheries Science Center, NOAA Fisheries Seattle, WA, USA <sup>2</sup>Washington State Department of Fish and Wildlife, Olympia, WA

# What is a Toxics-based Biological Observing System (TBiOS)?

- A biologically-based monitoring program.....
- Diagnostic research studies....
- Conceptual models.....

#### Developing TBiOS in Puget Sound

. . . .

- Include wider range of biological effects metrics (including population-level endpoints)
- Expand suite of indicator species to represent the entire Puget Sound food web
- Add new chemicals of concern
- Develop new thresholds
- Measure toxicant exposure in humans
- Integrate w/ other monitoring programs

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