Contaminants of Emerging Concern in the San Francisco Estuary

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State of CA CEC Coastal and Marine Ecosystems Science Advisory Panel Meeting

January 12, 2010

SAN FRANCISCO ESTUARY INSTITUTE

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Regional Monitoring Program for Water Quality in the San Francisco Estuary

Collaboration: SFEI, Regional Water Board, Dischargers

Objective: Science to support management

I. Status & Trends Monitoring (1993 -)
- Sediment and water (annually)
- Bivalves (every 2 years)
- Sport fish (every 3 years)
- Bird eggs (every 3 years)

II. Pilot and Special Studies
- Provides framework for adaptive management
- e.g. emerging contaminants

RMP Emerging Contaminants Workgroup

What CECs have the greatest potential to adversely impact beneficial uses in SF Bay?

- Develop cost-effective strategies to identify and monitor CECs
- Recommend studies to RMP technical and steering committees
- Recommend CECs for inclusion into long-term monitoring

Chemical screening → Pilot Study → Annual monitoring

RMP Emerging Contaminants Workgroup

- Meets twice a year
- Include stakeholders (dischargers, Regional Board, EPA Region 9, Cal DTSC, others)
- Expert Advisory Panel
  - Derek Muir, Environment Canada
  - Jennifer Field, Oregon State University
  - David Sedlak, UC Berkeley
  - Lee Ferguson, Duke University
- RMP funding for CEC projects depends on stakeholder management needs/priorities

RMP CEC Data

- Retrospective analyses of chromatograms (2002-2003)
- PBDEs in Bay water, sediments, wildlife (since 2002/2003)
- Pharmaceuticals, personal care products in South Bay (2006)
- Perfluorinated compounds (PFCs) and PBDEs in harbor seal blood (2007-2009) and bird eggs (2006)
- Chlorinated paraffins in wildlife (2008)
- Triclosan in Bay sediments (2008)
- Nonylphenol in small fish (2009)
- Current-use flame retardants in biosolids, sediments, wildlife (2008-2010)

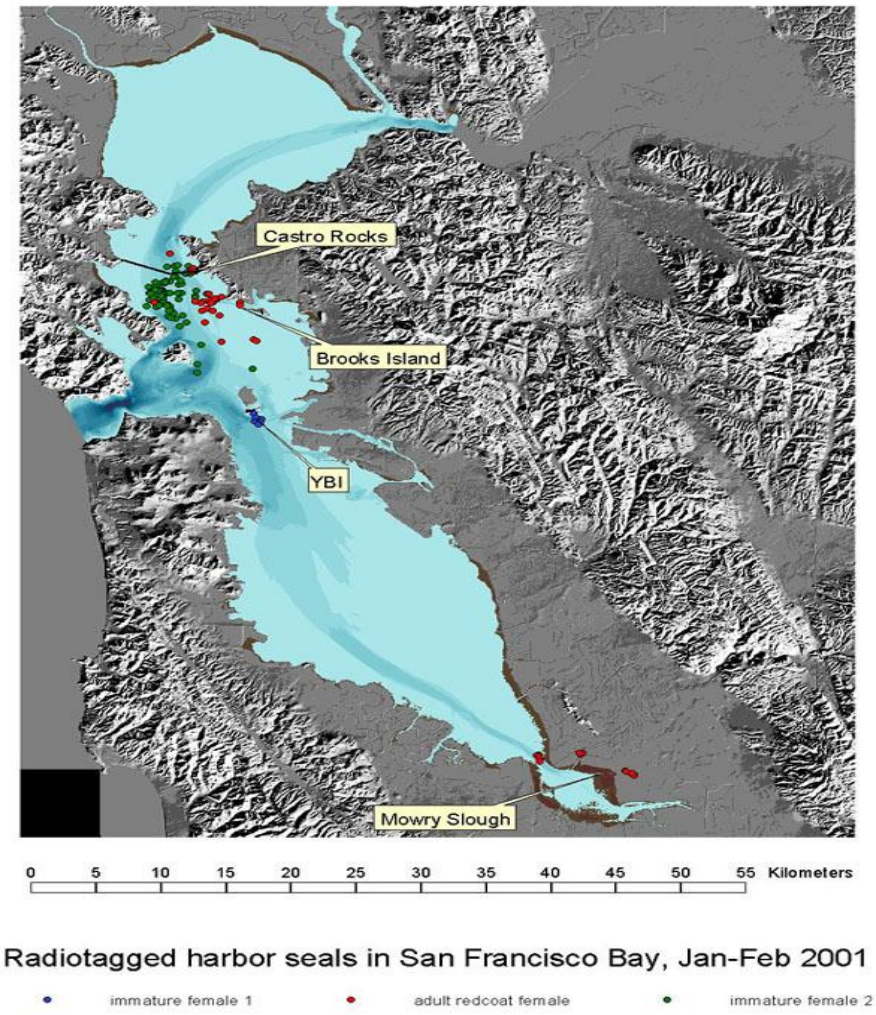
Other CA CEC Studies

- PBDEs and other BFRs in birds, harbor seals, humans (CA DTSC)
- PBDEs in SoCal marine mammals (Keith Maruya, SCCWRP)
- PFCs in sea otters in SF Bay, CA coast (Kannan 2006)
- Pyrethroids in SF Bay, Delta sediments (SFEI, Don Weston)
- Nonylphenol in coastal CA sediments, mussels, small fish (Lars Tomanek, Cal Poly)
- Irgarol in Bay waters near marinas (U of MD, NOAA)
- Endocrine disruption in Bay fish (Kevin Kelley, UC Riverside; Susanne Brander, UC Davis)
- Estrogenic activity in Central Valley waters (Lavado et al 2009)

PFCs in SF Bay Harbor Seals

- Collaboration with The Marine Mammal Center (Sausalito, CA)
- Health of the SF Bay harbor seal population
- PFCs in blood (live captures in 2007/2008)

Seal Haul-Out Sites

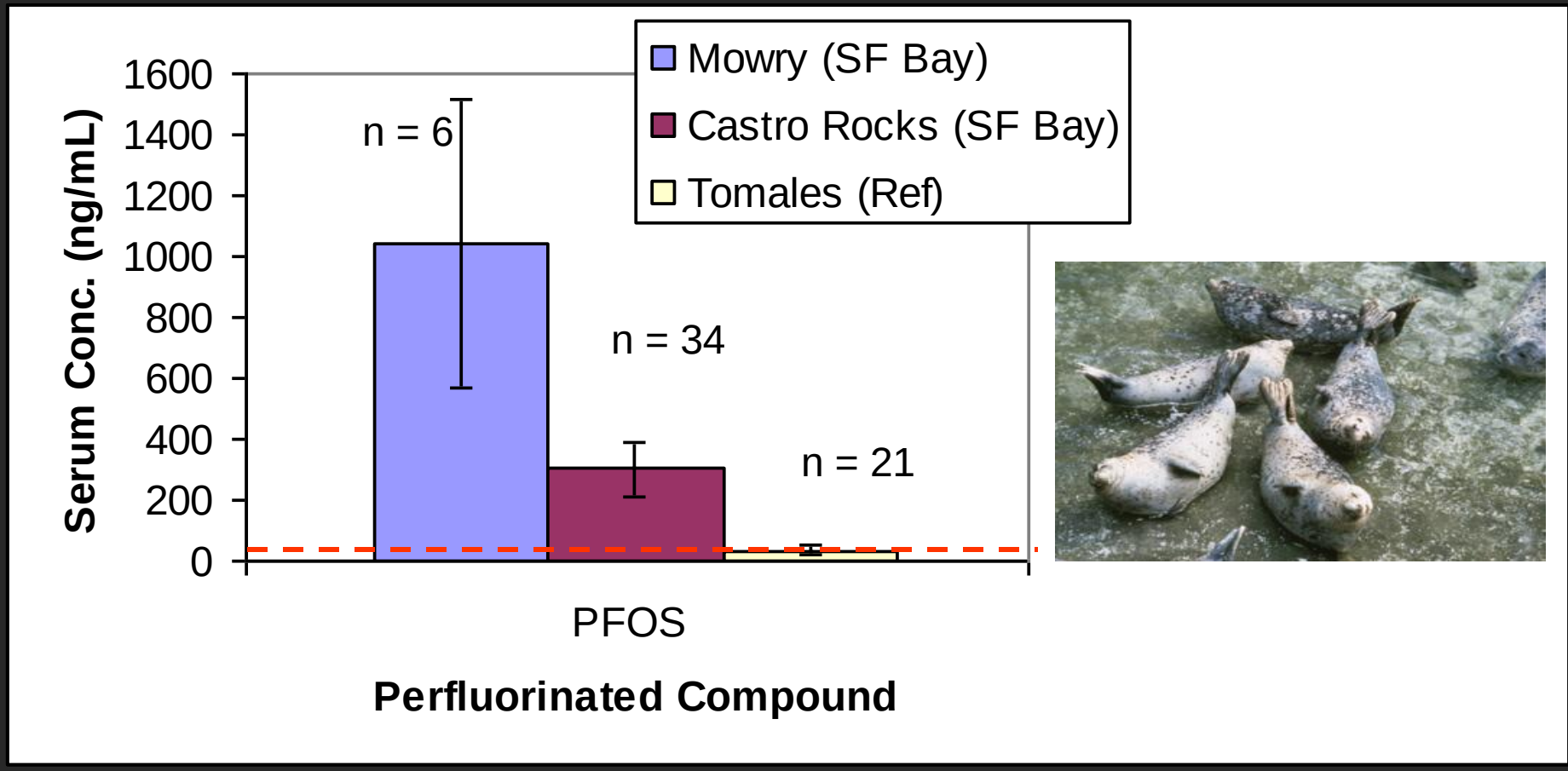


Draft Interim Report to NOAA Fisheries/NMFS, April 2001.
http://userwww.sfsu.edu/~halmark/tagging.htm

Study sites:

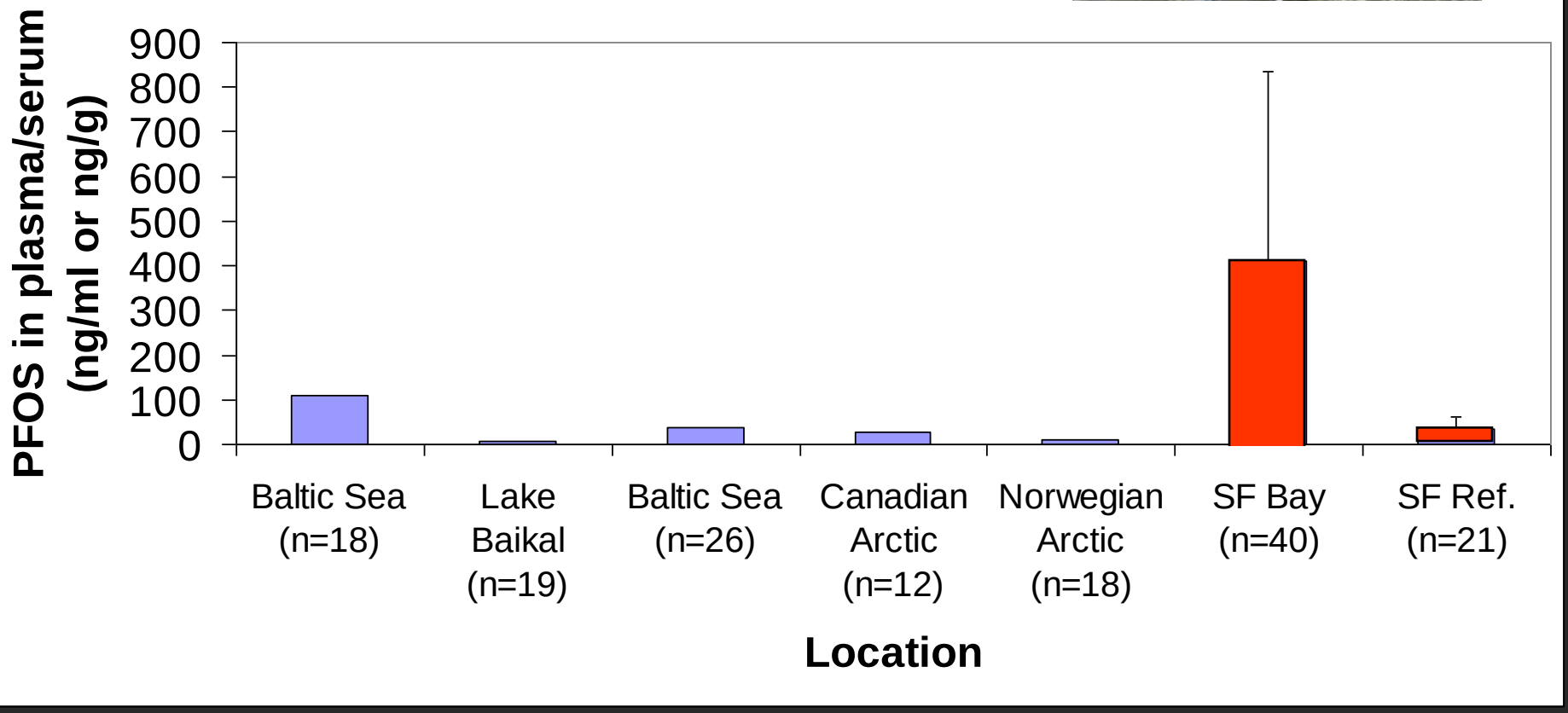
- Castro Rocks
- Mowry Slough
- Tomales Bay (ref)

PFOS Highest in South Bay Seals

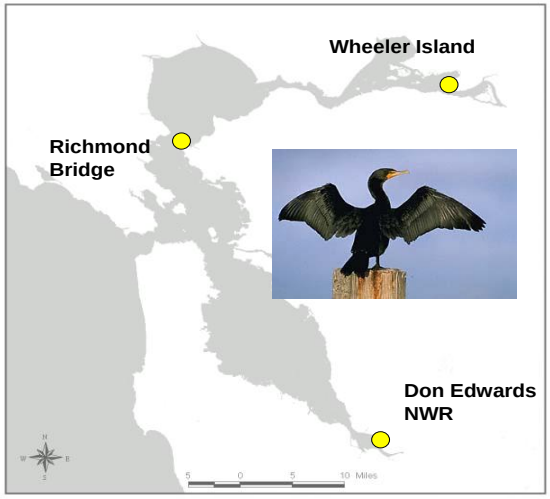


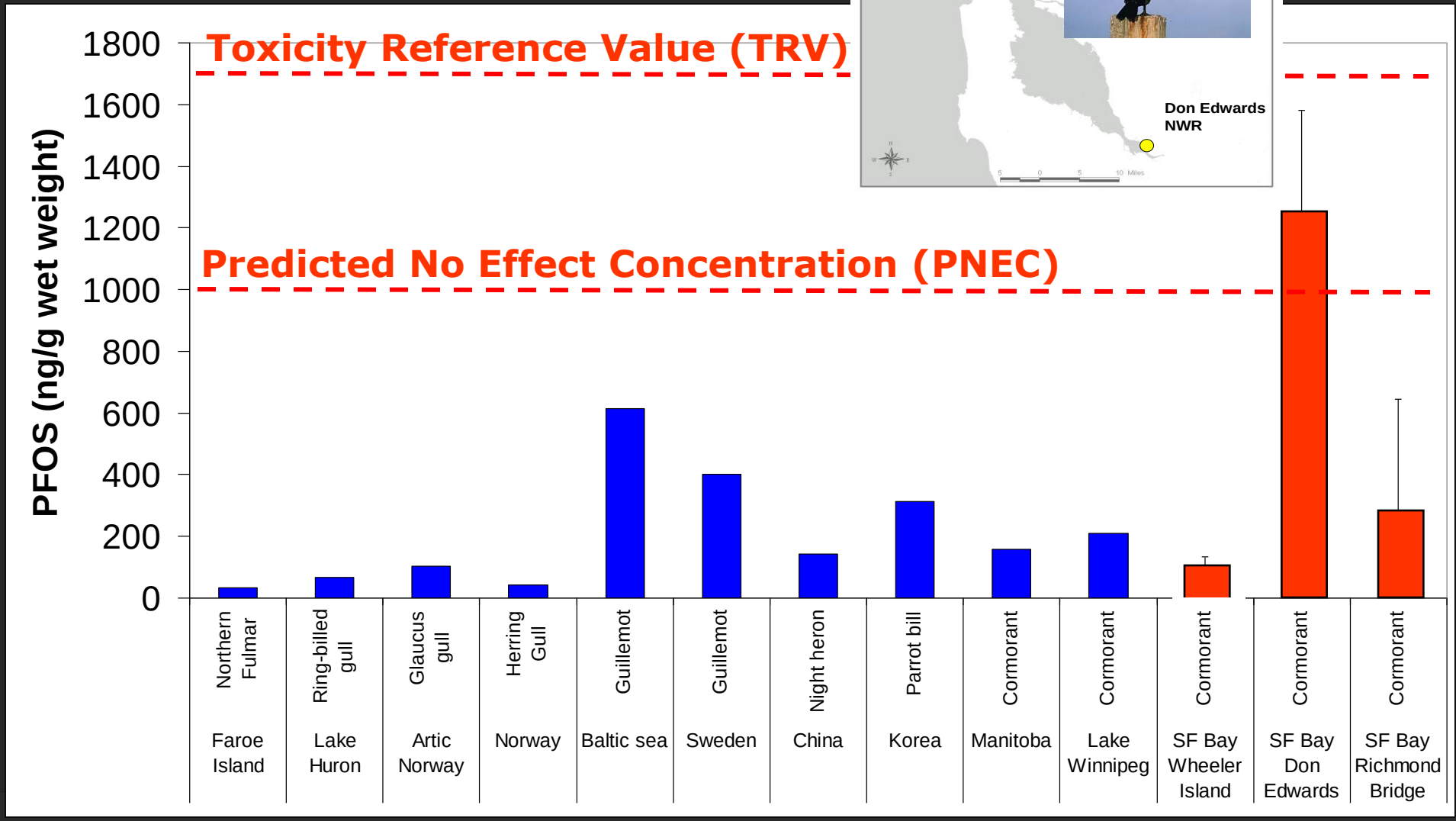
- Mean of US population in 2003-2004 (CDC) : ~20 ng/ml
- Carcinogenic, reproductive effects in lab studies

PFOS in Seal Blood Worldwide



PFOS in Bird Eggs is a Concern





TRV, PNEC from Newsted et al. 2005 Env Sci Technol

Will Have More SF Bay PFC Data Soon

- 2009 sport fish
- 2009 cormorant eggs
- Bivalves from Mussel Watch CA Pilot and AXYS pro bono work
- 2009-2010 RMP Pilot Study: Pathways of PFCs to the Bay
  - ambient surface waters
  - wastewater effluent
  - small fish
  - tributary loadings

Alternative Flame Retardants in San Francisco Bay

Objective:
Measure alternative BFRs in sediments and wildlife

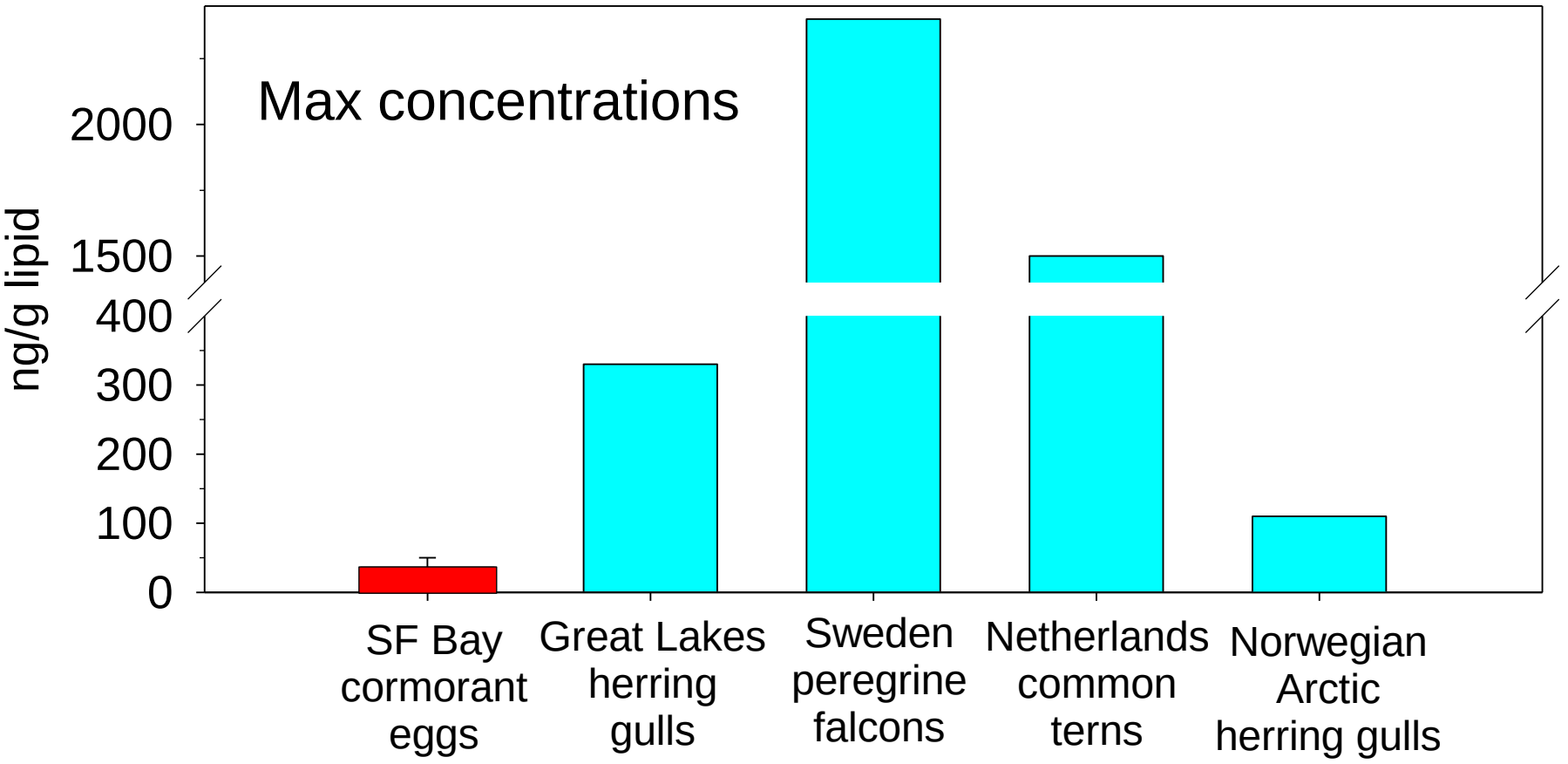
Samples analyzed:
Sediments (n=11, 2007)
Mussels (n=10, deployed 2008)
Sport fish (shiner surfperch and white croaker, n=14, 2006)
Harbor seal blubber (pups n=15, adults n=5, 2007-2008)
Cormorant eggs (one site, n=3 composites of 21 eggs, 2008)

Flame Retardants in Wildlife

PBDEs	Detected
Hexabromocyclododecane (HBCD)	Detected
Pentabromoethylbenzene (PBEB)	Detected
Dechlorane Plus®	Detected
Di(2-ethylhexyl) tetrabromophthalate (TBPH)	Not detected
Tetrabromobenzoate (TBB)	Not detected
Decabromodiphenylethane (DBDPE)	Not detected
1,2-Bis(2,4,6 tribromophenoxy)ethane (BTBPE)	Not detected
Hexabromobenzene (HBB)	Not detected

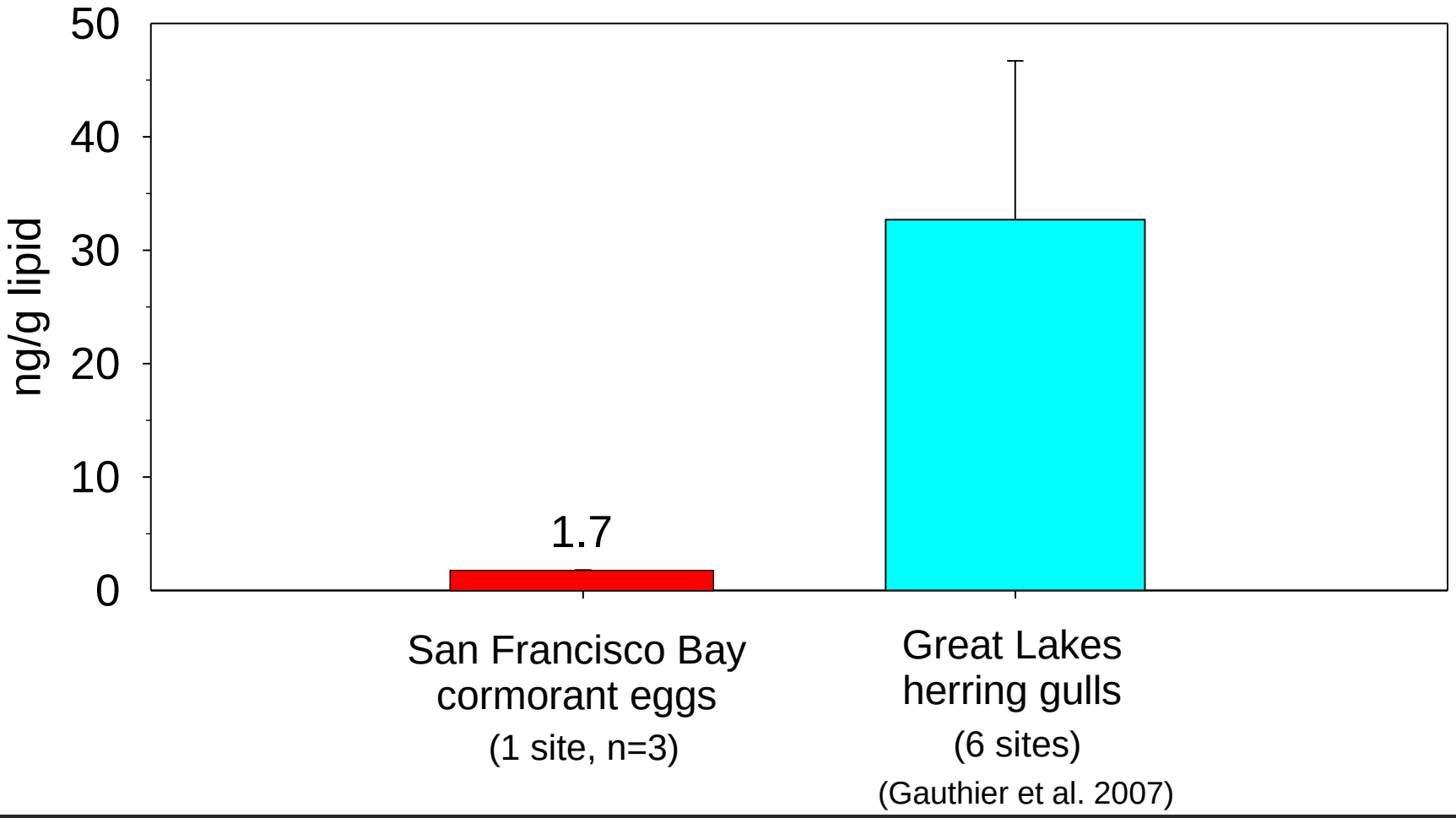
Tris(1,3-dichloropropyl)phosphate (TDCPP) ND in bird eggs

HBCD in SF Bay Bird Eggs Lower than Other Locations

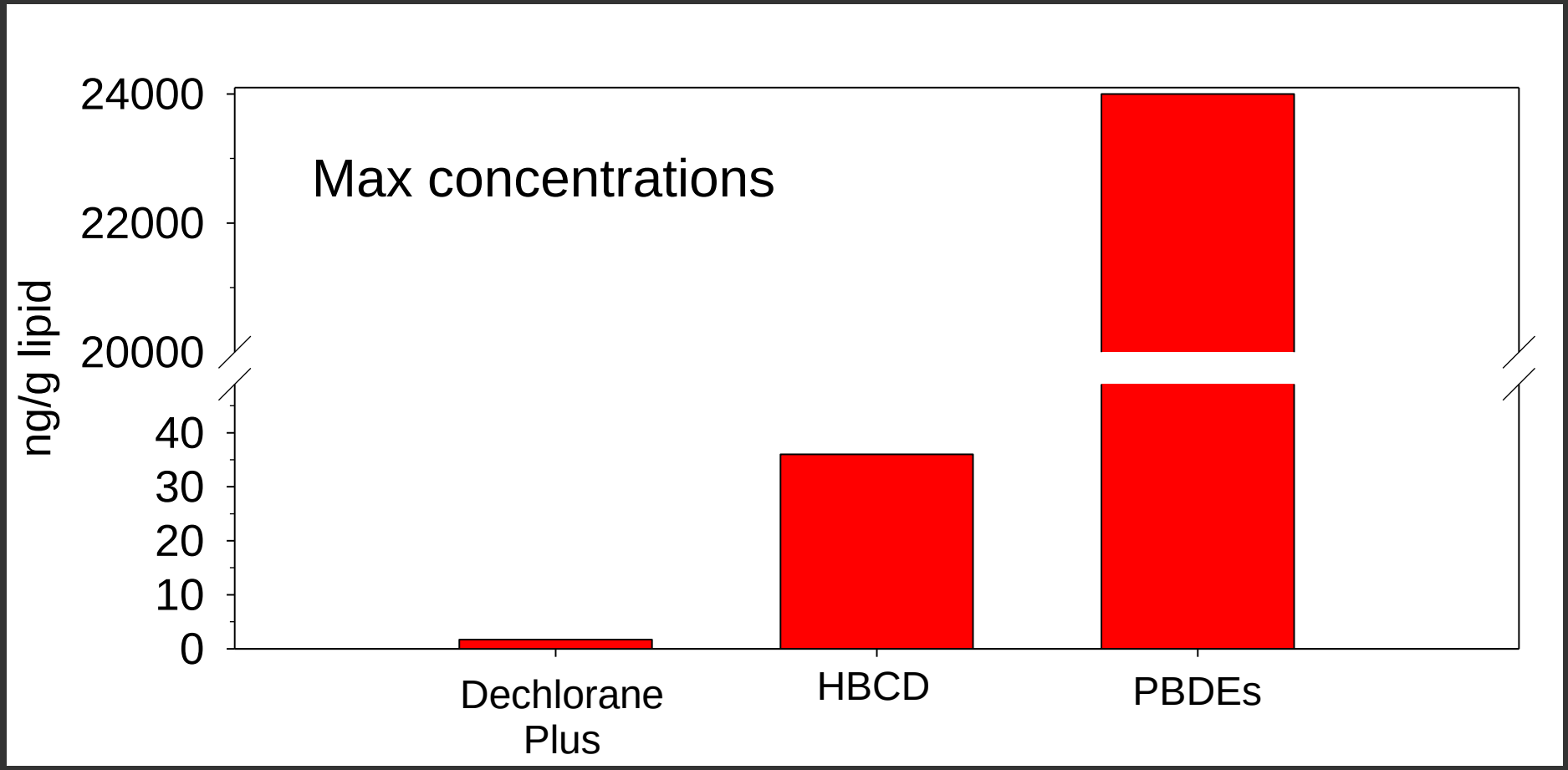


References: Gauthier et al. 2007, Lindberg et al. 2004, Morris et al. 2004, Knudsen et al. 2004

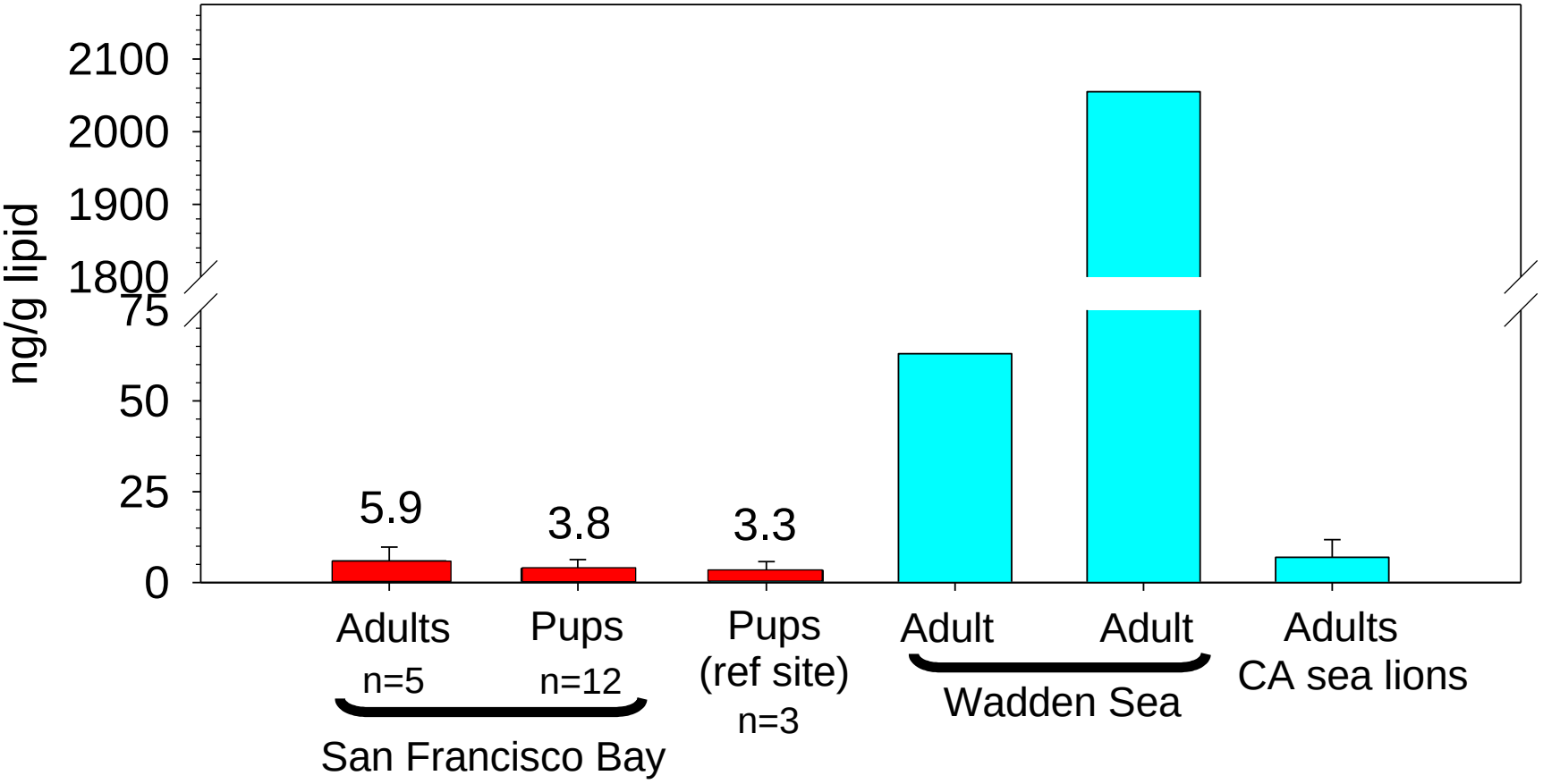
Dechlorane Plus in SF Bay Bird Eggs Lower than Great Lakes Gull Eggs



Dechlorane Plus, HBCD << PBDEs In Bird Eggs

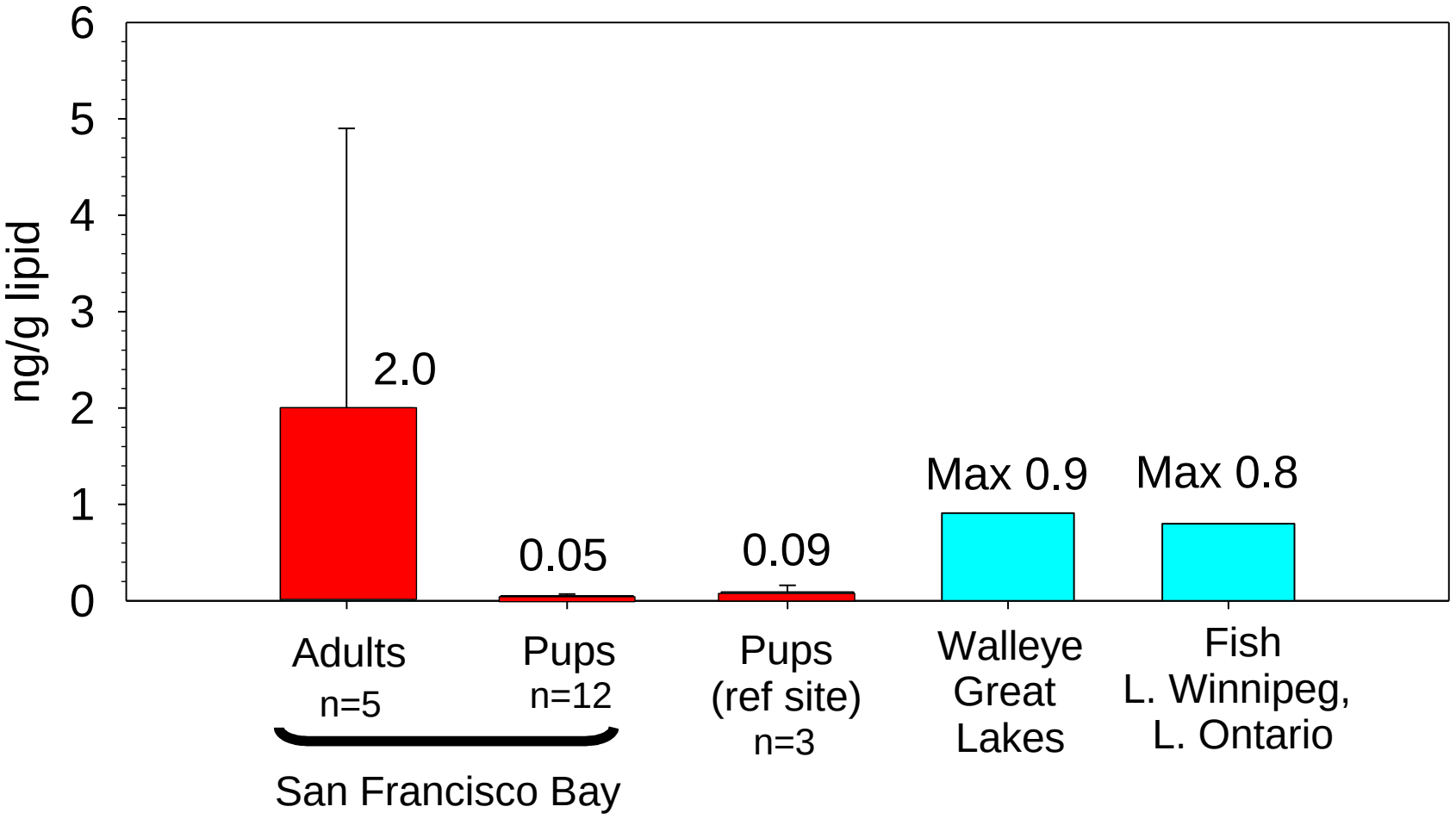


HBCD in SF Bay Harbor Seals Lower than Seals in Europe



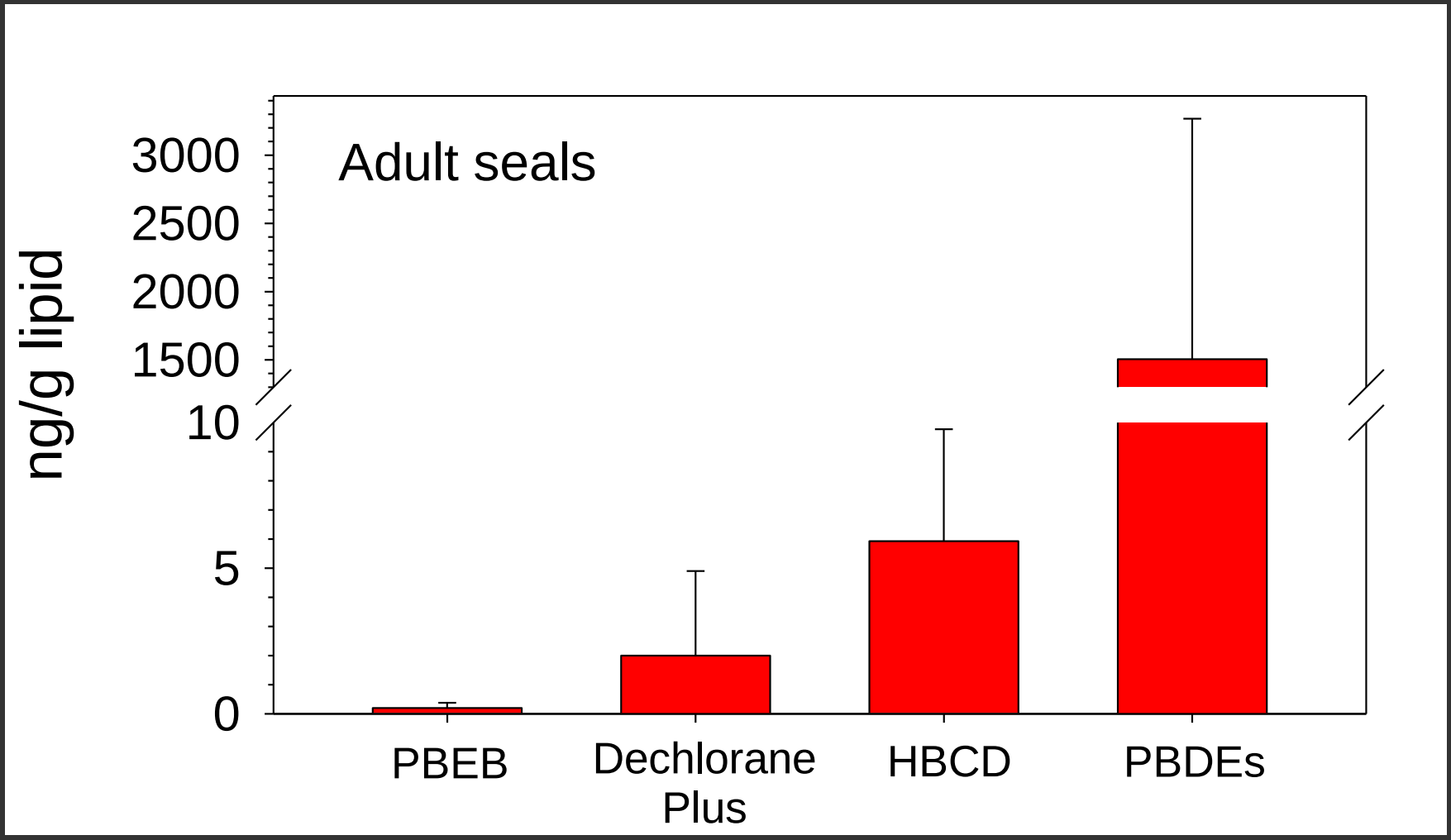
References: Morris et al. 2004, Stapleton et al. 2006

Dechlorane Plus in SF Bay Harbor Seals Comparable to Great Lakes Fish



References: Hoh et al. 2006, Tomy et al. 2007

Dechlorane Plus, PBEB, HBCD << PBDEs In Harbor Seals



On-Going RMP CEC Studies

- Pathways of PFCs to the Bay (2009-2010)
- White paper on select wastewater contaminants (2009-2010)
- Brominated dioxins/furans in sediments, fish, harbor seals (2010)
- Broadscan analysis of bivalves and harbor seal blood, blubber (2010-2011?)
- Extended lists of PFCs, PPCPs, alkylphenol ethoxylates in resident mussels, water, sediment (2010)

Possible Future CEC Studies?

- More endocrine disruption studies
  - estrogen assays?
- Nanomaterials
- Siloxanes

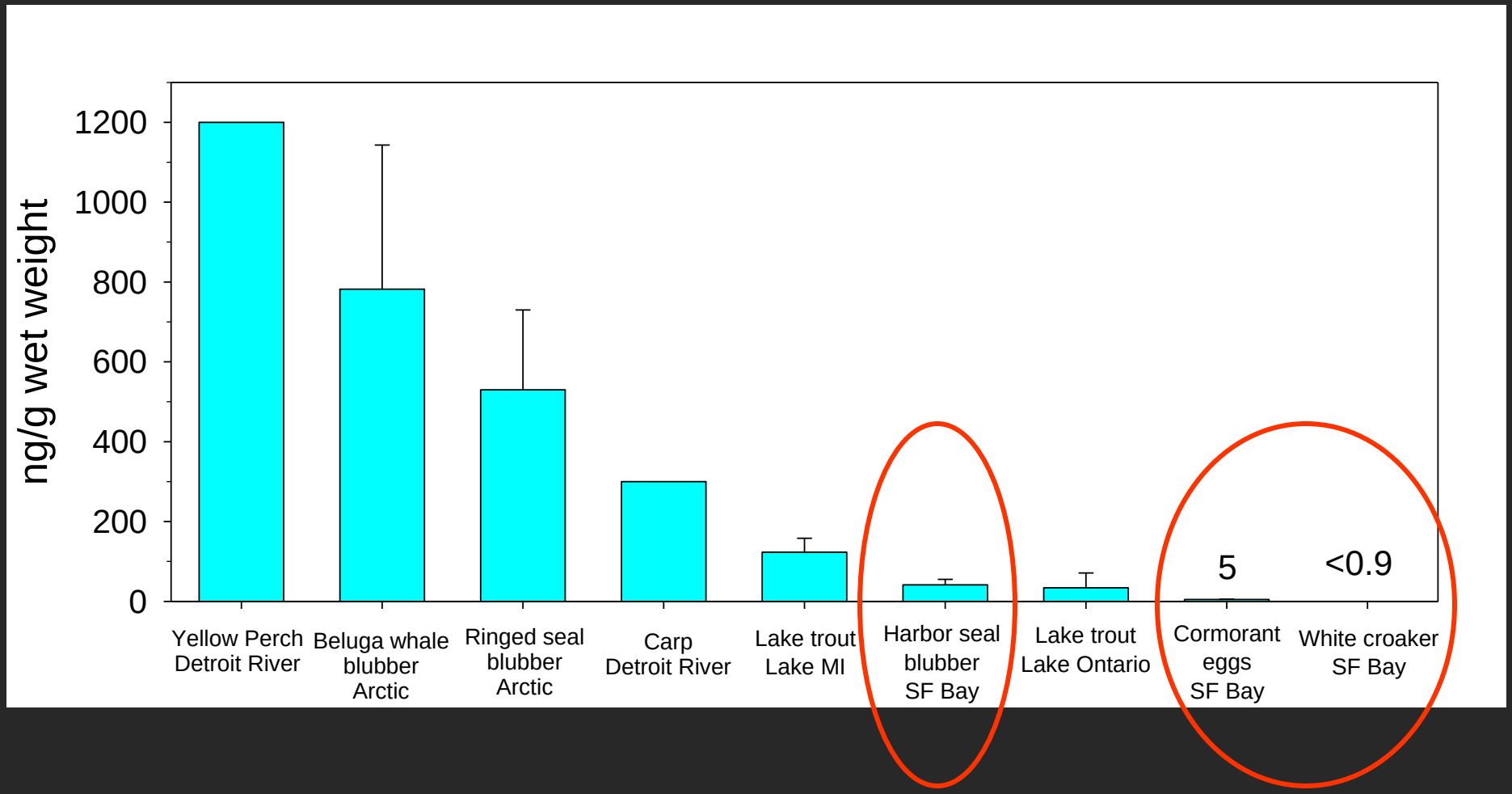
PPCPs in the South Bay

Mean concentration (ng/L)

compound	influent	effluent	Bay
Acetaminophen	60,000	<500	<300
Albuterol	20	2	<20
Caffeine	60,000	40	70
Ciprofloxacin	500	<300	<100
Codiene	200	<200	<200
Cotinine	1,000	30	<20
Diltiazem	200	30	2
Erythromycin Hydrate	200	200	10
Fluoxetine	20	30	<20
Gemfibrozil	1,000	30	10
Ibuprofen	10,000	<100	<100
Lincomycin	20	2	<5
Roxithromycin	3	<4	<1
Sulfadimethoxine	2	1	<200
Sulfamethoxazole	1,000	70	200
Sulfathiziazole	4	<4	<100
Trimethoprim	300	26	1
Warfarin	5	<1	<1

- Influent > Effluent > Bay Water
- Concentrations << available acute, chronic toxicity thresholds

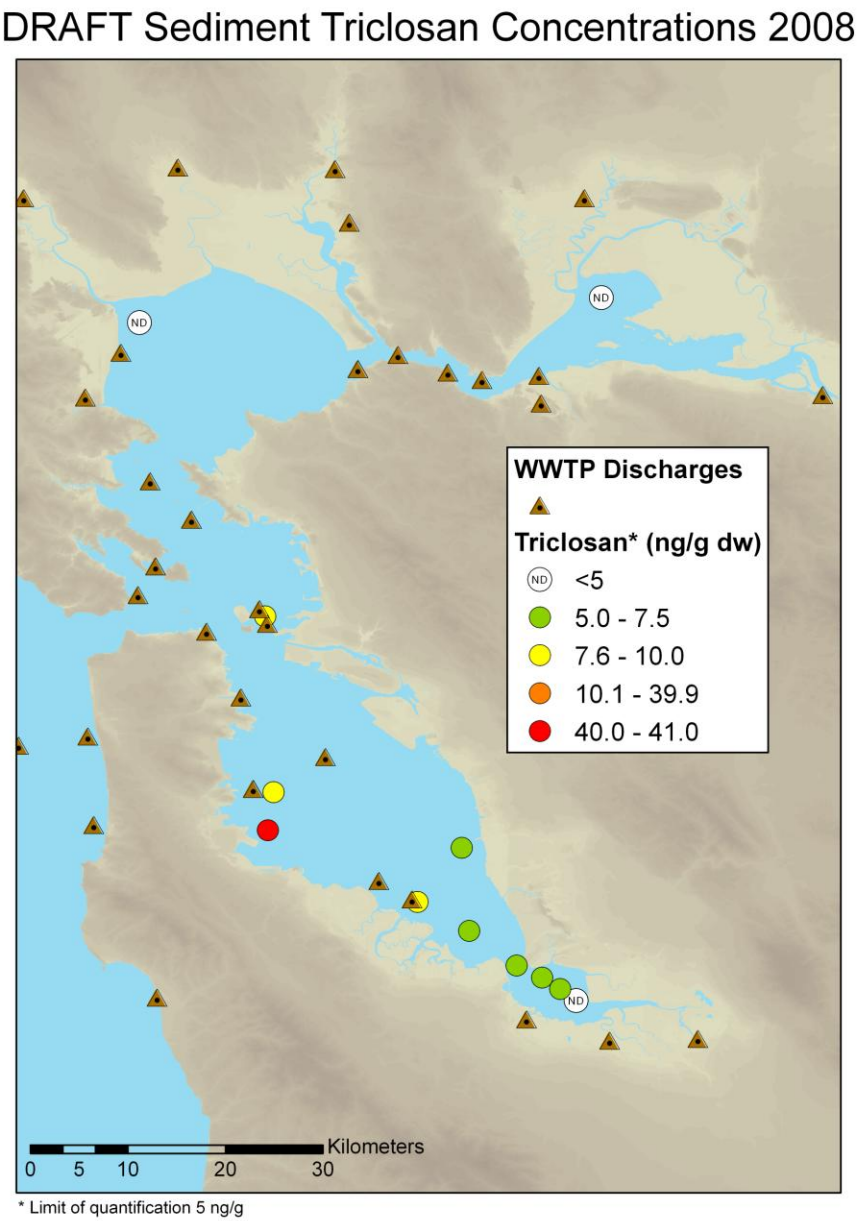
Short-chained Chlorinated Paraffins in SF Bay



- SF Bay samples: Surrogate standard quantifiable in fish only (148, 65 and 119%)
- In-kind analysis provided by Gregg Tomy, Canadian Dept of Fisheries and Oceans

Triclosan in Sediments

- 2008 S&T Monitoring
- Analysis by Rob Burgess, Mark Cantwell (US EPA)



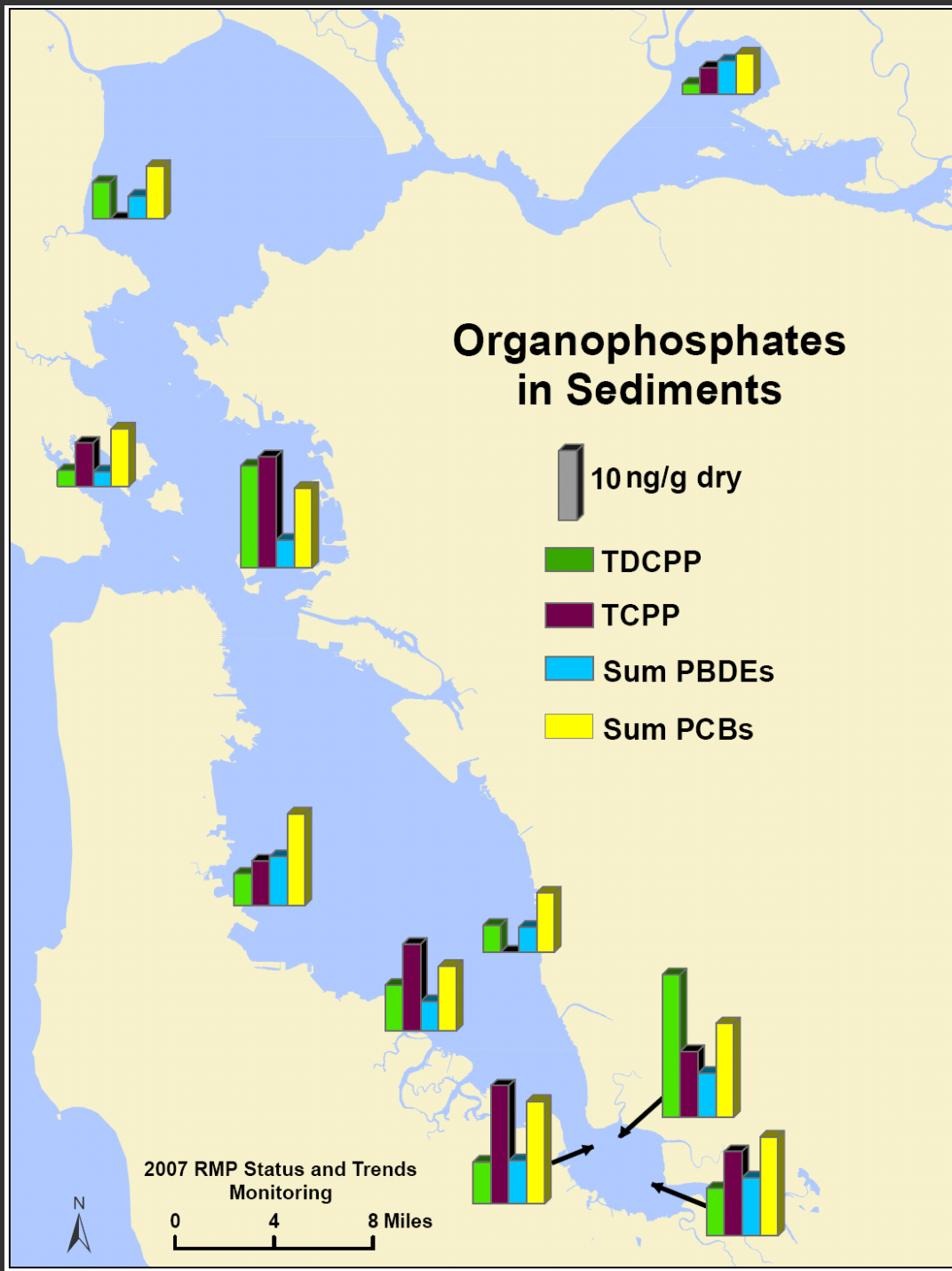
Impact from wastewater-derived contaminants?

White Paper

- 2009 Special Study
- Response to stakeholder concerns
- Which chemicals have the potential to impact human health and aquatic life and should be monitored?
- 'Top 10' compounds of concern
  - Compounds which represent several classes
- Challenge is linking available information to SF Bay
- Use assessment to inform future studies/monitoring

Phosphates are comparable to PBDEs, PCBs in sediment

- TDCPP, TCPP not detected in seals or cormorant eggs
- 1-2 orders of magnitude below draft PNEC (160 ng/g)
- Effects of longterm low level exposure largely unknown



Potentially Persistent PBDE Alternatives

Chemical	Primary Uses
Hexabromocyclododecane (HBCD)	insulation, textiles, thermoplastics
Tetrabromobisphenol-A (TBBPA)	printed circuit boards, thermoplastics
Decabromodiphenylethane (DBDPE)	thermoplastics
1,2-Bis(2,4,6 tribromophenoxy)ethane (BTBPE)	thermoplastics
Pentabromoethylbenzene (PBEB)	textiles, adhesives, coatings, polyurethane foam
Hexabromobenzene (HBB)	thermoplastics?
Dechlorane Plus®	electrical wires/cables, computer connectors, plastic roofing materials
Firemaster 550®	polyurethane foam