

Monitoring Water Quality to Ensure Sustainability



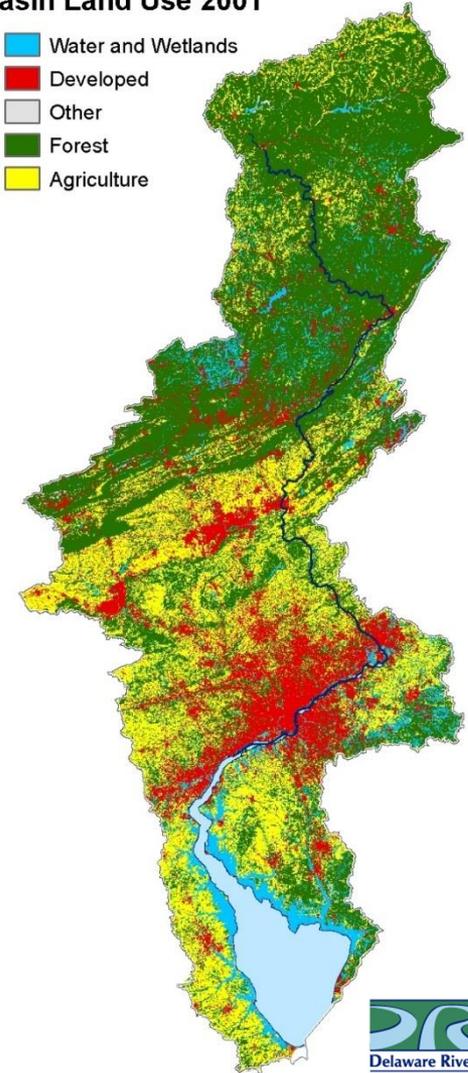
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Delaware River Basin Commission

October 4, 2017



Basin Land Use 2001

-  Water and Wetlands
-  Developed
-  Other
-  Forest
-  Agriculture





Outline



- * DRBC
 - * Regulations
 - * Monitoring Goals
 - * Data Uses
- * Status and Trend
 - * Water, Fish, Sediment
 - * Biological Monitoring
 - * Ambient Toxicity Bioassay
- * Environmental Management
 - * Legacy Pollutants
 - * Dissolved Oxygen
- * Criteria Development
 - * Metal bioavailability
- * Occurrence in River
 - * Emerging contaminants

Why was the DRBC created?

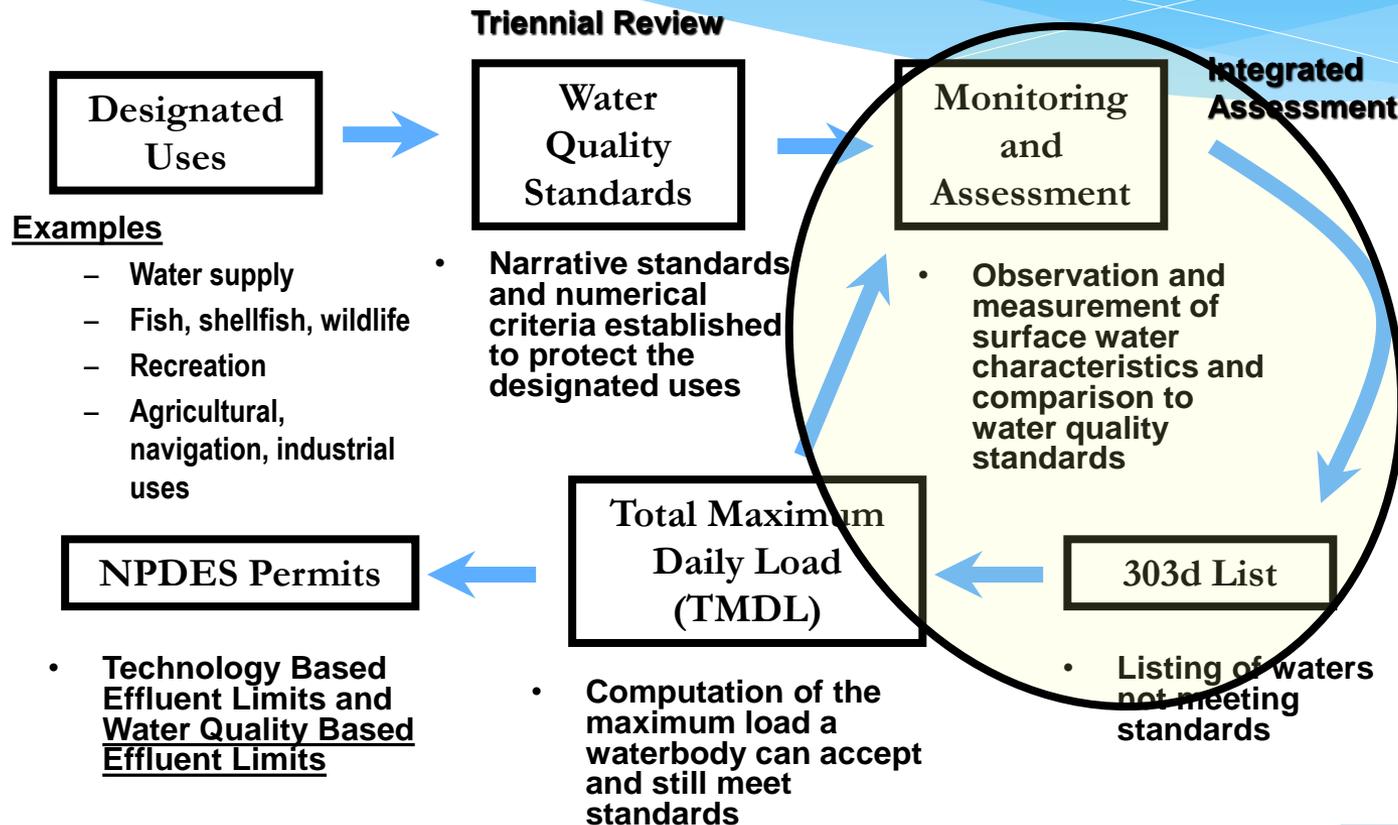
- Water supply shortages and disputes over the apportionment of the basin's waters;
- Severe pollution in the Delaware River and its major tributaries;
- Serious flooding



The 1937 *Philadelphia Record* editorial page cartoon depicts the time when the tidal Delaware was an open sewer, where pollution in some stretches robbed the river of all its oxygen needed to support fish and other aquatic life.

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

Clean Water Act Framework for Water Quality Management



Clean Water Act Framework for Water Quality Management

Water Quality Standards
anti-degradation policies to prevent deterioration of high-quality waters



WQS Objectives:

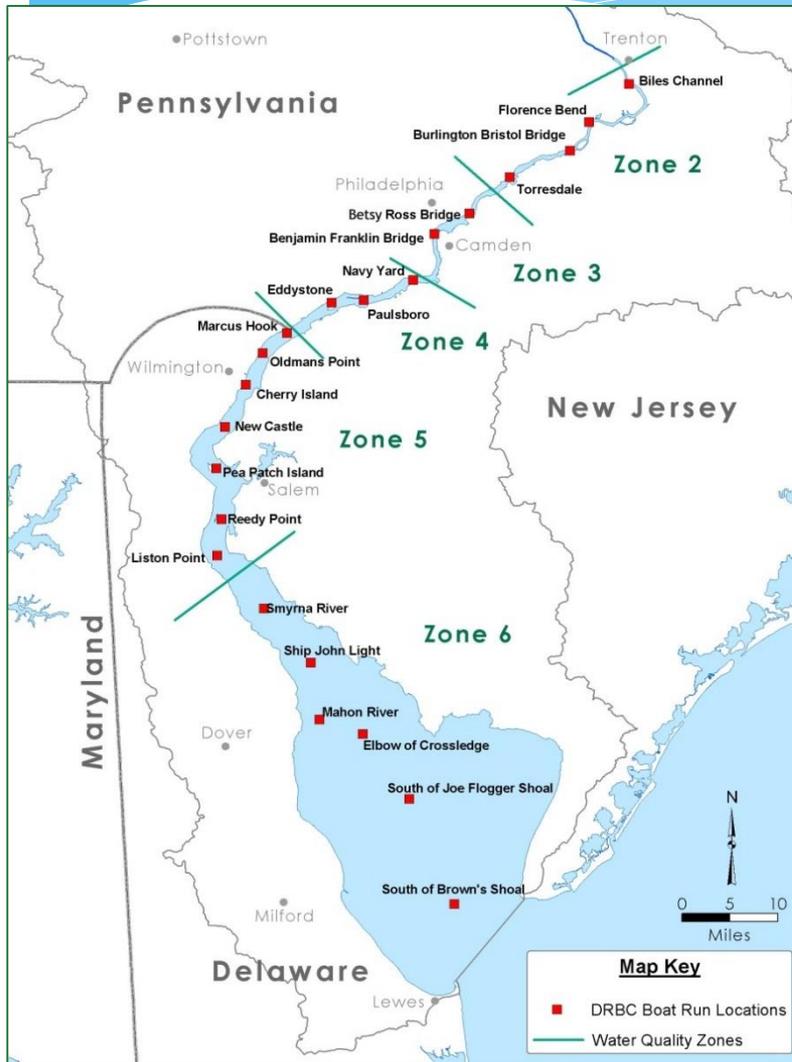
- * protection or preservation of **uses** associated with the water body
- * protection or preservation of the **water quality** with the intent of sustaining currently existing conditions
- * preservation of the water resources for **future or intended uses**

Monitoring Goals

- * Use current scientific knowledge and technology
- * Measure regulatory objectives of sustainable healthy waters
- * Assessment (status and trends)
- * Inform adaptive management
- * Data coordination



Delaware Estuary Water Quality Monitoring (Boat Run) Surface Water Monitoring



* Since mid-1960's (in some format)

* 22 Sites per month

* Parameter Groups

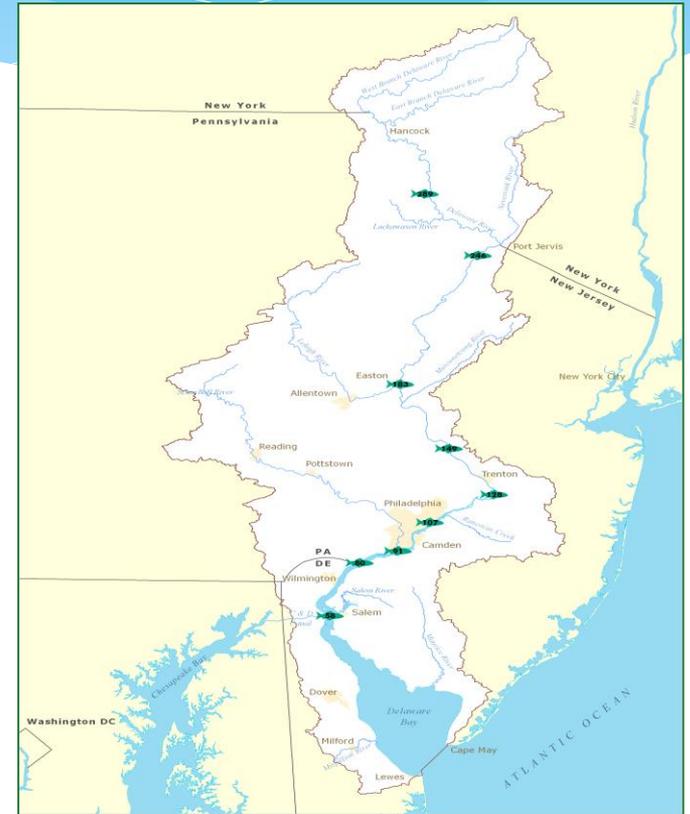
- Routine
- Nutrients
- Bacteria
- Metals
- Other parameters

* Sampling & Analysis performed by DNREC under contract to DRBC



Fish Tissue Monitoring

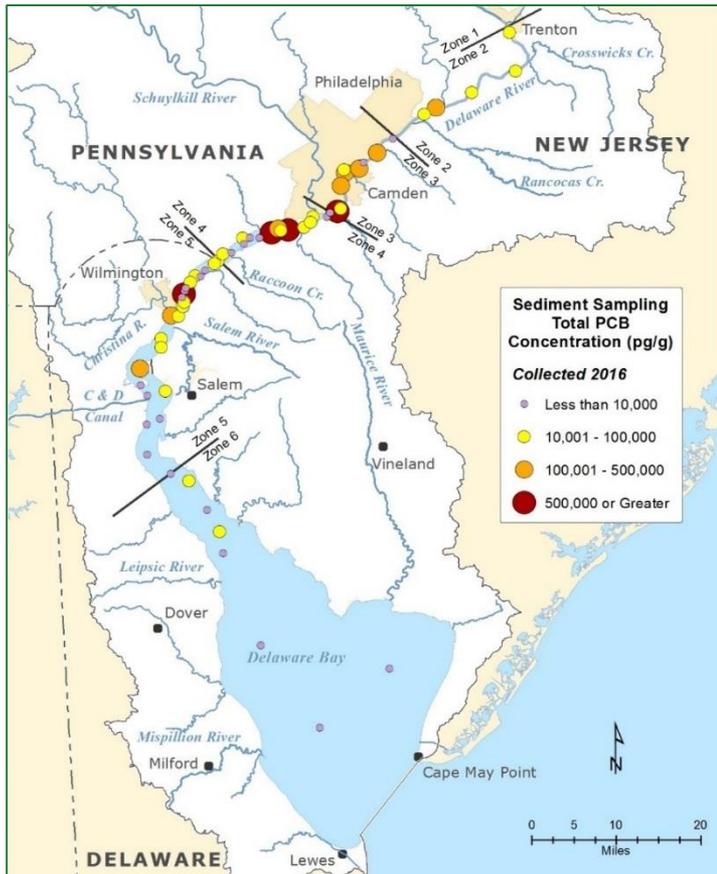
- * Tidal and non-tidal in Delaware River.
- * Frequency: Yearly 2000 - 2007, 2010, 2012, 2015, 2016 (Bay), 2018 (planned)
- * Two fish species at each site
 - Tidal: white perch, channel catfish
 - Non-tidal: smallmouth bass, white sucker
- * PCBs, Mercury, Methylmercury, Chlorinated pesticides, Dioxins/Furans, PFAS, Metals
- * Data used for fish consumption advisories in NJ



Sediment Monitoring

- * Periodic

- * PCBs, PAHs, PFAS, Pesticides



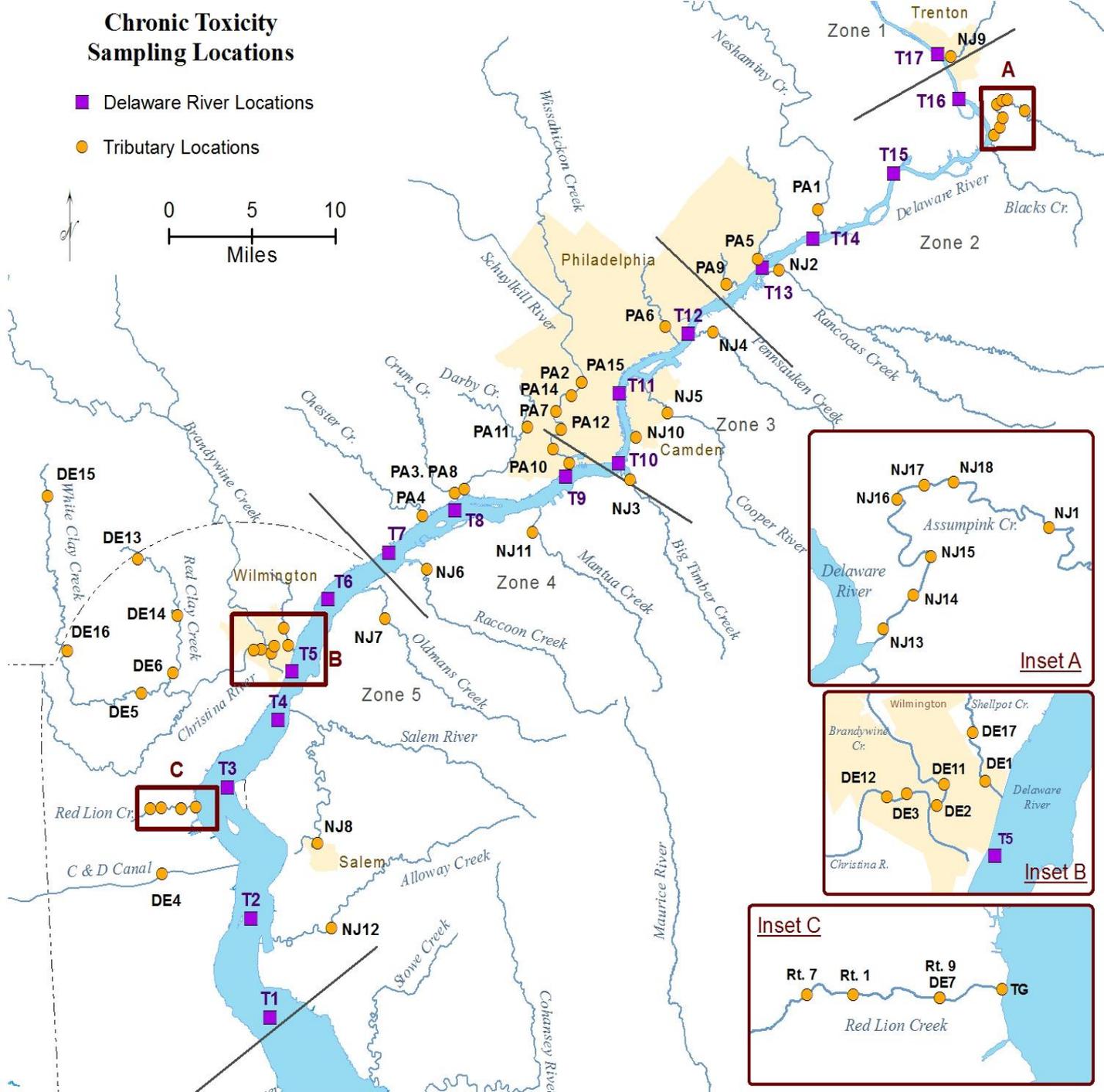
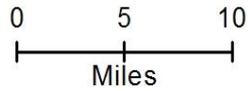
Biological Monitoring Program

- * Macroinvertebrates
- * Periphyton/Phytoplankton
- * 25 riffle sites in non-tidal Delaware River
- * Water Quality Parameters
- * Every 2 or 3 years
- * Assessment included in Delaware River Water Quality Assessment (305(b))



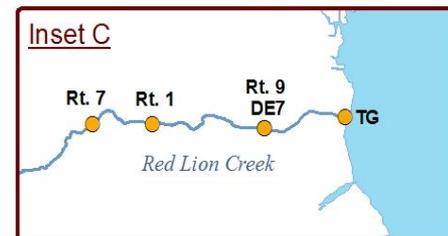
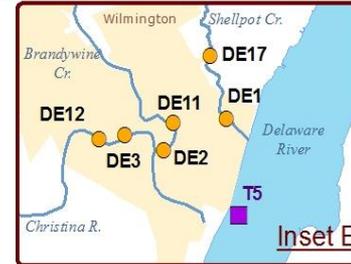
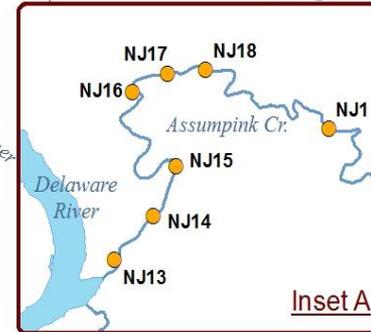
Chronic Toxicity Sampling Locations

- Delaware River Locations
- Tributary Locations



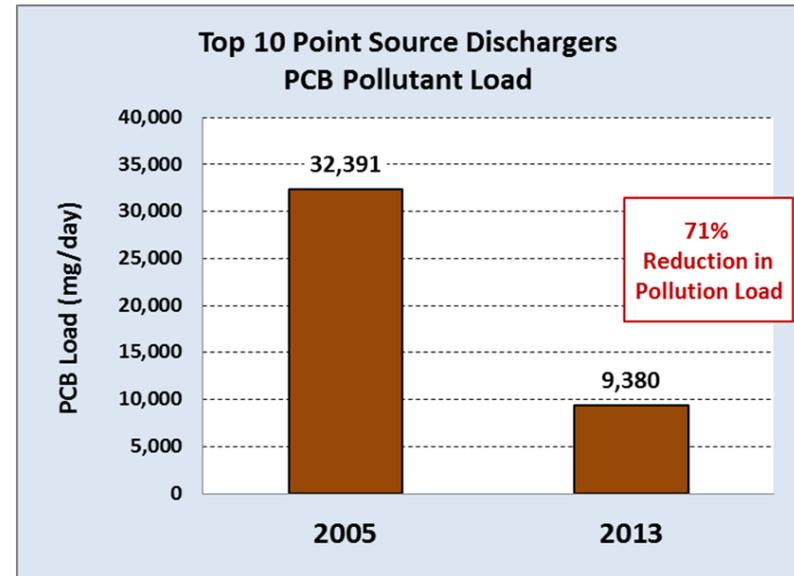
Surface Water Toxicity (survival, growth, reproduction)

- 1990 to present
- Mixtures
- Unknown contaminant
- Cumulative effects



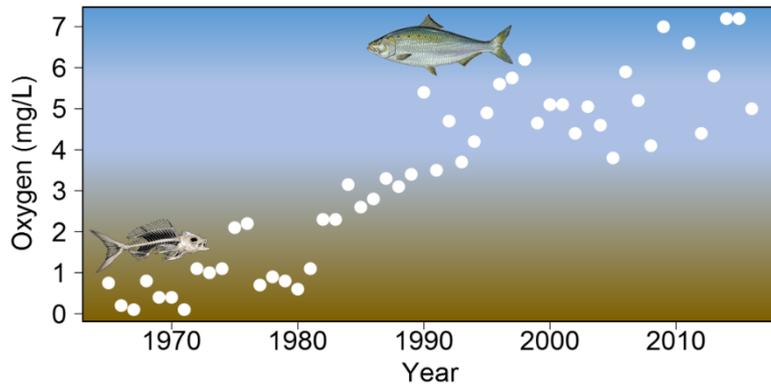
Polychlorinated Biphenyls (PCBs) Legacy Pollutant

- * **Problem:** Early 2000's ambient concentrations exceeding criteria by 2 to 3 orders of magnitude; Fish consumption advisories;
- * **Action:** DRBC developed TMDLs adopted by EPA in 2003 and 2006;
- * **Implementation:** Pollutant minimization plans – facilities identify and implement means of achieving maximum practicable reductions
- * **Status:**
 - 10 largest point sources reduced by over 70%
 - Nationally recognized program



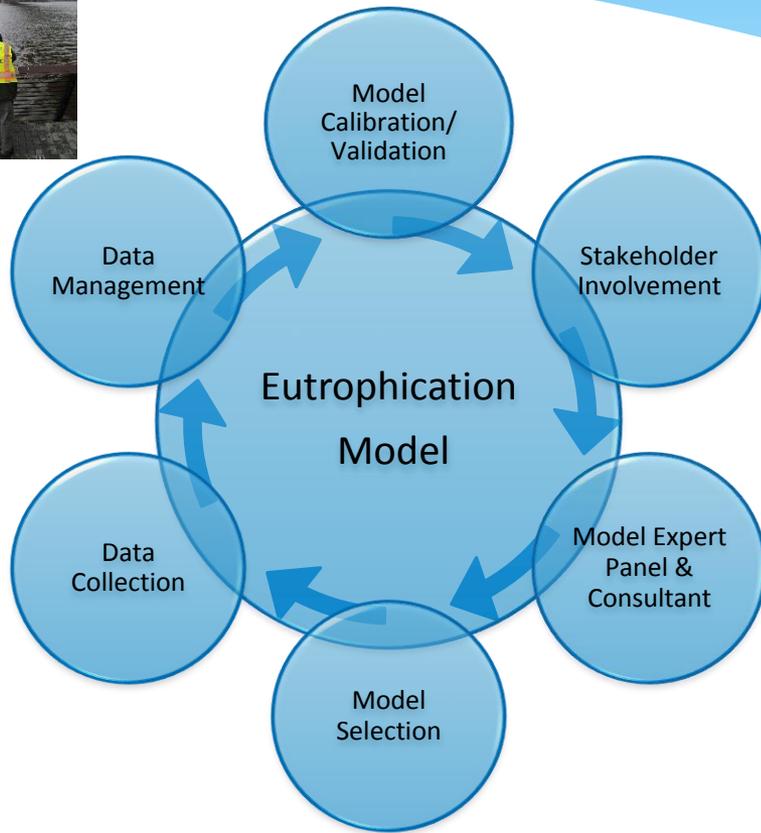
Dissolved Oxygen hypoxia and eutrophication model

July Oxygen at Ben Franklin Bridge

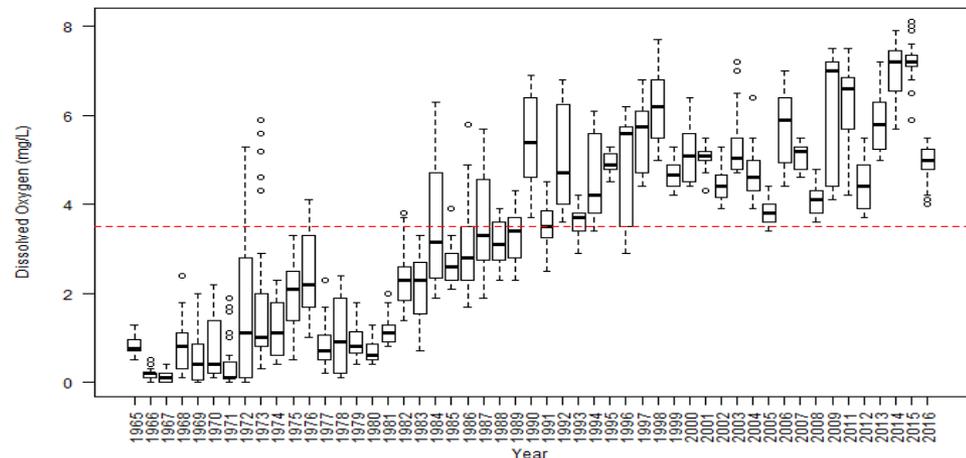


- * Improvement in DO levels in the Delaware River since 1965
- * Currently examining if current criteria for DO need revision to better protect fish reproduction

Modeling Eutrophication Processes in the Delaware Estuary to Link Watershed Efforts to Control Nutrient Impacts Environmental Management



July Dissolved Oxygen Daily Mean Values
USGS 01467200 Delaware R at Ben Franklin Bridge at Philadelphia



25 Years of Science-based Metals Policy

slide courtesy of Mary Reiley, USEPA
Criteria Development

Early 1980's Total Recoverable Metals

Not optimal but stable,
reproducible,
implementable
(USEPA 1985)

1985 Acid Soluble Metals

An acknowledged
improvement (USEPA
1985)

1993 Dissolved Metal Concentration

Base metals criteria on
bioavailable metal
(USEPA, 1993)

1994 Water Effect Ratios

Filled the chemistry
gap between lab and
ambient water
(Davies, 1994)

2007 Biotic Ligand Model

Accounts for the
variety of water
chemistry parameters
that impact metals
bioavailability
(USEPA, 2007)



Delaware River Basin Commission

DELAWARE • NEW JERSEY
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UNITED STATES OF AMERICA

EPA Aquatic Life Ambient Freshwater Quality Criteria – Copper 2007 Revision Biotic Ligand Model Based

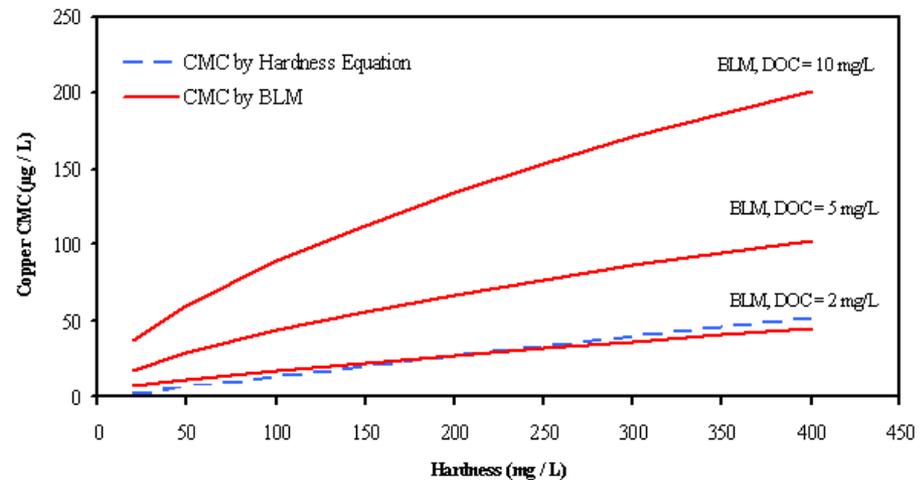
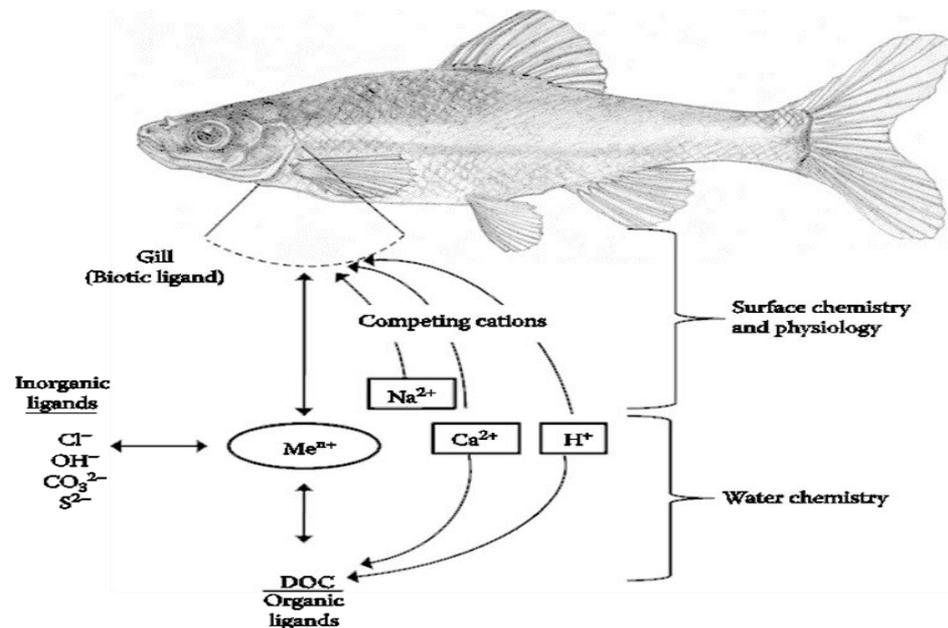


Figure 5. Comparison of CMC calculated by BLM or Hardness Equation Alkalinity (11 - 245 mg CaCO₃/L) and pH (7.3 - 8.7) Covary with Hardness

EPA-822-R-07-001 Feb 2007

Draft Estuarine/ Marine Copper Aquatic Life Ambient Water Quality Criteria July 2016

Factors that affect copper speciation

DOC

CO_3^{2-}

Cl^-

⋮

etc.

H^+

Cu^{2+}

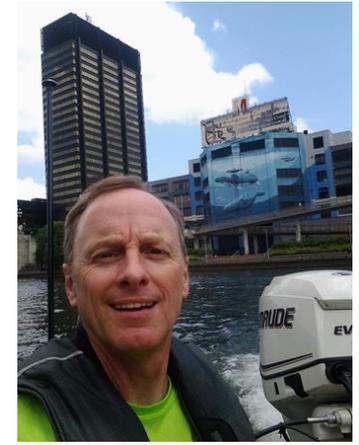
Ca^{2+}

Mg^{2+}

Competitive binding at biotic ligand



(Adapted from Santore et al. 2001).

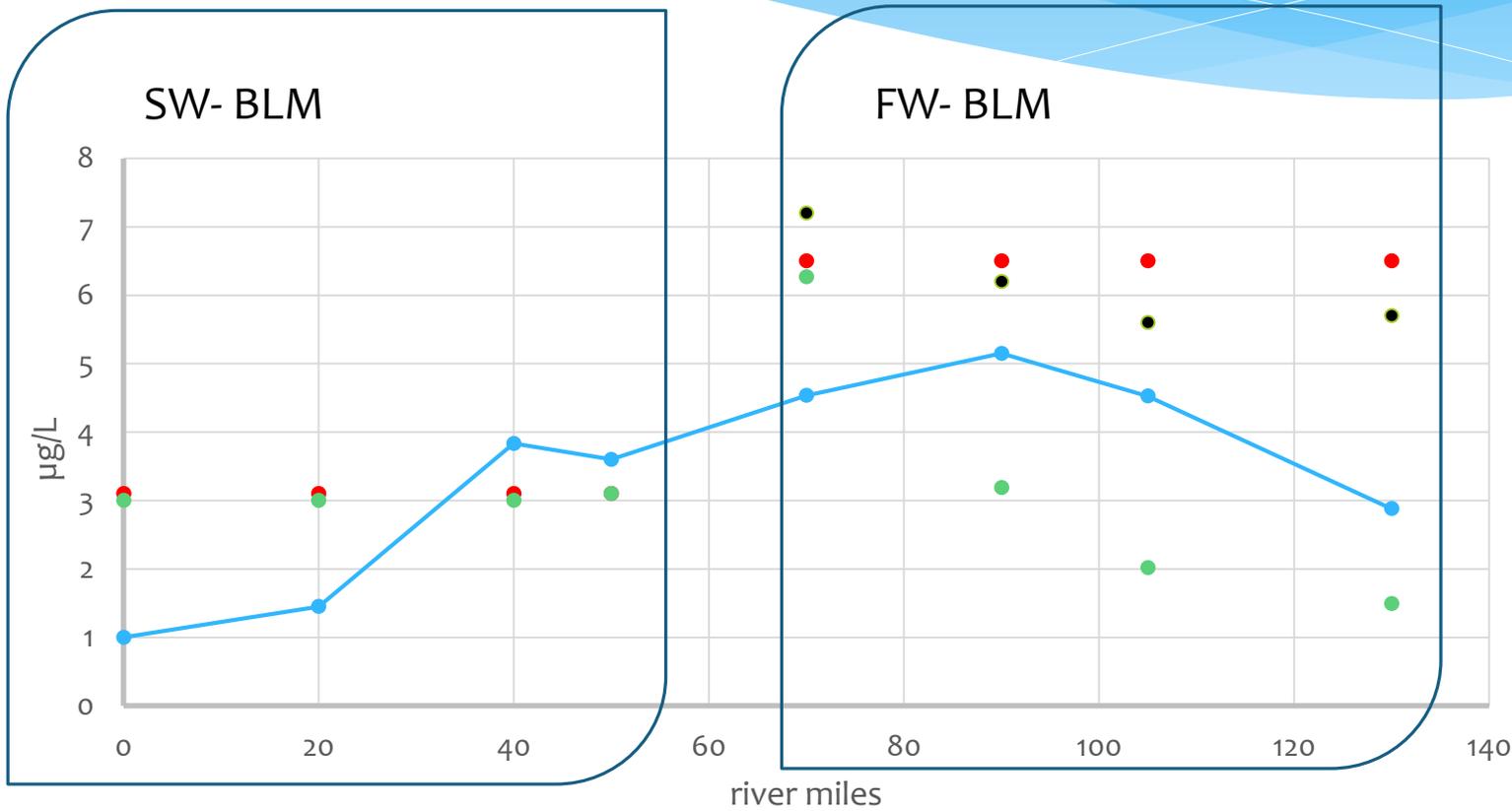


How would BLM based criteria be implemented?



Copper in tidal Delaware River and Bay

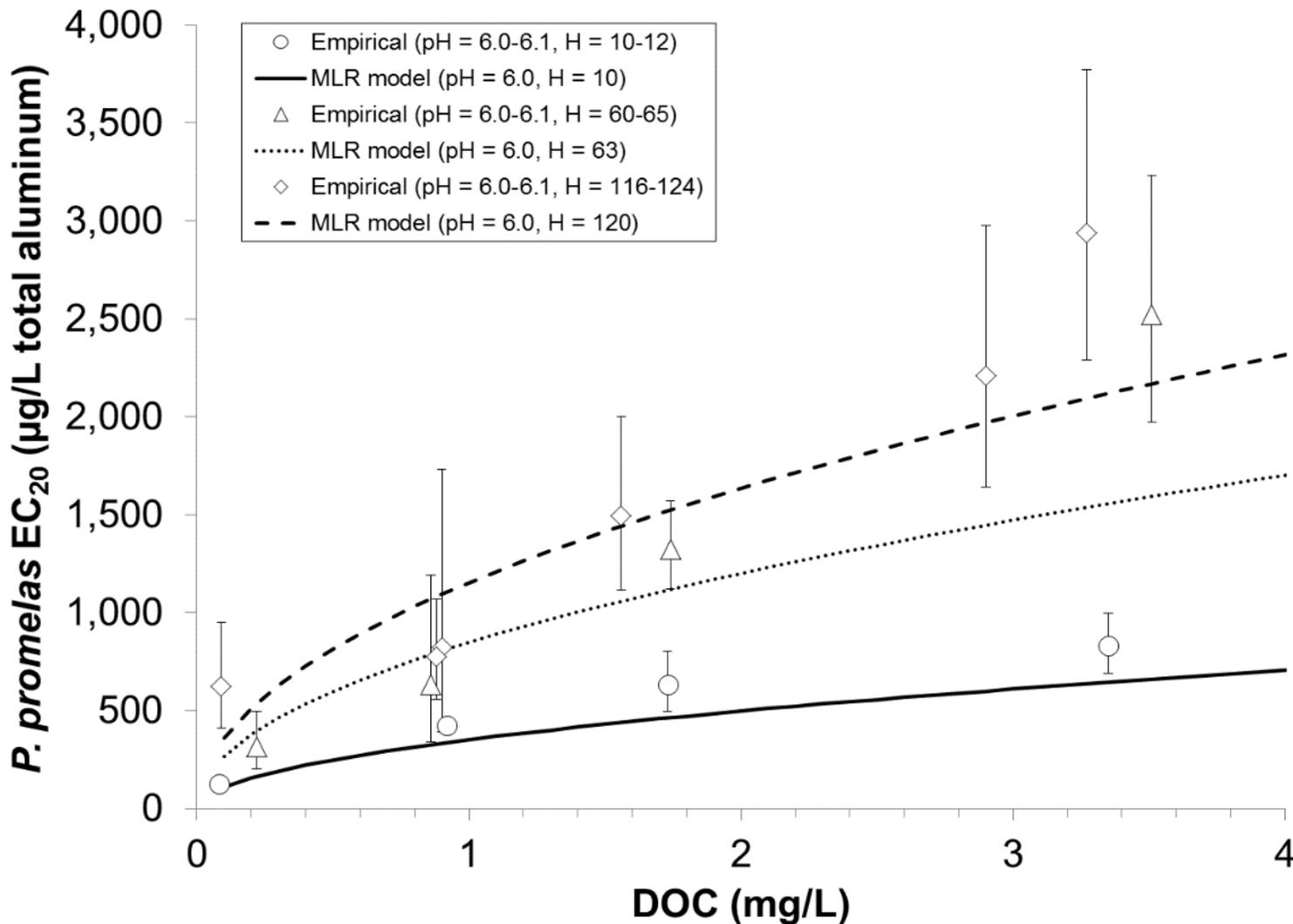
(illustrative and not for regulatory compliance)



● Ambient Cu, 95th % 2015-2016
 ● DRBC CCC
 ● BLM CCC
 ● CCC Sample Hardness

Multiple Linear Regression (MLR)

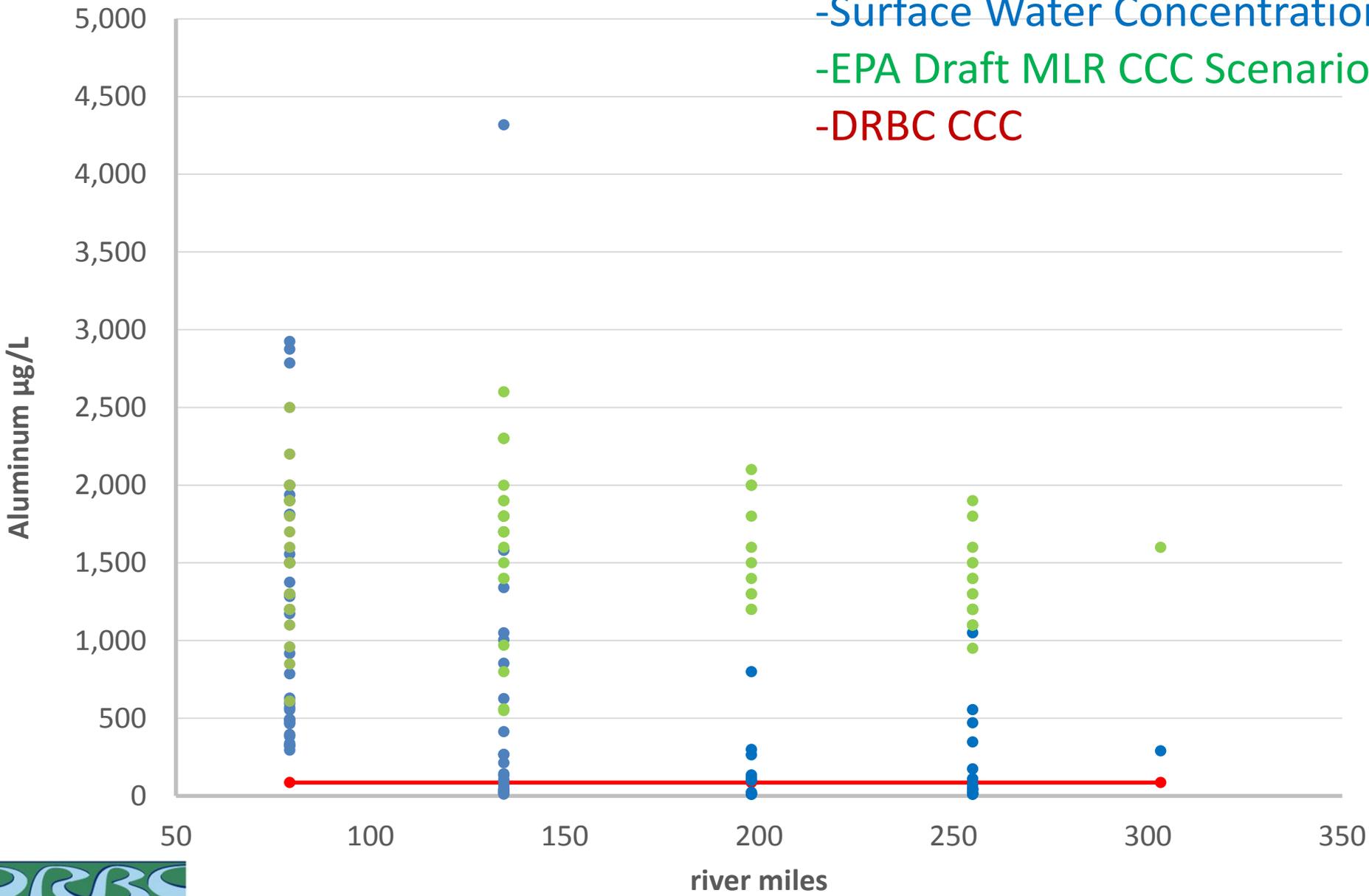
Observed and MLR-Predicted Aluminum EC₂₀s for *P. promelas* where DOC was Varied



Adapted from DeForest et al. 2017

Aluminum 2010 to 2015

- Surface Water Concentrations
- EPA Draft MLR CCC Scenarios
- DRBC CCC



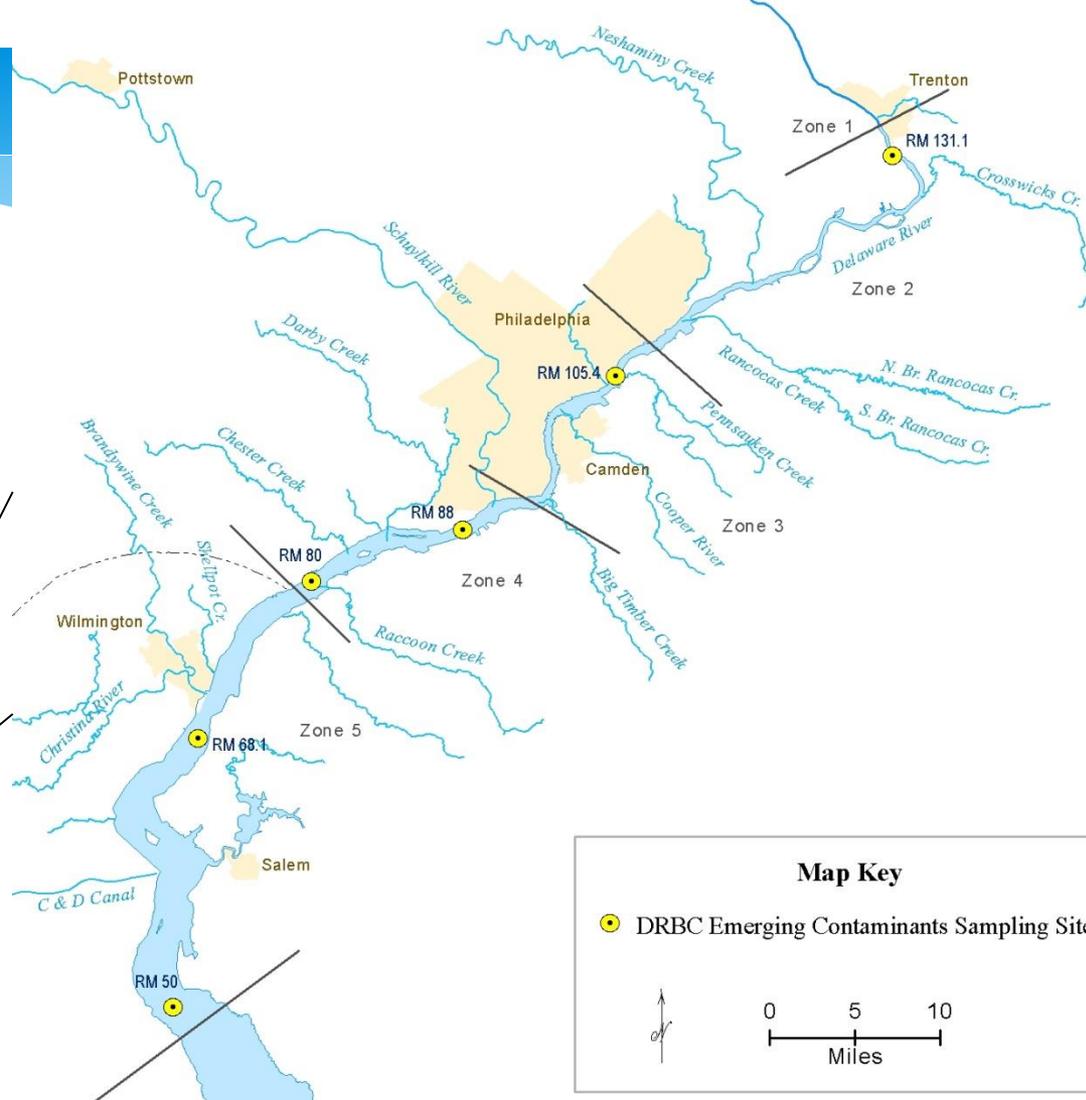
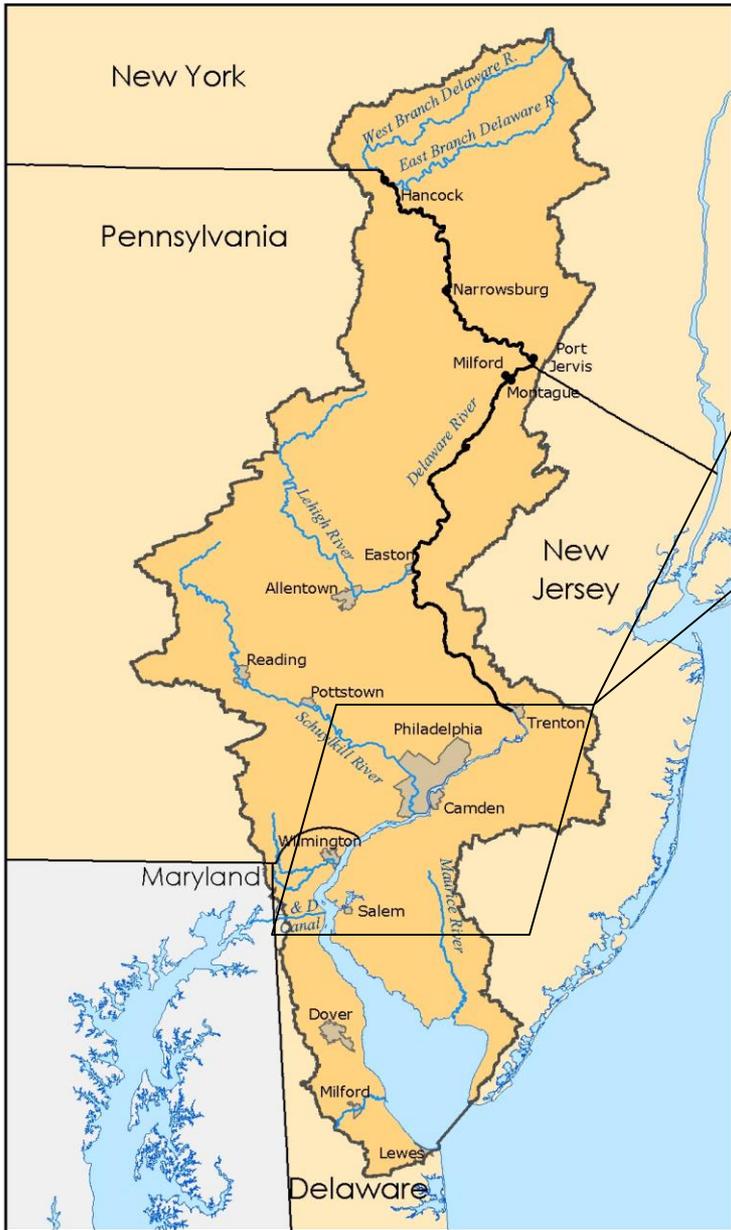
tidal



non-tidal

Illustrative and not for regulatory compliance

Delaware River Basin



PPCP occurrence surveys 2007,
2008, 2009
2017 (submitted for analysis)

PFAS Occurrence Surveys

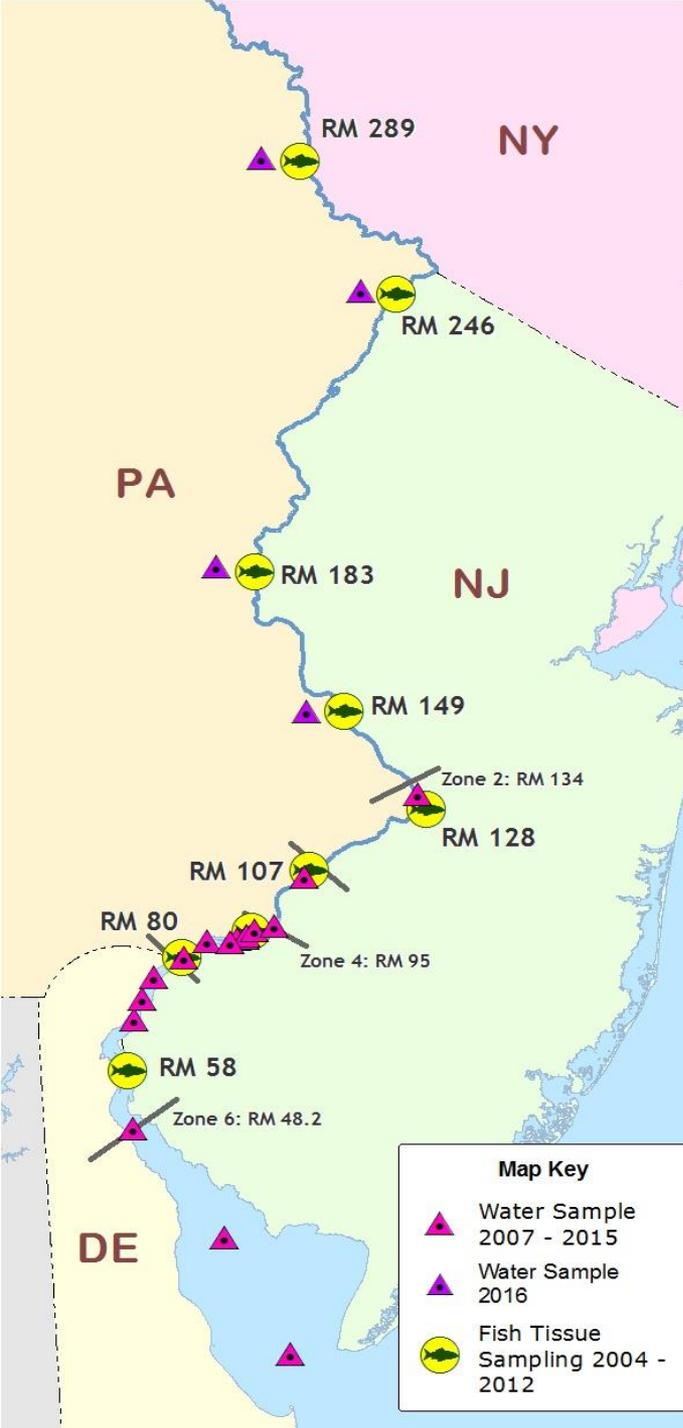
Surface Water Samples

Six tidal sites in 2007 - 2009

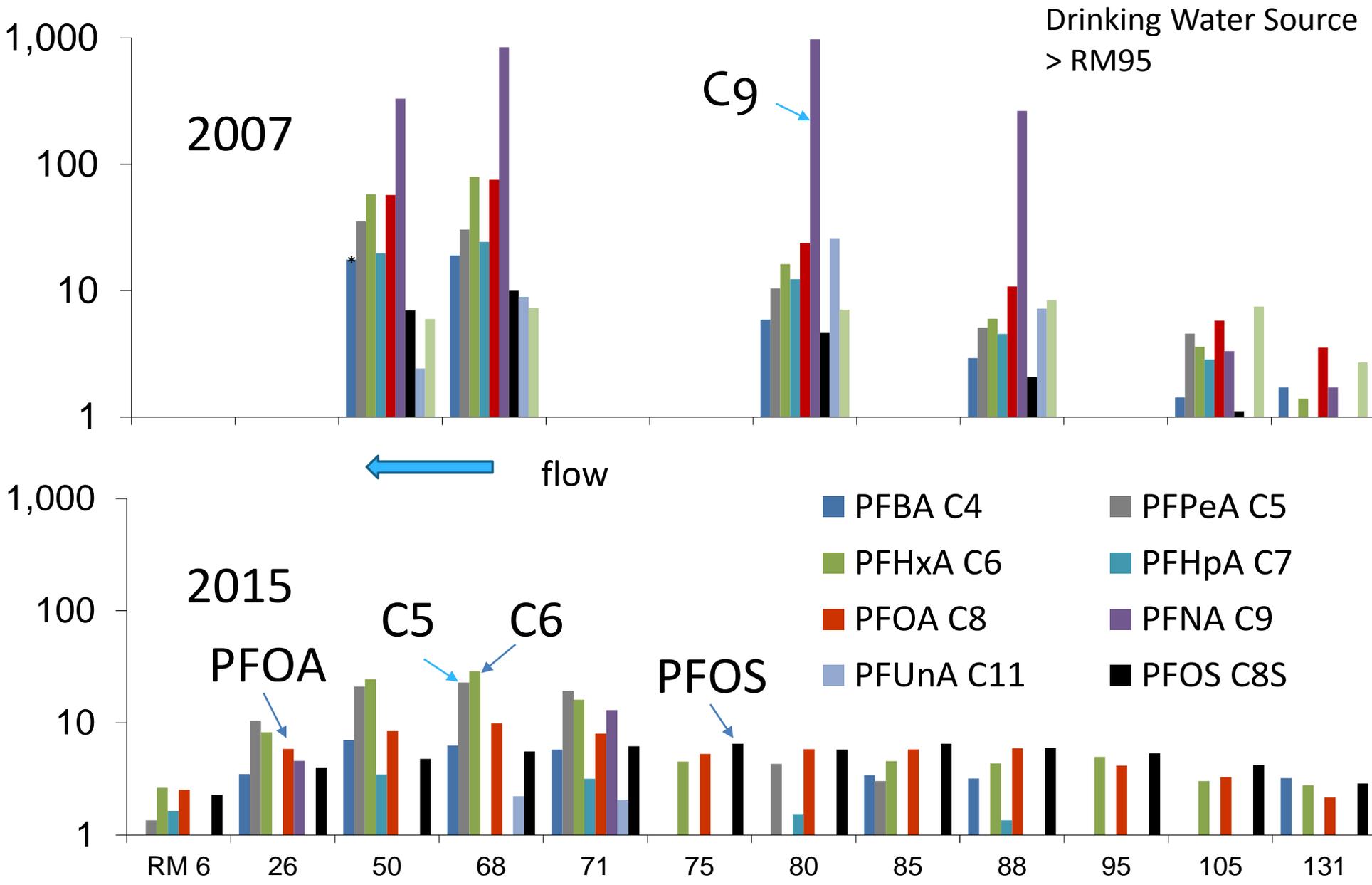
Fifteen tidal sites in 2015

Four non-tidal sites in 2016

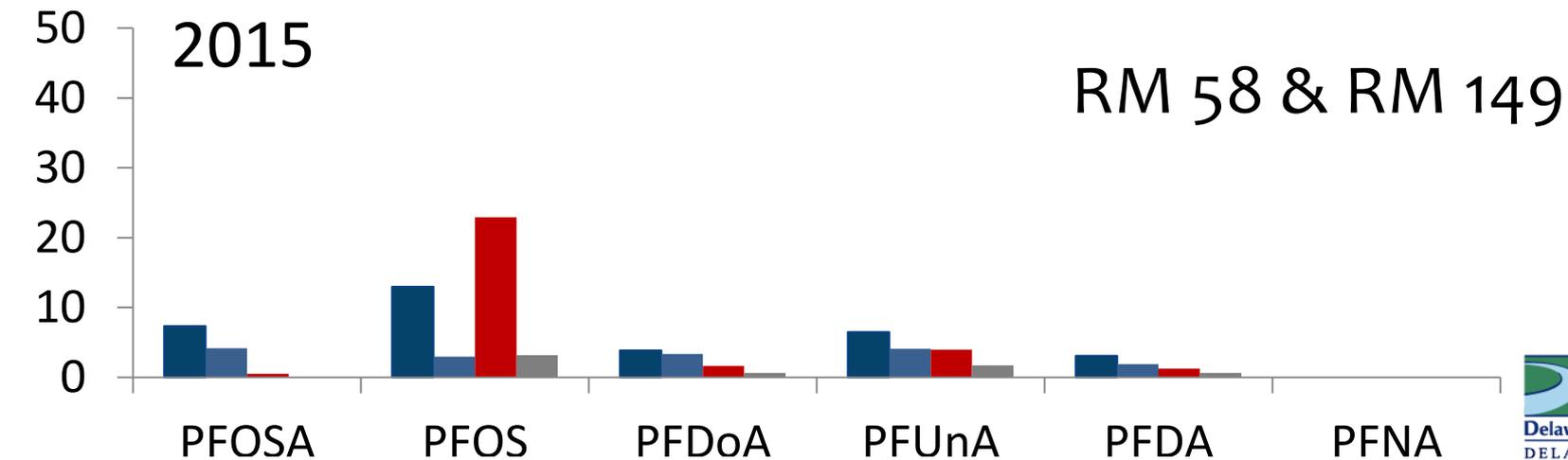
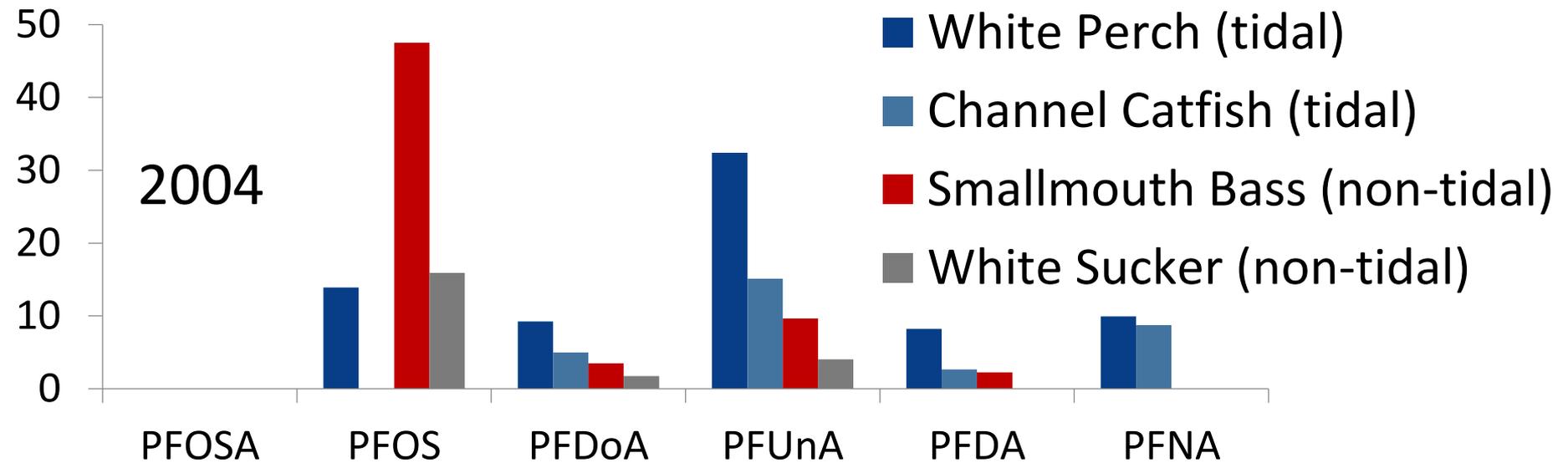
Fish Samples 2004 - 2015



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



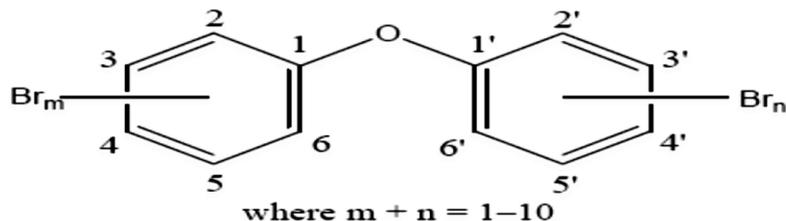
PFAS (ng/g) in fish fillet vary by species, location and year



Contaminants of Emerging Concern

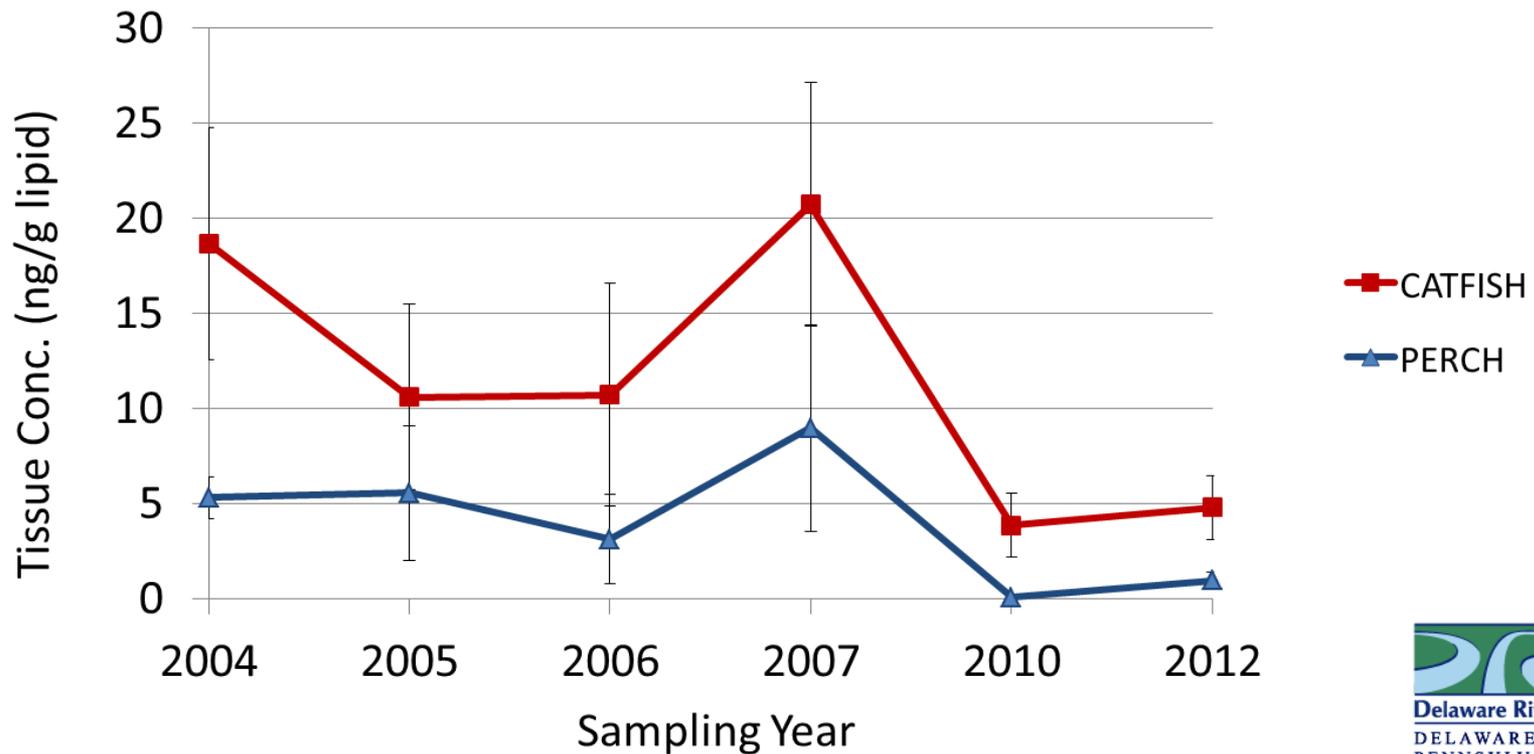
Why are Polybrominated Diphenyl Ethers (PBDE) Flame Retardants of Concern?

- * 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



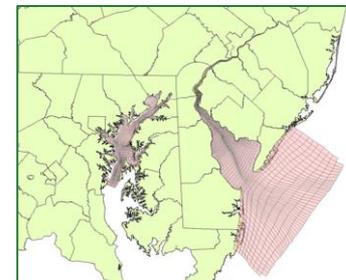
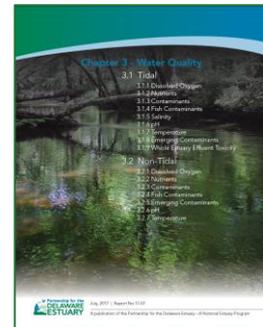
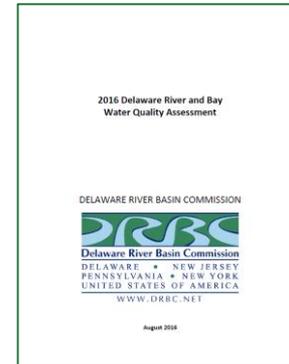
Polybrominated Diphenyl Ethers (PBDE) Flame Retardants

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



Delaware River and Bay Water Quality Data Uses

- * Delaware River & Bay Water Quality Assessment Report [Status]
- * State of the Estuary Report
 - Cooperation with Partnership for the Delaware Estuary (PDE) [Trends]
- * Model development (PCB TMDL and eutrophication) [Environmental Management]
- * Interactive data - Estuary Water Quality Explorer at <https://johnyagecic.shinyapps.io/BoatRunExplorer/> [Data Sharing]



Threats & Concerns

- * Increases in salinity, chlorides, conductivity (national problem);
- * Pharmaceuticals, personal care products, per and polyfluoroalkyl substances;
- * Gas development – Loss of headwater forests?

- * Monitoring to better understand the magnitude & frequency of problem (salts & emerging contaminants) and define baseline (gas);
- * Coordination with other agencies.

DRBC Science and Water Quality Management Staff

- * Thomas Fikslin
- * John Yagecic
- * Jacob Bransky
- * Ronald MacGillivray
- * Elaine Panuccio
- * Namsoo Suk
- * Gregory Cavallo
- * Li Zheng
- * Interns
 - * Andrew Garcia
 - * Julia Ragazzo



Questions?



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