Bioaccumulation of Contaminants of Emerging Concern in San Francisco Bay

Presentation at Bioaccumulation Symposium
December 17th, 2012
Meg Sedlak, Jay Davis, and Don Yee
The Universe of CECs to Monitor

INDUSTRIAL CHEMICALS: ~ 84,000

PHARMACEUTICALS: ~3,000
PESTICIDES: ~1,000
COSMETIC AND ADDITIVES: ~3,000
FOOD ADDITIVES: ~9,000

Muir and Howard 2006
CECs Evaluated to Date in Biota

- Pharmaceuticals and personal care products (mussels)
- Alkylphenol ethoxylates (mussels/ small fish/ bird eggs)
- Single-walled carbon nanotubes (mussels)
- Perfluorinated compounds (PFCs)
- Polychlorinated biphenyls (PCBs)
- Polybrominated diphenyl ethers (PBDEs)
- Alternative flame retardants
Tiered Prioritization

- Tier IV: High Concern
  - PFOS
  - Nonylphenols
  - PBDEs

- Tier III: Moderate Concern
  - PPCPs
  - Pyrethroids

- Tier II: Minimal Concern
  - Fipronil

- Tier I: Unknown Concern
  - Many Other Chemicals
PFOS

• Use
  – Wide variety of applications
  – Withdrawn from US market in 2002
  – Large reservoir from historic use and precursors

• Toxic
  – Developmental toxicity, compromised immune systems, and endocrine disruptor

• Detected in Bay seals, bird eggs, small fish, bivalves and sport fish
Monitoring Bay Seals
PFOS in Seals

Source: Sedlak and Greig 2012 JEM
Limited Tox Data for Seals

• Suppression of immune systems
  – CA Sea Otter
    • Higher incidence of disease (Kannan et al. 2006)
  – Rats
    • Significantly higher mortality in rats infected with influenza at environmentally relevant concentrations of PFOS (Gurunge et al. 2009)

• Adverse neonatal outcomes
  – Humans
    • Reduced body weight and head circumference (Apelberg et al. 2007)
Monitoring Cormorants
PFOS in Bird Eggs

Predicted No Effects Concentration

Conc (ng/g ww)

- Wheeler Island
- Richmond Bridge
- Don Edwards

Suisun Bay
- Central Bay
- South Bay

2006
2009
PFOS in Bird Eggs

- Faroe Island
- Lake Huron
- Artic Norway
- Baltic Sea
- Manitoba
- Lake Winnipeg
- SF Bay WI
- SF Bay DE
- SF Bay RB
- Northern Fulmar
- Ring-billed gull
- Glaucous gull
- Guillemot
- Double-crested Cormorant
PFOS in Small Fish

San Francisco Bay
Low Accumulation in Bivalves

Source: Dodder et al. 2012. Submitted. Occurrence of contaminants of emerging concern in mussels (Mytilus spp.) along 1 the California coast and the influence of land use, storm water discharge, and 2 treated wastewater effluent.
QUANTIFYING CECs 2012

PFC Special Study Sampling Sites

- Bird Eggs: 9
- Fish: 31
- Seal Serum: 41
- Sediment: 12
- Water: 20

CDFG Site 244, CDFG Site 216, Castro Rocks, CDFG Site 106, CDFG Site 102, CDFG Site 101, CDFG Site 140, Corkscrew Slough, Cooley Landing, Mowry Slough, Alviso Slough
PBDEs – A Success Story?

- Widely used and widely detected
- Phase-out of Penta and Octa in 2006; Deca by 2013
- Dramatic decline in Bay Biota
  - Cormorant eggs
  - Bivalves
  - Tern eggs
  - Sportfish
- Summary paper out Q1 2013
PBDEs in Bivalves

![Graph showing PBDEs in bivalves]

- **Rivers**
- **San Pablo Bay**
- **Central Bay**
- **South Bay**
- **Lower South Bay**

**PBDE 47**

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**Graph Details:**
- **Y-axis:** ng/g dw
- **X-axis:** Years (2002 to 2010)
- **Legend:** Graphs for different regions over time.
# Alt. Flame Retardants

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Chris Werme article
Alt Flame Concentrations << than PBDEs

Adult seals

ng/g lipid

PBEB  Dechlorane Plus  HBCD  PBDEs
Bay Concentrations Generally Lower

Chlorinated Paraffins in San Francisco Bay Wildlife

ng/g wet weight

Yellow Perch Detroit River
Beluga whale blubber Arctic
Ringed seal blubber Arctic
Carp Detroit River
Lake trout Lake MI
Harbor seal blubber SF Bay
Lake trout Lake Ontario
Cormorant eggs SF Bay
White croaker SF Bay

5 <0.9
Alternative Approaches to ID CECs

Courtesy of Dr. John Kucklick, NIST
## Chlorinated Compounds

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<th>Compound</th>
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<td>605-48-1</td>
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**Chemical Structures:**

- **Dichlorodiphenylsulfone**
- **Hexachlorofulvene**
- **Dichlorobenzil**
- **Dichlorobenzophenone**

*On Howard and Muir List*
Findings

• We are detecting CECs at low concentrations in Bay Biota
• We lack an understanding of the effects of long term exposure of CECs to Bay Biota
• We lack an understanding of life cycles of Bay Biota
• It is important to choose the right species to monitor
Thanks!

• EC Workgroup Advisory Panel
• Richard Grace and AXYS Analytical
• Heather Stapleton, Duke University and Mark LaGuardia, VIMS
• Denise Greig, formerly of The Marine Mammal Center
• Josh Ackerman and Colin Eagles-Smith, USGS
• Kathy Hieb and Max Fish, CDFG
Questions? Dive in!

- Reports, data download, presentations: [www.sfei.org/rmp](http://www.sfei.org/rmp)

- Or contact me – meg@sfei.org

900,000 Data Points