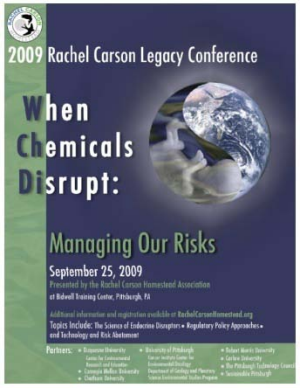
Rachel Carson Legacy Conference
"When Chemicals Disrupt:
Managing Our Risks"



Wildlife Effects from Exposure to Pharmaceutical Estrogens and Xenoestrogens (PEXE): State of the Science

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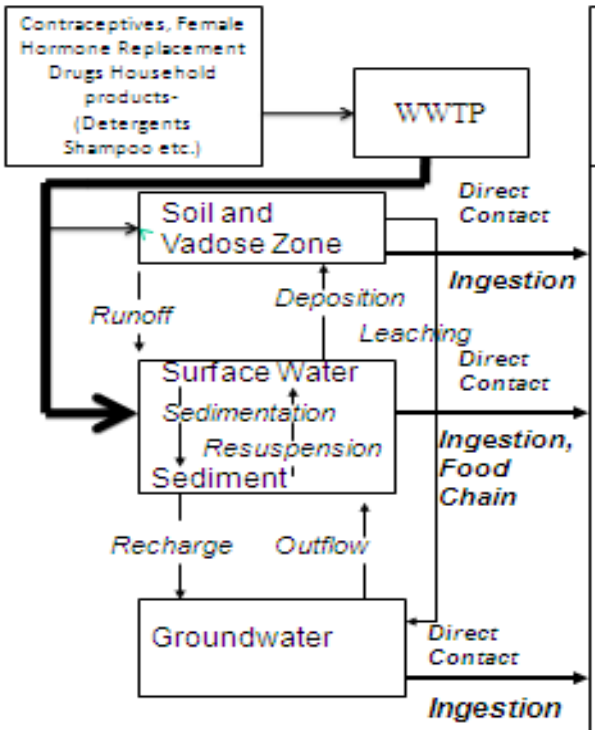
The Scientific Basis for PEXE Threats to Aquatic Animal Survival, Growth and Development and Reproduction and Rationale for Biomonitoring Ecological Receptors as Sentinels for Human Exposure

- Many PEXE's are highly lipophylic or fat loving due to their high octonol-water partition coefficients. They thus may enter fish directly through skin transfer as well as through the gills, and ingestion of water and prey.
- Fish classically bioaccumulate lipophylic steroid estrogens (estrone [E1], 17-ethinylestradiol [EE2]), and xenoestrogens (estrogen mimicking chemicals) such as bisphenol-A, alkylphenoxylate detergent surfactants and banned DDT and PCB's. These are also stored in human adipose tissue.
- Contaminants in sediments and water bioaccumulate in aquatic food chains and concentration levels can be magnified over 100X water and sediment levels in higher tropic level feeders. They thus magnify the signal of the presence of PEXE'S in the aquatic environment.
- Lipophilic (hydrophobic) chemicals are more rapidly exchanged between the water and organism than they are excreted or biodegraded by the organism. Fish studies thus give us good data on exposure over time.

Conceptual Model of Most Probable PEXE Exposure Routes to Ecological Receptors and Humans from Municipal Wastewater Systems



Aquatic Ecological Receptors	Terrestrial Ecological Receptor	Humans
N/A	Dermal, Ingestion	Dermal, Ingestion
Gills, Dermal, Ingestion	Dermal, Ingestion	Dermal, Ingestion
NA	NA	Dermal, Ingestion

From Wright-Walters, M and Volz, CD., Invited Abstract and Presentation: Third National Conference on Environmental Science and Technology, North Carolina A& T, 2009.

Selected PEXE Contaminant Concentrations by Country in Aquatic Matrices

Study	Compound/ Conc. range	Matrix	Country
Desbrow et al. 1998.	E1, (1- 76 ng/L) E2, (1- 48 ng/L) EE2, (<1 to 7 ng/L)	WWTP effluent	UK
Sole et al., 2000	DES, (nd-43 ng/L) NP, (6- 343 ug/L) E2, (nd- 644 ug/L)	WWTP effluents	Spain
Kutch et.al., 2001	BPA, (300 pg/L - 2 ng/L) NP, (2 -15 ng/L) OP, (150 pg/L - 5 ng/L) Steroid hormones, (100 pg/L-2 ng/L)	Drinking water	Germany
Huggett et al., 2003.	E1, (≤1 - 42 ng/L) E2 , (≤1- 20 ng/L) NP, (12 - 79 µg/L)	WWTP effluents	USA
Furuichi et al;. 2004.	E1, (17.1-107.6ng/L) E2, (2.6-14.7ng/L) EE2, (<0.2ng/L) BPA, (16.5-150ng/L) NP, (78-144ng/L) OP, (20.7-47.5ng/L)	River water	Japan
Pawlowski et al. 2004	E2, (1- 5.6 ng/L) E1, (1.2-19 ng/L) EE2, (<1-1.5 ng/L)	WWTP effluents	Germany
Kidd et al., 2007.	EE2, (5–6 ng/L)	Lake water	Canada

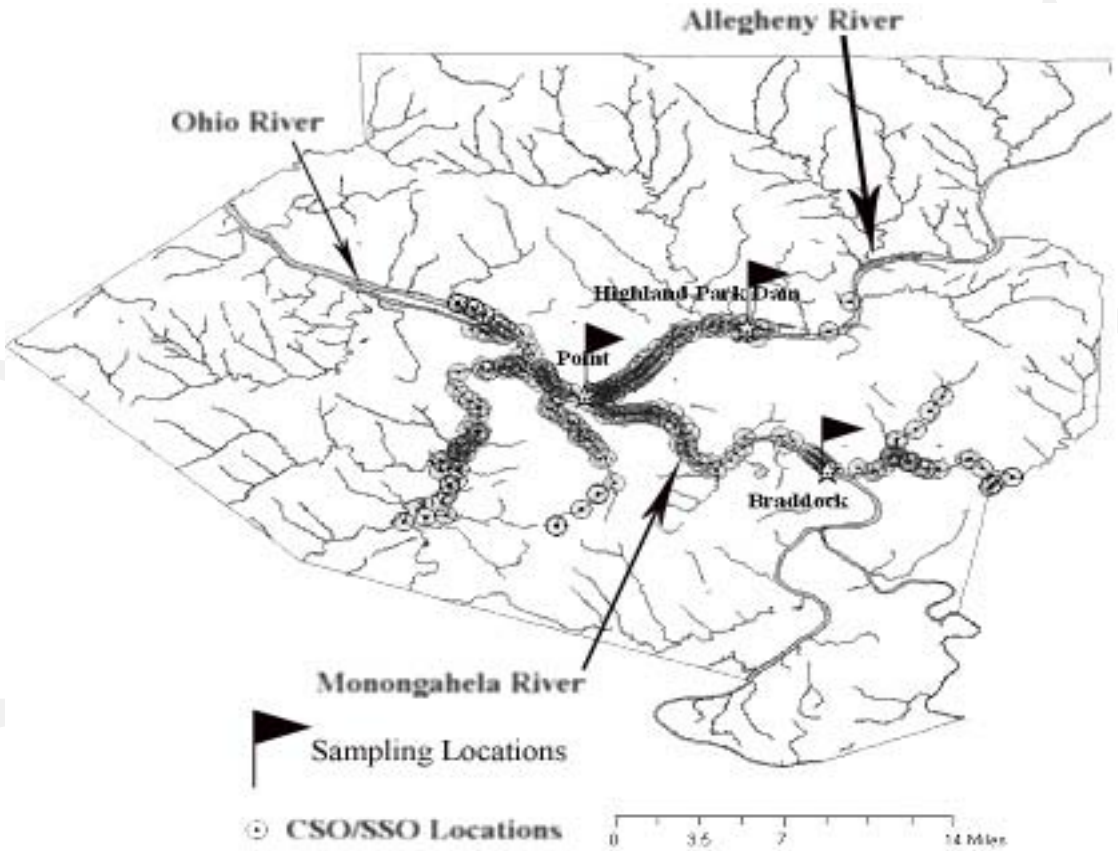
From Wright-Walters, M and Volz, CD., Invited Abstract and Presentation: Third National Conference on Environmental Science and Technology, North Carolina A& T, 2009.

Evidence that PEXE Exposure from Wastewater Treatment Plants Causes Testicular Oocyte (TO)Formation and Vitellogenin Induction in Male Fishes

- Male roach, *Rutilus rutilis*, populations in UK rivers downstream from sewage treatment works have a high frequency of TO and vitellogenin induction (Jobling et al. 1998).
- Intersex frequency in roach was also correlated with exposure to domestic sewage effluents in Danish streams (Bjerregaard et al. 2006).
- High TO in male spottail shiners *Notropis hudsonius* collected at sites in the St. Lawrence River with sewage contamination (Aravindakshan et al. 2004).
- High TO in sharptooth catfish *Clarias gariepinus* inhabiting a reservoir in South Africa with estrogenic water pollution (Barnhoorn et al. 2004).
- White suckers *Catostomus commersonii* from wastewater effluent-dominated Colorado streams (Woodling et al. 2006).

Extracted from V. S. BLAZER, L. R. IWANOWICZ, AND D. D. IWANOWICZ, 2007. Intersex (Testicular Oocytes) in Smallmouth Bass from the Potomac River and Selected Nearby Drainages, Journal of Aquatic Animal Health 19:242–253.

Pittsburgh's Problem-16 Billion Gallons Per Year of Untreated Sewage and Overflow Water-Location of Combined and Sanitary Sewer Overflows in Allegheny County –ALCOSAN Sewershed



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Multi-disciplinary Collaborators: Pittsburgh Fish Consumption Study and Allegheny River Stewardship Project

- UPCI/CEO, Devra Davis PhD, MPH, Maryann Donovan, PhD, MPH, Talal El- Hafnawy MD, PhD
- UPMC, Patricia Eagon PhD, Frank Houghton, PhD
- GSPH

  -Ravi Sharma, PhD, GIS Methodologies, BCHS

  -Evelyn Talbott, DrPH, MPH, Epidemiology

  -Roslyn Stone, PhD, John Wilson, PhD, and Diana Lenzner, MPH, Biostatistics
- Rachel Carson Homestead, Patricia DeMarco, PhD
- CHEC/GSPH, Chuck Christen M Ed, DrPH cand., Andrew Michanowicz MPH, Maxine Wright –Walters, PhD
- 3 Rivers Ecological Research Center, PA Fish and Boat Commission, Sue Thompson, PhD, and Robert Ventorini

Pittsburgh Fish Consumption Study 2005-2007

Objective A:

To determine if the estrogenicity index of channel catfish fillet significantly varies by proximity to dense concentrations of CSOs/ SSOs, as measured by the MCF-7 and BT-20 human breast cancer cell proliferative assays.

Objective B:

To determine if the channel catfish Estrogen (E)-screen model can be used to help identify the sources of pharmaceutical estrogen and xenoestrogen pollution.

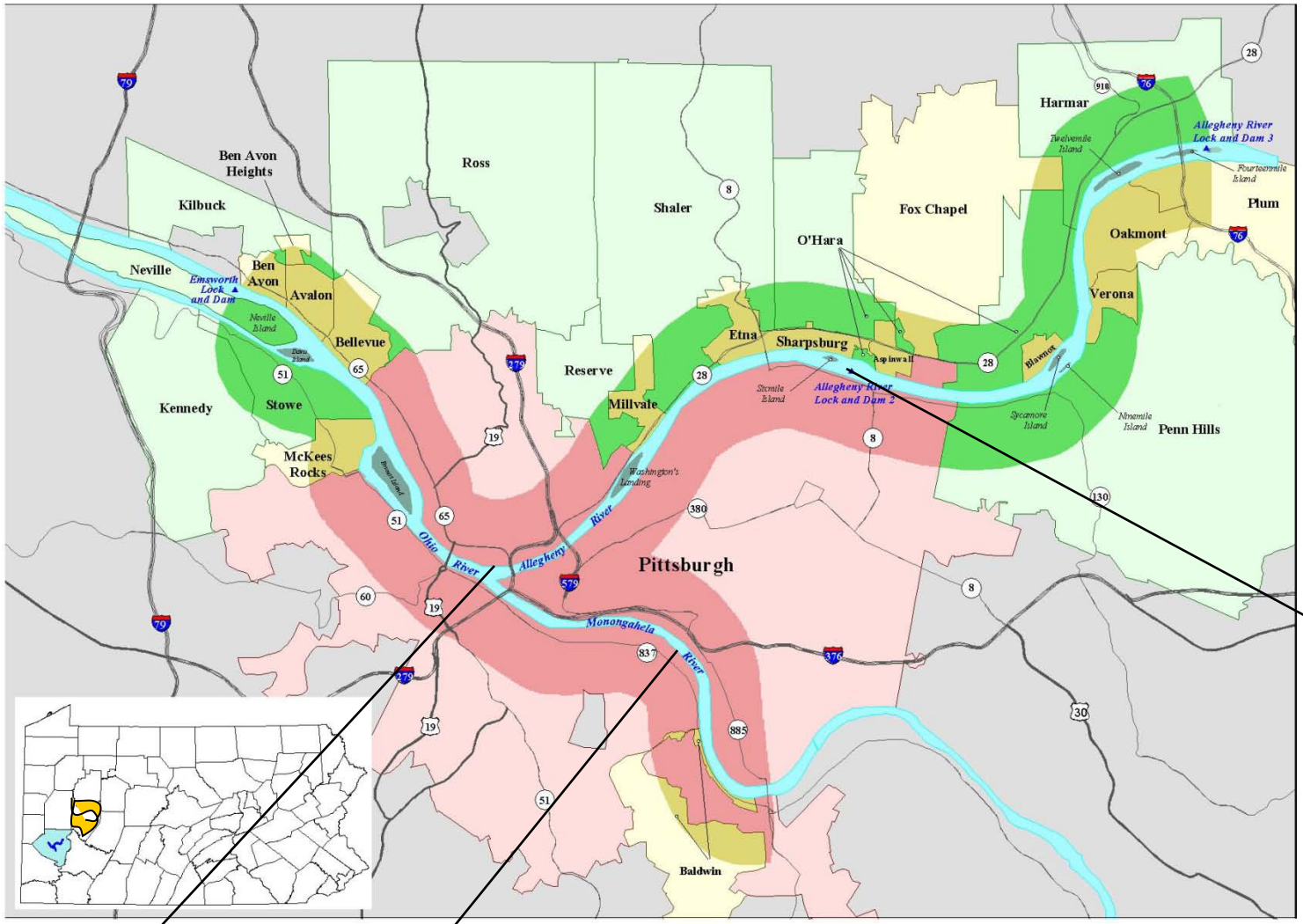
Objective C:

To involve semi-subsistence and recreational anglers in a Community Based Participatory Environmental Research Project (CBPR).

Objective D:

To demonstrate to policymakers the known biological effects and potential environmental public health consequences of failure to update Allegheny County's and southwestern Pennsylvania's antiquated sewer systems.

Locations of Channel Catfish Catch in Southwestern Pennsylvania



Highland Park

Point State Park

Monongahela River near the U. S. Steel Edger Thompson Works

- Dams
- Allegheny County
- Islands
- City of Pittsburgh
- Boroughs
- Townships

Darker shades represent areas contained within the corridor.

0 1 Miles

Scale 1:90,000
Accuracy: 5 ft.

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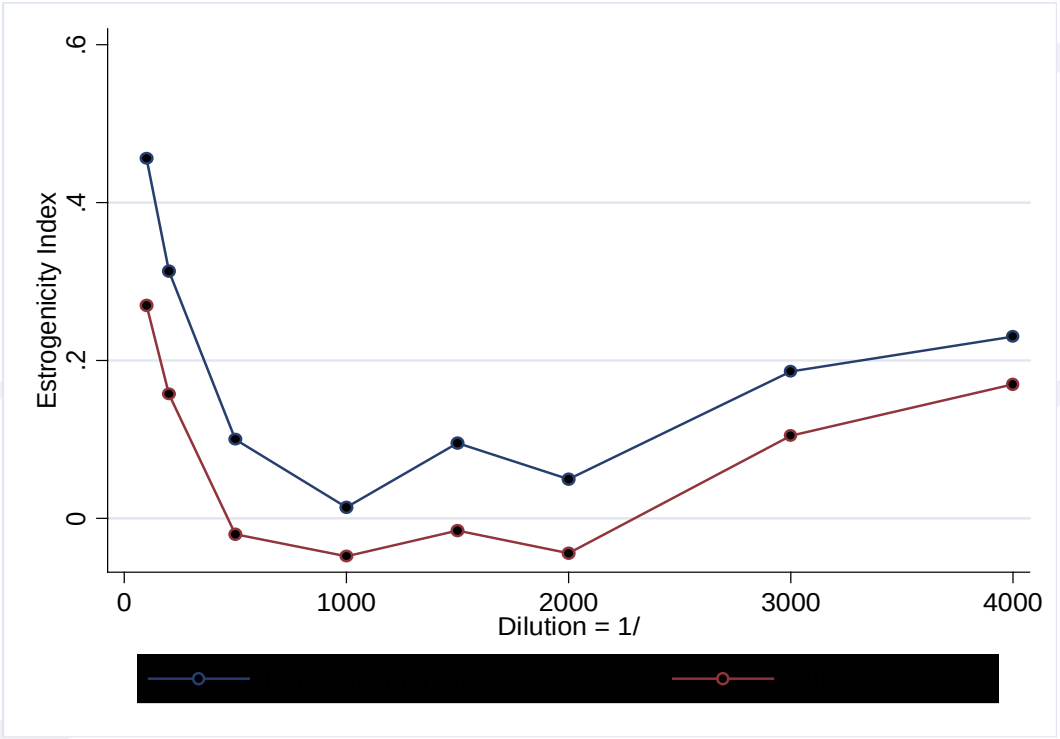
Mean Estrogenicity Index by Fish Extract Dilution: Point State Park and Braddock Dam [Dense CSO/SSO] vs Highland Park Dam and Kittanning Dam on the Allegheny River [Less Impacted by CSOs/SSOs]



Estrogenicity Index is a normalized value = Proliferation Index at each dilution/ Mean Estradiol Response per plate.

Statistically Significant Relationship Exists Between Catch Locations With High Density of CSO/SSO's and MCF-7 Proliferation and Estrogenicity Indexes

Sampling Location	Point State Park, Confluence	Braddock Dam – Monongahela River	Highland Park Dam - Allegheny River	Kittanning Dam - Allegheny River
CSOs/SSOs Radius of 1 Mile	**53**	**53**	17	3*
CSOs/SSOs 1 mile upstream	32	22	6	1

* within a radius of 3 miles

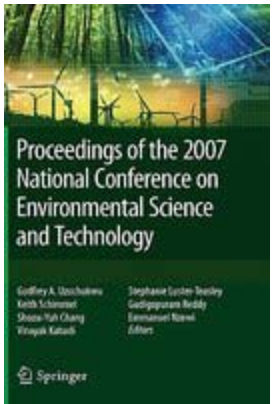
Proliferation Index Data

	store	HPD	Kittanning	Braddock
HPD	p=0.54			
Kittannning	p=0.34	p=0.75		
Braddock	p=0.01	p=0.03	p=0.03	
Point	p<0.01	p=0.01	p=0.01	p=0.49

Statistical analysis performed using Linear Intercept Regression with coefficient contrasts compared using Wald's Test

Estrogenicity Index Data

	store	HPD	Kittanning	Braddock
HPD	p=0.63			
Kittannning	p=0.30	p=0.57		
Braddock	p=0.01	p=0.03	p=0.05	
Point	p<0.01	p<0.01	p<0.01	p=0.15



From: Conrad Daniel Volz, DrPH, MPH , Frank Houghton, PhD, Nancy Sussman, PhD, Diana Lenzner, MS, Devra Davis, PhD, MPH, Maryann Donovan, PhD, MPH, Talal El -Hefnawy, PhD, MD and Patricia Eagon, PhD, 2009.**CHANNEL CATFISH ESTROGENICITY AND SEWER OVERFLOWS; IMPLICATIONS FOR XENOESTROGEN EXPOSURE**, Proceedings of the 2007 National Conference on Environmental Science and Technology **,** Springer Publications, NY, NY.

Conclusions

- Estrogenic activity of catfish flesh and fat does vary significantly by spatial location to dense concentrations of CSOs/SSOs.
- Non-estrogenic proliferation factors seem not involved as BT-20 cells were not affected.
- Catfish can serve as biomonitors for estrogenic pollution.
- The Community-Based Participatory Environmental Research Project energized anglers and river communities to become stewards of the river-this has led to further sampling of fish and water for specific estrogenic contaminants in the Allegheny River.

Public Health Implications

- River water is the source of tap water for over 1,200,000 in the Pittsburgh region. 16 billion gallons of sewage overflow is deposited in source drinking water for Pittsburgh per year.
- Pharmaceutical estrogens and xenoestrogens are hypothesized to be released in even higher concentrations from CSOs/SSOs than from WWTP.
- There is no regulations requiring WWTP or water treatment facilities to test for or treat water for estrogenic substances.
- Large susceptible population groups may be at risk for estrogenic exposure through municipal drinking water sources.

Research in Progress/ Manuscript Preparation

- An Updated Weight of Evidence Approach to the Aquatic Hazard Assessment of Bisphenol A: Maxine Wright-Walters PhD, Manuscript Submission-Science for the Total Environment.
- Estrogenicity Index of Shad Species from the Allegheny River, with Patricia Eagon PhD and Frank Houghton, PhD.
- Identification of Selected PEXE in Fish Brains from the Monongahela, and Allegheny Rivers with Talal El-Hefnawy MD, PhD and Vicky Blazer, PhD.

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- Program partners included Venture Outdoors and Clean Water Action, Rachael Carson Homestead, and the Alle-Kiski Health Foundation.

The Center for Healthy Environments and Communities CHEC

- For more information on estrogenic contaminants in water visit the CHEC website at www.chec.pitt.edu . Navigate to **Info for Experts** and select **Estrogenic Contaminants**.
- Put CHEC to work in your community or join CHEC as a partner in a **Community-Based Participatory Environmental Research Project**.

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