PFAS in Surface Water, Sediment and Fish from the Delaware River

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Why was the DRBC created in 1961?

- 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
Emerging Contaminants
DRBC 2004 to 2018

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

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

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

Human Health Effects

- Monitored in blood serum general population (bind to protein)
- Association with liver damage, increased cholesterol, thyroid disease, decreased response to vaccines, asthma, decreased fertility and birth weight, pregnancy–induced hypertension/pre-eclampsia

Laboratory Animal

- Primary effects in lab animals are liver, developmental and immune toxicity

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

- Scientific understanding is evolving
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 using LC/MS/MS Method
- Analysis by SGS-Axys Analytical LTD

### Sulfonates and Sulfonamide

<table>
<thead>
<tr>
<th># of carbons</th>
<th>Compound Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Perfluorobutanesulfonate (PFBS)</td>
</tr>
<tr>
<td>6</td>
<td>Perfluorohexanesulfonate (PFHxS)</td>
</tr>
<tr>
<td>8</td>
<td>Perfluoroctanesulfonate (PFOS)</td>
</tr>
<tr>
<td></td>
<td>Perfluoroctane sulfonamide (PFOSA)</td>
</tr>
</tbody>
</table>

### Carboxylates

<table>
<thead>
<tr>
<th># of carbons</th>
<th>Compound Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Perfluorobutanoate (PFBA)</td>
</tr>
<tr>
<td>5</td>
<td>Perfluoropentanoate (PFPeA)</td>
</tr>
<tr>
<td>6</td>
<td>Perfluorohexanoate (PFHxA)</td>
</tr>
<tr>
<td>7</td>
<td>Perfluoroheptanoate (PFHpA)</td>
</tr>
<tr>
<td>8</td>
<td>Perfluorooctanoate (PFOA)</td>
</tr>
<tr>
<td>9</td>
<td>Perfluorononanoate (PFNA)</td>
</tr>
<tr>
<td>10</td>
<td>Perfluorodecanoate (PFDA)</td>
</tr>
<tr>
<td>11</td>
<td>Perfluoroundecanoate (PFUnA)</td>
</tr>
<tr>
<td>12</td>
<td>Perfluorododecanoate (PFDoA)</td>
</tr>
</tbody>
</table>
Surface Water Samples
Six tidal sites in 2007, 2008, 2009
Fifteen tidal sites in 2015
Four non-tidal sites in 2016
PFAS (ng/L) decreases in surface water vary by compound.

2007

C9

Drinking Water Source > RM95

2015

C5

C6

PFOA

PFOS
PFAS in sediment 2016 similar to other urban areas

Sediment surficial grab with Ponar.
Sampling Locations and Fish Species
2004 - 2015

Non-Tidal Locations
- Narrowsburg, NY, RM 290
- Milford, PA, RM 246
- Easton, PA, RM 183
- Lambertville, NJ, RM 149

Non-Tidal Fish Species
- Catosomus commersonni (white sucker)
- Mictopterus dolomieu (smallmouth bass)

Tidal Location
- Crosswicks Creek, RM 128
- Tacony-Palmyra Br., RM 107
- Woodbury Creek, RM 91
- Raccoon Creek, RM 80
- Salem River, RM 58

Tidal Fish Species
- Ictalurus punctatus (channel catfish)
- Morone americana (white perch)

Sample Design
Collected periodically by electrofishing or hook & line
Composite of five (5) fish of similar size of each species collected at each location (fillet)
PFAS (ng/g) in fish fillet vary by species, location and year.

Graph showing PFAS levels in fish fillet for the years 2004 and 2015.
Next Steps

Ongoing
Fish – 2018 collection with PFAS analysis

Recommended
Extend list of PFAS analytes (e.g., replacement compounds)

Surface Water
* Compile data from non-DRBC surveys in tidal river when available
* Deploy passive samplers in non-tidal river (seeking external funds),

Sediment
* Sample targeted non-tidal sites (seeking external funds)
Questions?

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