Per and Polyfluorinated Alkyl Substances (PFAS)

Sesha Kallakuri
Michigan Department of Health and Human Services
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PFAS

- Synthetic class of compounds
- About 4600 chemicals
- Well known and well studied – PFOA and PFOS
- PFOA – PerFluoroOctanoic Acid (1947 – 2002)
- PFOS – PerFluoroOctane Sulfonate (1949 – 2002)
Chain Lengths

**Short-chain**
- PFBS  $n = 4$
- PFPeS  $n = 5$

**Long-chain**
- PFHxS  $n = 6$
- PFHpS  $n = 7$
- PFOS/PFOA  $n = 8$

**Chemical Structures**
- **PFBS**
- **PFOS**
Characteristics

- Incredibly Stable
- Highly soluble and mobile
- Grease, soil and water-repellant properties
- Bioaccumulative in fish
Blood Levels of the Most Common PFAS in People in the U.S. from 2000-2014

* Average = geometric mean

Exposure to PFAS chemicals

- Drinking contaminated water
- Eating fish caught from water contaminated by PFAS
  - “Do Not Eat” Health Advisories
- Incidentally swallowing contaminated soil or dust
- Eating food packaged in materials containing PFAS
- Using some consumer products (i.e. non-stick cookware, treated fabrics)
- PFAS absorption through skin is negligible
Potential Associated Health Outcomes – PFOA and/or PFOS

**Humans**
- Lowering a woman’s chance of getting pregnant
- Increasing the chance of high blood pressure in pregnant women
- Increasing the chance of thyroid disease
- Increasing cholesterol levels
- Changing immune response
- Increasing chance of cancer, especially kidney and testicular cancers

**Animals**
- Developmental effects
- Reproductive effects
- Liver effects
- Endocrine effects (thyroid)
- Immune effects
- Tumors (liver, testicular*, pancreatic)

* PFOA only
Health Advisories

- No federal regulations
- Health Advisories for Drinking Water
  - **EPA Provisional Health Advisory**, 2009
    *Short-term adverse health effects*
    PFOS: 200 ppt
    PFOA: 400 ppt
  - **EPA Lifetime Health Advisory**, 2016
    *Long-term adverse health effects*
    PFOS + PFOA: 70 ppt
- Protective of unborn baby against developmental effects
- Protective of all against non-cancer and cancer effects
USEPA’s Lifetime Health Advisory

Illustrating the concept behind a Lifetime Health Advisory: Perfluorooctanoic acid (PFOA)

* Exact numbers have been generalized for illustration

ppt = Parts per trillion

- Lowest dose that causes an effect in rat pups: 6,000,000* ppt (1,000,000 ng/kg/day)
- Rodent to human conversion
- Human equivalent dose: 98,000 ppt (5,300 ng/kg/day)
- Human protections
- Dose that is safe in the most vulnerable people (like developing babies): 350 ppt (20 ng/kg/day)
- Accounting for other exposures in the environment
- Lifetime Health Advisory for PFOA in drinking water: 70 ppt (ng/L)
## MDHHS

### Public Health Drinking Water Screening Levels

<table>
<thead>
<tr>
<th>PFAS</th>
<th>Public Health Drinking Water Screening Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFOA</td>
<td>9 ppt (parts per trillion)</td>
</tr>
<tr>
<td>PFOS</td>
<td>8 ppt</td>
</tr>
<tr>
<td>PFHxS</td>
<td>84 ppt</td>
</tr>
<tr>
<td>PFNA</td>
<td>9 ppt</td>
</tr>
<tr>
<td>PFBS</td>
<td>1000 ppt</td>
</tr>
</tbody>
</table>
The Michigan Fish Consumption Advisory Program

Michigan Department of Health and Human Services

www.mi.gov/EatSafeFish.com
General Process For Consumption Guideline Development

**Sampling & analysis**
- Planning
- Fish collection (DNR/EGLE)
- Fish processing (filets)
- Analysis of filets (MDHHS Analytical Chemistry Laboratory)

**Data evaluation**
- Comparing fish tissue chemical levels to screening levels
- Additional considerations

**Issuing a guideline**
- Outreach products – ESF Guides and others (statewide and site-specific)
### Eat Safe Fish - Alpena

**Lake Besser**

<table>
<thead>
<tr>
<th>Type of Fish</th>
<th>Chemicals of Concern</th>
<th>Size of Fish (length in inches)</th>
<th>MI Servings per Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bullhead</td>
<td>Mercury</td>
<td>Any</td>
<td>4</td>
</tr>
<tr>
<td>Carp</td>
<td>PCBs</td>
<td>Any</td>
<td>6 Per Year²</td>
</tr>
<tr>
<td>Largemouth Bass</td>
<td>Mercury</td>
<td>Under 18”</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over 18”</td>
<td>1</td>
</tr>
<tr>
<td>Rock Bass</td>
<td>Mercury</td>
<td>Under 8”</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over 8”</td>
<td>2</td>
</tr>
<tr>
<td>Smallmouth Bass</td>
<td>Mercury</td>
<td>Under 18”</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over 18”</td>
<td>1</td>
</tr>
<tr>
<td>Walleye</td>
<td>Mercury</td>
<td>Under 20”</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over 20”</td>
<td>6 Per Year</td>
</tr>
</tbody>
</table>

Lake Besser
Lake Winyah (aka Seven Mile pond)
Thunder Bay River (main branch)
### Statewide Safe Fish Guidelines

- Based on typical amount of chemicals found in fish filets tested from around the state.
- Can be used for lakes, rivers, and fish species not included in the Eat Safe Fish Guide.

<table>
<thead>
<tr>
<th>Type of Fish</th>
<th>Chemical of Concern</th>
<th>Size of Fish (Length in Inches)</th>
<th>MI Servings per Month*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black Crappie</td>
<td>Mercury</td>
<td>Any Size</td>
<td>4</td>
</tr>
<tr>
<td>Bluegill</td>
<td>Mercury</td>
<td>Any Size</td>
<td>8</td>
</tr>
<tr>
<td>Carp</td>
<td>PCBs</td>
<td>Any Size</td>
<td>2</td>
</tr>
<tr>
<td>Catfish</td>
<td>PCBs &amp; Mercury</td>
<td>Any Size</td>
<td>4</td>
</tr>
<tr>
<td>Largemouth Bass</td>
<td>Mercury</td>
<td>Under 18”</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over 18”</td>
<td>1</td>
</tr>
<tr>
<td>Muskellunge (Muskie)</td>
<td>Mercury</td>
<td>Any Size</td>
<td>1</td>
</tr>
<tr>
<td>Northern Pike</td>
<td>Mercury</td>
<td>Under 30”</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over 30”</td>
<td>1</td>
</tr>
<tr>
<td>Rock Bass</td>
<td>Mercury</td>
<td>Any Size</td>
<td>4</td>
</tr>
<tr>
<td>Smallmouth Bass</td>
<td>Mercury</td>
<td>Under 18”</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over 18”</td>
<td>1</td>
</tr>
<tr>
<td>Suckers</td>
<td>Mercury</td>
<td>Any Size</td>
<td>8</td>
</tr>
<tr>
<td>Sunfish</td>
<td>Mercury</td>
<td>Any Size</td>
<td>8</td>
</tr>
<tr>
<td>Walleye</td>
<td>Mercury</td>
<td>Under 20”</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over 20”</td>
<td>1</td>
</tr>
<tr>
<td>White Crappie</td>
<td>Mercury</td>
<td>Any Size</td>
<td>4</td>
</tr>
<tr>
<td>Yellow Perch</td>
<td>Mercury</td>
<td>Any Size</td>
<td>4</td>
</tr>
</tbody>
</table>
- 20 deer were collected from near the Alpena sites
- Non-detect to very low levels of PFAS tested in deer meat
- Very little scientific information exists on whitetail deer and PFAS chemicals
- Additional testing and modeling studies to understand PFAS consumption in wildlife
- Baiting and feeding is banned in Alpena county
- [www.michigan.gov/eatsafegame](http://www.michigan.gov/eatsafegame)
Foam

Naturally occurring Foam

PFAS-containing Foam
Avoid Foam

- Foam may have high amounts of PFAS.
- Rinse off foam after contact. Rinsing in the lake or river is okay.
- Bathe or shower after the day’s outdoor activities.
- Touching the water is not a concern. Enjoy swimming, boating, and fishing.
- Incidental swallowing of foam with high levels of PFAS is a concern.
- Do not allow pets to drink foamy water.
- Rinse pets with fresh water after contact with foam to avoid swallowing PFAS that may be on their fur.
Risk Assessment of Foam

- Foam-to-liquid conversion factor
- Incidental ingestion rate (~ 1 tsp of liquid from foam/day)
- Body weight
- Skin surface area
- Available skin permeability coefficient (ability of chemical to cross the skin)
- Oral (incidental ingestion) + Dermal (whole-body contact)
- 2hrs/day (for oral), 3hrs/day (for dermal)
  5days/week for 12 weeks (i.e. Summer) on the lake shore
- Total exposure dose decreases with increase in age
- Hazard Quotient (HQ) = \[
\frac{\text{Total exposure dose}}{\text{Minimal Risk Level}}
\]

HQ < 1: no risk of adverse health effects
HQ > 1: Further evaluation of risk and PH actions such as advisories may be appropriate
### SW/Foam Results

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>Sample Date</th>
<th>PFOA</th>
<th>PFOS</th>
<th>Total PFAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>9th Ave Culvert</td>
<td>4/24/2018</td>
<td>3.62</td>
<td>4.53</td>
<td>55.89</td>
</tr>
<tr>
<td>Island Bridge</td>
<td>4/24/2018</td>
<td>1.19</td>
<td>12.8</td>
<td>21.529</td>
</tr>
<tr>
<td>Island Bridge (right bank)</td>
<td>4/24/2018</td>
<td>0.863</td>
<td>ND</td>
<td>4.393</td>
</tr>
<tr>
<td>3rd Ave &amp; Carter</td>
<td>4/25/2018</td>
<td>8.74</td>
<td>490</td>
<td>656.07</td>
</tr>
<tr>
<td>Island Bridge</td>
<td>4/5/2019</td>
<td>10.5</td>
<td>1060</td>
<td>1316</td>
</tr>
</tbody>
</table>

* Units in nanogram per liter (ng/L) or parts per trillion (ppt); 1 ng/L = 1 ppt
Additional Resources

- Michigan PFAS Action Response Team (MPART)
  www.michigan.gov/pfasresponse
- Environmental Protection Agency (EPA)
  www.epa.gov/pfas
- Agency for Toxic Substances and Disease Registry (ATSDR)
  https://www.atsdr.cdc.gov/pfas/