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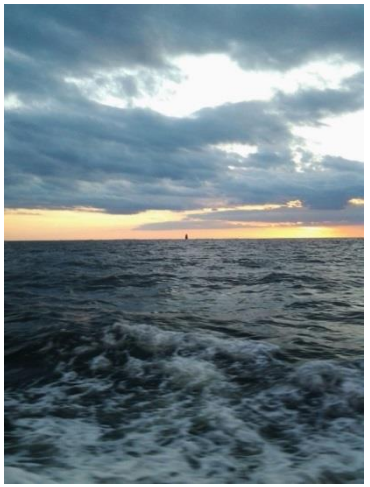

Lessons Learned from other watersheds: Delaware River Basin Contaminants of Emerging Concern Surveys & PCB TMDL

Ron MacGillivray, Ph.D.

Senior Environmental Toxicologist

STAC workshop

May 23, 2019

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Why was the DRBC created in 1961?

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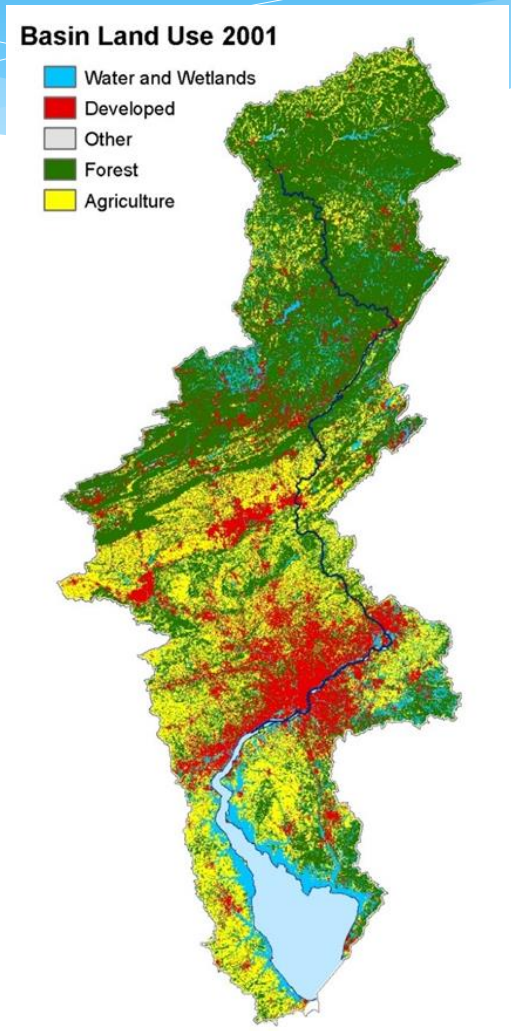
- Water supply shortages and disputes over the apportionment of the basin's waters;
- Severe pollution in the Delaware River and its major tributaries;
- Serious flooding

Five Equal Members:
Delaware
New Jersey
Pennsylvania
New York
Federal Government



Strategy for Contaminants of Emerging Concern

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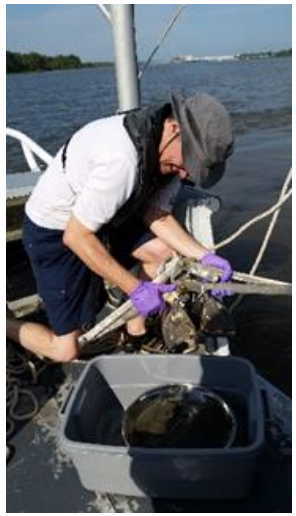
* What are the occurrences and sources of CEC in the Delaware River and Bay?
* What are the risks to designated uses in Delaware River and Bay from CEC?
* What actions can be identified to minimize CEC impacts in the Delaware River and Bay?



Contaminants
DRBC 2004 to 2018

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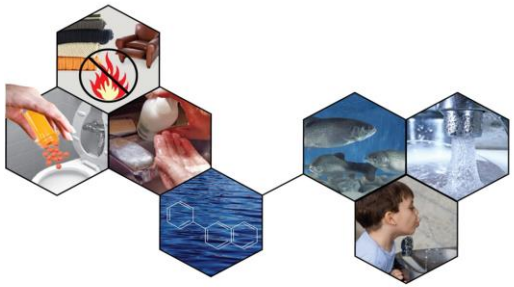
- Pharmaceuticals and Personal Care Products (PPCP)
- Hormones
- Stain repellants/non-stick surfaces/fire fighting foams [PFAS]
- Flame Retardants [PBDE]
- Detergents [NP]
- Plasticizers [bis-phenol A]
- Surveys in surface water, fish and sediment



Current Water Quality Concerns
Why are Pharmaceuticals and Personal Care Products (PPCP) of concern?

* Biological effects (diclofenac, triclocarban)
* Resistant to degradation (carbamazapine)
* Widespread and increasing use (ibuprofen, metformin)
* Wastewater treatment plants are not designed to remove (trimethoprim, erythromycin)
* Effects on aquatic life (hormone EE2)

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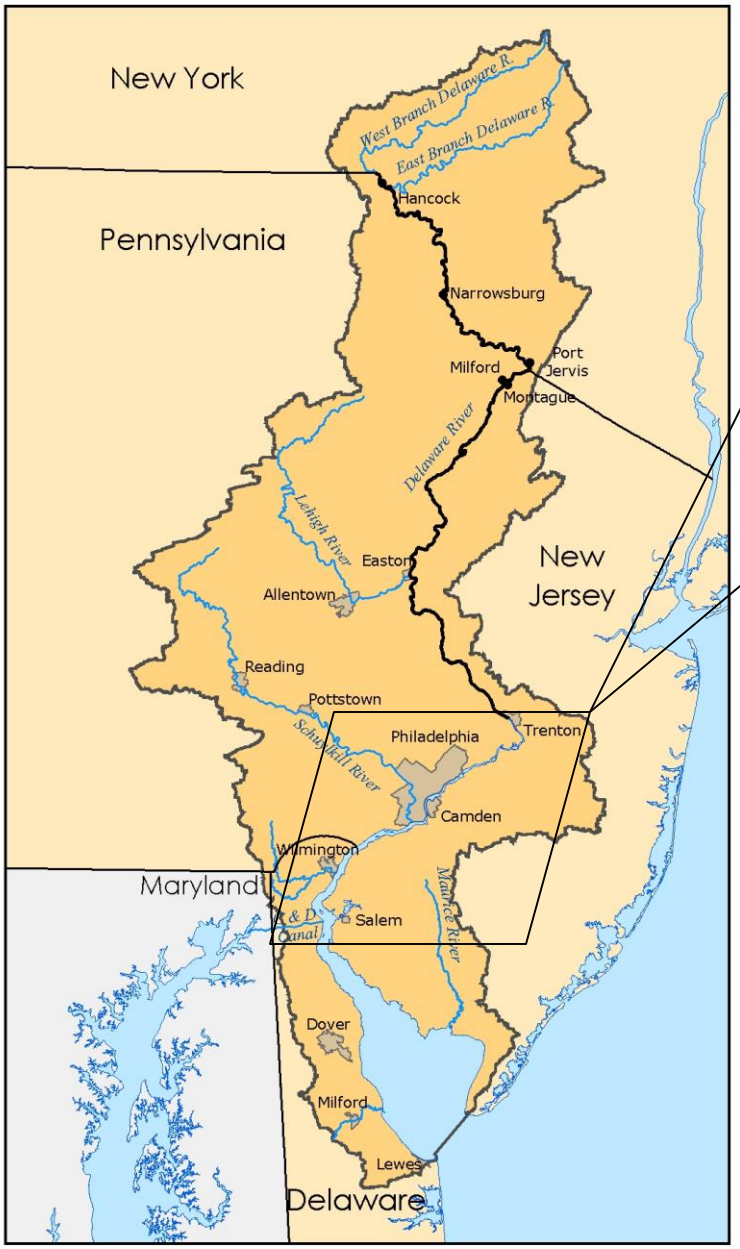

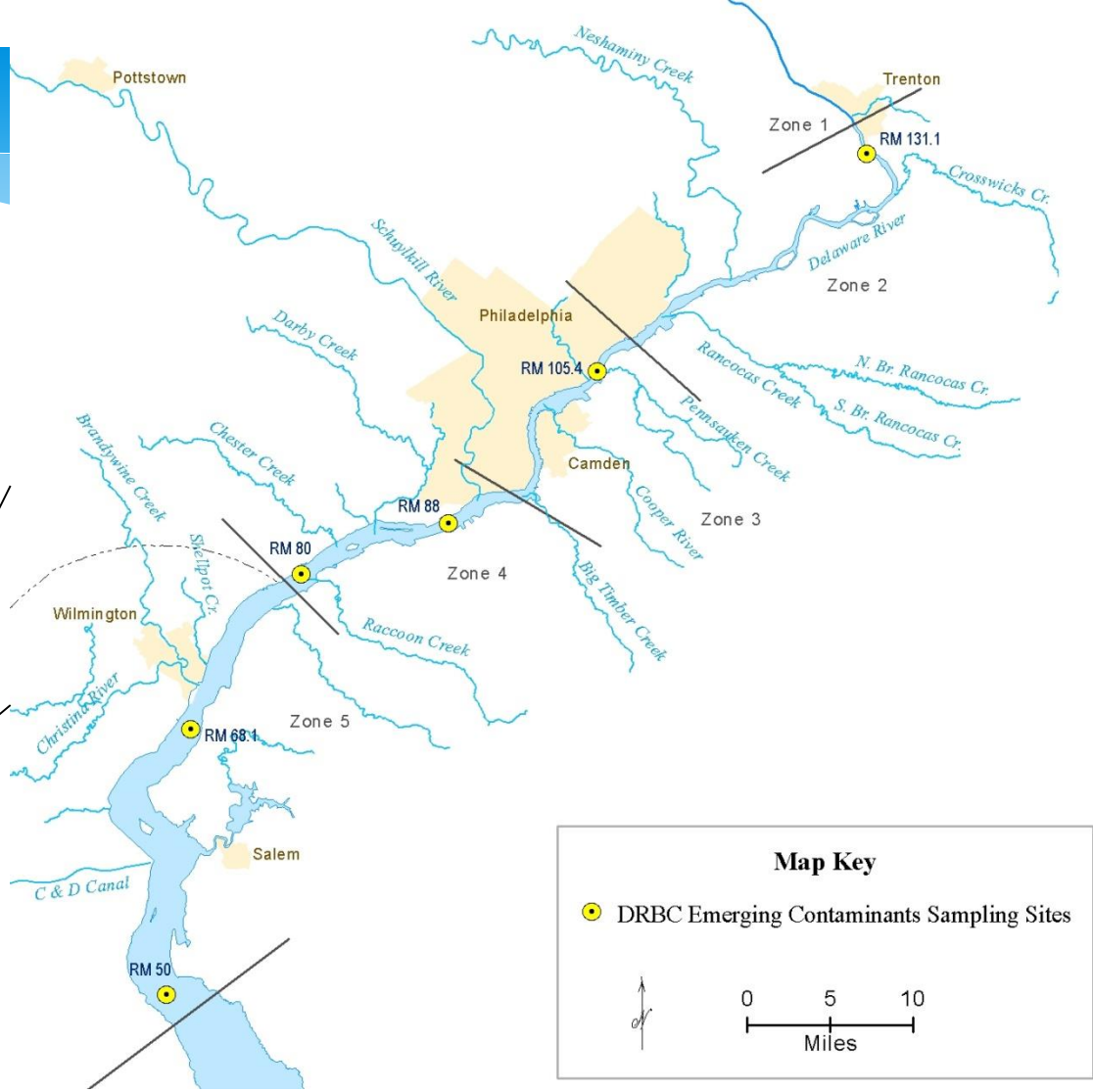

PPCP surveys 2007, 2008, 2009

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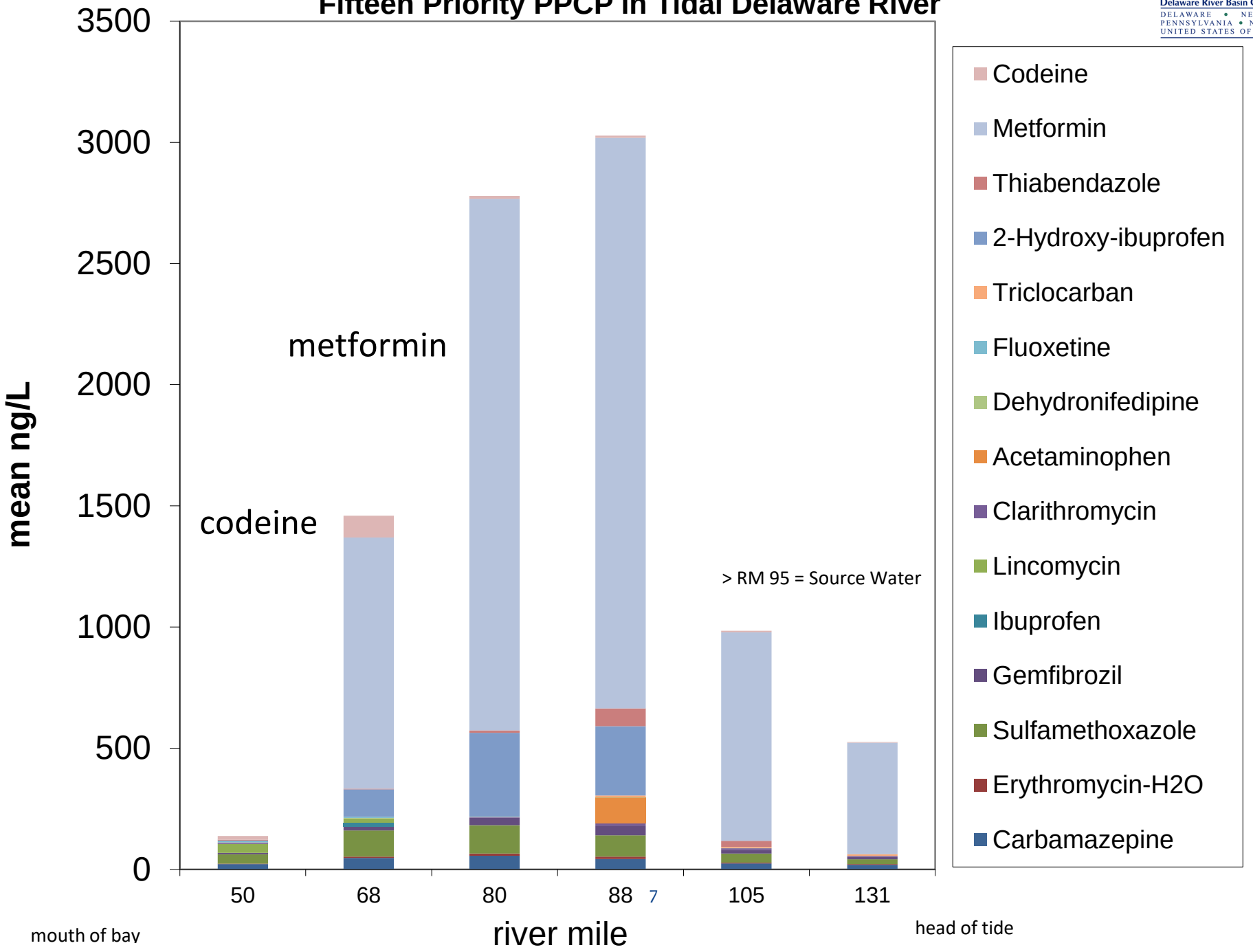
Fifteen Priority PPCP in Tidal Delaware River



Why are Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) of Concern?

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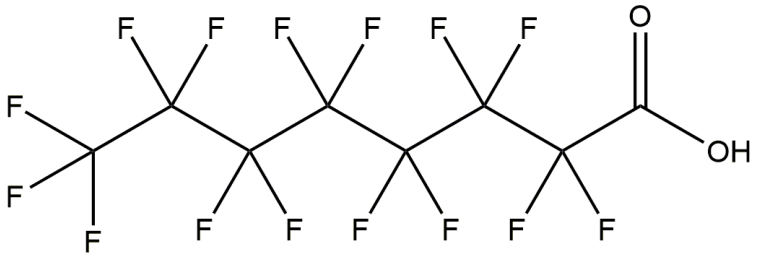
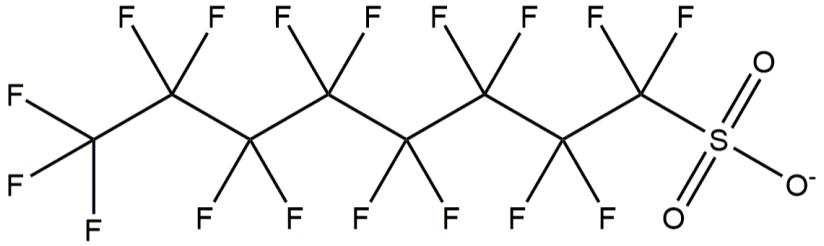
* Properties
* Uses
* Sources
* Stewardship
* Alternatives
* Discharges
* Persistence
* Toxicity
* Bioaccumulation



Perfluorooctanoic acid (PFOA)



Perfluorooctane sulfonate (PFOS)

https://journals.plos.org/plosbiology/article/figure?id=10.1371/journal.pbio.2002855.g001

www.itrcweb.org

Human Health Effects

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Association with liver damage, increased cholesterol, thyroid disease, decreased response to vaccines, asthma, decreased fertility and birth weight, pregnancy–induced hypertension

EPA HA PFOS & PFOA 70 ng/L, NJDEP MCL PFNA 13 ng/L

Ecotoxicity

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Ecological Effects

* National WQC for aquatic life not derived
* Long chain PFAS bioaccumulate
* Many PFAS are persistent (short and long chain)
* Moderately acute and slightly chronically toxic to aquatic organisms (survival, growth and reproduction)
  * PNEC for PFOS 0.6 to 6.6 ug/L (Qi et al. 2011)
  * PNEC for PFOA 1,250 ug/L (Hoke et al. 2015)
  * PNEC for PFHxA (C6) 199 ug/L (Hoke et al. 2015)
* Sublethal effects observed (e.g., histopathology, neurological and immune effects) non-standard tests

- Water grab samples in HDPE bottles
- Fish samples are composites of five standard fillets.
- Sediment surficial grab with Ponar.
- Analytical Parameters & Methods: 13 compounds, isotope dilution, LC/MS/MS Method
- Analysis by SGS-Axys Analytical LTD

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Sulfonates and Sulfonamide

# of carbons	
4	Perfluorobutanesulfonate (PFBS)
6	Perfluorohexanesulfonate (PFHxS)
8	Perfluorooctanesulfonate (PFOS)
8	Perfluorooctane sulfonamide (PFOSA)

Carboxylates

# of carbons	
4	Perfluorobutanoate (PFBA)
5	Perfluoropentanoate (PFPeA)
6	Perfluorohexanoate (PFHxA)
7	Perfluoroheptanoate (PFHpA)
8	Perfluorooctanoate (PFOA)
9	Perfluorononanoate (PFNA)
10	Perfluorodecanoate (PFDA)
11	Perfluoroundecanoate (PFUnA)
12	Perfluorododecanoate (PFDoA)

PFAS Sample Sites

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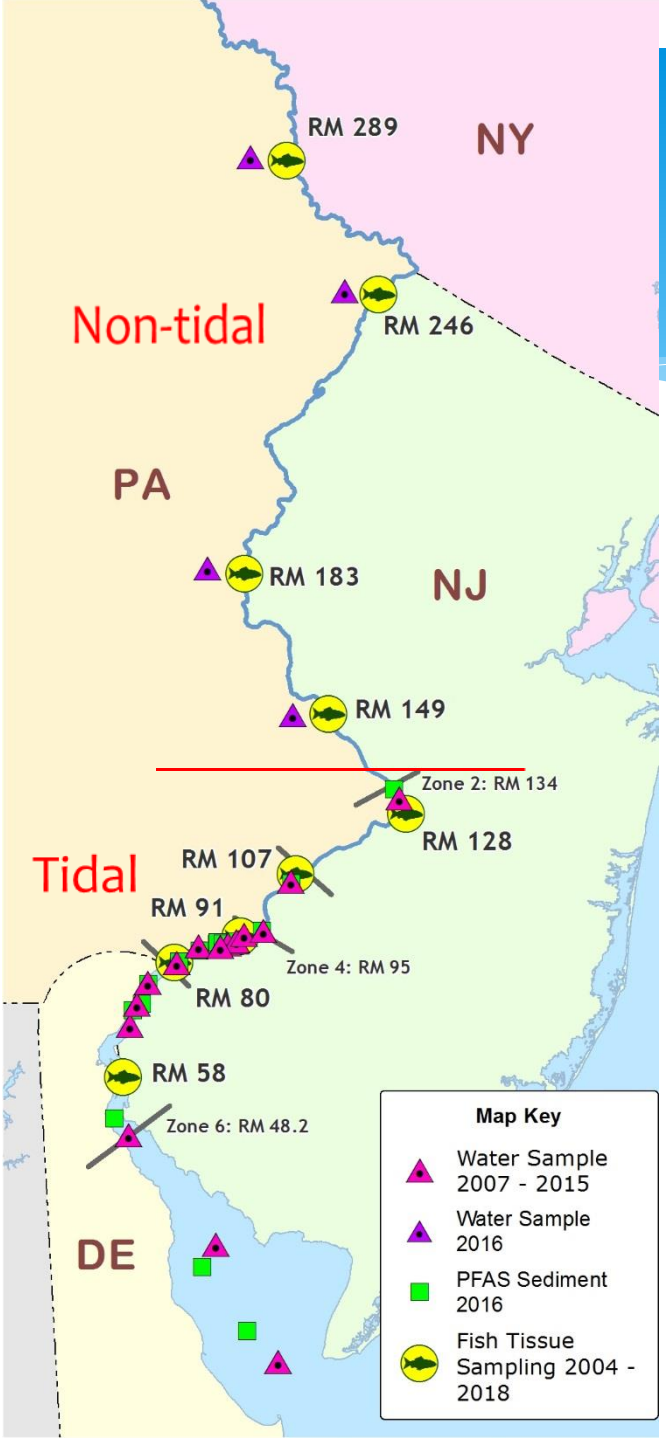

Surface water

Six tidal sites in 2007, 2008, 2009

Fifteen tidal sites in 2015

Four non-tidal sites in 2016

Fish

Four non-tidal and five tidal sites in 2004, 2005, 2006, 2007, 2010, 2012, 2015 and 2018

Sediment

Fifteen tidal sites in 2016

PFAS (ng/L) decreases in surface water vary by compound

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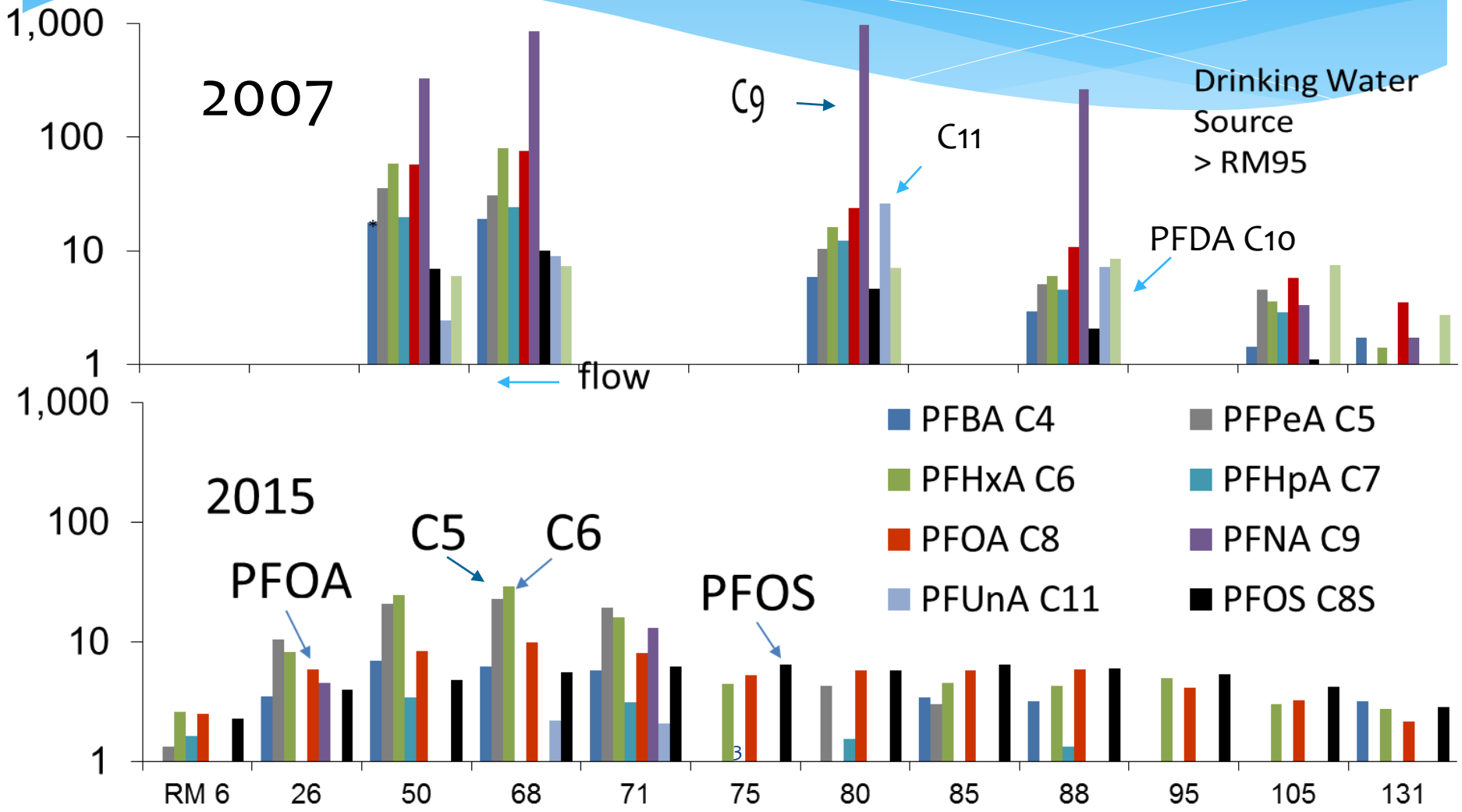
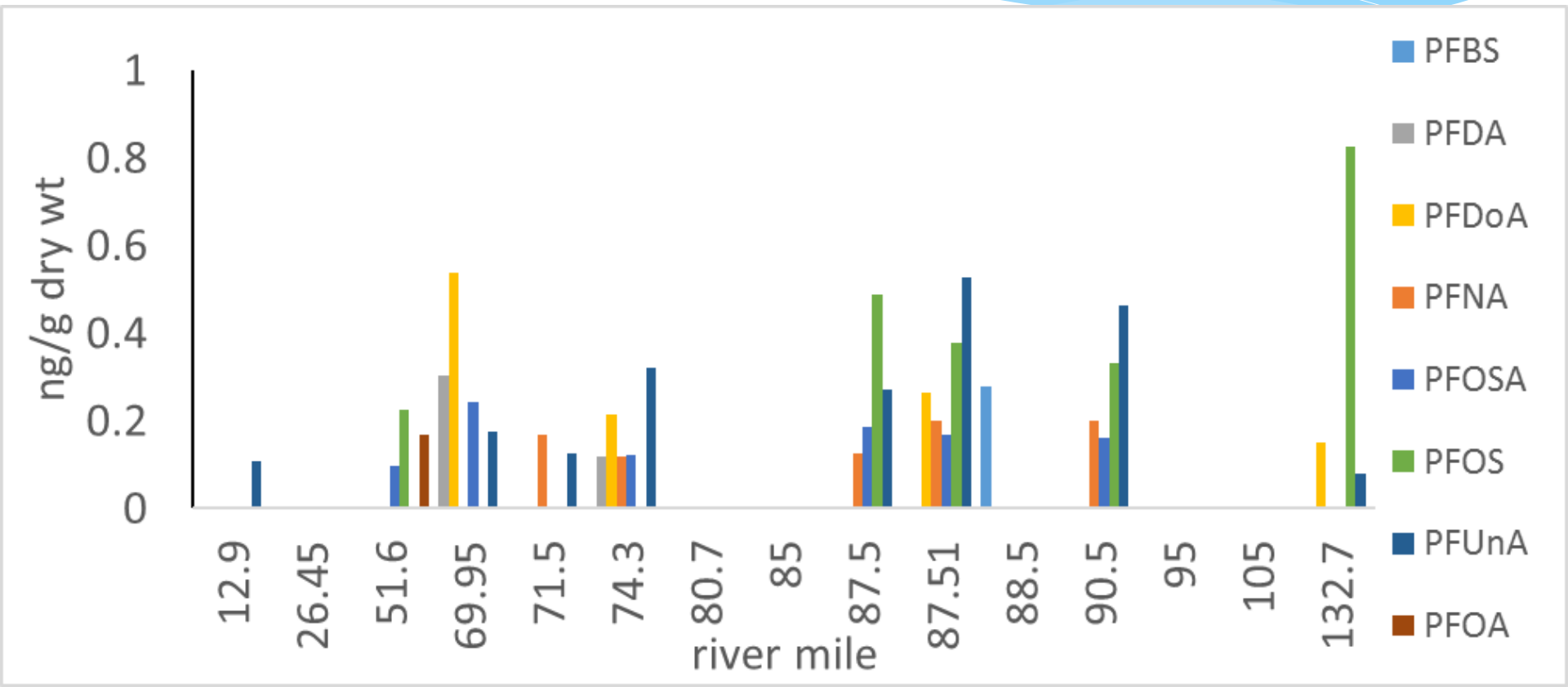


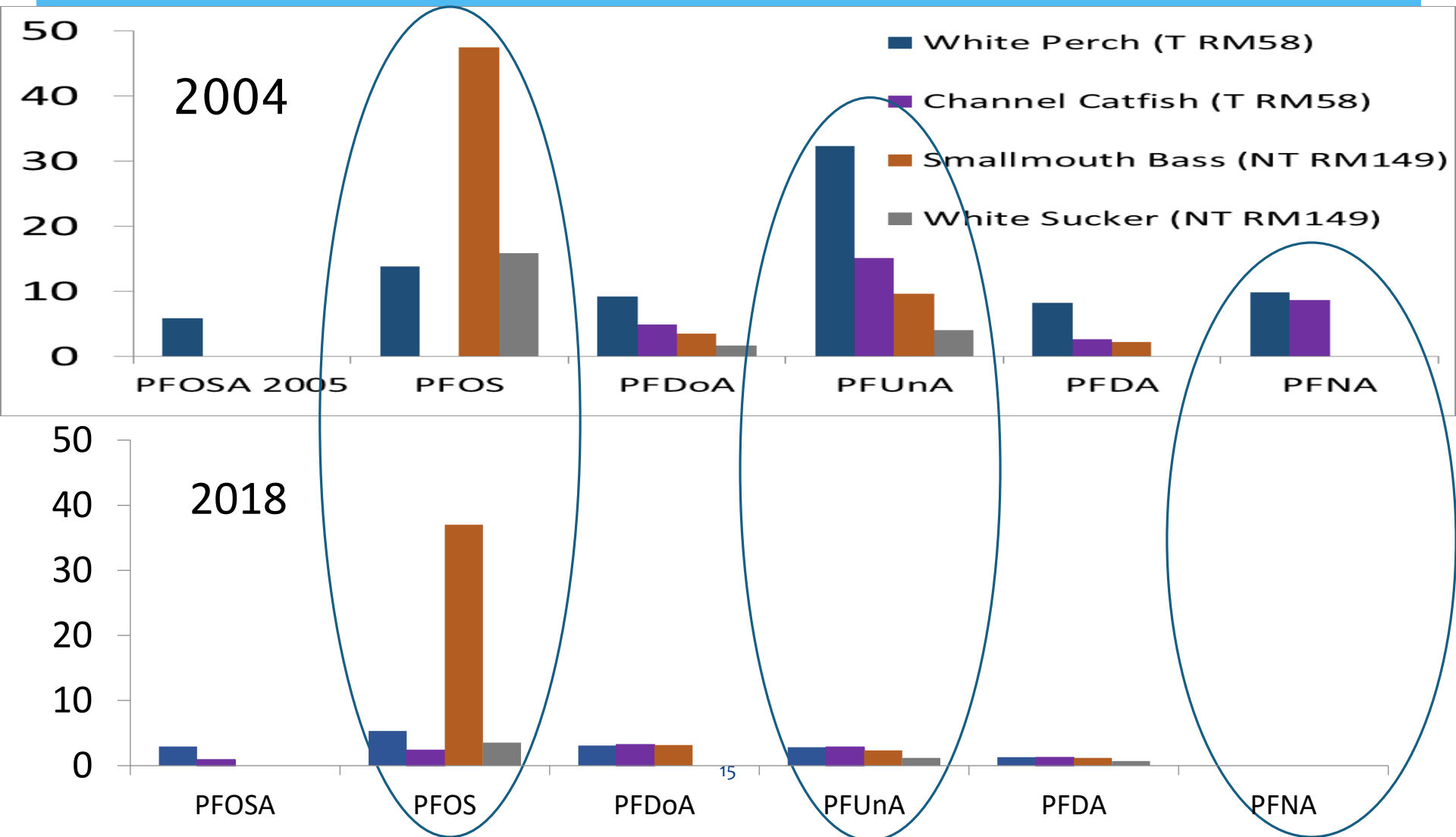
PFAS in sediment 2016

low concentrations similar to other urban areas



Sediment surficial grab with Ponar.

PFAS (ng/g) in fish fillet vary by species, location and year



Why are Polybrominated Diphenyl Ethers (PBDE) Flame Retardants of Concern?

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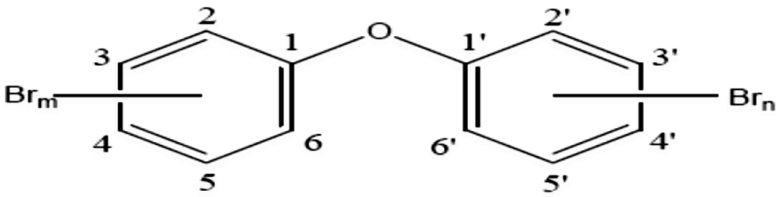
* Used in consumer products such as television casings and polyurethane foam inside furniture cushions.
* **Indoor dust** is believed to be the primary source of human exposure (~ 90%) but **dietary exposure** is also a concern
* PBDEs are characterized as persistent, bioaccumulative, toxic compounds.
* High PBDE levels in serum alter steroid hormones levels and thyroid function, motor and cognitive deficits in children
* Voluntary phase-outs, EPA action plan and SNUR, state bans including NY



where m + n = 1–10

Polybrominated Diphenyl Ethers (PBDE) Flame Retardants

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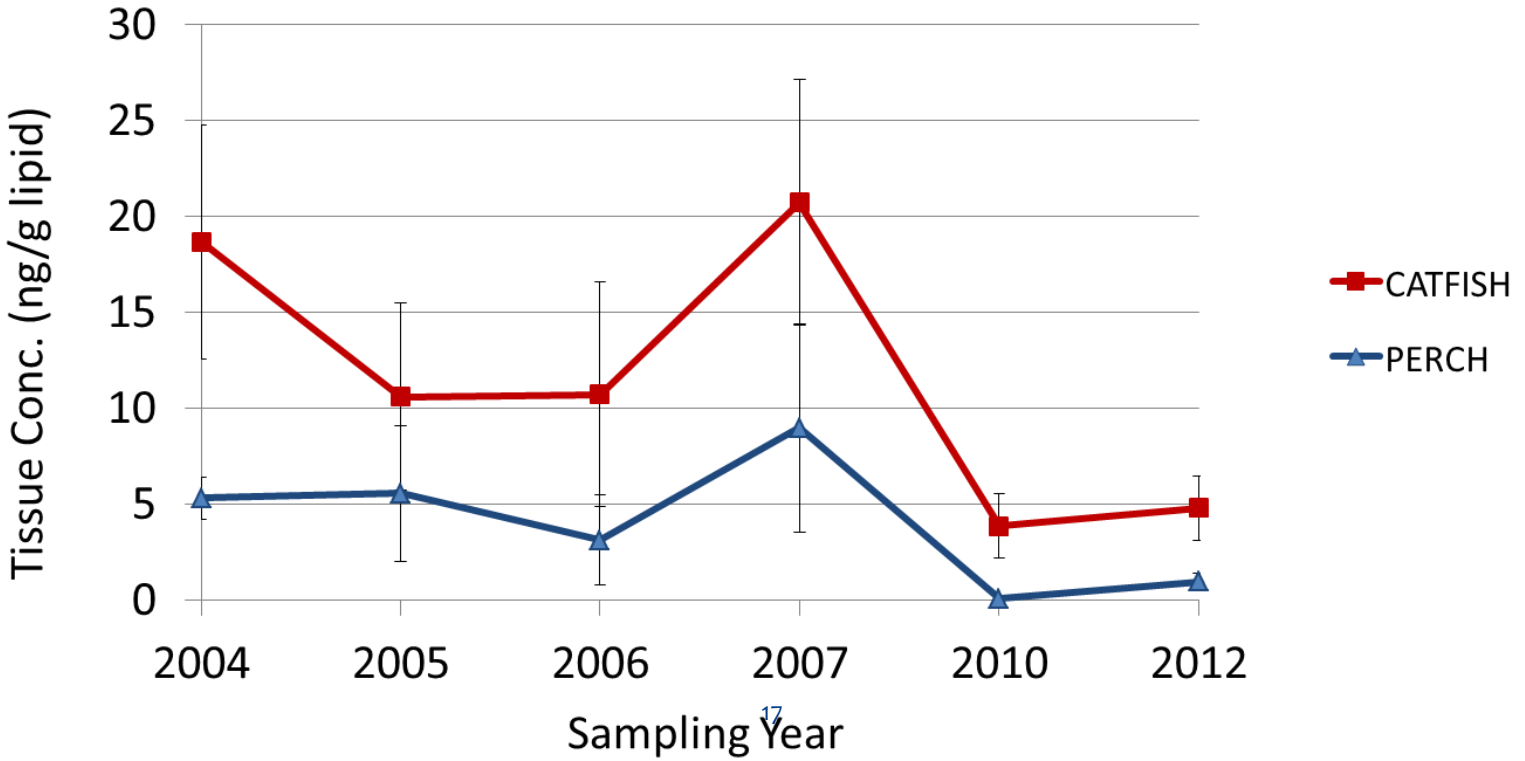
Lipid normalized tissue concentrations of BDE 209 in catfish and perch by year sampled



Data Needs

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- CEC have been detected in surface water, sediment and fish from the main stem Delaware River
- Data needs:
  - for fish consumption advisories (more main stem data and advisory triggers)
  - for source water protection (occurrence and sources)
  - for protection of aquatic life (measured environmental concentrations and predicted no effect concentrations, bioaccumulation factors (BAF)

Contaminants of Emerging Concern Collaborative Projects

DRBC & AXYS Analytical Services Ltd - behavior of the triclosan investigated under laboratory chlorination conditions and in a wastewater treatment plant - 2010

Pape J, M Woudneh, R Grace, G Cavallo, R MacGillivray, T Fikslin, and J Cosgrove. 2013. Fate of Triclosan In Tertiary Wastewater Treatment: Chlorination. Water Quality Research Journal of Canada Vol 48 No 4 pp 333–343

DRBC & Temple U. WET Ctr - Occurrence and Aquatic Toxicity of Contaminants of Emerging Concern (CECs) in Tributaries of an Urbanized Section of the Delaware River Watershed – PPCP - manuscript submitted

DRBC, PDE & Temple U. WET Ctr - Delaware Estuary Microplastics Monitoring and Cleanup – NFWF - 2019 -2020
https://www.state.nj.us/drbc/quality/reports/microplastics.html

Contaminants of Emerging Concern Collaborative Projects

DRBC, NJDEP & EPA-NERL - Detection, Evaluation, and Assignment of Multiple Poly- and Perfluoroalkyl Substances (PFAS) in Environmental Media from an Industrialized Area of New Jersey – DRBC staff collected surface water and sediment samples in tidal NJ Del R tribs as part of a larger survey - 2017

PCB Monitoring Data in the Delaware Estuary

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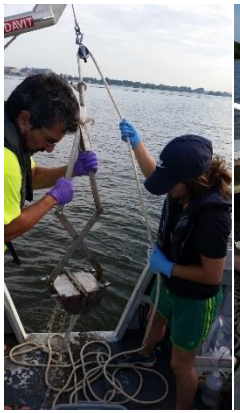
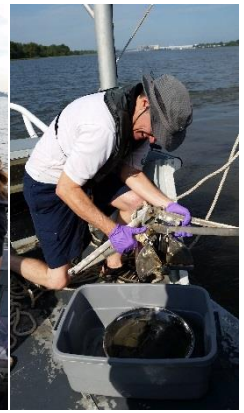
1) Fish Tissue
2) Ambient Water
3) Sediment
4) Atmosphere
5) Point Sources





PCB TMDLs for the Delaware Estuary

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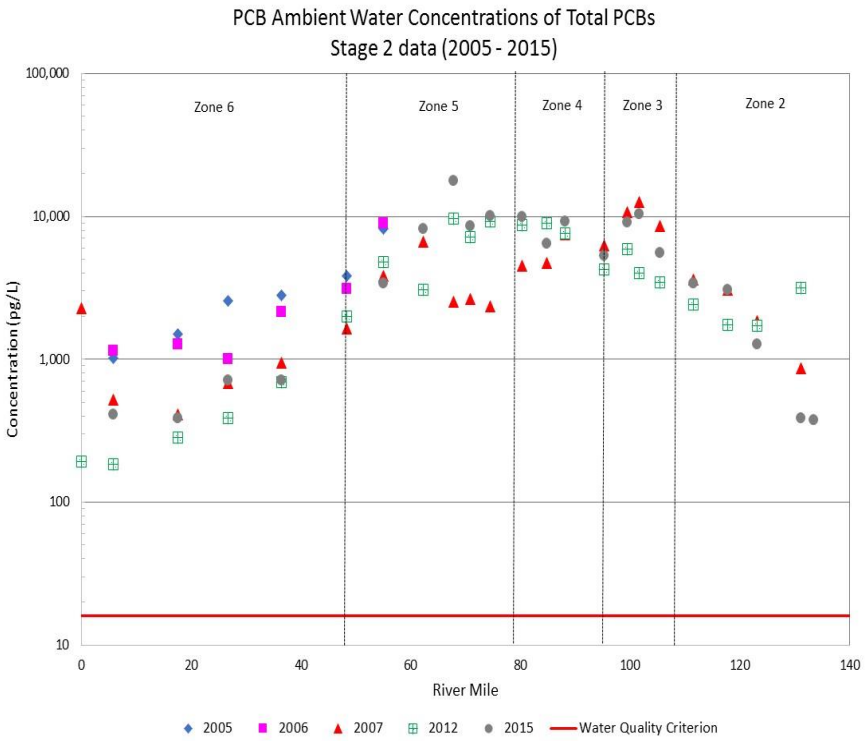
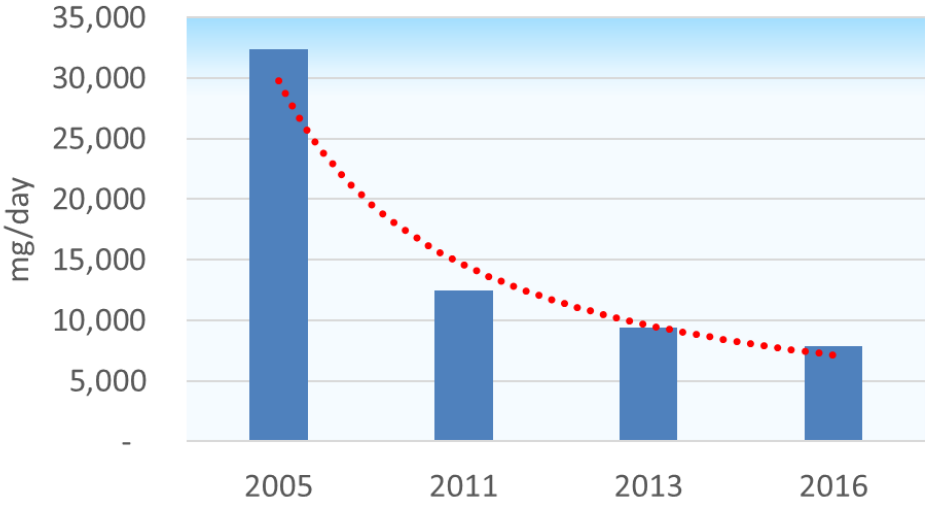
- Production of PCBs banned in 1970s but
  - Active sources – aging transformers, electrical equipment, hydraulic equipment, paint, caulk
  - Inadvertent production of PCBs
- Fish consumption advisories for the entire Estuary and Bay issued by all three states.
- Listed as “impaired” by all three states in 1990s.
- PCB levels in ambient water are 100s to 1000s times greater than the WQ criterion.
- DRBC developed and EPA established PCB TMDLs for the Delaware Estuary and Bay in 2003 and 2006.



Implementation PCB TMDLs

- DRBC adopted Pollutant Minimization Plan (PMP) Requirements for Discharges of Toxic Pollutants: Water Quality Regulations § 4.30.9 (incorporated by reference at 18 CFR Part 410).
- Over 90 point dischargers have developed and implemented PCB PMPs since 2005.
  - Removal of know sources
  - Tracking back potential sources and removal
  - Monitoring using EPA method 1668A
- Cleanup and cutoff PCB pathways of contaminated sites by state agencies.
- DRBC is currently developing State 2 PCB TMDLs for Delaware Estuary and Bay
  - DRBC adopted the revised PCB criterion in 2013.
  - Added element, action level, in implementation strategy to ensure the continuous PCB load reduction is achieved

76% reduction in PCB loadings from Top Ten Point Source Dischargers



Fish Consumption Advisory Changes for General Population

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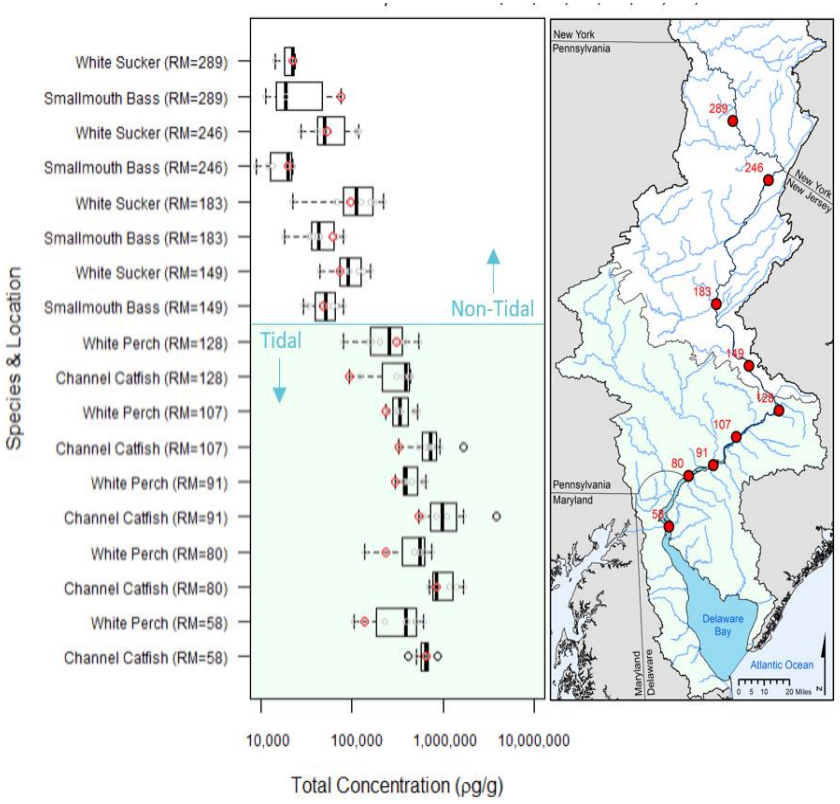
- New Jersey and Delaware have revised advisories in the Delaware Estuary (tidal) from PA/DE Border to C&D Canal (RM:80-58)
  - All fin fish including; white perch and channel catfish
    - Before 2015 — Do not eat
    - 2015-2017 — One meal per year
    - 2018 — Three meals per year

- PA revised advisories from Trenton, NJ to Morrisville PA bridge to PA/DE border
  - for carp
    - Before 2015 — Do not eat
    - 2016 — Six meals per year



Lessons Learned
from PCB TMDLs and Implementation

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* Importance of centralized organization
  * Basin, intrastate approach: Delaware River Basin Commission, Chesapeake Bay Program
* For consistency in:
  * Data quality (sampling method, analytical method, and detection limits)
  * Centralized data management and data sharing
  * Regulation (WQC and Pollutant Minimization Plan in DRBC's WQRs)
  * Adaptive Management (PMPs)
  * Communication
    - quarterly co-regulators conference call focused on implementation of PCB TMDLs
    - Numerous workshops for the regulated community on implementation of PMPs

Lessons Learned
from CEC

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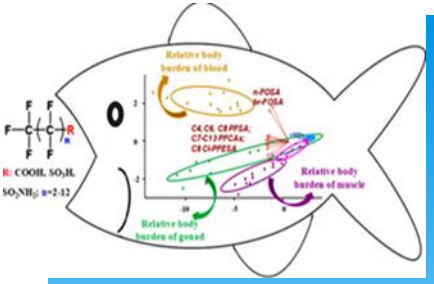
* Importance of basin and interstate approach (Delaware River Basin Commission, Chesapeake Bay Program)
* High Quality Consistent Analysis (trends)
* Collaborate (academics and basin states)
* Piggy-back projects (PCB TMDL, Nutrient Surveys, CEC)
* Expect the unexpected
* Communicate (TAC, workgroups, presentations)



Shi et al, 2018 ES&T

Questions

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DRBC Contaminants of Emerging Concern

https://www.state.nj.us/drbc/quality/reports/cecs.html

PCBs

https://www.state.nj.us/drbc/quality/toxics/pcb.html