

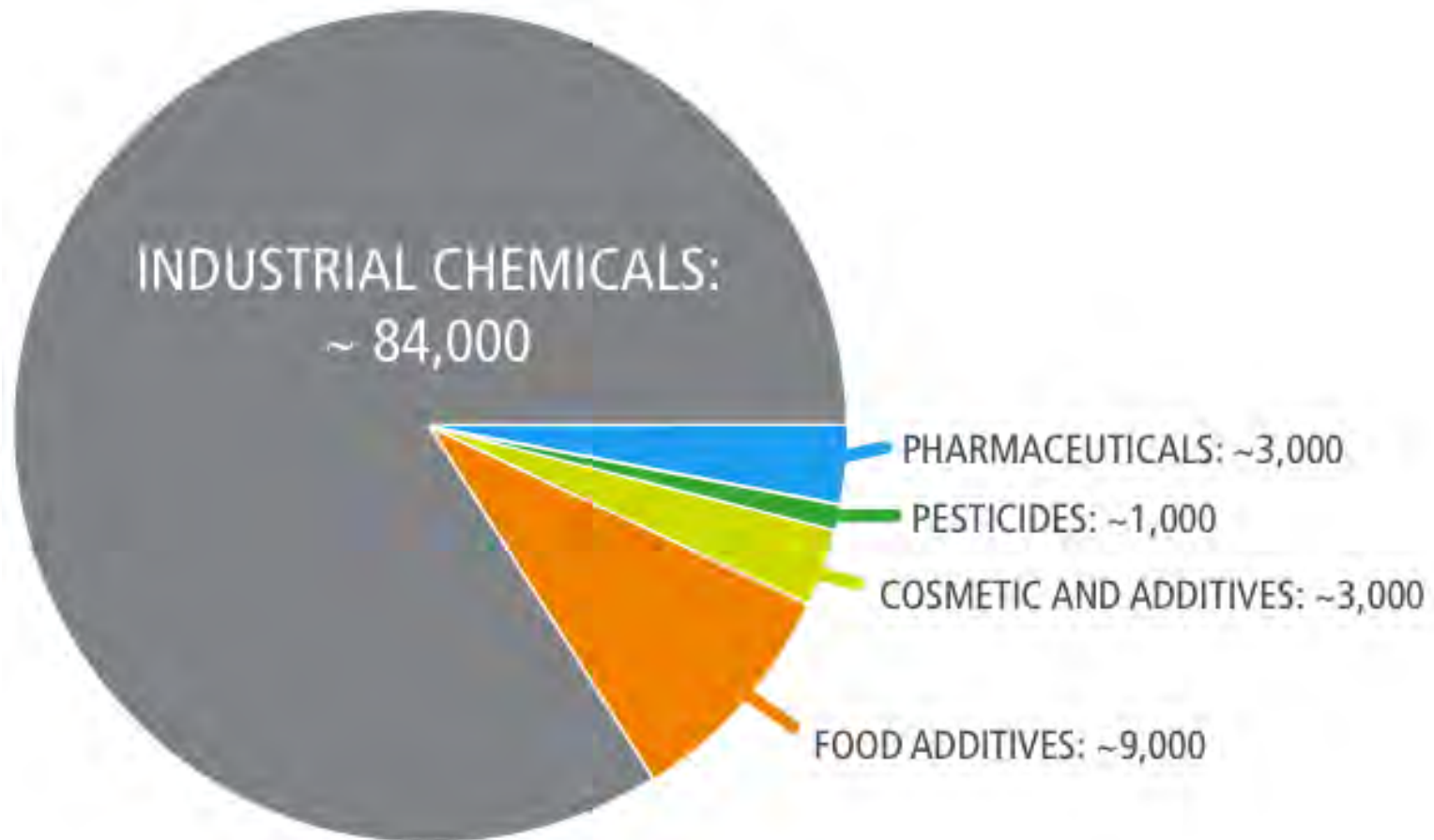
# **Bioaccumulation of Contaminants of Emerging Concern in San Francisco Bay**

Presentation at Bioaccumulation Symposium

December 17<sup>th</sup>, 2012

Meg Sedlak, Jay Davis, and Don Yee

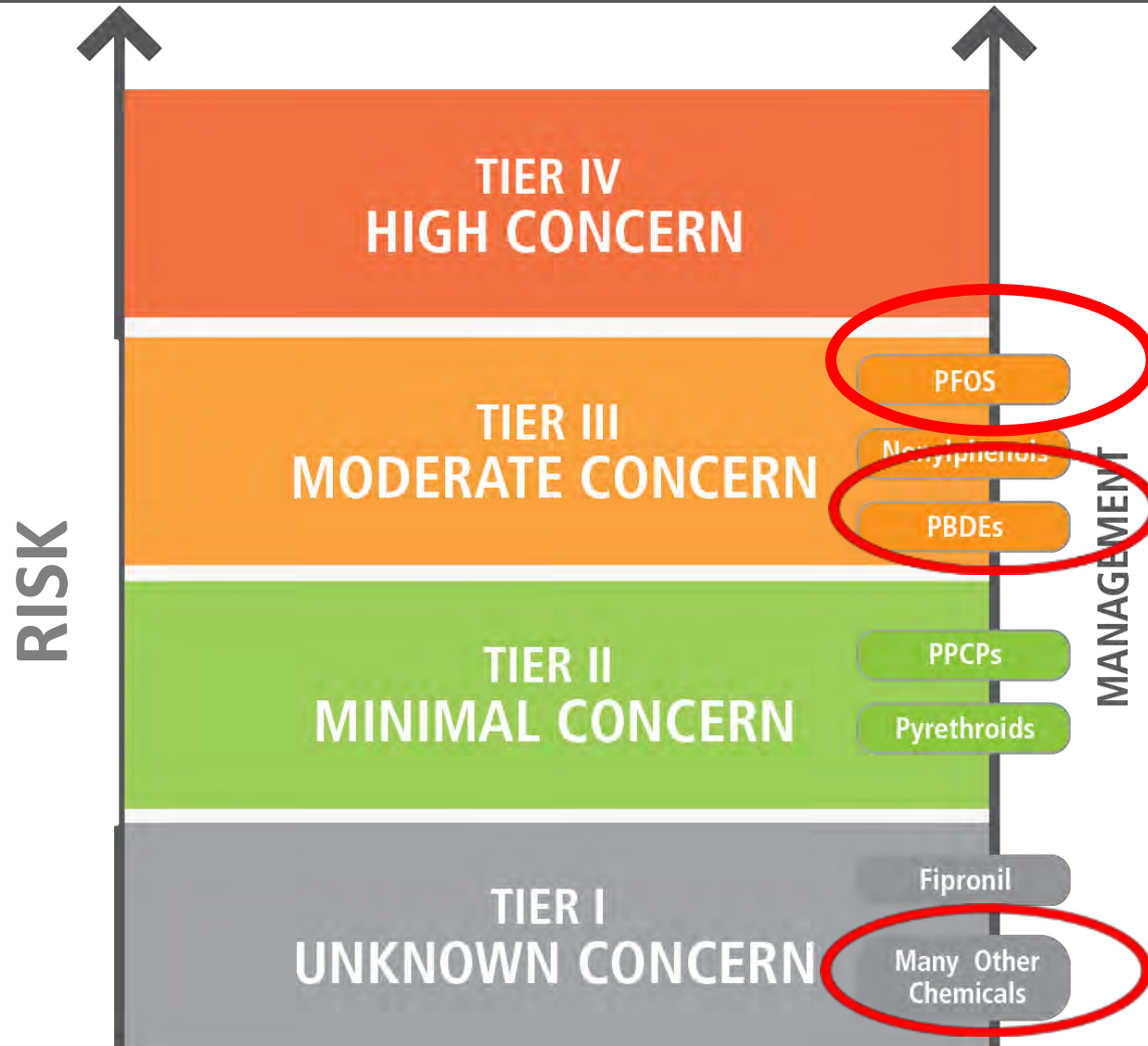
# The Universe of CECs to Monitor



# 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)
- Polybrominated diphenyl ethers (PBDEs)
- Alternative flame retardants

# Tiered Prioritization



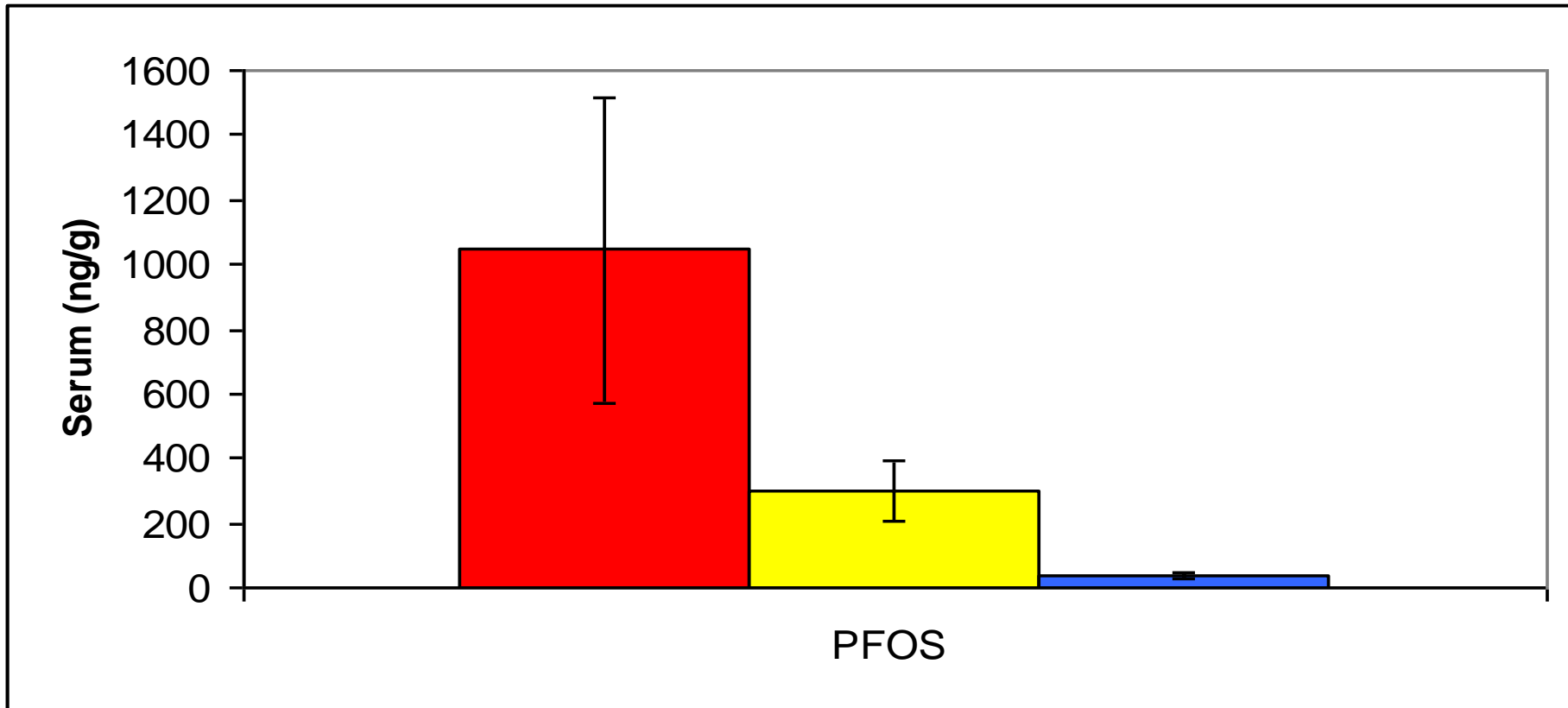
# PFOS

- 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  - Withdrawn from US market in 2002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

Mowry Slough  
(n=6)

Richmond  
Bridge (n=34)

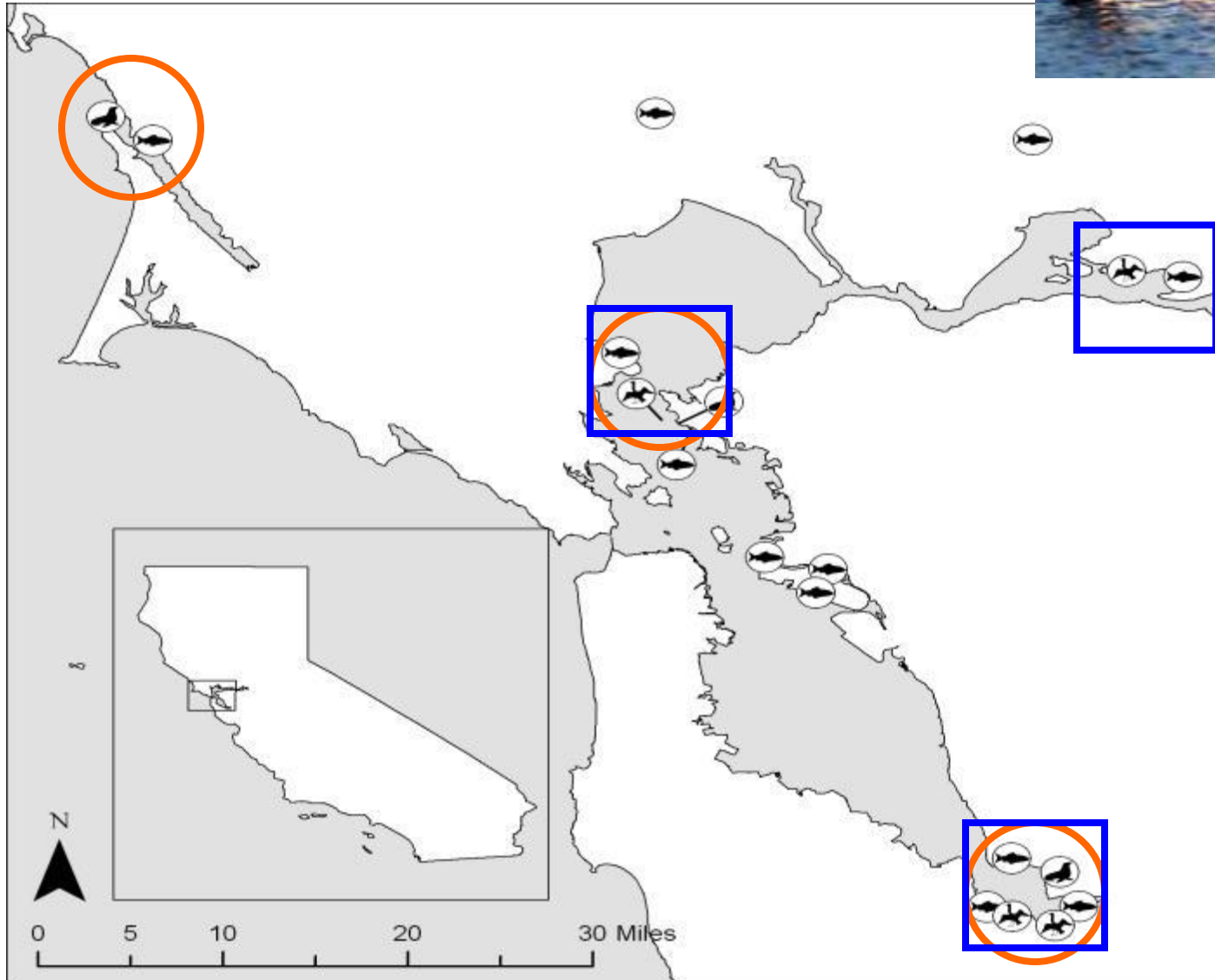
Tomales Bay  
(n=21)

# 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)

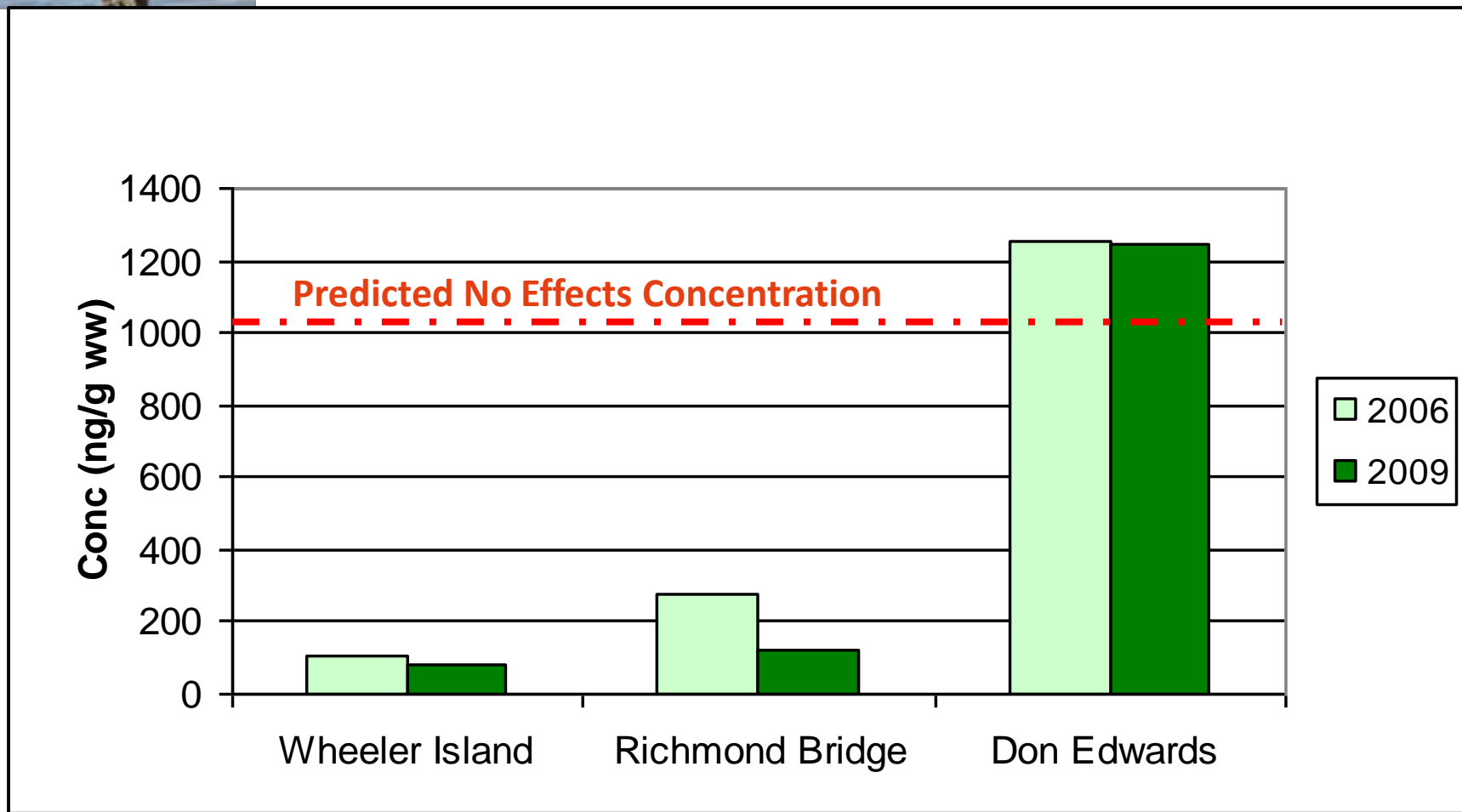


# Monitoring Cormorants





# PFOS in Bird Eggs



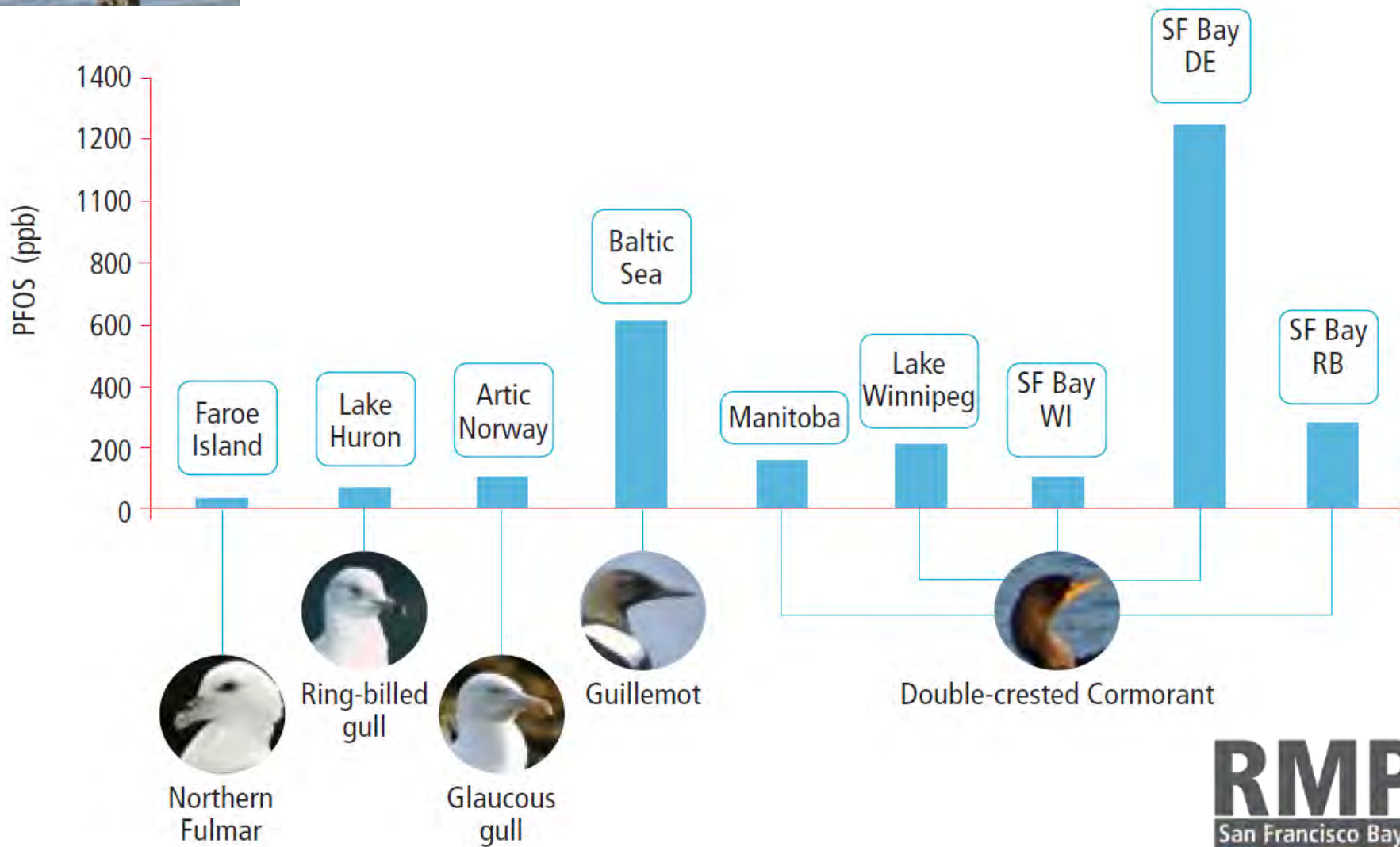
Suisun Bay

Central Bay

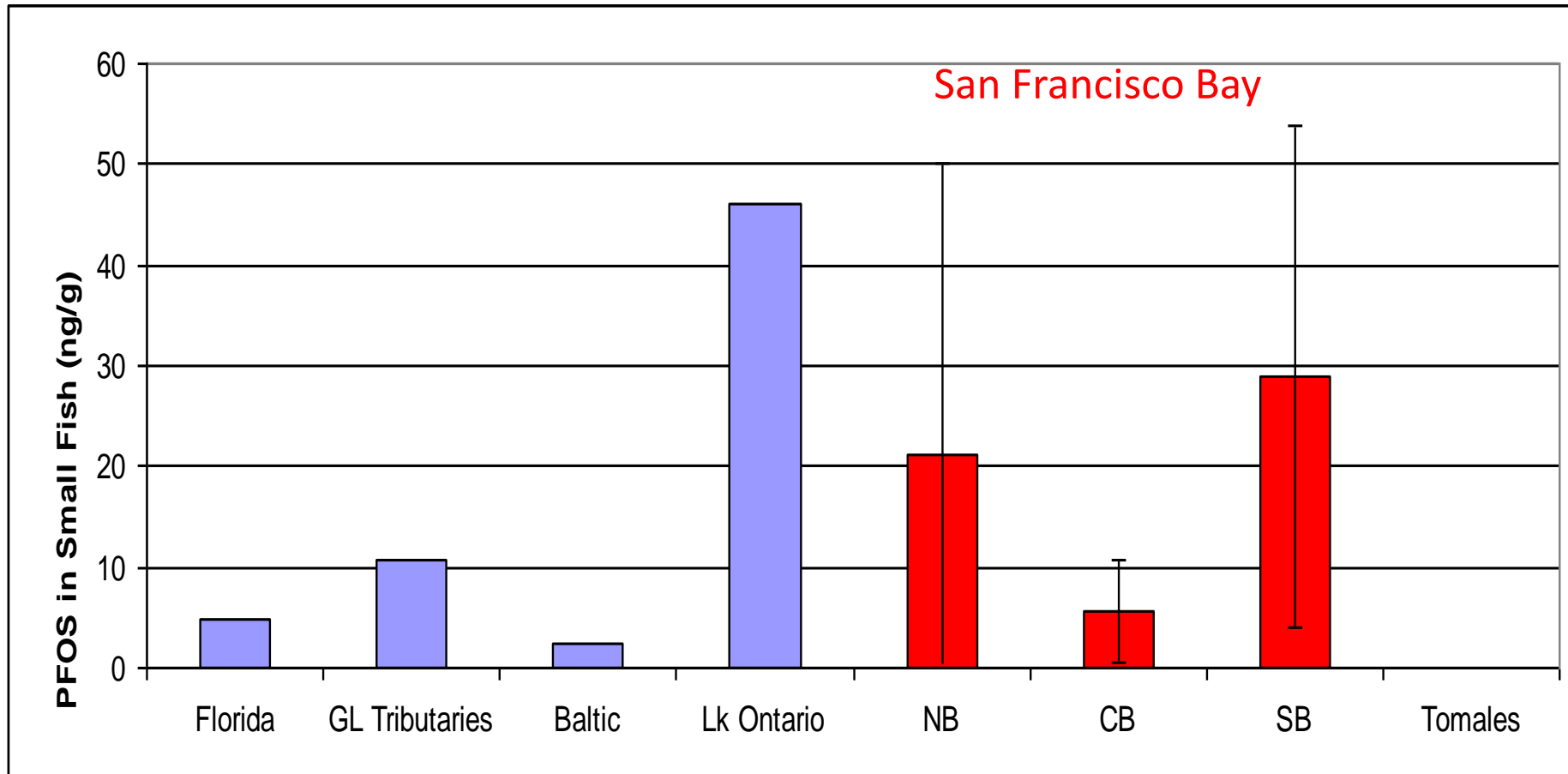
South Bay



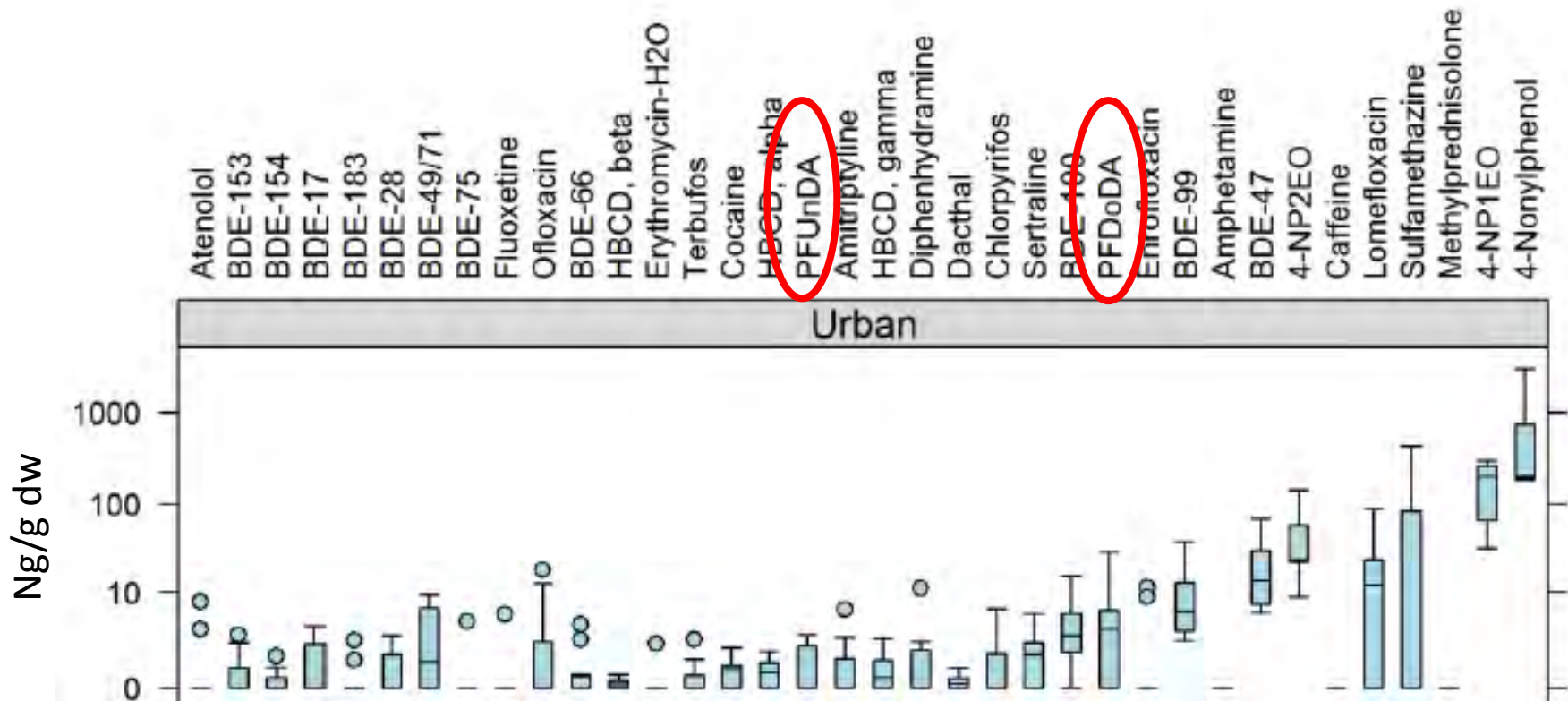
# PFOS in Bird Eggs



# PFOS in Small Fish



# 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

CDFG Site 244

CDFG Site 216

Castro Rocks

CDFG Site 106

CDFG Site 102

CDFG Site 101






CDFG Site 140

Corkscrew Slough

Mowry Slough

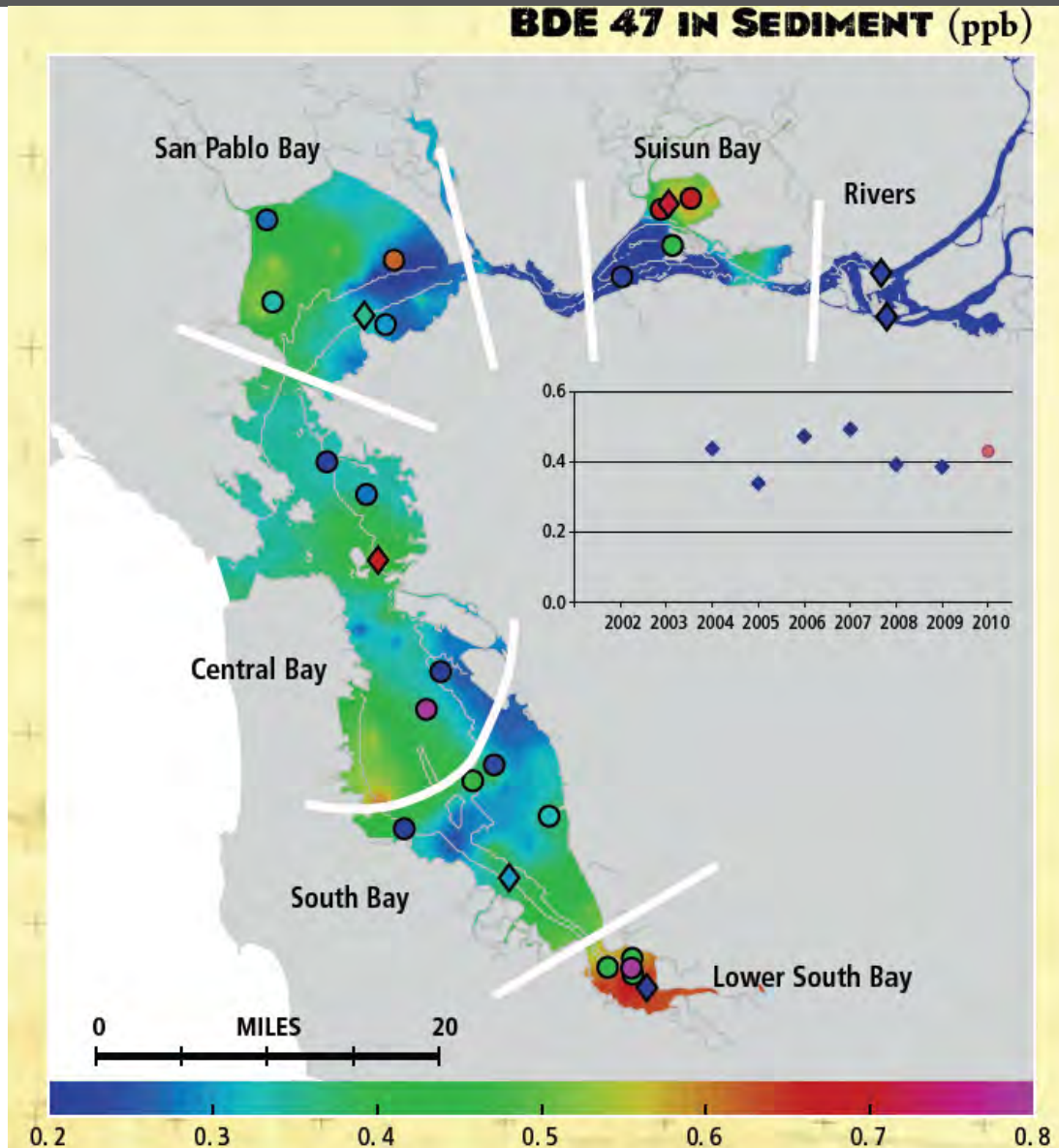
Cooley Landing

Alviso Slough

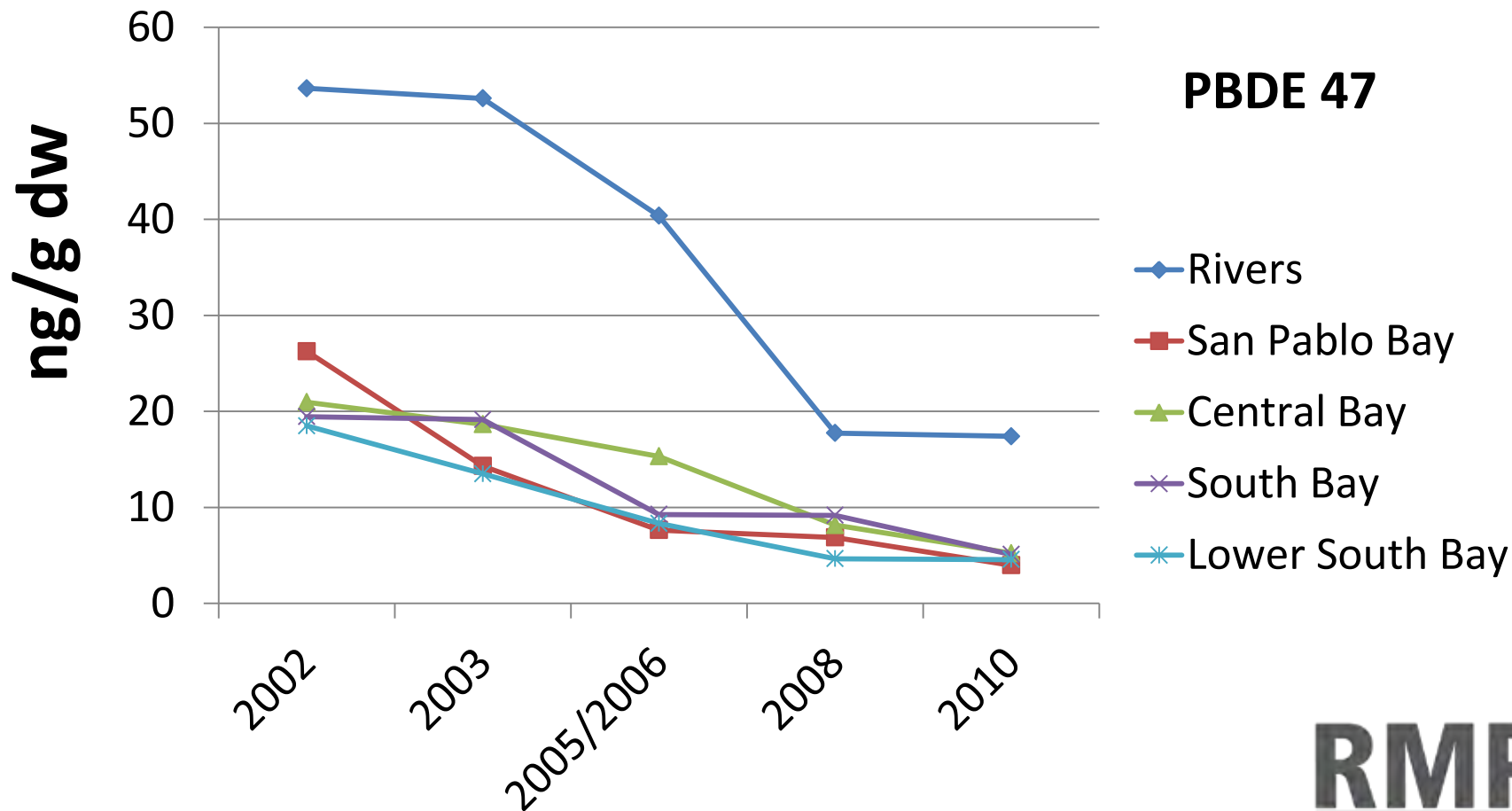
|   |            |           |
|---|------------|-----------|
|  | Bird Eggs  | <b>9</b>  |
|  | Fish       | <b>31</b> |
|  | Seal Serum | <b>41</b> |
|  | Sediment   | <b>12</b> |
|  | Water      | <b>20</b> |

# 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



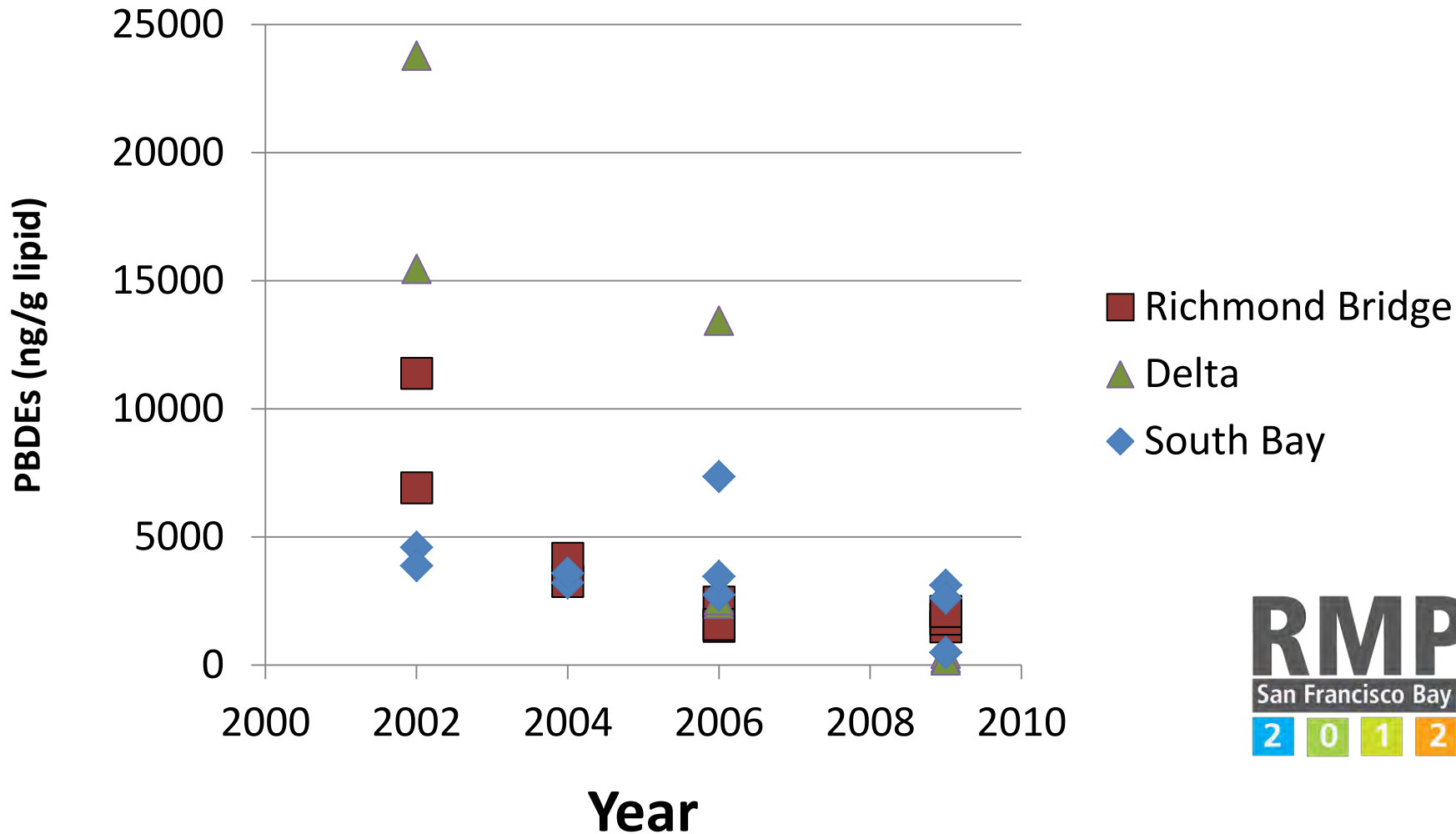
# PBDEs in Bivalves







# PBDEs in Cormorant Eggs



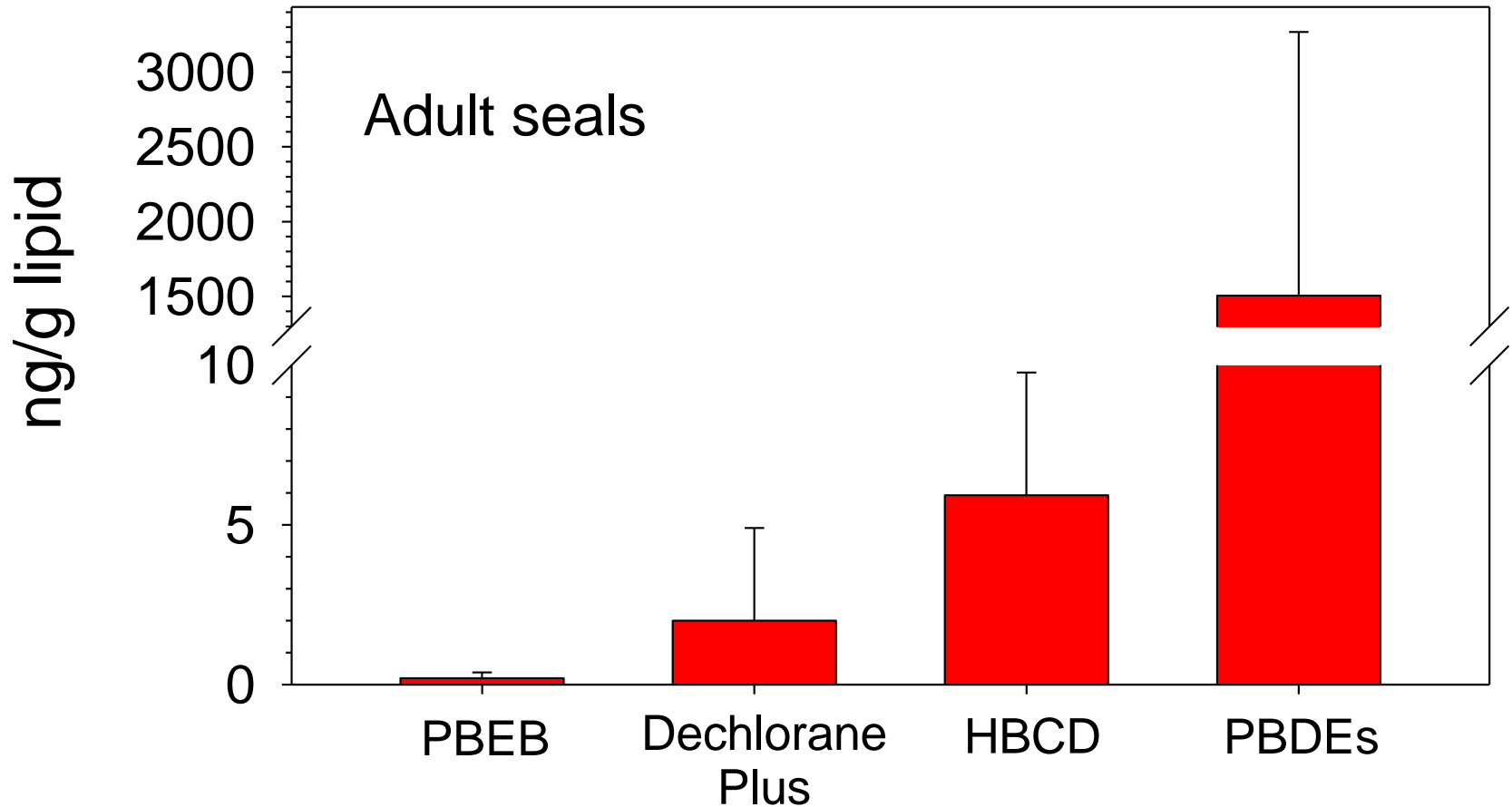
# Alt. Flame Retardants

|                                     |              | HPV? | Prop 65? | Bivalves | Bird | Fish | Seal |
|-------------------------------------|--------------|------|----------|----------|------|------|------|
| <b>Phosphates</b>                   | TDCPP        |      | Yes      | ND       | ND   |      |      |
|                                     | T CPP        |      |          | ND       |      |      |      |
|                                     | TCEP         |      | Yes      | ND       | ✓    |      |      |
|                                     | TBEP         |      |          |          | ✓    |      |      |
|                                     | TPP          | Yes  |          | ✓        | ✓    |      |      |
| <b>Deca/ Octa PBDE replacements</b> | DBDPE        | Yes  |          | ?        | ?    | ?    | ?    |
|                                     | BTBPE        | Yes  |          | ND       | ND   | ND   | ND   |
|                                     |              |      |          |          |      |      |      |
| <b>Penta PBDE replacements</b>      | TBPH         | Yes  |          | ?        | ?    | ?    | ?    |
|                                     | TBB          | Yes  |          | ?        | ?    | ?    | ?    |
|                                     |              |      |          |          |      |      |      |
| <b>Other</b>                        | DP           | Yes  |          | ✓        | ✓    | ✓    | ✓    |
|                                     | HBCD         | Yes  |          | ✓        | ✓    | ✓    | ✓    |
|                                     | Cl Paraffins |      |          |          | ✓    | ✓    | ✓    |
|                                     | PBEB         |      |          | ✓        | ND   | ND   | ✓    |

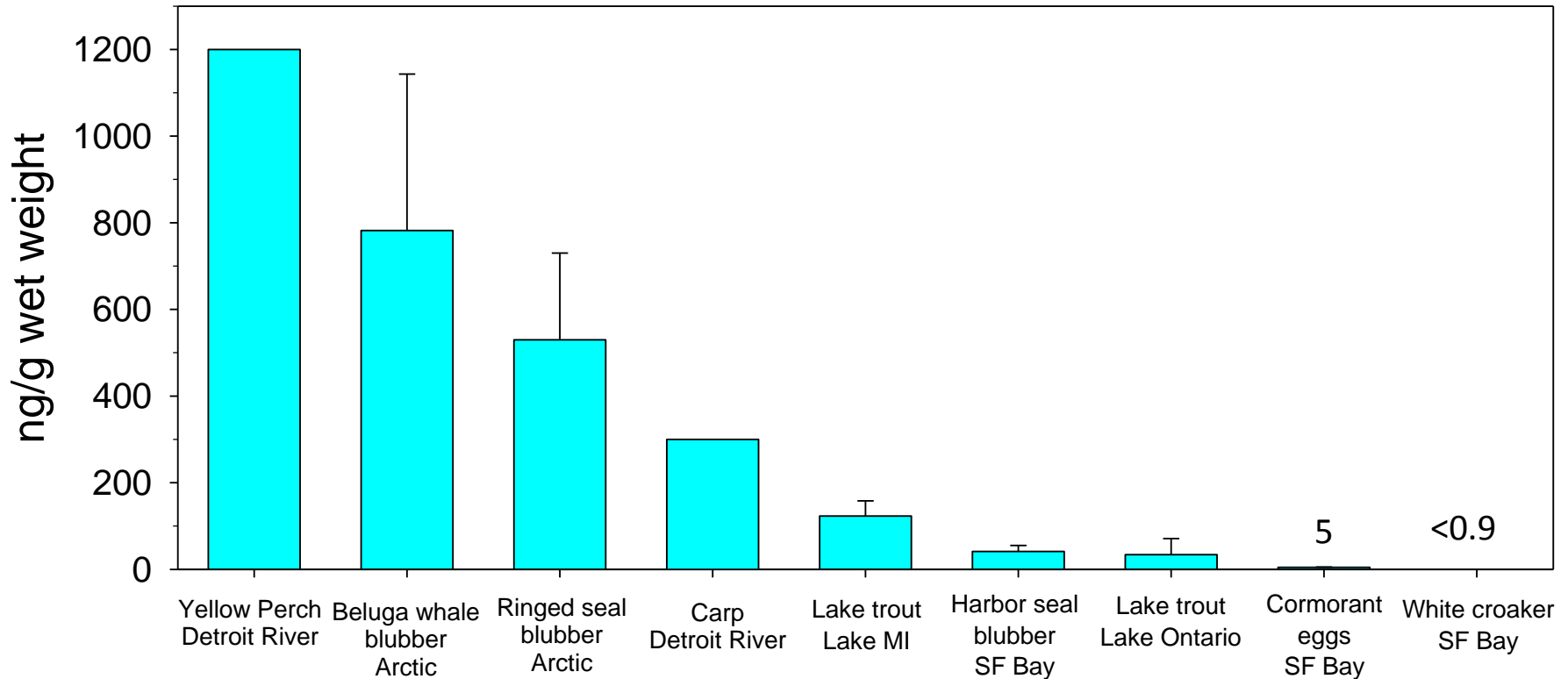
Chris Werme article



# Alt Flame Concentrations << than PBDEs

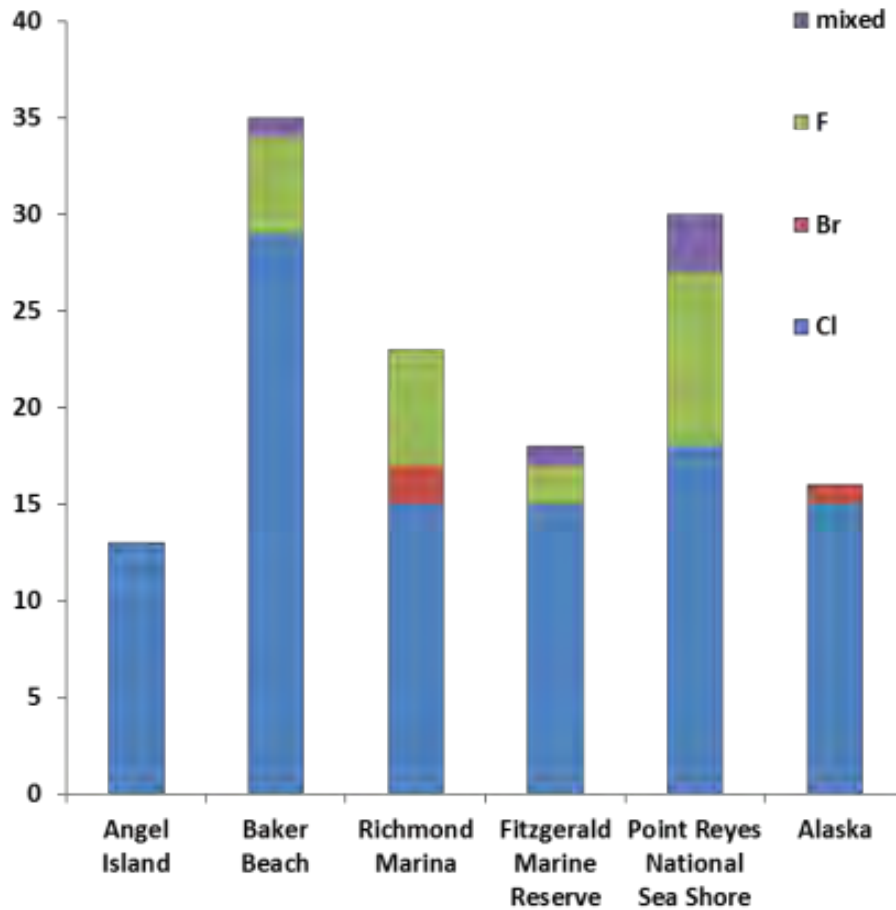


# Bay Concentrations Generally Lower



## Chlorinated Paraffins in San Francisco Bay Wildlife

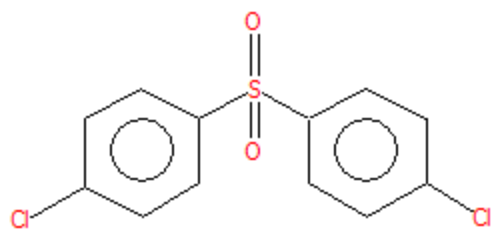
# Alternative Approaches to ID CECs



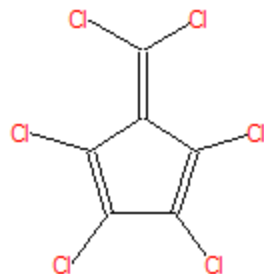
Courtesy of Dr. John Kucklick, NIST

# Chlorinated Compounds

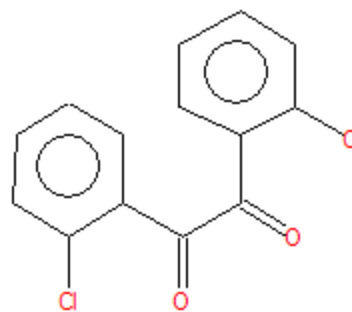
| Compound                      | CAS#       | Comments                             |
|-------------------------------|------------|--------------------------------------|
| Dechlorane 602                | 31107-44-5 | flame retardant                      |
| p,p'-Dichlorodiphenyl sulfone | 80-07-9    | polymer starting material for "Udel" |
| Hexachlorofulvene             | 6317-25-5  | polymer use?                         |
| Dichlorobenzil                | 21854-95-5 | dyes, resins, disinfectant?          |
| Dichlorobenzophenone          | 5293-97-0  | ?                                    |
| Dichloroanthracene            | 605-48-1   | combustion product?                  |



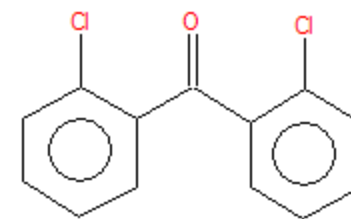
Dichlorodiphenylsulfone  
On Howard and Muir List



Hexachlorofulvene



Dichlorobenzil



Dichlorobenzophenone

# 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](mailto:meg@sfei.org)

## 900,000 Data Points

