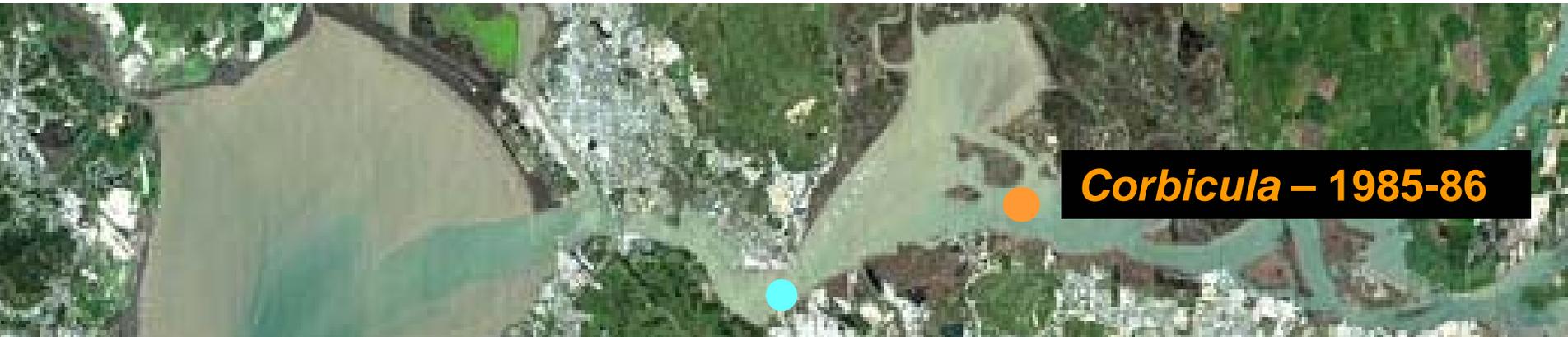
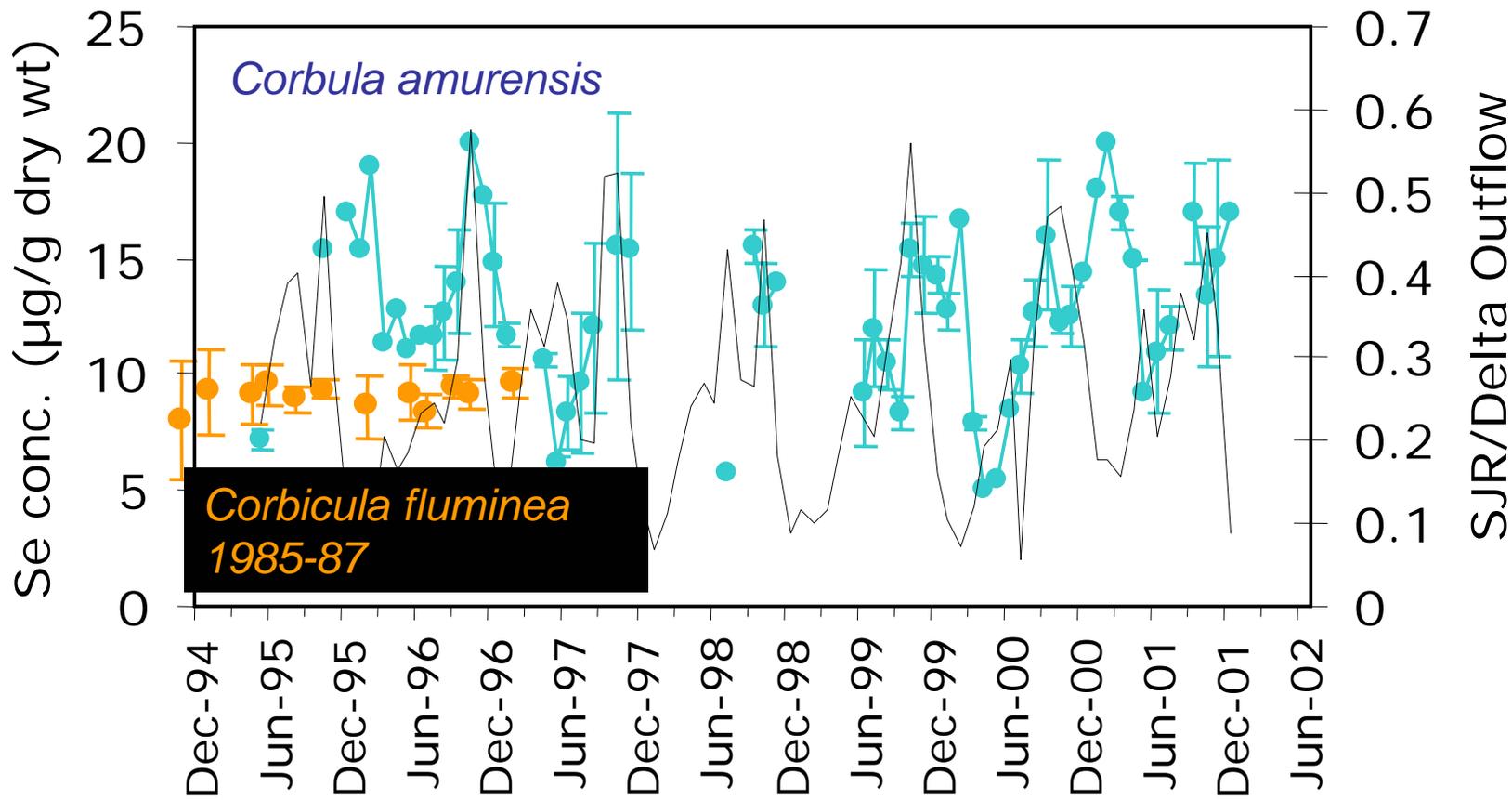


Water Quality in the Bay-Delta:

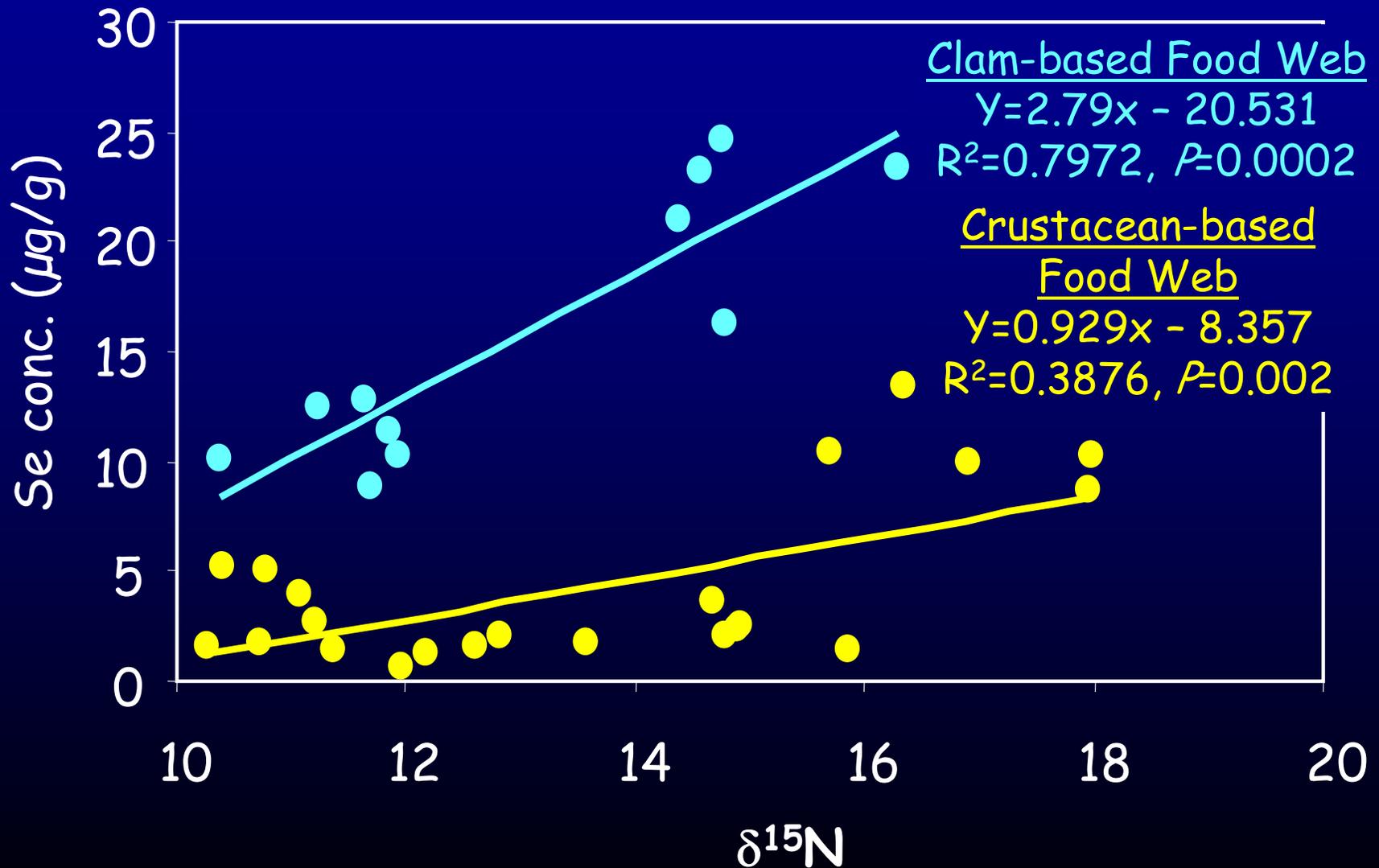
Bioaccumulative Pollutants

Samuel N Luoma, PhD

Selenium

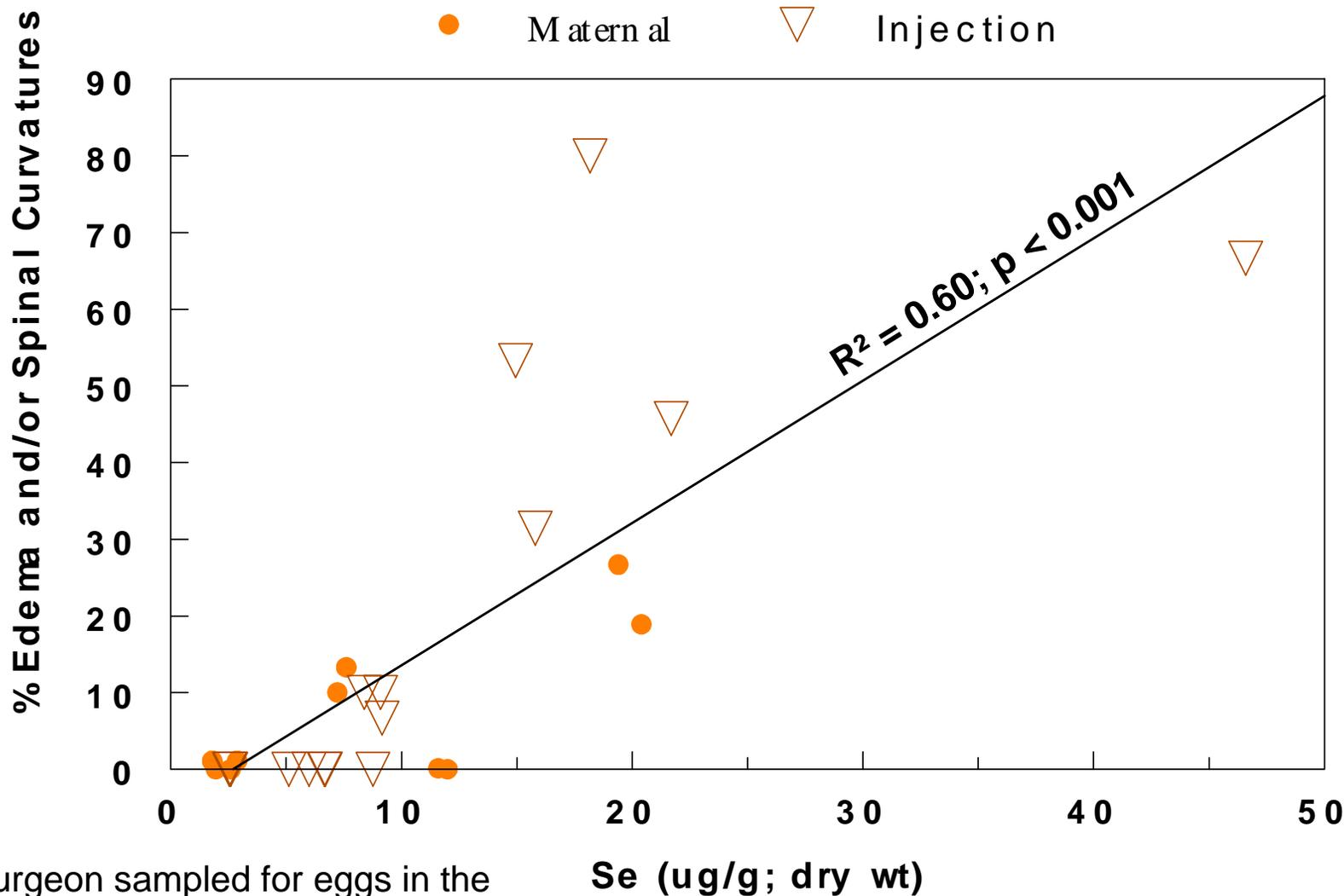


Clam-based Food Web Has a Higher Se Biomagnification Potential than Crustacean Food Web



Effects of Selenium in White Sturgeon Larvae

Maternal and Injection Exposures Combined



Out of six sturgeon sampled for eggs in the 1990's, 4 had eggs ranging from 8 – 12 ppm Se and one had eggs with 29 ppm.

Linville 2007

Dry year/low flow season

SIERRA NEVADA

Sacramento R. 141 *

3-5 *

San Joaquin R.

San Luis Drain
3 Scenarios

COAST RANGES

CENTRAL

VALLEY

Delta

Pumped south

6,800 *

18,700 *

44,880 *

Oil refineries

680 *

San Francisco Bay

* lbs Se/6 months
** Critically dry year average (1986-1998) (lbs Se/6 mos)

Guidelines
($\mu\text{g Se/g dry wt}$)

20-50
Birds
(Scaup liver)

20-50
Fish
(Sturgeon liver)

10-40
Clams

1.5-4
Particulates

($\mu\text{g Se/L}$)
1-5
Water

1,557

664

261

519

221

87

163

70

28

36

15

6.2

2.1

5.1

12*

Selenium concentrations in the food web
($\mu\text{g Se/g dry wt}$)

K_d Partitioning coefficient (3×10^3)

AE Assimilation efficiency (0.55)

* Concentrations ($\mu\text{g Se/L}$) in the North Bay near the site of input (i.e., head of estuary) with instantaneous mixing.

Mercury

Mercury has known effects on contamination of the human food chain and environmental justice.

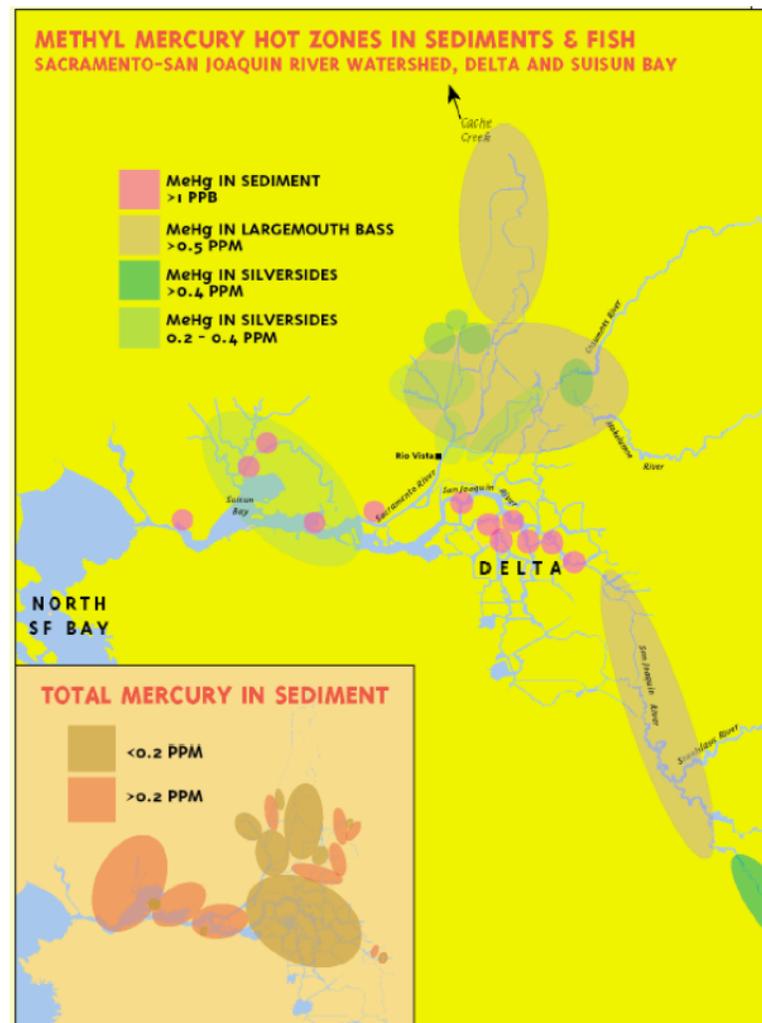
Effects on species less certain; Evidence it impedes recovery of clapper rail in South Bay... (Schwartzbach et al 2006)

- Loss of habitat is the first order cause of the decline (90% of suitable marsh lost)
- Elimination of other stressors is essential to preserving the remnant populations
- Reproductive potential of the clapper rail was found to be 'much reduced over natural potential' (7 eggs/nest yield 1.9 – 2.5 chicks, after predation).
- histopathology typical of chemical contamination; Other chemicals eliminated as causes;
- Hg = 0.5 – 12.9 $\mu\text{g/g dw}$; 50% of eggs > 2.5 $\mu\text{g/g dw}$

Mercury monitoring is essential. (Delta Vision)

Mercury

UC Davis



Although mercury is found at levels of concern throughout the Bay-Delta system monitoring of sport fish (Largemouth Bass) and prey species (Silversides) indicate that methylmercury production is highest in Delta tributaries. (CALFED Science Program 2005)

Mercury

Stewart et al, in review

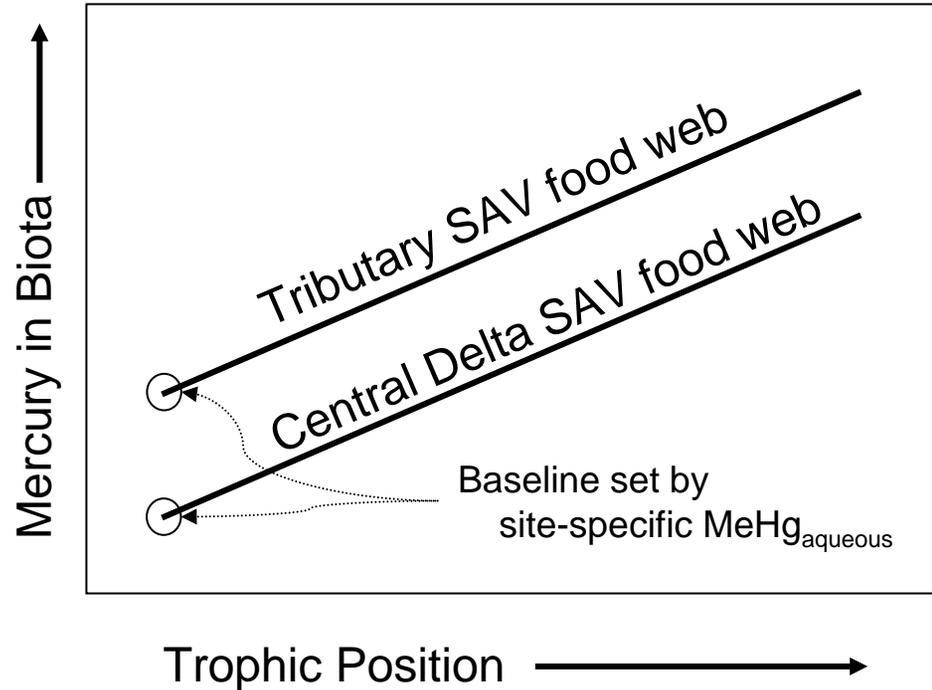


Figure 1. Schematic showing similar patterns of increasing mercury concentrations in biota with increasing trophic position (biomagnification) in submerged aquatic vegetation (SAV) food webs in the tributaries and central delta. Relative differences observed among biota at any trophic level among different locations appear to be determined at the base of the food web and are correlated with site-specific aqueous MeHg concentrations.

Legacies

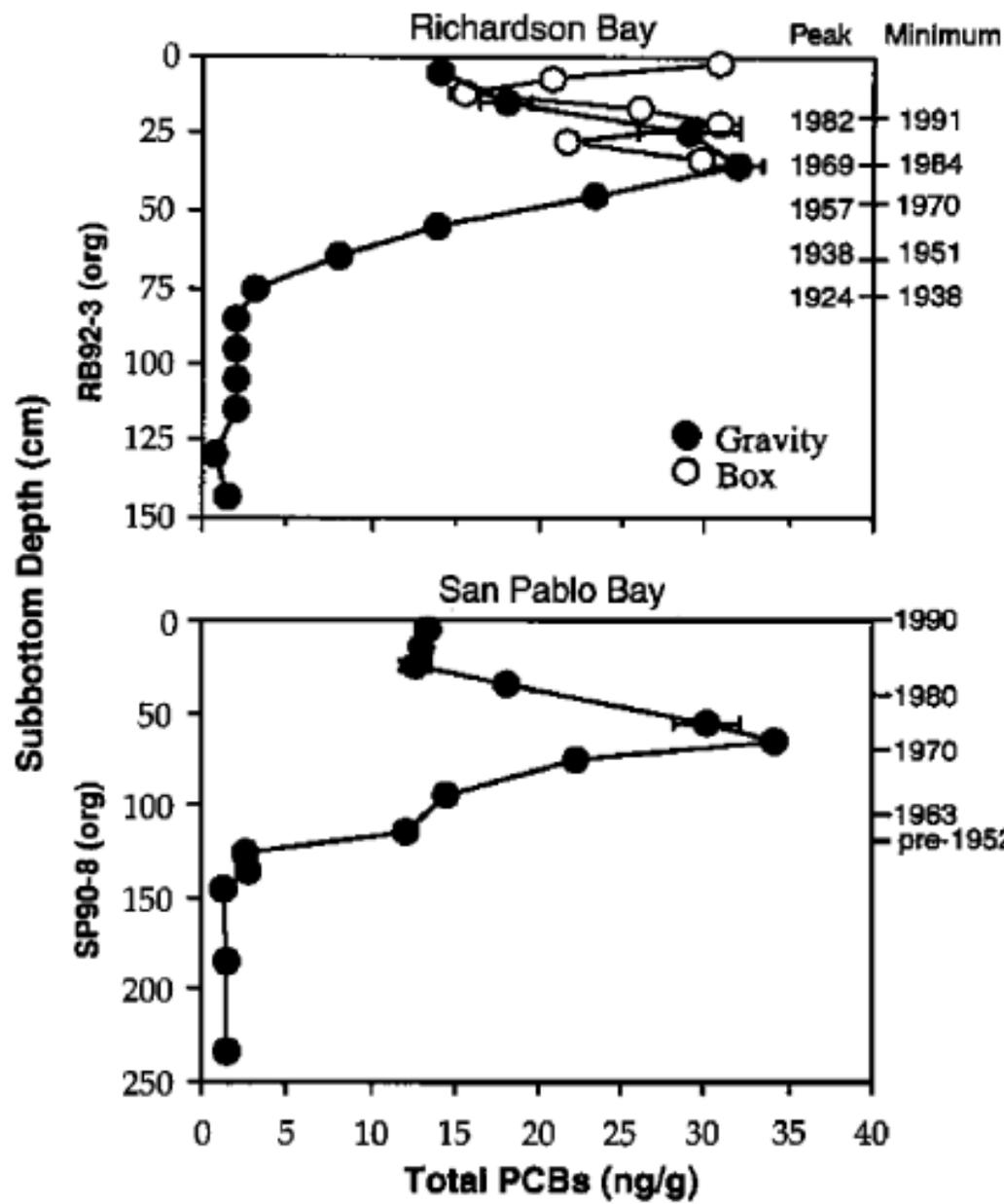


Fig. 10. PCB concentrations in sediment cores from San Francisco Bay. From Venkatesan et al. (1999). RB92-3 from Richardson Bay (near Alcatraz) and SP90-8 from San Pablo Bay.

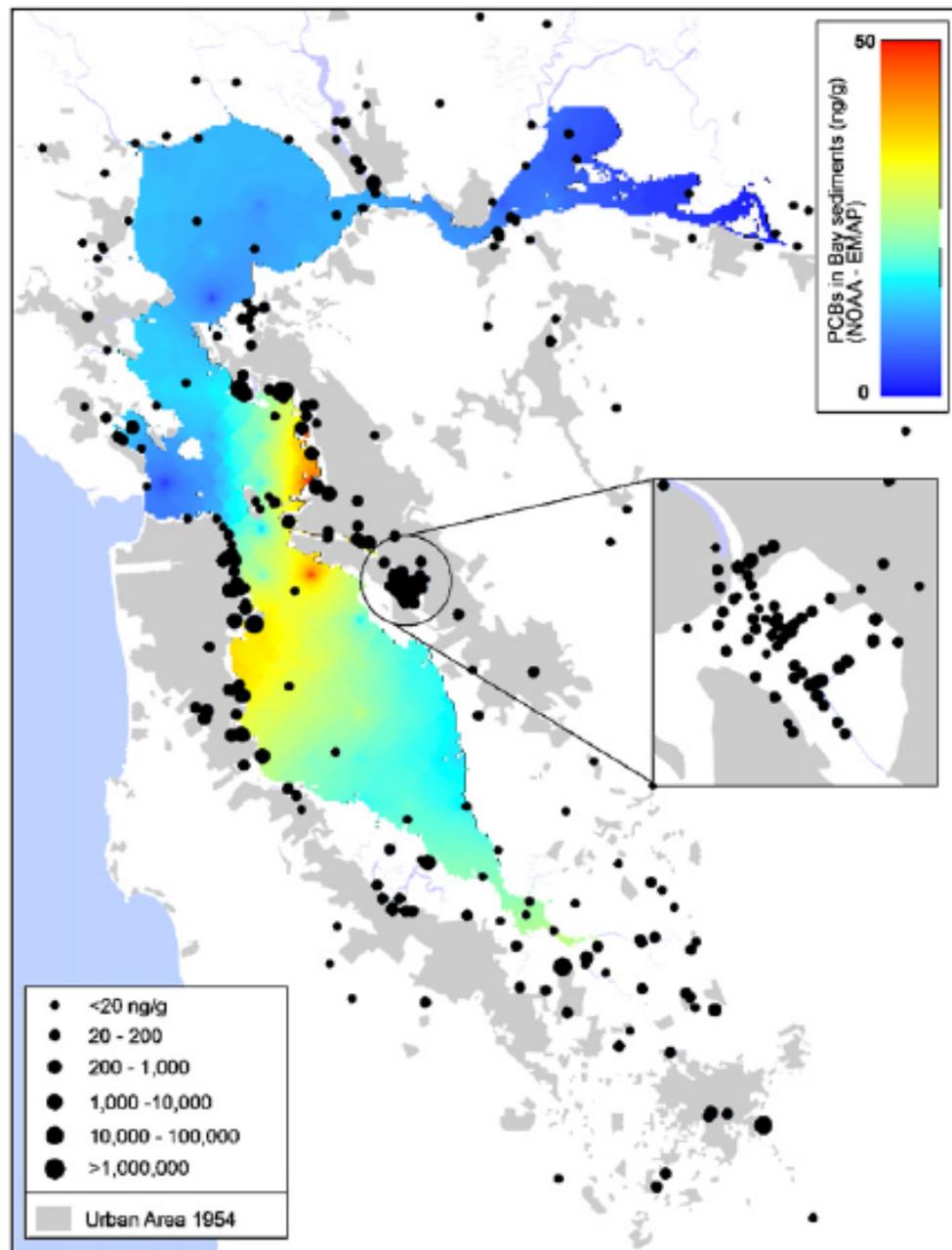


Fig. 5. Average PCB concentrations in Bay Area sediment. Shading in the Bay based on the 2000 and 2001 NOAA-EMAP survey (USEPA, 2001).

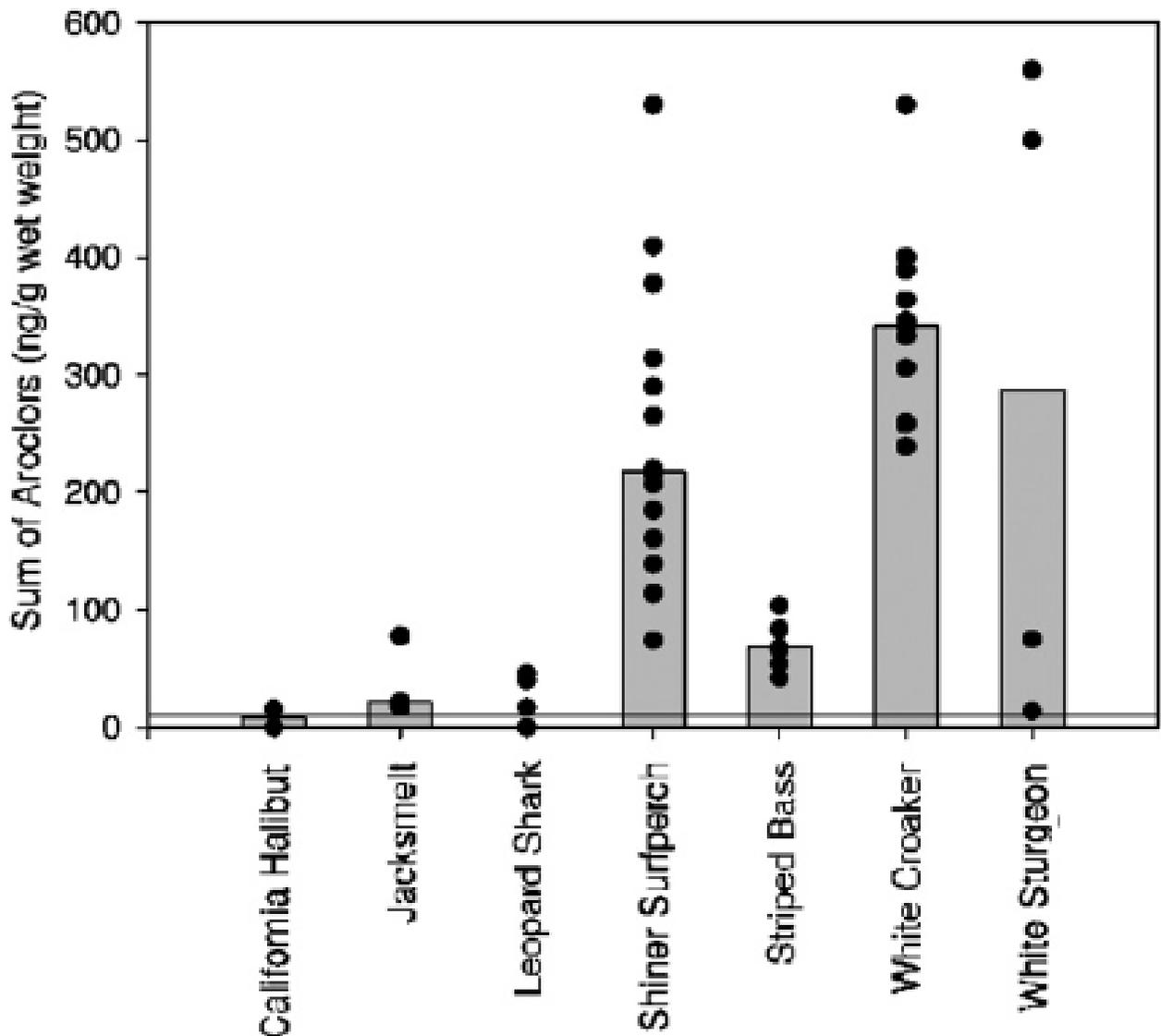
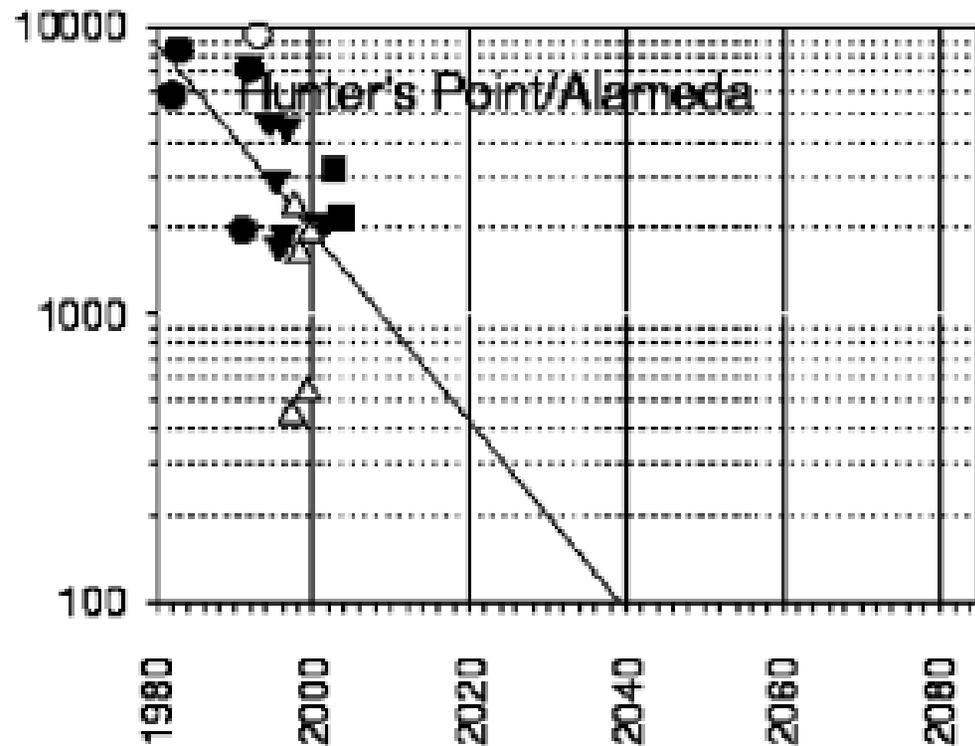
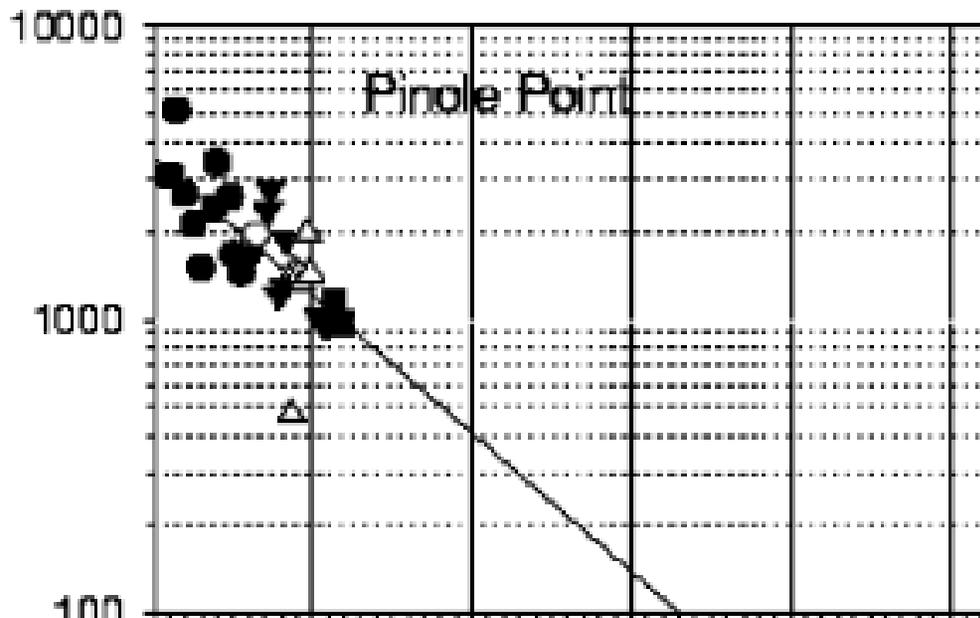
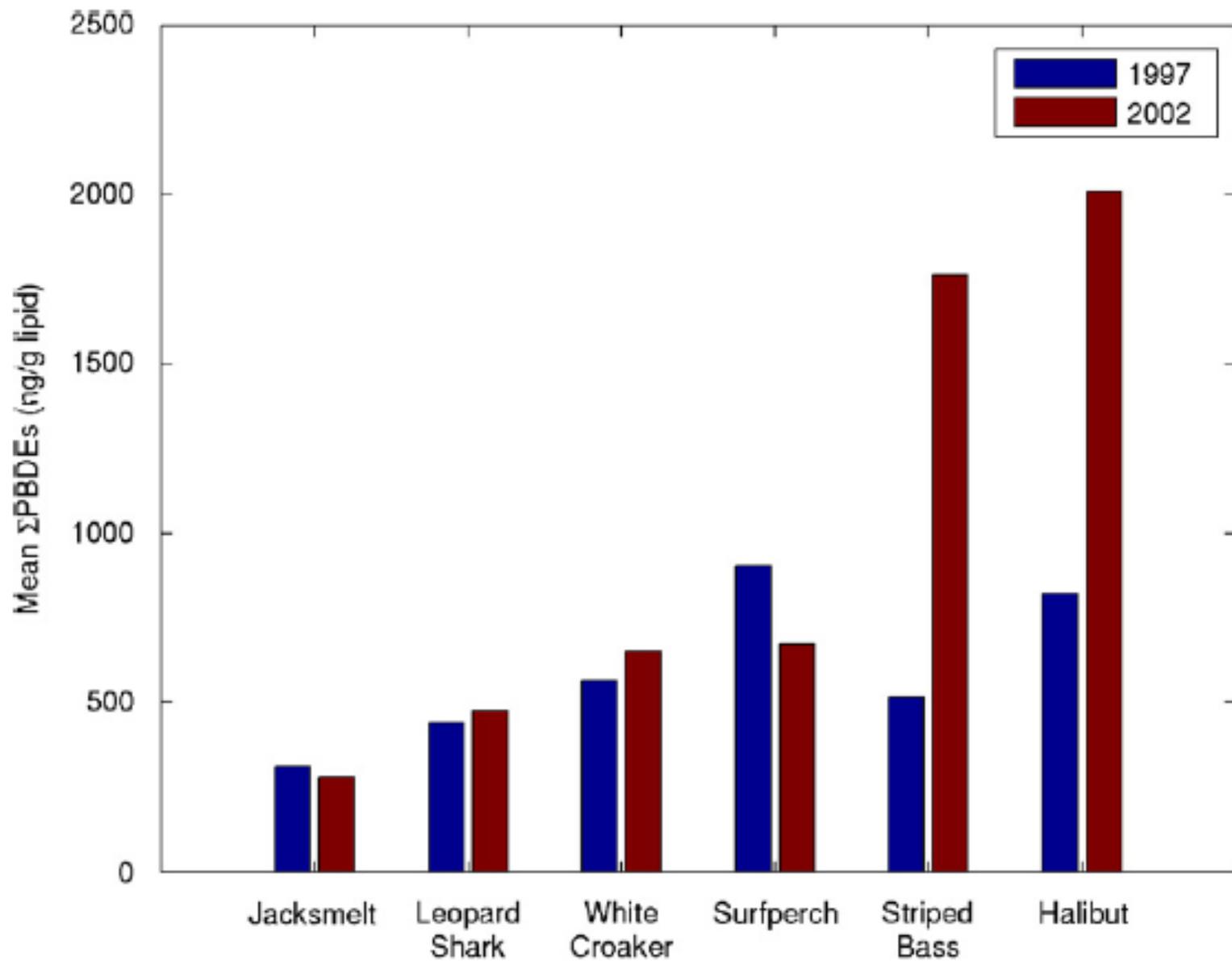


Fig. 4. PCB concentrations (as Aroclors) in San Francisco Bay sport fish, 2003 (Davis et al., 2006). Bars show medians, points are individual samples representing composites of multiple fish. Line indicates TMDL sport fish target of 10 ng/g.

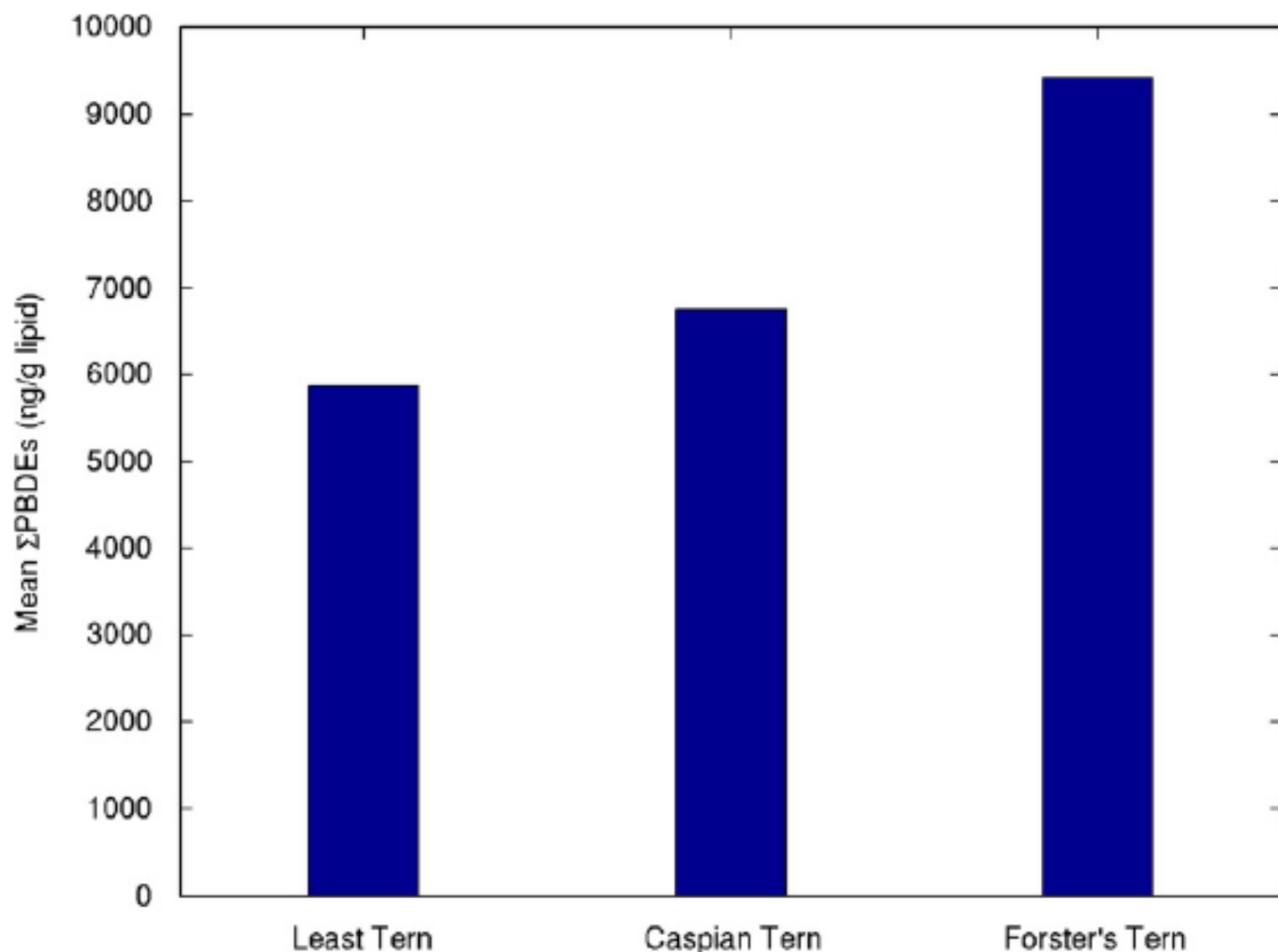
PCB
(ng/g lipid in
mussels,
M. edulis)



Emerging Contaminants

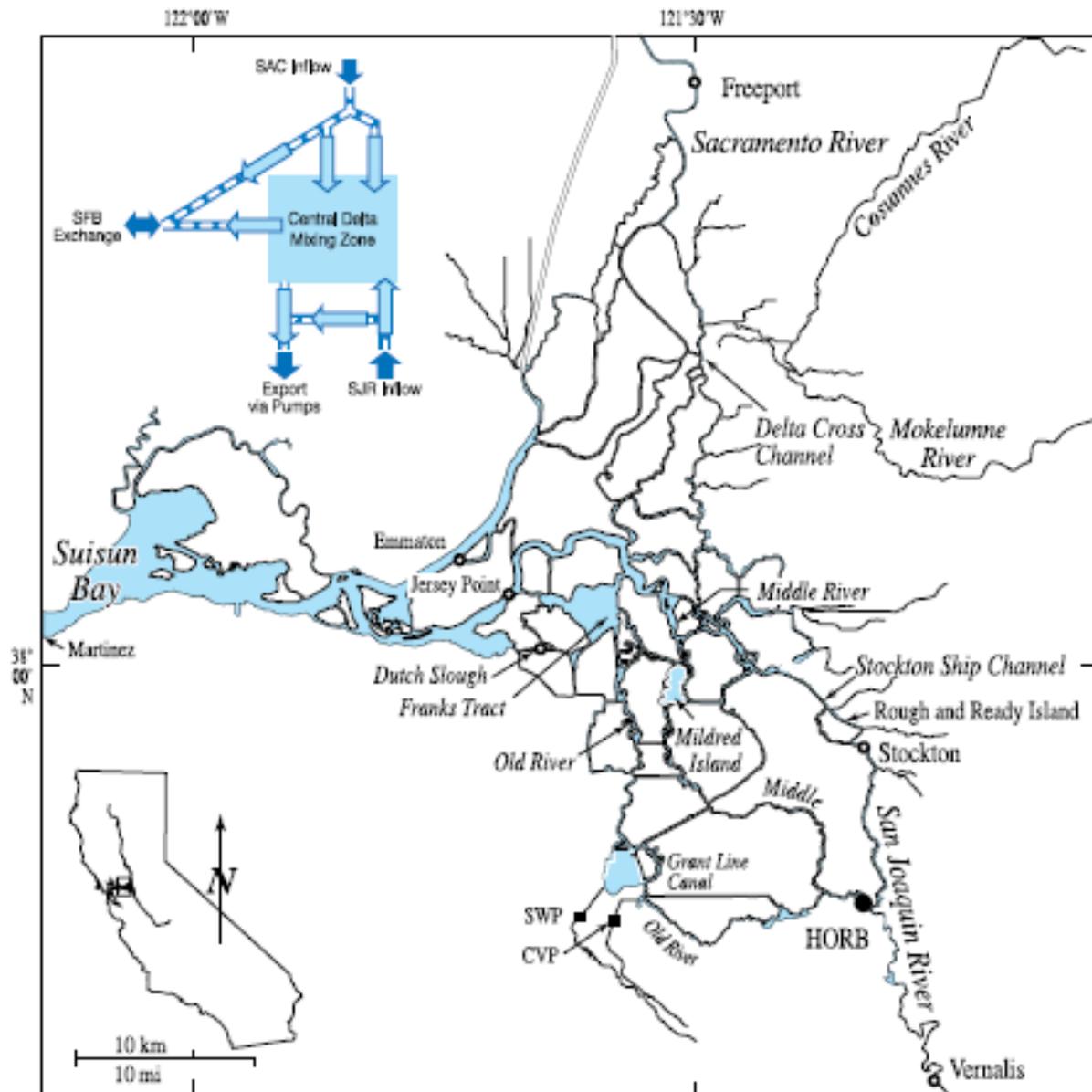


Mean PBDE concentrations in San Francisco Bay fish (*source: Holden et al., 2003; SFEI, 1999*). Striped bass and halibut show significant increases in their total PBDE tissue concentrations between 1997 and 2002.



concentrations in San Francisco Bay Tern Eggs (*source*: She et al., 2004). The highest concentrations found in San Francisco Bay Forster's tern eggs (63 ppm).

Infrastructure



Monsen et al
2007

Figure 2. Map of the Sacramento-San Joaquin Delta. Inset: Schematic illustrating the base flow routes through the Delta.

The mean concentration measured in three composite samples (10–15 fish in each) in 1965 was 830 ng/g wet (as Aroclors). In comparison, the Bay-wide median concentration measured in 2003 (Davis et al., 2006) was 220 ng/g wet (as Aroclors), suggesting a reduction of approximately 74% over this 38-year span.

Concentrations in shiner surfperch over the past 9 years have shown no clear pattern of decline (Fig. 6—expressed as sums of congeners). Davis et al 2006

Effects of changing operations &/or infrastructure

Monsen, Cloern and Burau, 2007, *SFEWS*

- *Transport routes change*
- *Source mixtures change*
- *Flushing times change*

Table 1. Water quality comparison between the Sacramento River, San Joaquin River, and In-Delta Agricultural Return water for water years 1999-2001.

Monsen et al 2007

Water Quality Parameter	Sacramento at Freeport ¹	San Joaquin at Vernalis	In-Delta Agricultural Return Water ²
Specific Conductance	144 ± 28	621 ± 183	562 ± 206
Alkalinity (mg CaCO ₃ L ⁻¹)	55 ± 12	85 ± 24	83 ± 18
Nitrite+Nitrate (mg N L ⁻¹)	0.12 ± 0.05	1.62 ± 0.59	
Dissolved Organic Carbon (mg C L ⁻¹)	1.84 ± 0.53	2.83 ± 0.47	14.1 ± 7.7
Total Dissolved Selenium ³	0.07 ng/l	0.6 – 6 ng/L	Negligible ⁴

“If the major water projects ultimately route water around the Delta, the remaining Delta water sources will have a proportionately increased influence on Delta water quality.”

Delta visions

Reduction of export pumping decreases the proportion of Sacramento River water in the central Delta...Monsen et al 2007

Changing Delta conveyance may reduce or eliminate the “incidental benefit” of current through-Delta conveyance, whereby high quality water moving through the central Delta dilutes many tributary and in-Delta sources of pollutants. Delta visions