



PAHs in Bay surface waters:
A comparison of pre- and post-
Cosco Busan oil spill data

RMP TRC meeting March 10, 2009

SCAT Map Nov. 19

● Heavily impacted sites



The Oil

- Bunker C/No. 6 fuel oil; Intermediate Fuel Oil (IFO 380)
- Residual fuel (98%) and distillate/diesel (2%)
- 'Floating oil'
- Very little expected to disperse in water column initially
- Shoreline is secondary source of subsurface oil (tar balls)



Photo: Chris Reddy

Table 10-3 Homo- and Heteroatomic PAH Composition for 71 Worldwide IFO 380 Heavy Fuel Oils (Concentrations in µg/kg)

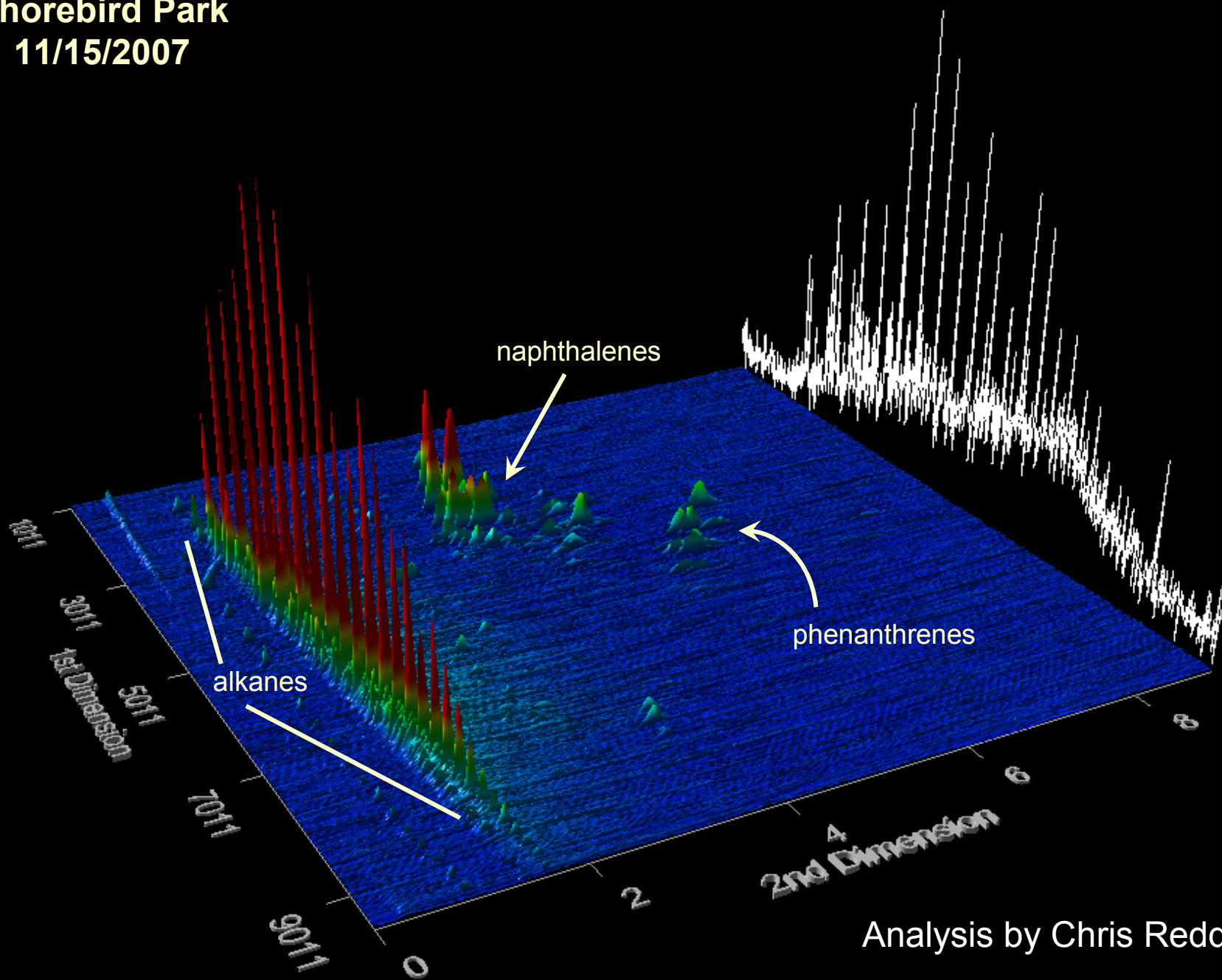
	<i>Abvr</i>	<i>Min</i>	<i>Max</i>	<i>95th</i> <i>percentile</i>	<i>Mean</i>	<i>Std Dev</i>	<i>% CV</i>
Naphthalene	N0	108	9,502	3,263	2,129	1,255	59%
C1-Naphthalenes	N1	635	11,296	8,295	5,334	2,210	41%
C2-Naphthalenes	N2	671	10,839	10,085	5,881	2,220	38%
C3-Naphthalenes	N3	504	6,309	5,265	2,927	1,168	40%
C4-Naphthalenes	N4	291	2,823	2,215	1,141	533	47%
Biphenyl	Bph	19	1,731	481	295	215	73%
Acenaphthylene	AcI	ND	ND	NA	ND	ND	NA
Acenaphthene	Ace	20	1,334	325	195	154	79%
Dibenzofuran	DbF	7	215	161	85	40	47%
Fluorene	F0	31	665	311	150	92	61%
C1-Fluorenes	F1	77	767	560	270	145	54%
C2-Fluorenes	F2	146	1,252	874	441	222	50%
C3-Fluorenes	F3	182	1,442	789	438	228	52%
Anthracene	AN	9	120	89	47	21	46%
Phenanthrene	P0	7	1,025	735	358	196	55%
C1-Phenanthrenes/Anthracenes	P1	305	3,515	1,874	1,022	586	57%
C2-Phenanthrenes/Anthracenes	P2	504	5,718	2,542	1,329	831	62%
C3-Phenanthrenes/Anthracenes	P3	398	4,401	2,065	1,013	644	64%
C4-Phenanthrenes/Anthracenes	P4	169	1,870	872	451	265	59%
Dibenzothiophene	D0	19	324	190	83	55	66%
C1-Dibenzothiophenes	D1	86	1,049	536	250	153	61%
C2-Dibenzothiophenes	D2	144	2,002	877	374	275	73%
C3-Dibenzothiophenes	D3	196	1,654	795	348	231	66%
C4-Dibenzothiophenes	D4	104	744	408	190	118	62%
Fluoranthene	FL	5	65.5	40	20	10	50%
Pyrene	PY	25	469	243	125	75	60%
C1-Fluoranthenes/Pyrenes	FP1	100	1,807	630	350	257	73%
C2-Fluoranthenes/Pyrenes	FP2	174	2,718	780	481	370	77%
C3-Fluoranthenes/Pyrenes	FP3	101	2,187	639	373	280	75%
Benz[a]anthracene	BaA	8	275	91	47	33	69%
Chrysene	CO	20	479	156	84	56	67%
C1-Chrysenes	C1	69	1,820	557	303	218	72%
C2-Chrysenes	C2	94	1,893	732	344	242	70%
C3-Chrysenes	C3	27	692	287	126	93	73%
C4-Chrysenes	C4	9	231	137	43	37	87%
Benzo[b]fluoranthene	BbF	3	68.1	23	14	8	59%
Benzo[j,k]fluoranthene	BjkF	2	27.7	15	7	4	60%
Benzo[a]fluoranthene	BaF	ND	ND	NA	ND	ND	NA
Benzo[e]pyrene	BeP	9	159	60	31	20	63%
Benzo[a]pyrene	BaP	4	159	76	30	22	71%
Perylene	Per	2	83.8	52	20	14	69%
Indeno[1,2,3-c,d]pyrene	IND	1	15.1	7	3	3	100%
Dibenz[a,h]anthracene	DBA	1	23.3	15	6	4	66%
Benzo[g,h,i]perylene	Bghi	2	48.9	35	13	9	70%

- ‘Fresh’ oil
- Complex mixture
- 90% LPAH
- Alkyl PAH dominate
- Matches CB oil

Source: Oil Spill Environmental Forensics: Fingerprinting and Source Identification. Wang and Stout. 2006.

**Cosco Busan Oil Spill
Shorebird Park
11/15/2007**

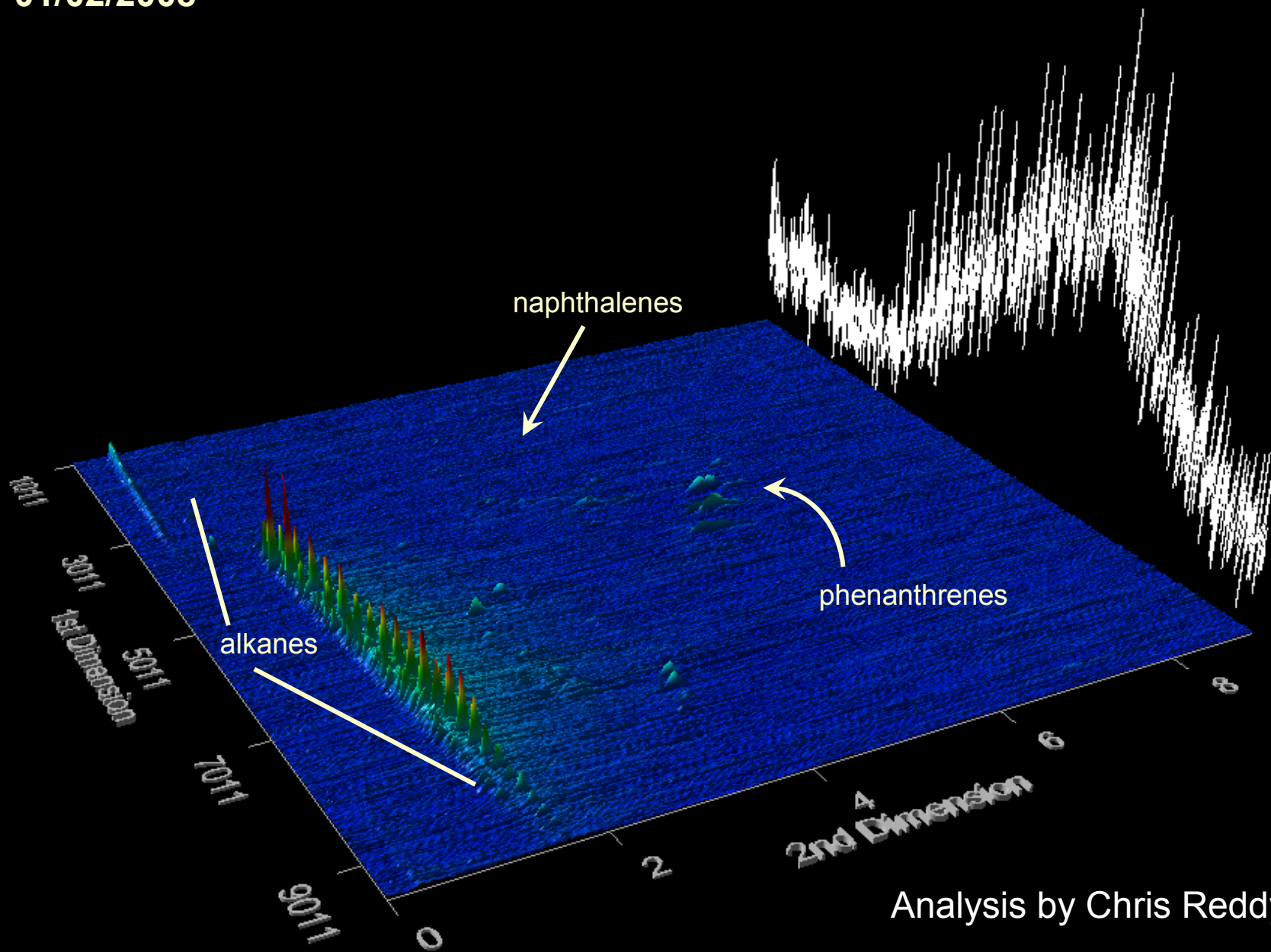
Masses: TIC



Analysis by Chris Reddy

**Cosco Busan Oil Spill
Point Isabel
01/02/2008**

Masses: TIC

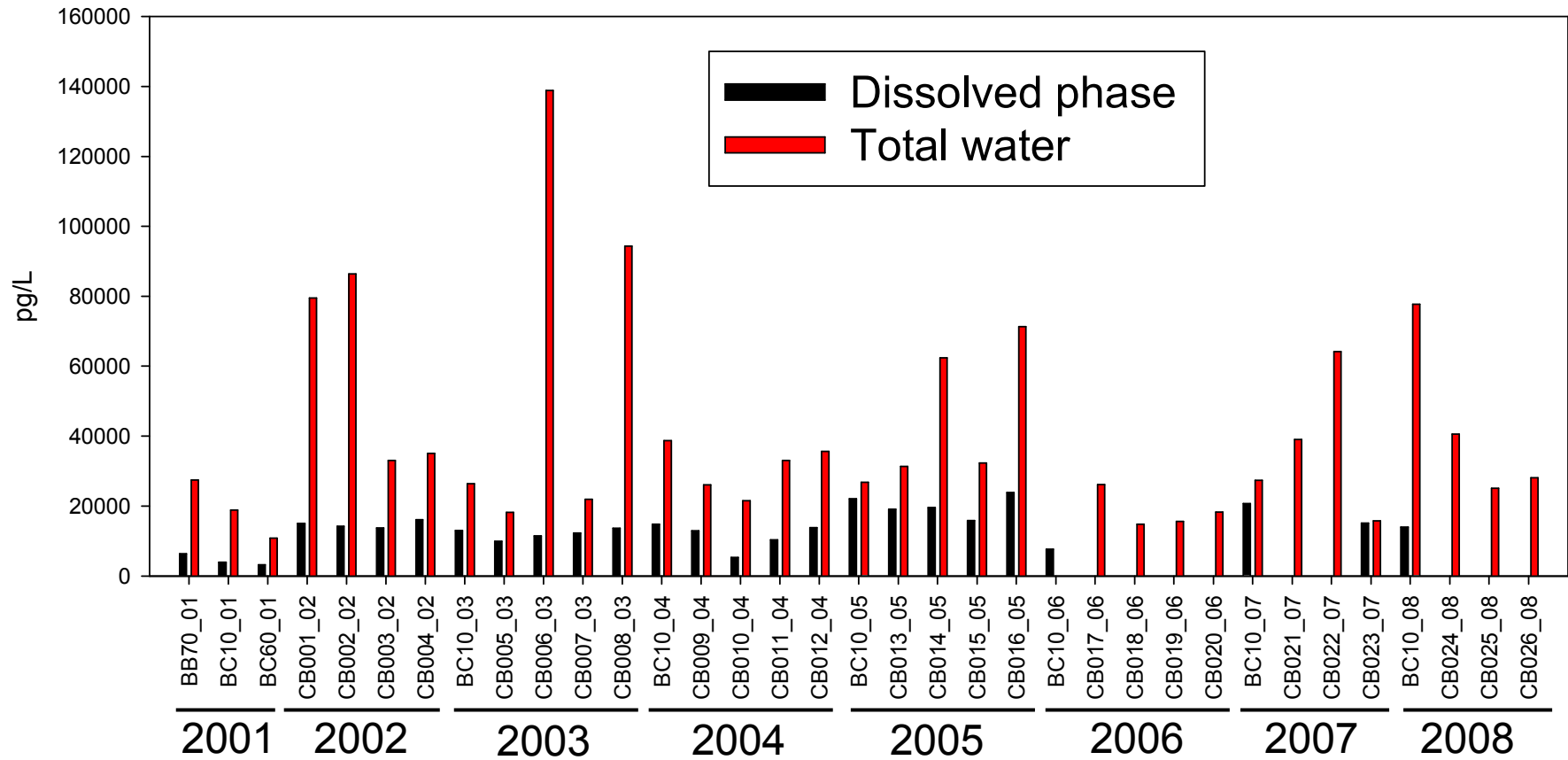


Analysis by Chris Reddy

Staff Conclusions/Recommendations

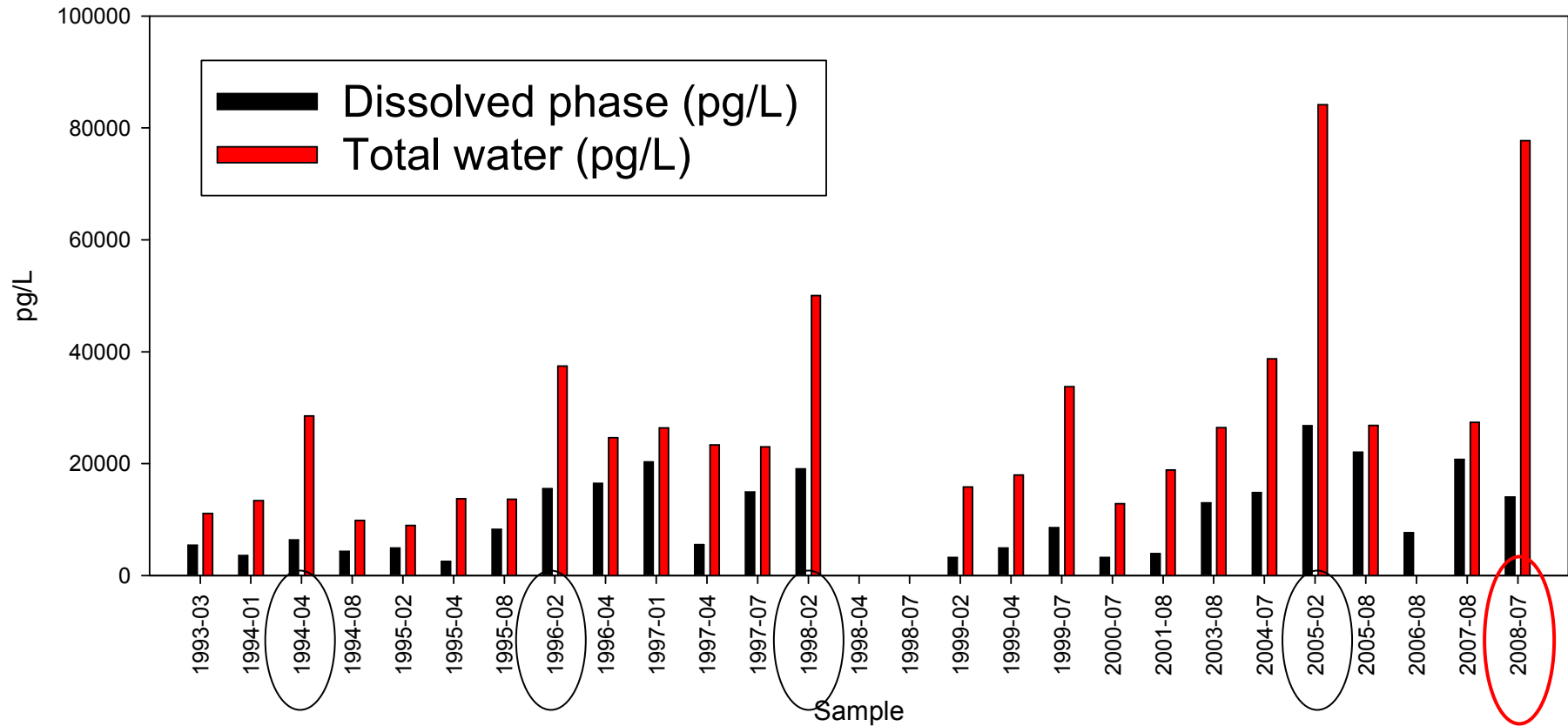
- In Central Bay, 2008 PAH water concentrations were within range of historical data.
- Do not analyze PAHs in 2009 water samples (pending 2008 TSS concentrations).
- Memo with summary of data and our recommendation drafted following receipt of TSS data.

PAHs in water from Central Bay sites 2001-2008



All summer sampling

Sum PAH in water at BC10 (Yerba Buena Island)



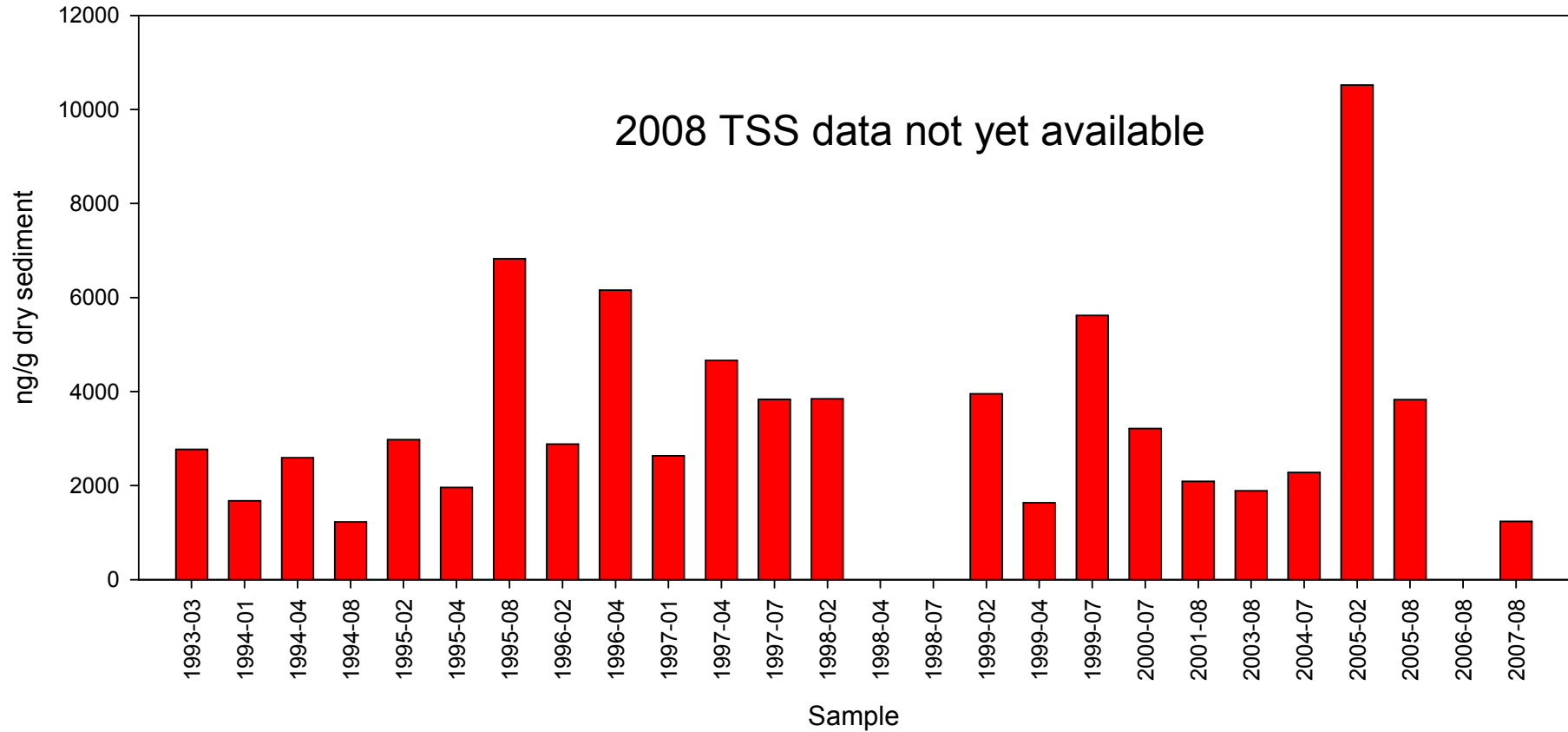
Total water PAH for AXYS years (2001-2007):

Mean = 27,600 pg/L

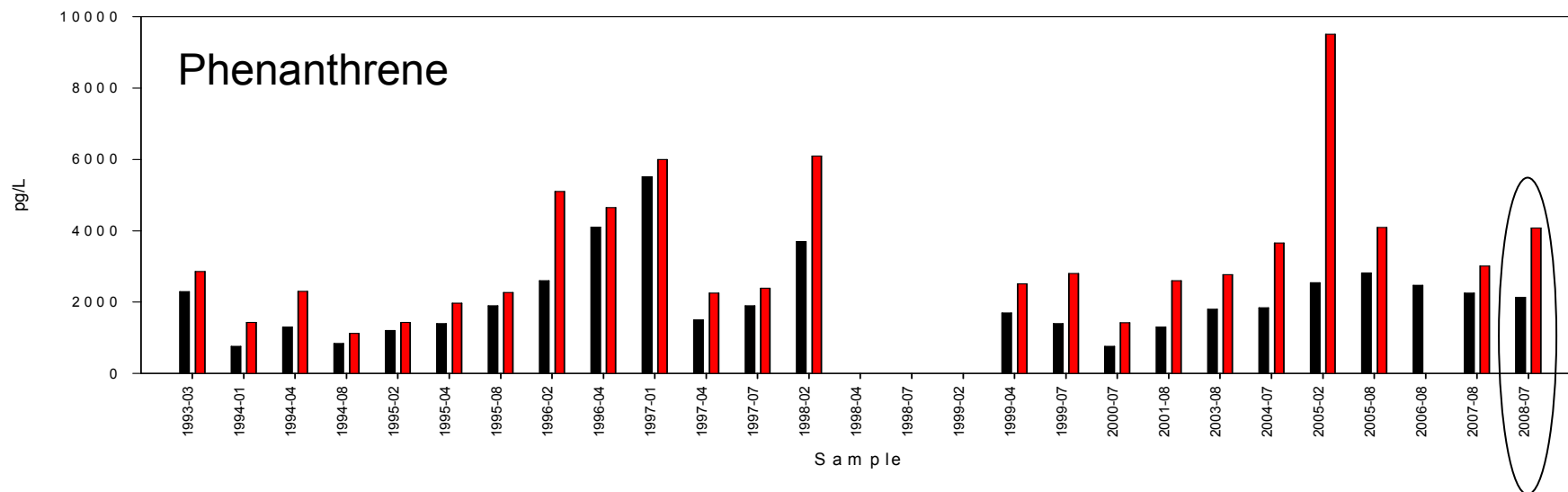
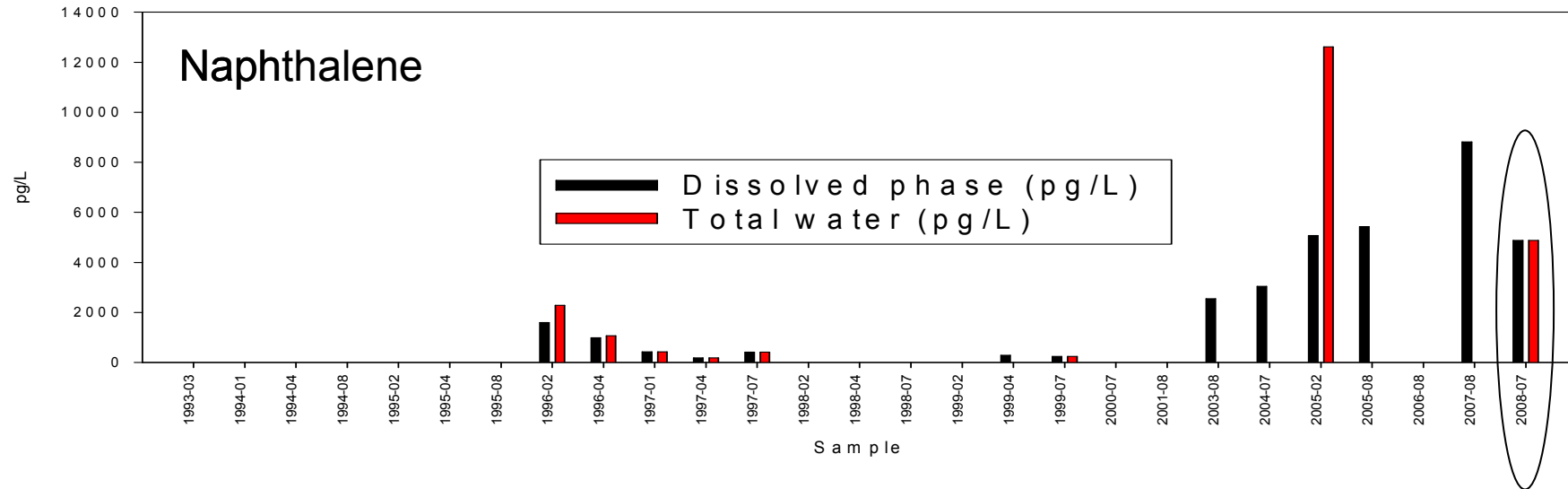
Mean + 2SD = 42,000 pg/L

2008 total water PAH: 78,000 pg/L

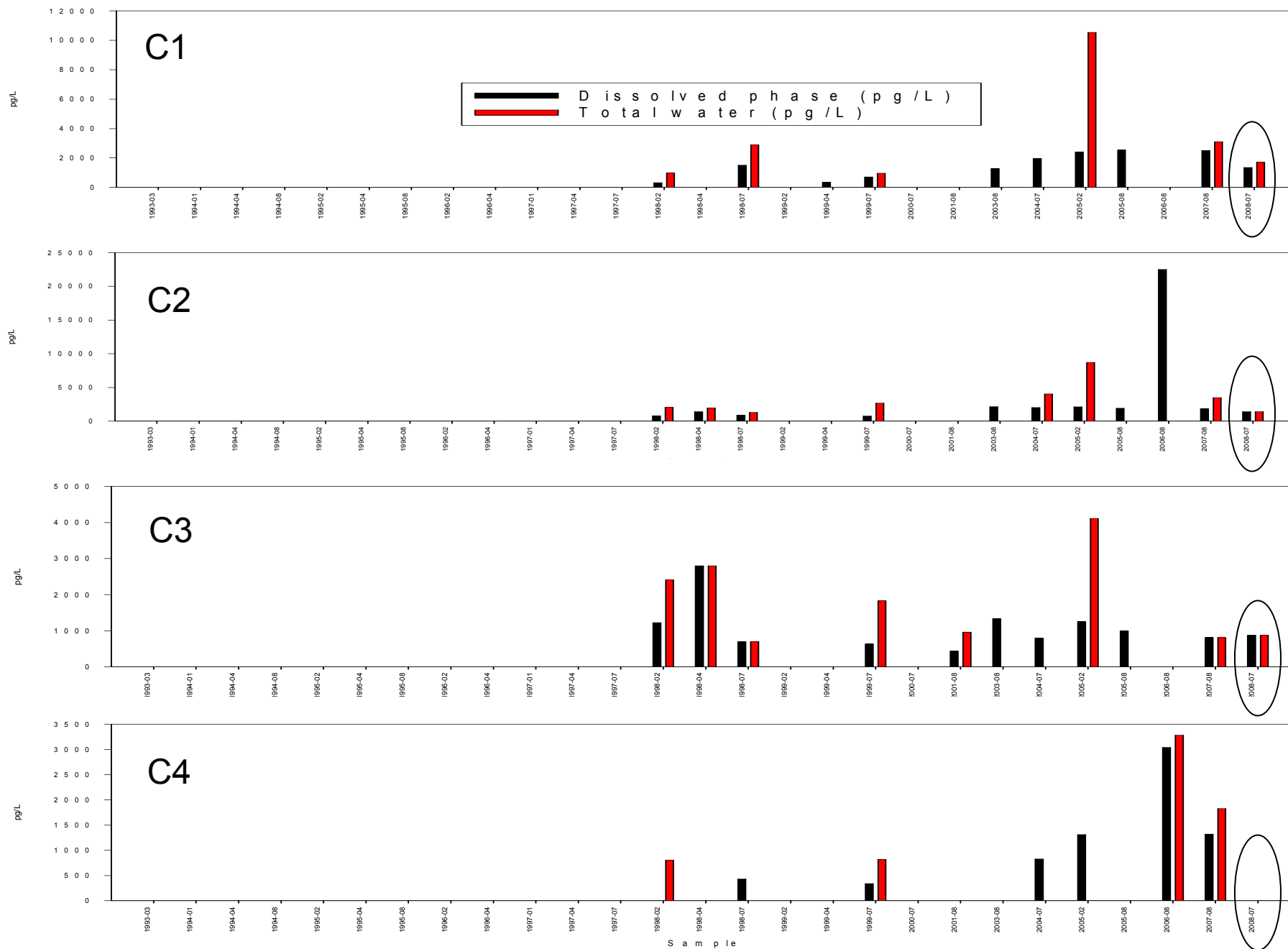
Total water PAH normalized to TSS/SSC



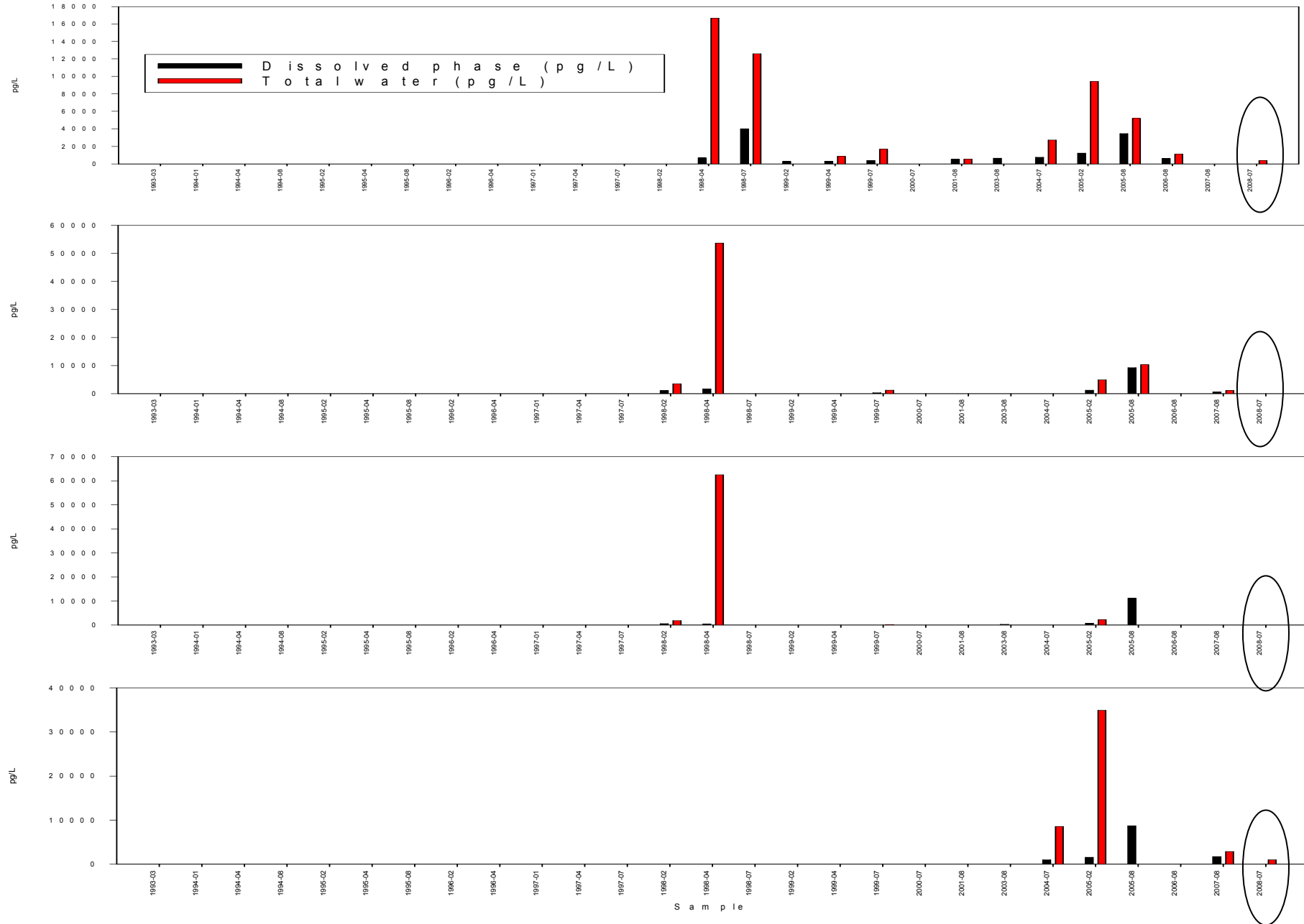
Naphthalene and Phenanthrene at BC10



Alkylated Naphthalenes at BC10



Alkylated Phenanthrenes at BC10



Water PAHs 2002-2006

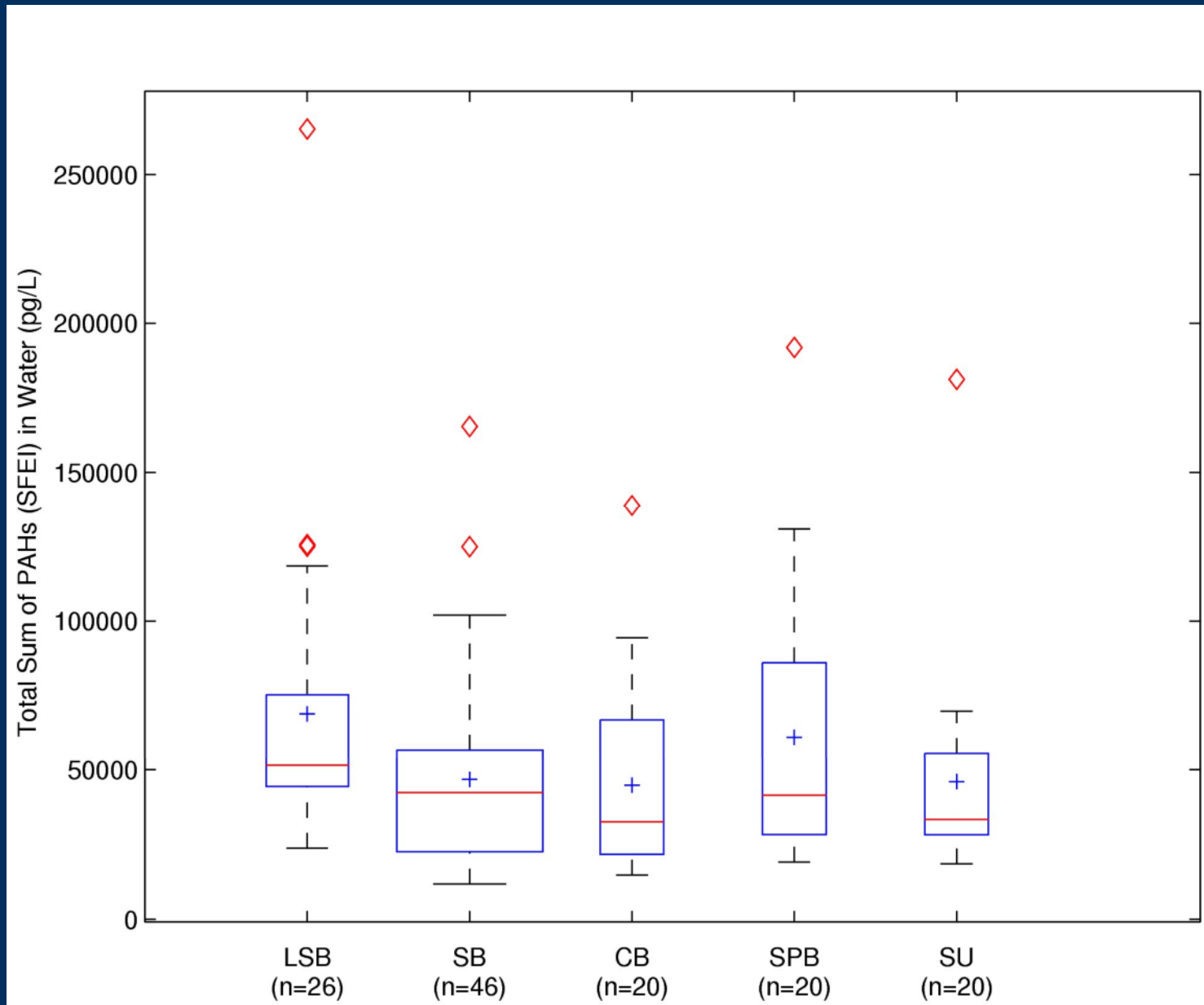


Table 10-4 Summary Statistics for Certain PAH Diagnostic Metrics for 71 Worldwide IFO 380 Heavy Fuel Oils (See Table 10-3 for Compound Abbreviations.)

	<i>Min</i>	<i>Max</i>	<i>95th percentile</i>	<i>Mean</i>	<i>Std Dev</i>	<i>% CV</i>
<i>PAH Metrics</i>						
Total PAH (mg/kg, oil) ¹	8,414	51,345	42,757	27,171	8,974	33%
Priority Pollutant PAH (mg/kg, oil) ²	616	12,575	4,768	3,227	1,539	48%
%TPAH as PP PAH	5.84	25.1	13.9	11.7	2.7	24%
Total Naphthalenes (mg/kg, oil)	0.26	3.73	2.90	1.74	0.67	39%
Total Dibenzothiophenes	0.06	0.58	0.28	0.12	0.08	65%
LPAH (mg/kg, oil)	5,465	49,289	39,480	24,751	8,591	35%
HPAH (mg/kg, oil)	791	13,148	4,076	2,419	1,666	69%
%LPAH	63.1	98.2	96.2	90.2	6.8	7%
%HPAH	1.77	36.9	25.4	9.8	6.8	69%
<i>Selected Diagnostic Ratios</i>						
MPI ³	1.46	3.43	2.7	2.5	0.22	9%
MPR ³	3.27	5.05	4.8	4.4	0.30	7%
%2MA/P1	4.21	8.86	8.1	6.9	0.97	14%
D2/P2	0.06	0.77	0.5	0.3	0.12	41%
D3/P3	0.08	0.86	0.7	0.4	0.15	40%
FL/PY	0.11	0.25	0.2	0.2	0.02	13%
BaA/CO	0.22	0.65	0.6	0.6	0.07	12%
AN/P0	0.06	0.18	0.2	0.1	0.02	18%

¹Σ54 PAH and alkylated PAH per Table 3.²Σ16 US EPA Priority Pollutant PAH.³Methylphenanthrene index and ratio, respectively. See Radke et al. (1982).⁴% 2-methyl-anthracene/Σmethyl-phenanthrene isomers.