

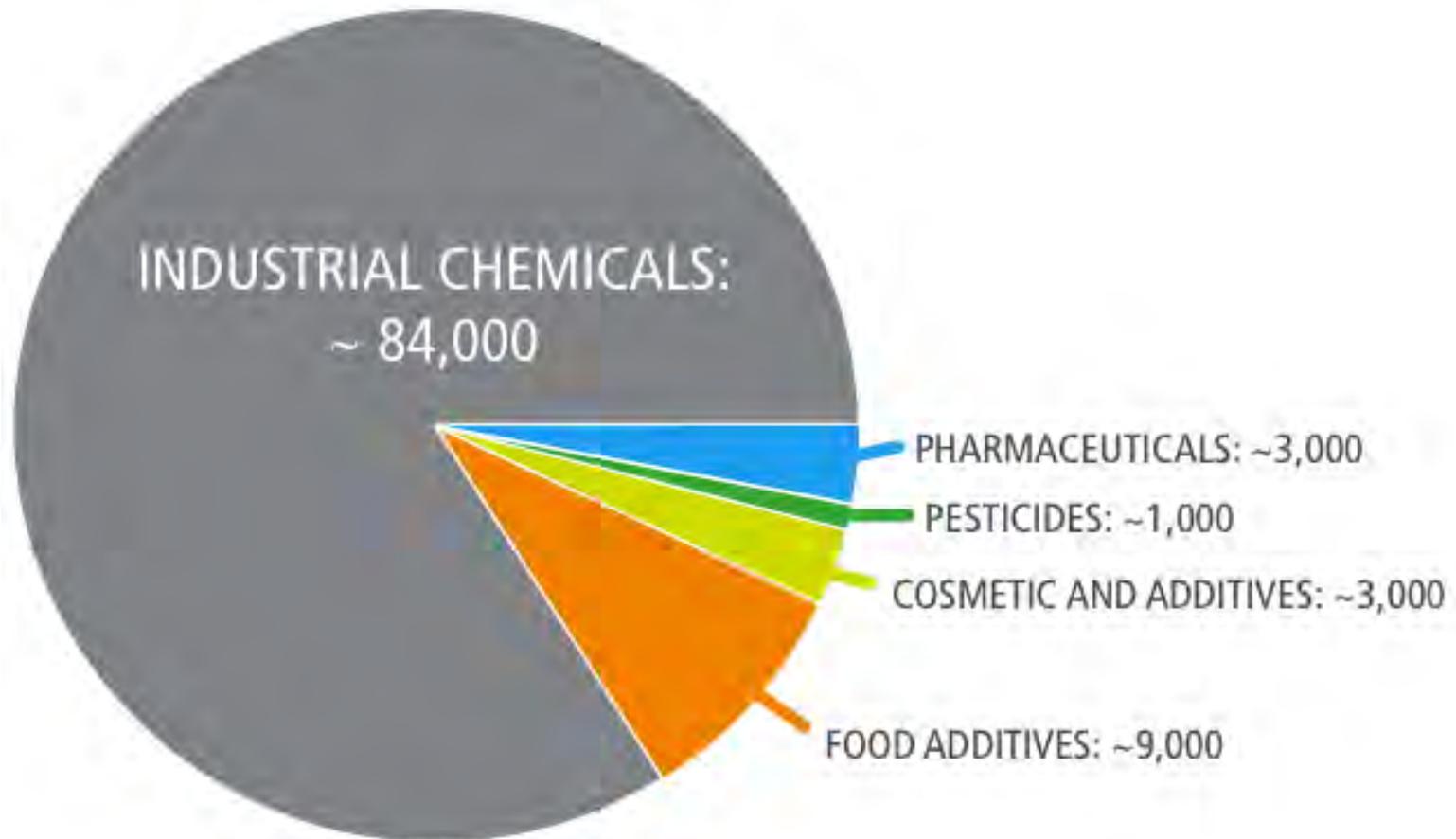
Bioaccumulation of Contaminants of Emerging Concern in San Francisco Bay

Presentation at Bioaccumulation Symposium

December 17th, 2012

Meg Sedlak, Jay Davis, and Don Yee

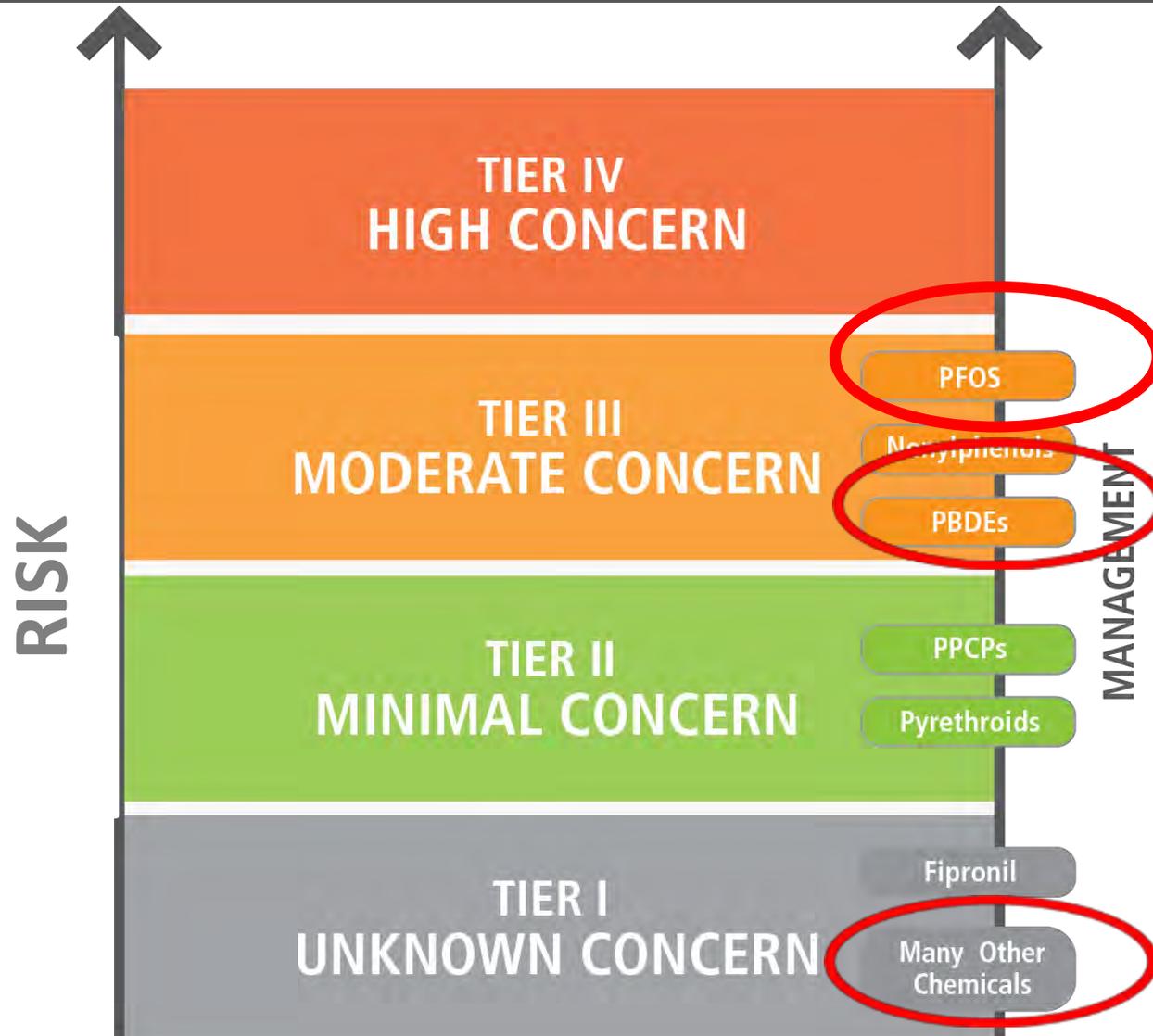
The Universe of CECs to Monitor



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

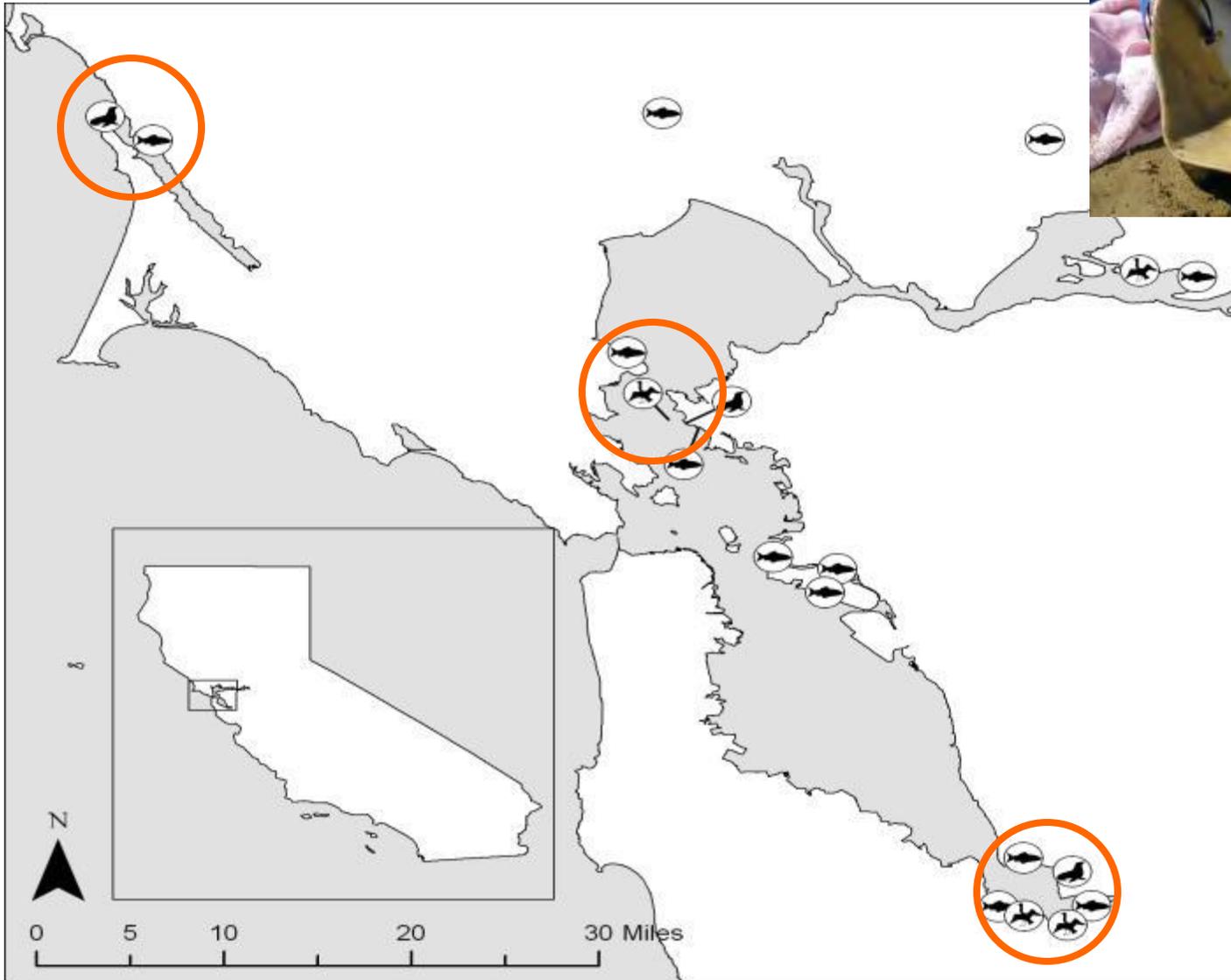
Tiered Prioritization



PFOS

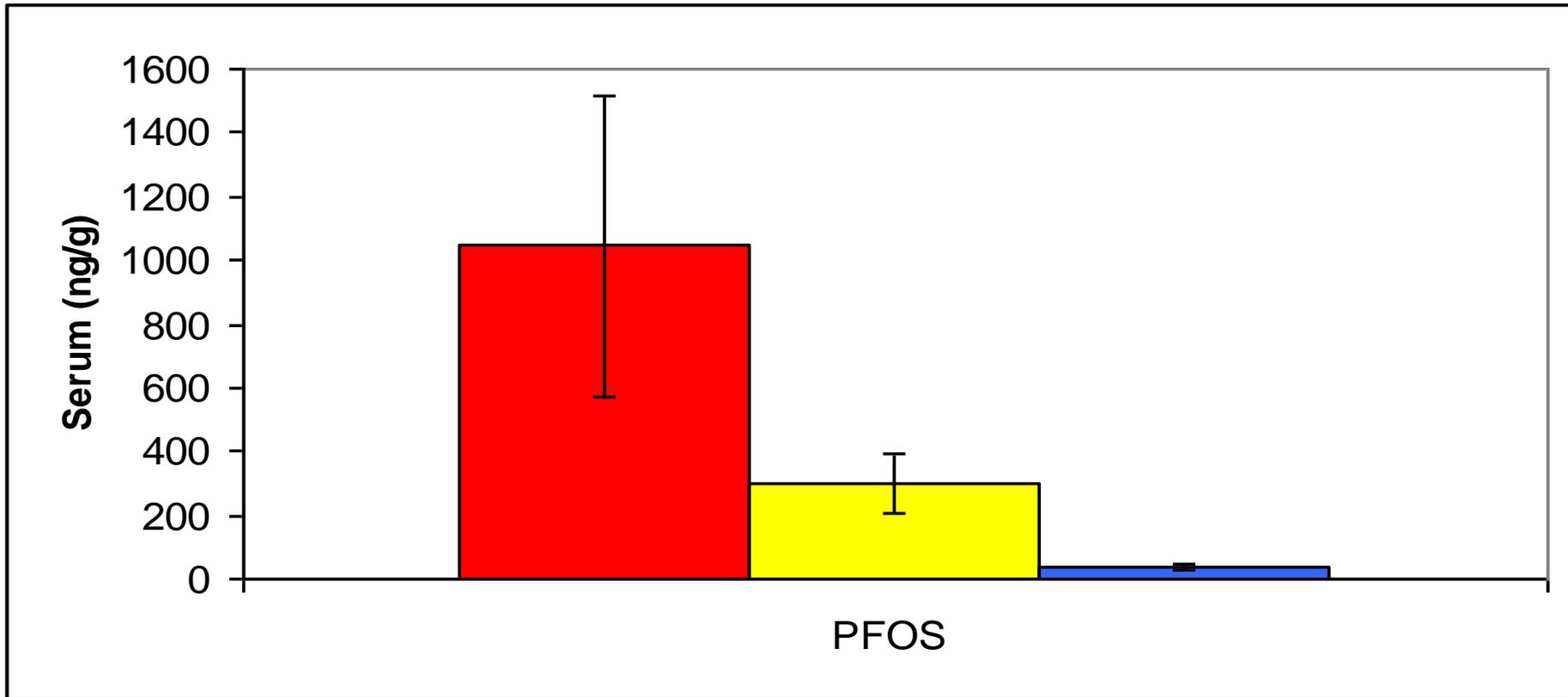
- Use
 - Wide variety of applications
 - Withdrawn from US market in 2002
 - Large reservoir from historic use and precursors
- Toxic
 - Developmental toxicity, compromised immune systems, and endocrine disruptor
- Detected in Bay seals, bird eggs, small fish, bivalves and sport fish

Monitoring Bay Seals





PFOS in Seals



Source: Sedlak and Greig 2012 JEM

Mowry Slough
(n=6)

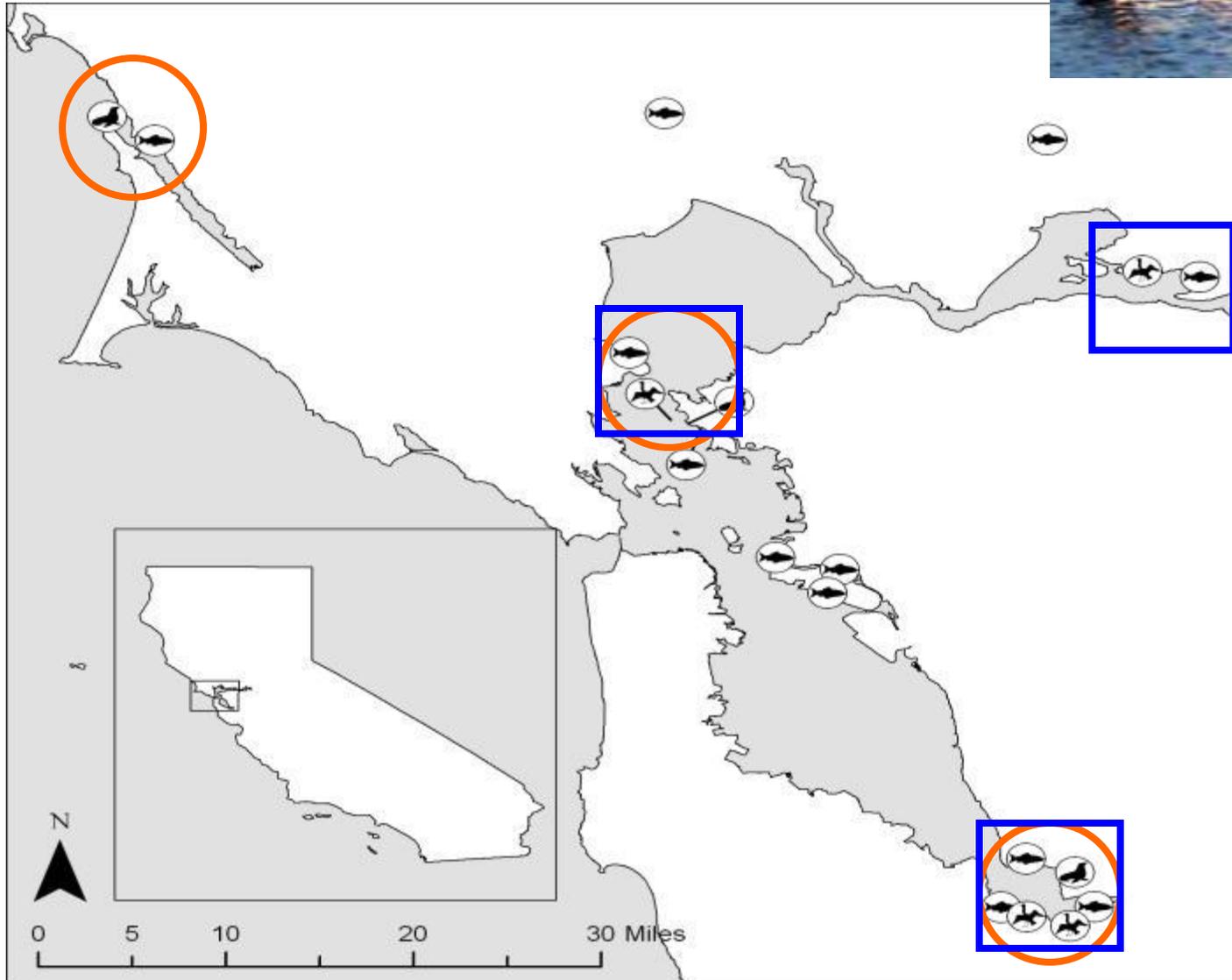
Richmond
Bridge (n=34)

Tomales Bay
(n=21)

Limited Tox Data for Seals

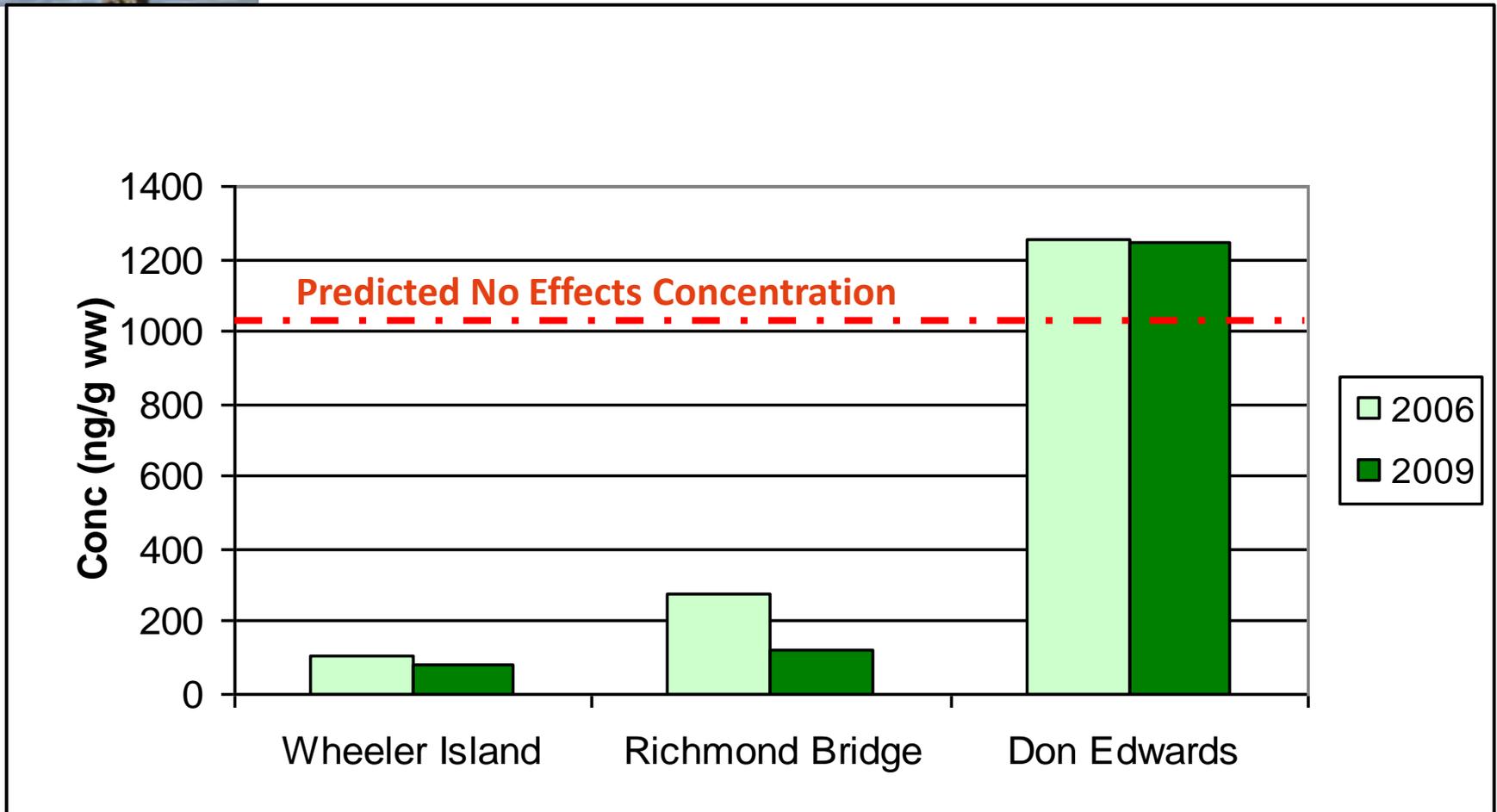
- **Suppression of immune systems**
 - CA Sea Otter
 - Higher incidence of disease (Kannan et al. 2006)
 - Rats
 - Significantly higher mortality in rats infected with influenza at environmentally relevant concentrations of PFOS (Gurunge et al. 2009)
- **Adverse neonatal outcomes**
 - Humans
 - Reduced body weight and head circumference (Apelberg et al. 2007)

Monitoring Cormorants





PFOS in Bird Eggs



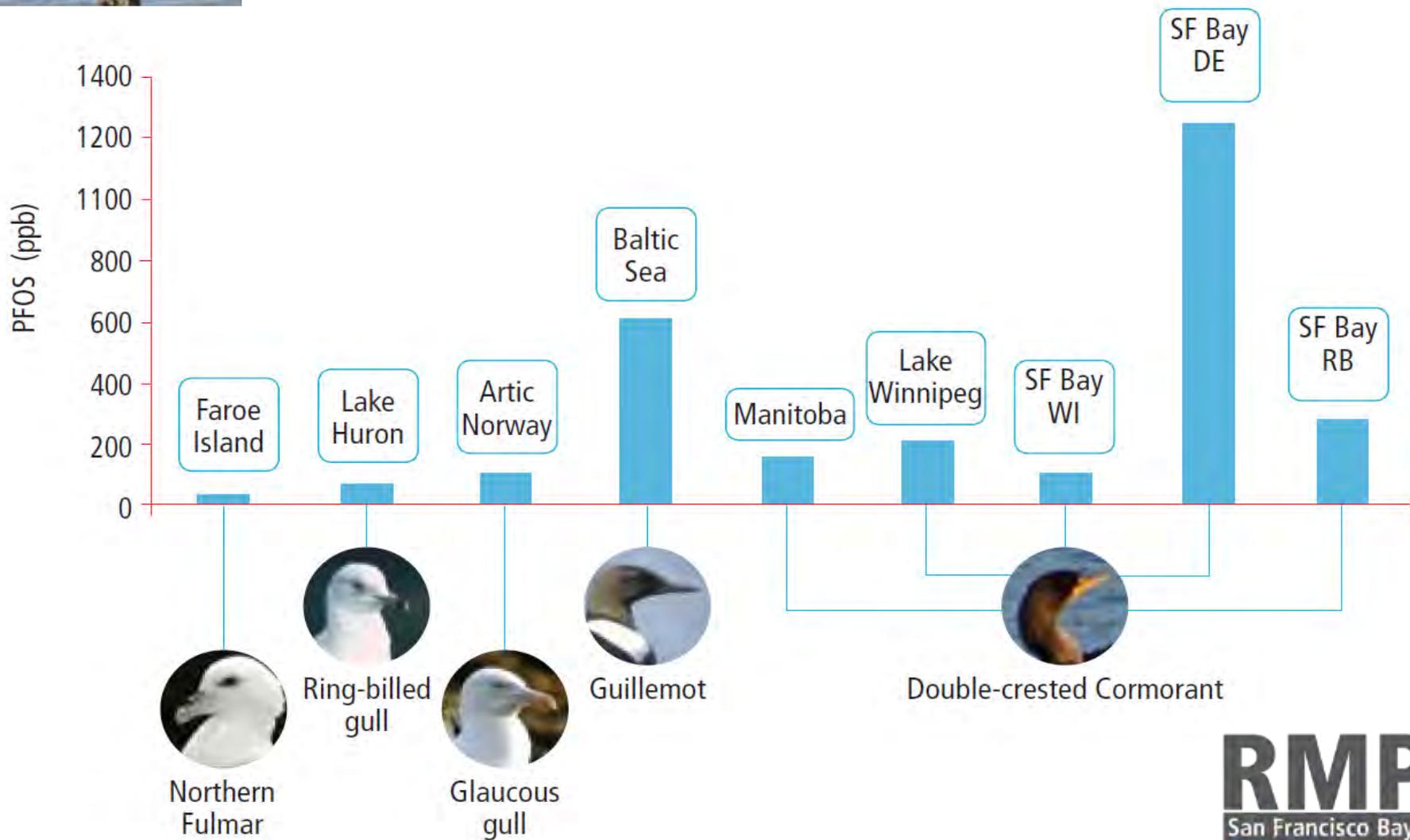
Suisun Bay

Central Bay

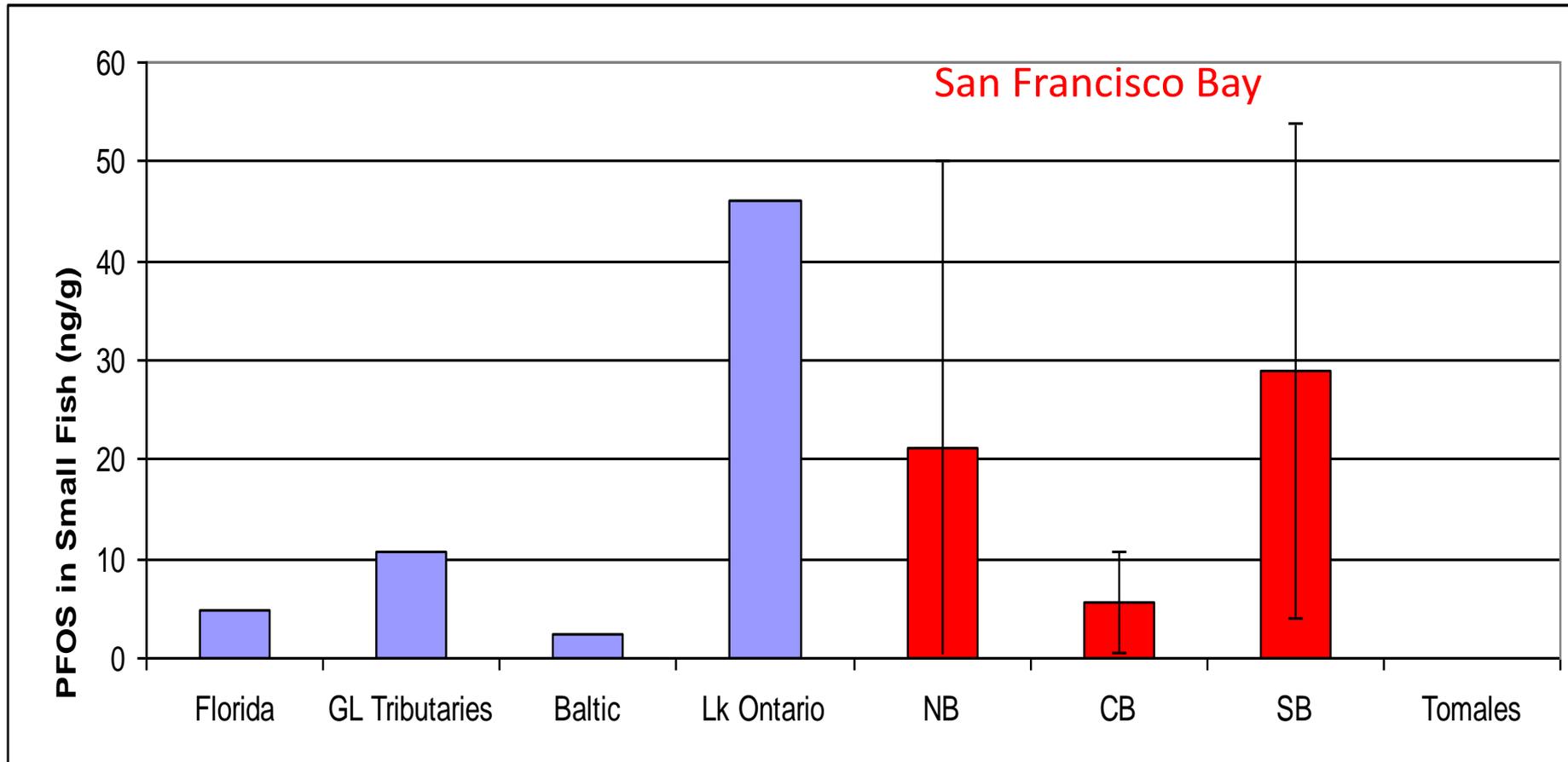
South Bay



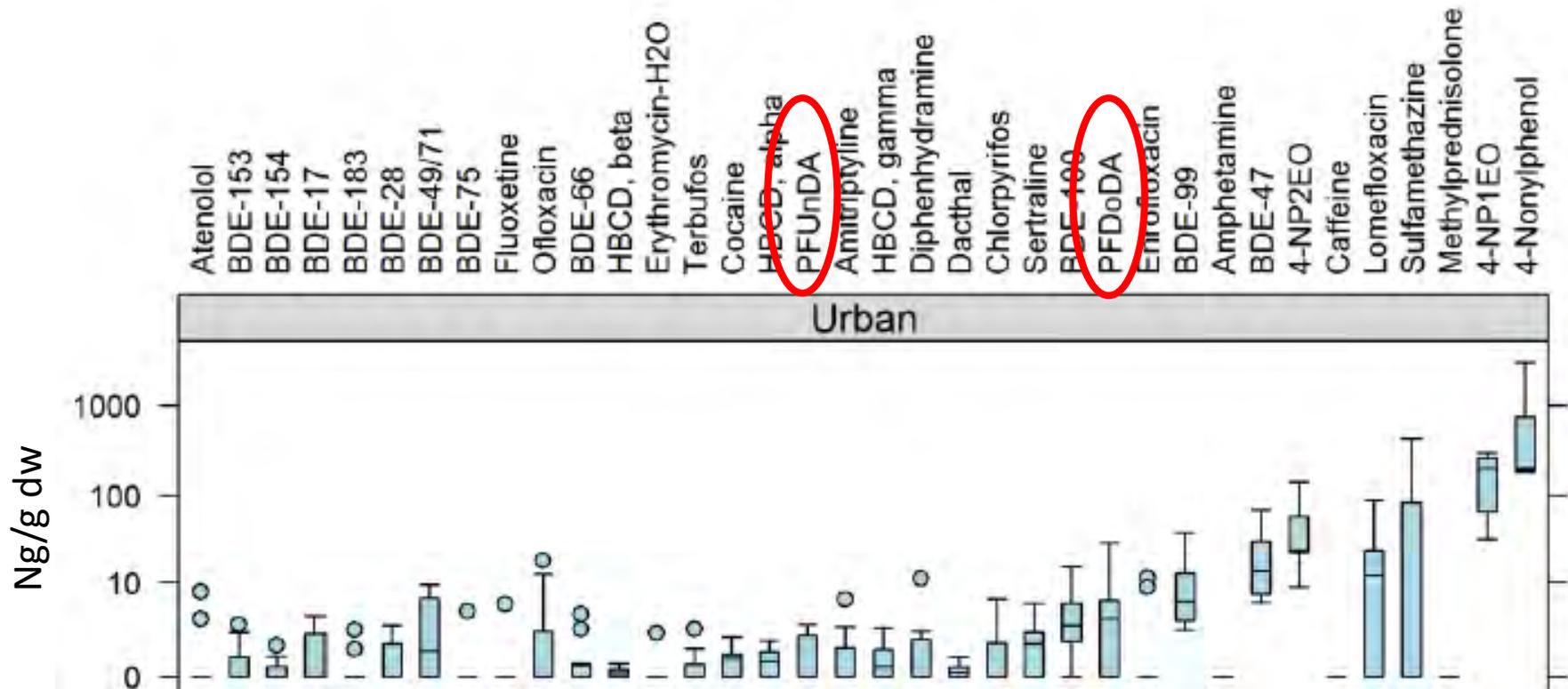
PFOS in Bird Eggs



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

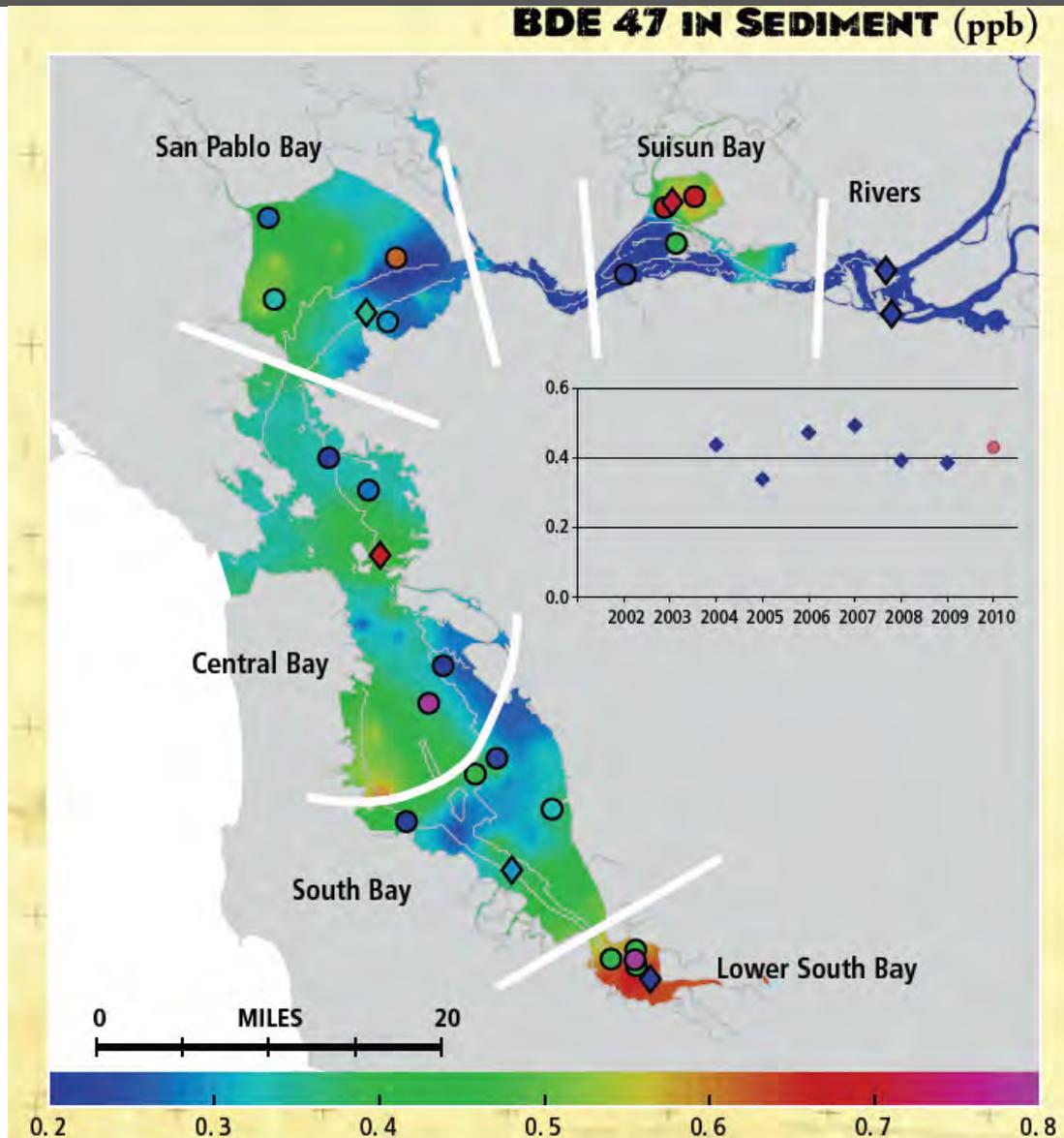
Alviso Slough

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

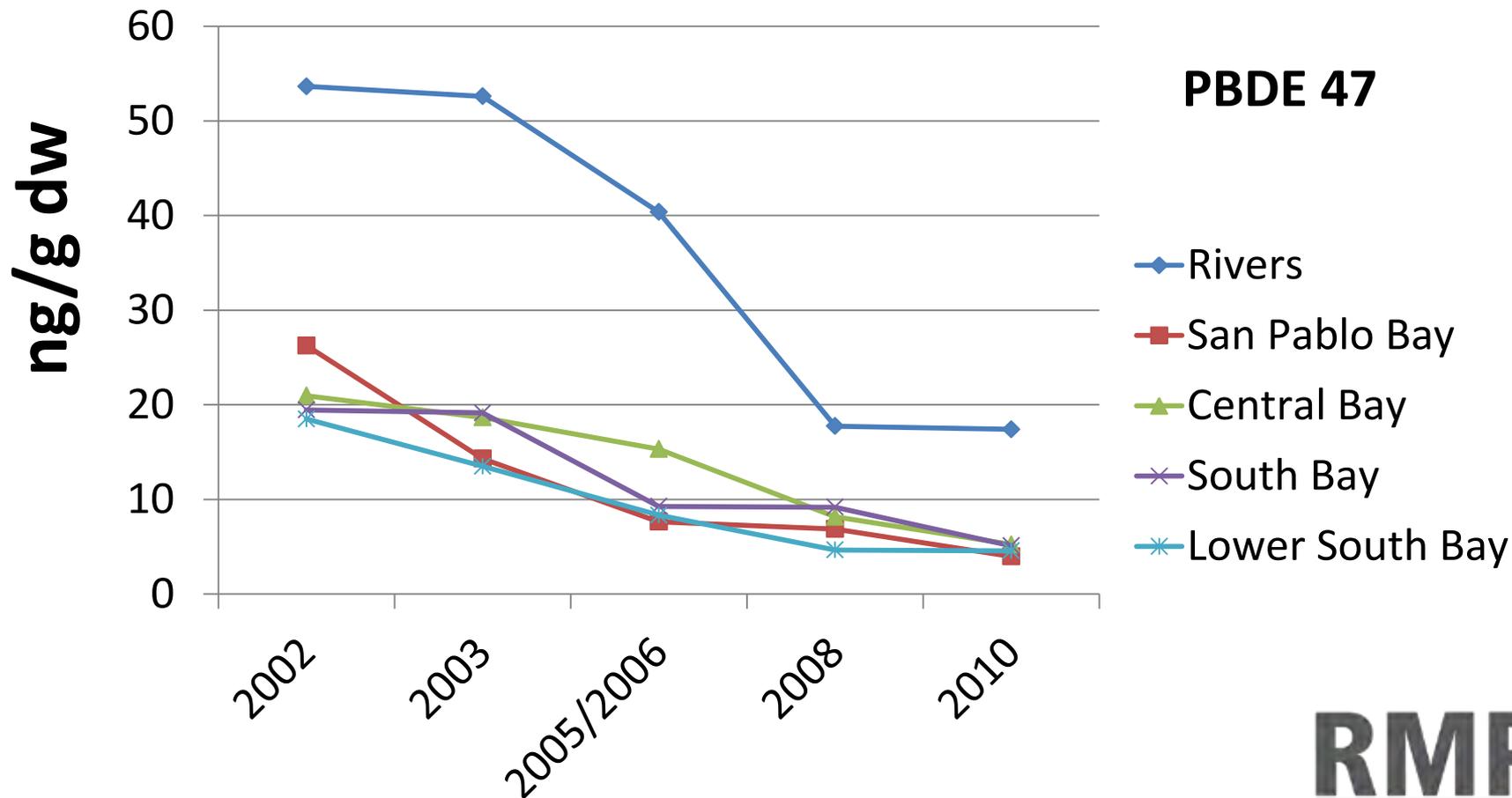


PBDEs – A Success Story?

- 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

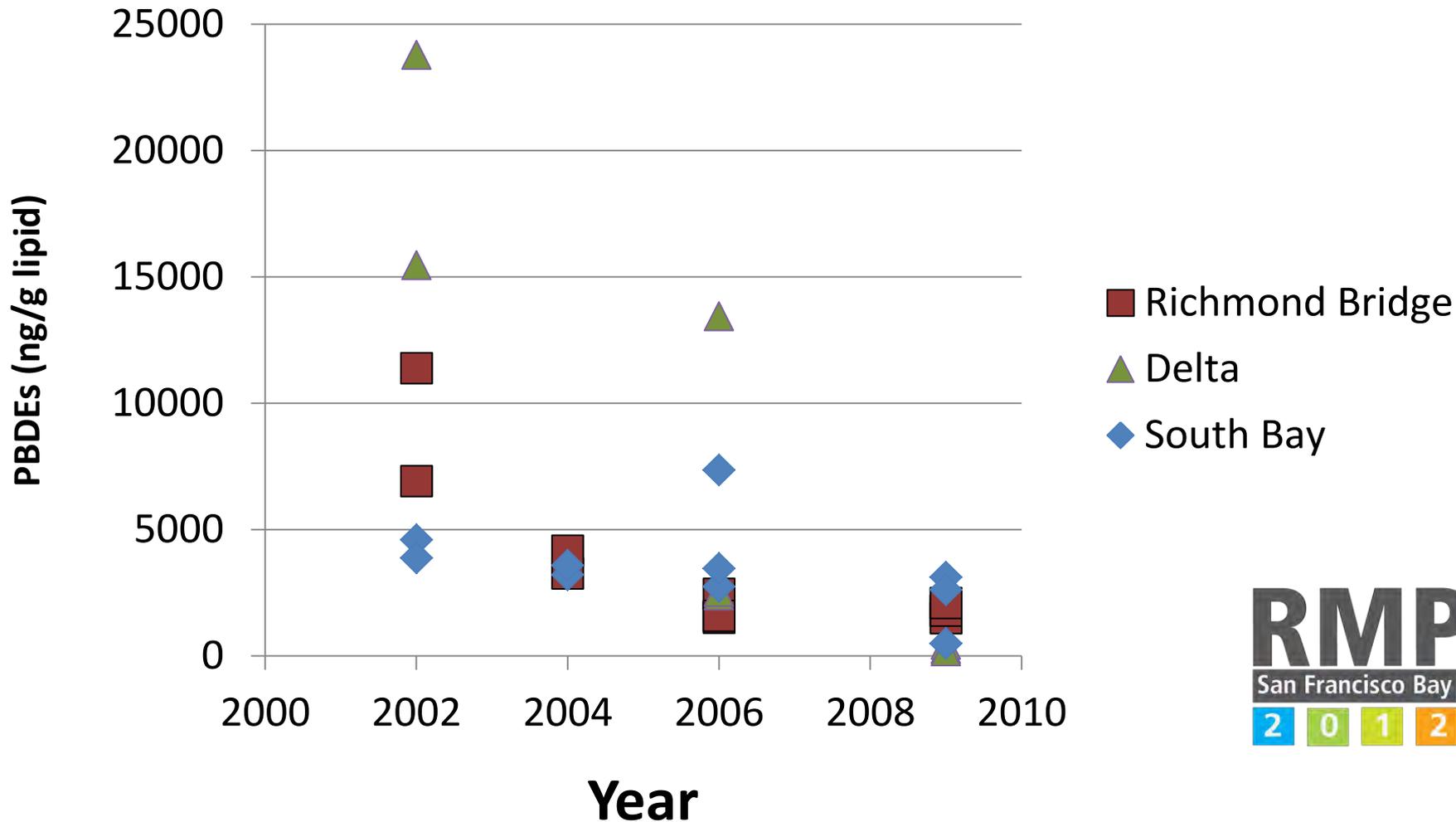


PBDEs in Bivalves





PBDEs in Cormorant Eggs



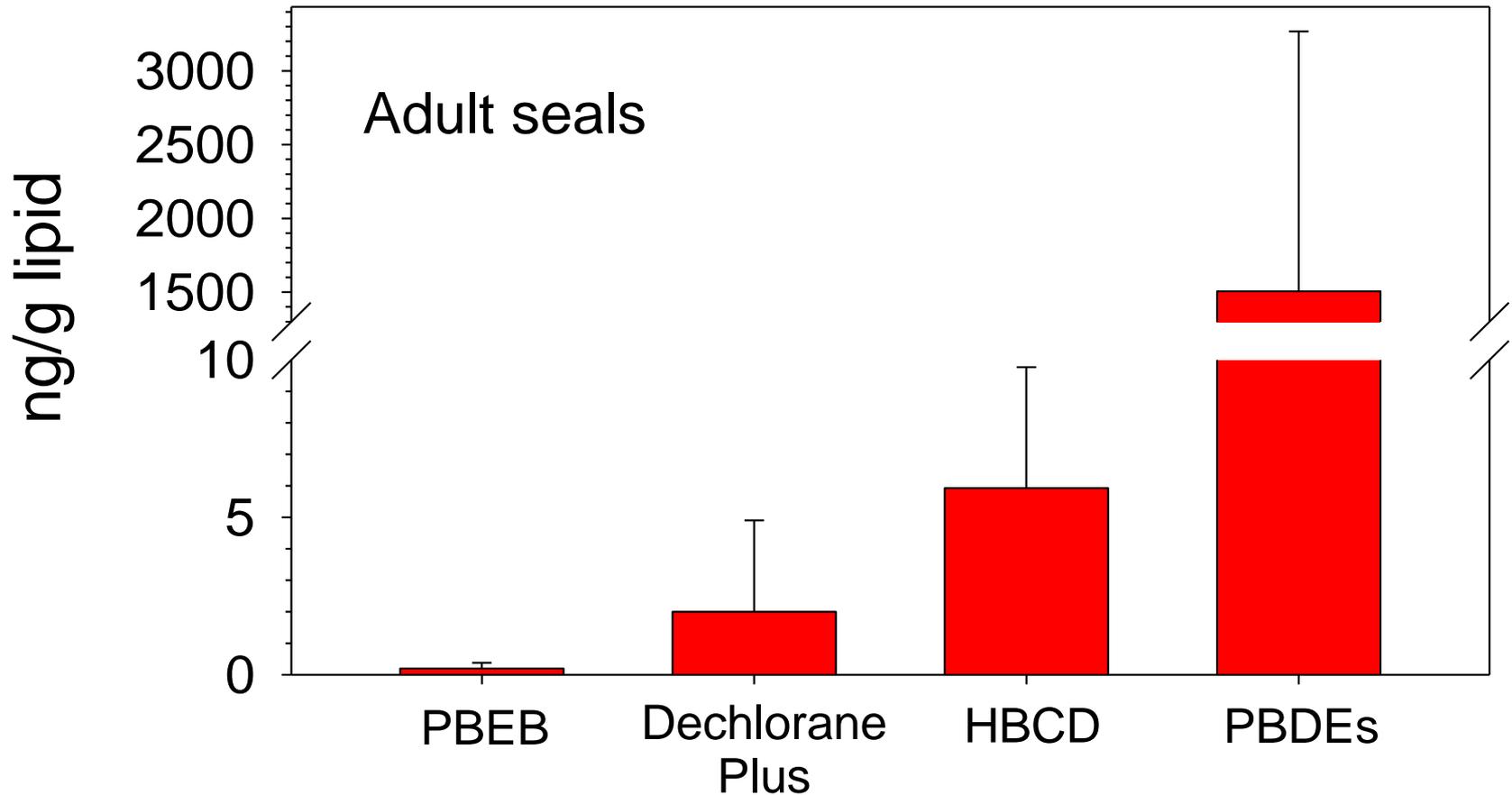
Alt. Flame Retardants

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

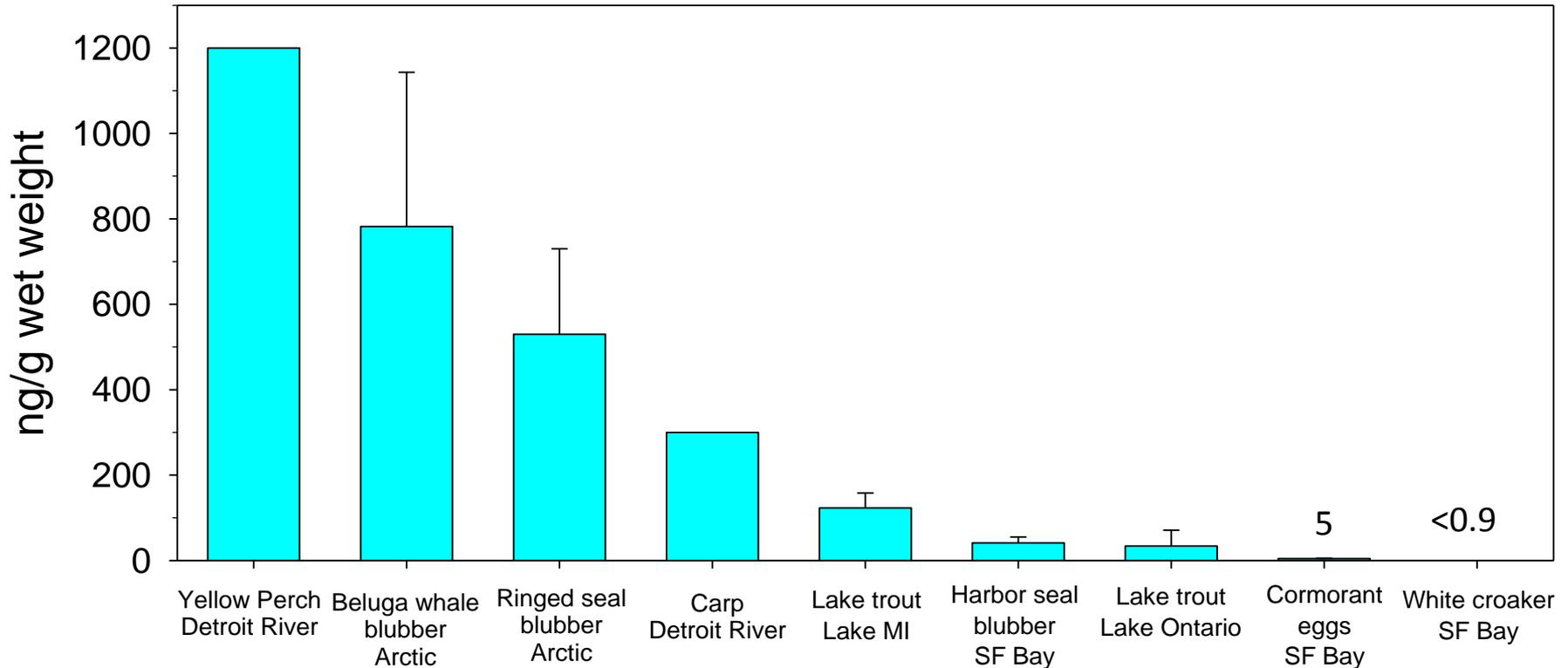
Chris Werme article



Alt Flame Concentrations << than PBDEs

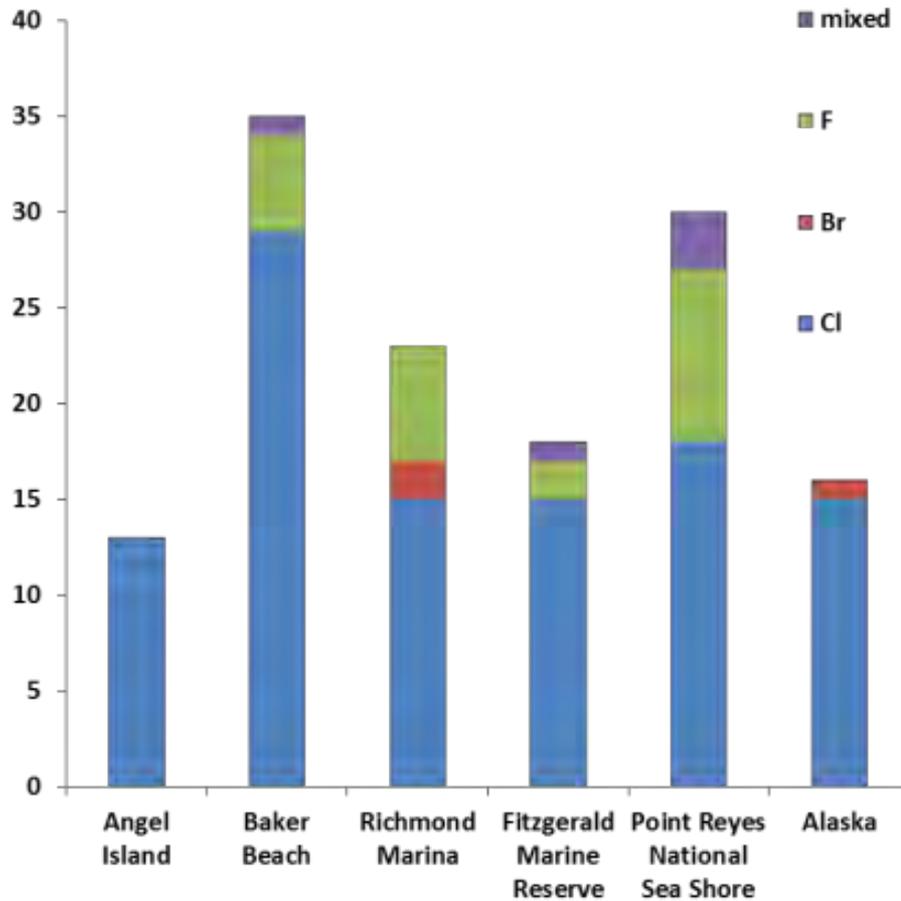


Bay Concentrations Generally Lower



Chlorinated Paraffins in San Francisco Bay Wildlife

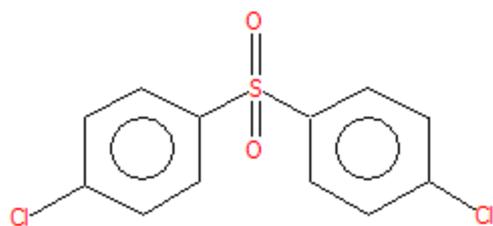
Alternative Approaches to ID CECs



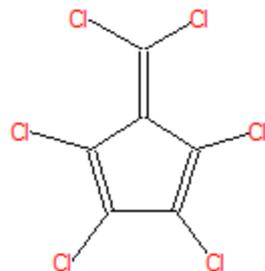
Courtesy of Dr. John Kucklick, NIST

Chlorinated Compounds

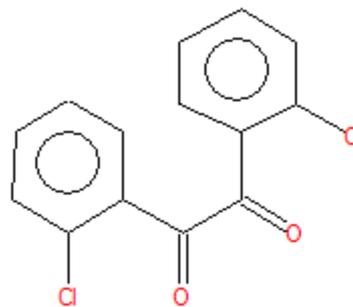
| Compound | CAS# | Comments |
|-------------------------------|------------|--------------------------------------|
| Dechlorane 602 | 31107-44-5 | flame retardant |
| p,p'-Dichlorodiphenyl sulfone | 80-07-9 | polymer starting material for "Udel" |
| Hexachlorofulvene | 6317-25-5 | polymer use? |
|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



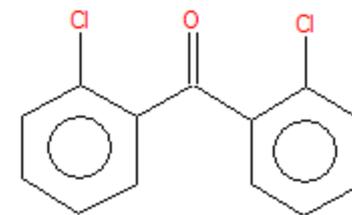
Dichlorodiphenylsulfone
On Howard and Muir List



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

- Or contact me – meg@sfei.org

900,000 Data Points

