2020 RMP ANNUAL MEETING

PFAS in San Francisco Bay

Ezra Miller, PhD
About Me

• Joined SFEI as Liz
  – please don’t use this name anymore

• Pronouns: ze/zir
  “I saw Ezra’s talk at the Annual RMP meeting. Ze talked about PFAS, and also how to use zir pronouns.”
Los Angeles Times

California lawmakers vote to phase out toxic firefighting foam

By ANNA M. PHILLIPS | STAFF WRITER
AUG. 30, 2020 | 3:15 PM
What are PFAS?

Poly- and Perfluoroalkyl Substances

- Contain C-H bonds or other labile features
- Some can transform in the environment
- Not much data
- Regrettable substitution?
- Highly persistent in the environment

- No C-H bonds
- Not susceptible to biological breakdown
- More data
- Restricted production/use

Image Credit: Regenesis
### CECs in San Francisco Bay

<table>
<thead>
<tr>
<th>Concern Level</th>
<th>Harmful Substances</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Concern</strong></td>
<td>- None currently</td>
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<tr>
<td></td>
<td>- <strong>PFAS</strong></td>
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<tr>
<td></td>
<td>- Alkylphenols, Alkylphenol Ethoxylates</td>
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<tr>
<td></td>
<td>- Fipronil, Imidacloprid, Bisphenols</td>
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<tr>
<td></td>
<td>- Organophosphate Esters, Microplastics</td>
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<tr>
<td><strong>Moderate Concern</strong></td>
<td>- PBDEs and HBCD</td>
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<td>- Pharmaceuticals, Pyrethroids*</td>
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<td>- Personal Care &amp; Cleaning</td>
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<td></td>
<td>- PBDDs / PBDFs</td>
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<tr>
<td><strong>Low Concern</strong></td>
<td>- Alternative Flame Retardants</td>
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<td></td>
<td>- Pesticides, Plastic Additives, QACs</td>
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<td></td>
<td>- Siloxanes, SDPAs, UV-BZTs, others</td>
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<tr>
<td><strong>Possible Concern</strong></td>
<td>- Uncertainty as to impact</td>
</tr>
</tbody>
</table>
PFAS in Aquatic Animals

**BIOACCUMULATION**
- PFOS widely observed, others typically at lower levels
- Concentrate in blood, brain, liver, other organs
  - Distributions vary by species due to differences in metabolism/excretion
- Maternal transfer to eggs, offspring

**TOXICITY**
- Most studies on PFOS, PFOA
  - Effects vary with chain length, functional groups, species, sex
- Diverse modes of action
  - Reproduction, development, metabolism, growth
- Sensitive species
  - Marine mammals, birds
PFAS Ecotoxicity Thresholds and

HISTORIC BAY DATA
PFAS in SF Bay Water

Last monitored in winter 2009/2010
- 13 PFAS + 4 PFOS precursors
- PFOA detected in highest concentrations

New! California Environmental Screening Levels (ESLs) for Water
- For ecotoxicity:
  - PFOS: 75 ng/L
  - PFOA: 4,400 ng/L
- For human health (seafood ingestion):
  - PFOS: 0.0047 ng/L
  - PFOA: 0.022 ng/L
PFOS in SF Bay Fish

SF Bay small (prey) fish: up to 240 ng/g ww
SF Bay sport fish: up to 17 ng/g ww (fillets)

State Fish Consumption Advisory Levels

Minnesota:
do not eat if > 200 ng/g
unlimited meals, < 10 ng/g ww

Michigan:
for 4 meals/month, < 38 ng/g ww
16 meals/month, < 9 ng/g ww

New Jersey:
for 1 meal/month, < 17 ng/g ww
unlimited meals, < 0.56 ng/g ww
Developmental Toxicity in Birds

Egg hatching success
PFOS:
- 3M sponsored lab study toxicity threshold
  PNEC: 1,000 ng/mL yolk \(^{(}\text{Newsted et al. 2005})\)
- Field study of tree swallows suggested reduced hatching above 150 ng/g ww; not seen in follow-up \(^{(}\text{Custer et al. 2012, 2019})\)
- Canada Federal Tissue Quality Guideline for Bird Eggs: 1,900 ng/g ww

PFOA and other long-chain carboxylates:
Lab studies show similar toxic impacts, potency
PFAS in SF Bay Bird Eggs

PFOS Levels Suggest Potential Risk

Impacts not considered:
- Neurodevelopment
- Immune system
- Heart rate
- Lipid metabolism (especially important for migratory birds)
Impacts in Marine Mammals

- PFAS linked to alterations of thyroid homeostasis in polar bears (Nilsen et al. 2011)
- Atlantic bottlenose dolphins with high PFAS exposure exhibit changes in cell proliferation, signaling, and response (Fair et al. 2013)
  - State of chronic immune activation, susceptible to disease
- PFOA and PFOS in California sea otters associated with infection (Kannan et al. 2006)
- PFNA and PFDA linked to changes in liver lipid and carbohydrate metabolism enzymes in wild Baikal seals (Ishibashi et al. 2008)
  - Similar levels in SF Bay seals
What’s next?

ONGOING AND FUTURE RMP WORK
Stormwater (ongoing)

UPCOMING WORK
• 2019 sport fish data coming soon!
• Sport fish – 2024
• Bay water – 2021
• Bird eggs – 2021
Response to State Water Board Investigation Orders

• Monitoring required at POTW facilities >1 MGD
  – Quarterly monitoring of influent, effluent, ROC, and biosolids

• Region 2 will conduct a regional study
  – Phase 1: Monitor up to 15 facilities (Q4 2020)
  – Phase 2: Additional monitoring to support evaluation of PFAS occurrence, trends, and/or source identification

• [https://www.waterboards.ca.gov/pfas/](https://www.waterboards.ca.gov/pfas/)
Uncertainties: Occurrence and Impacts of Many More PFAS, Alone and in Mixtures

Fluorine mass balance
• PFOS dominates but…
• Dozens more PFAS are present, including many not routinely measured

Are Bay animals exposed to unexpected PFAS?

(Spaan et al. 2019)
PFAS are widespread in SF Bay food web

- PFOS is most abundant
- May pose risks to wildlife, though levels are declining

Occurrence and impacts of many other PFAS and mixtures unknown

SF Bay Study Priorities:
- Stormwater, wastewater monitoring
- Bay water, fish, bird egg monitoring
PFAS in Your Life

- Microwave popcorn
- Fast food packaging
- Cosmetics
- Nonstick cookware
- Baby bibs
- Sprayable stain protectors
- Stain-resistant carpets, rugs, and furniture
- Outdoor gear with “durable water repellent” coating
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Useful Resources for the General Public

saferchemicals.org/get-the-facts/toxic-chemicals
ewg.org/avoidpfas
toxicfreefuture.org/key-issues/chemicals-of-concern
Questions?

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