Emerging Contaminants: Tackling Tomorrow’s Problems, Today

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What are emerging contaminants?

Wilson and Schwarzman 2009
RMP CEC Strategy: Three Elements

1. CEC monitoring, evaluating risk

2. Sharing expertise, learning from others

3. Non-targeted monitoring (bioassays, broadscans)
**Tier 4**
High Concern

**Moderate or High Impact**

- PFOS
- Fipronil
- Nonylphenol
- PBDEs

**Tier 3**
Moderate Concern

**Low Impact**

- HBCD
- Pyrethroids*
- Pharmaceuticals
- Personal Care Product Ingredients
- PBDDs and PBDFs

**Tier 2**
Low Concern

**No Impact**

- Alternative Flame Retardants
- Fluorinated Chemicals
- Pesticides, Plasticizers
- Many others

**Tier 1**
Possible Concern

**Unclear**
PBDEs
Polybrominated diphenyl ethers
Why add flame retardants?

To meet California Bureau of Home Furnishings flammability standards

PBDEs added to foam, plastics, fabrics
PBDEs: SF Bay Hot Spot

Bay harbor seal PBDE levels doubled every 1.8 years

She et al. 2002
PBDEs: Bans & Phase-outs

US phase-out 2004, California ban 2006

US phase-out 2013
Strong signs of recovery for Bay
Flame Retardant Problem Persists

Manufacturers replace PBDEs with Alternative Flame Retardants
What are Alternative Flame Retardants?

Global consumption to reach 5.2 billion pounds by 2018
(BCC Research 2013)

Bis(2-ethylhexyl)-2,3,4,5-tetrabromophthalate (TBPH or BEH-TBP) 2-ethylhexyl-2,3,4,5-tetrabromobenzoate (TBB or EH-TBB) Tris(1,3-dichloro-2-propyl) phosphate (TDCPP or chlorinated tris) Tris(1-chloro-2-propyl) phosphate (TCP) Triphenyl phosphate (TPhP) Ethylene bis-tetrabromophthalalimide (EBTEBP) 1,2-dibromo-4-(1,2-dibromoethyl)cyclohexane (DBE-DBCH or TBECH) Dechlorane 602 Tributyl phosphate (TBP) Pentabromoethylbenzene (PBEB) Decabromodiphenyl ethane (DBDPE) Bis(2,4,6-tribromophenoxy)ethane (TBPE) Hexabromobenzene (HBB) Tetrade cabromodiphenoxybenzene (TDBDPB) Tetrabromobisphenol A (TBBPA) Isopropylated triaryl phosphate isomers (particularly mono-ITP) Tripropylphosphate (TPrP) V6 organophosphate: 2,2-bis(chloromethyl)trimethylene bis[bis(2-chloroethyl)phosphate] Hexabromocyclododecane (HBCD) Dechlorane Plus (DP); Bis(hexachlorocyclopentadieno)cyclooctane Dibutyl chlorendate Resorcinol bis-diphenylphosphate Bisphenol A bis-(diphenyl phosphate) (BAPP) 9,10-Dihydro-9-oxa-10-phosphaphenanthen e-10-oxide (DOPO) Tris(2-chloroethyl) phosphate (TCEP) Tris(2-butoxyethyl) phosphate (TBEP) Tris(2,3-dibromopropyl) phosphate Tricresyl phosphate 2-Ethylhexyl-diphenyl phosphate Tris(2-bromo-4-methylphenyl) phosphate Tris(2-ethylhexyl) phosphate Tris(tri bromoneopentyl) phosphate Bis(2-chloropropyl) 2-chloro-1-methyl ethyl phosphate Isopropyl diphenyl phosphate Tri(t-butylphenyl) phosphate Tris(4-butylphenyl) phosphate (TBPP) Tris(2-chloropropyl)phosphate Tris(isobutylphenyl) phosphate Phosphoric acid, mixed 3-bromo-2,2-dimethylpropyl and 2-bromoethyl and 2-chloroethyl esters Tetrabromobisphenol A-bis(2,3-dibromopropylether) (TBBPA-DBPE) Tetrabromobisphenol A dihydroxyethyl ether (TBBPA-DHEE) Tetrabromobisphenol A bis(allyl ether) (TBBPA-BAE) Carbonic dichloride, polymer with 4,4'- (1-methylthylidine)bis [2,6-, 6-dibromophenol] and phenol tetrabromobisphenol related. Polymeric – tetrabromobisphenol-A carbonate oligomer, phenoxy end capped - BC-52 (Great lakes) N,N'-ethylenebis[4,5-dibromohexahydro-3,6-methanophthalimide] Octabromo-1,3,3-trimethyl-1-pheny lindane (OBIND) 1,2,3,4,5-Pentabromo-6-chlorocyclohexane (PBCC) Hexachlorocyclopentadienyl dibromocyclooctane (HCDBCO) Tris(tetrabromophenoxy) triazine (TBPT) Melamine Cyanurate Melamine Polyphosphate Phosphonate Oligomer/Polyphosphonate Poly[phosphonate-co-carbonate] Benzene, 1,1'-(1,2-ethanediylbis(oxy))bis [2,3,4,5,6-pentabromo- 1,2-Benzenedicarboxylic acid, 3,4,5,6-tetrabromo-, 2-(2-hydroxyethoxy)ethyl2-hydroxypropyl ester (e.g. Diester/ether diol of tetrabromophthalic anhydride) (E)-N,N'-bis(2,4,6-tribromophenyl)but-2-enediamide Di-2-ethylhexyl chlorendate 2,4,6-tribromophenyl allyl ether (ATE) Pentabromotoluene PBT Tetrabromophthalic anhydride (TPA) 2-(2-Hydroxy ethoxy)ethyl 2-hydroxypropyl- 3,4,5,6-tetrabromophthalate Tris(2,3-dibromopropyl) isocyanurate (TBC) 1,2,5,6-Tetrabromocyclooctane (TBCO) Dechlorane 604 Dechlorane 603
Changing the Rules

California Bureau of Home Furnishings

- TB117-2013: New standard for foam furniture, exemptions for baby products
- SB 1019: Furniture labeling law

Mark Leno, San Francisco State Senator
PFOS
Perfluorooctane sulfonate
What are perfluorochemicals?

Widely used stain and water repelling coatings

Carpets & furniture
Cookware
Food packaging
Clothing
PFOS in the Bay

PFOS in harbor seal blood (parts per billion)

Ahrens et al. 2009
Giesy and Kannan 2001
PFOS in the Bay

South Bay
Harbor seals
PFOS in Serum

Seal Serum Result in ng/g or ng/mL

PFOS

2004 to 2008
2009 to 2012
2014

TIER 3
MODERATE CONCERN
Replacements head to Bay: Wastewater

- PFPeA
- PFBA
- 8:2 diPAP
- 6:2 diPAP
- PFDA
- PFNA
- PFOA (phased out)
- PFOS (phased out)
- PFHxDA
- PFHxS
- PFHpA
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Non-targeted Monitoring: A Broad Scan

HARBOR SEAL BLUBBER

CHEMICALS NEWLY IDENTIFIED AS CONTAMINANTS IN SAN FRANCISCO BAY WILDLIFE

MUSSELS

2,2'-dichlorobenzil

Dyes, Coatings, Plastics (Limited Use)

4-tert-butylamphetamine*

Derived from Amphetamine

9,10-dichloroanthracene

and another similar dichloroanthracene*

Produced During Combustion

methyl triclosan*

Derived from Triclosan Antibacterial Ingredient Common in Liquid Hand and Dish Soap, Personal Care Products, and Other Consumer Goods
CECs: Eyes on the Horizon
Thank you