University of Houston
Parsons Water&Infrastructure
PBS&J

Total Maximum Daily Load for Dioxin in the Houston Ship Channel

Main tasks Phase III – (WO7)

- Develop a QAPP for additional data collection
- Conduct dioxin monitoring and additional data collection in the HSC
- Model fate and transport of dioxins in the HSC using sophisticated models
- Participate in stakeholder process
- Estimate TMDL allocations
- Evaluate PCB data gathered to date

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Task 1 – Develop a QAPP

- QAPP approved on 01/27/2004
- Amendment 1, approved on 07/01/2004, developed to add:
  - vertical profiles of dioxin at 2 locations
  - high-resolution sediment sampling
  - boundary concentrations for model
- Amendment 2, approved on 08/19/2004, developed to
  - add one set of runoff samples
  - modify dry/wet and add bulk deposition sampling
  - add air sampling by particle size
- Annual update, submitted on 01/20/2005
  - add flow measurements

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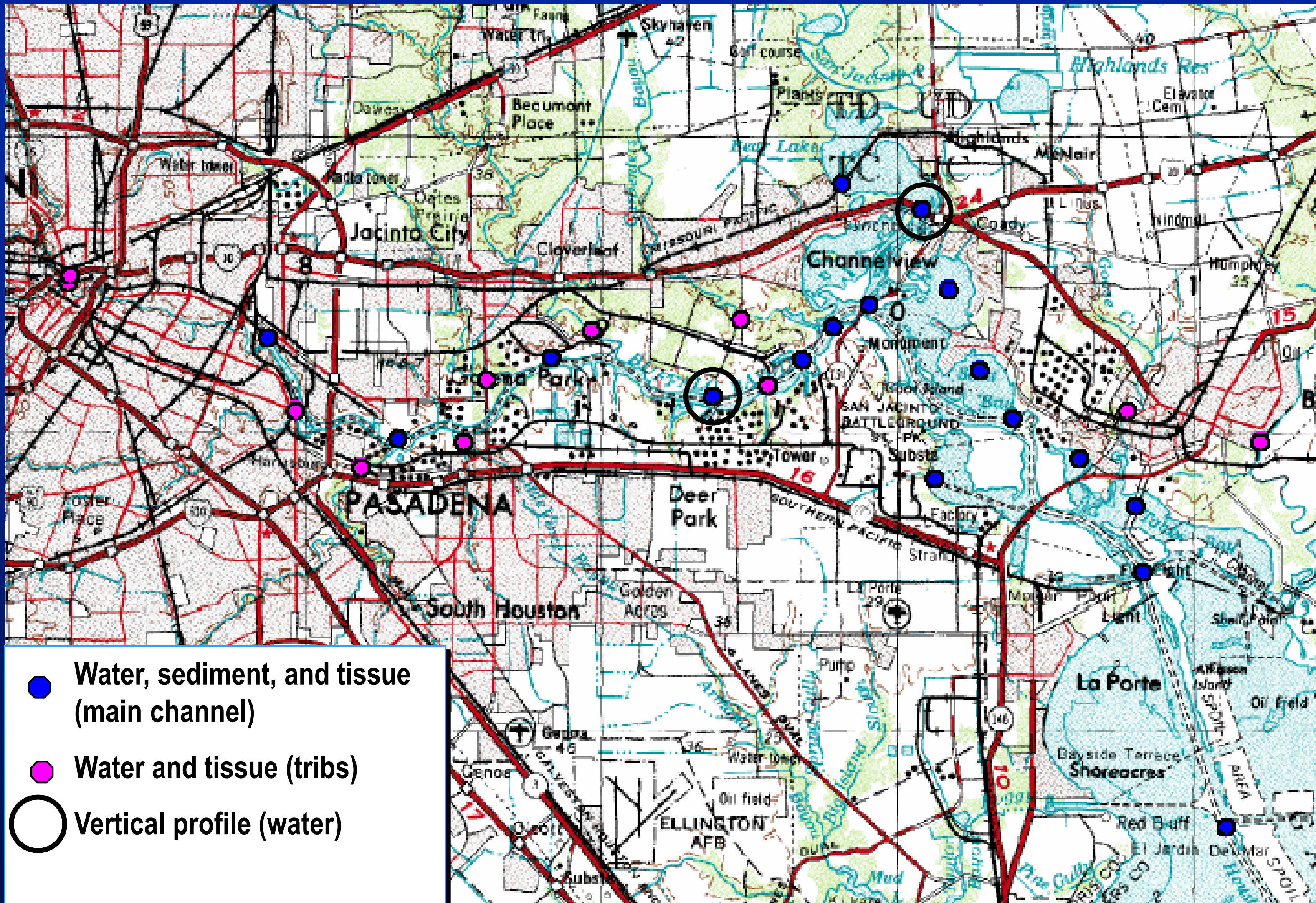
Task 2 – Monitoring and data collection

- *Assess current levels and trends in the project area*:
  - 17 in-channel locations for water (dissolved and particulate matter), sediment, fish, and crab twice
  - 11 tributary locations for fish and crab 1 time
  - sediment cores from 6-8 locations to gather data on the historical deposition of dioxins and furans as well as accumulation rates
  - 2 locations for deep&shallow water sampling once
  - 15 locations for high-resolution sediment sampling once
  - 2 locations in upper watershed for water sampling once

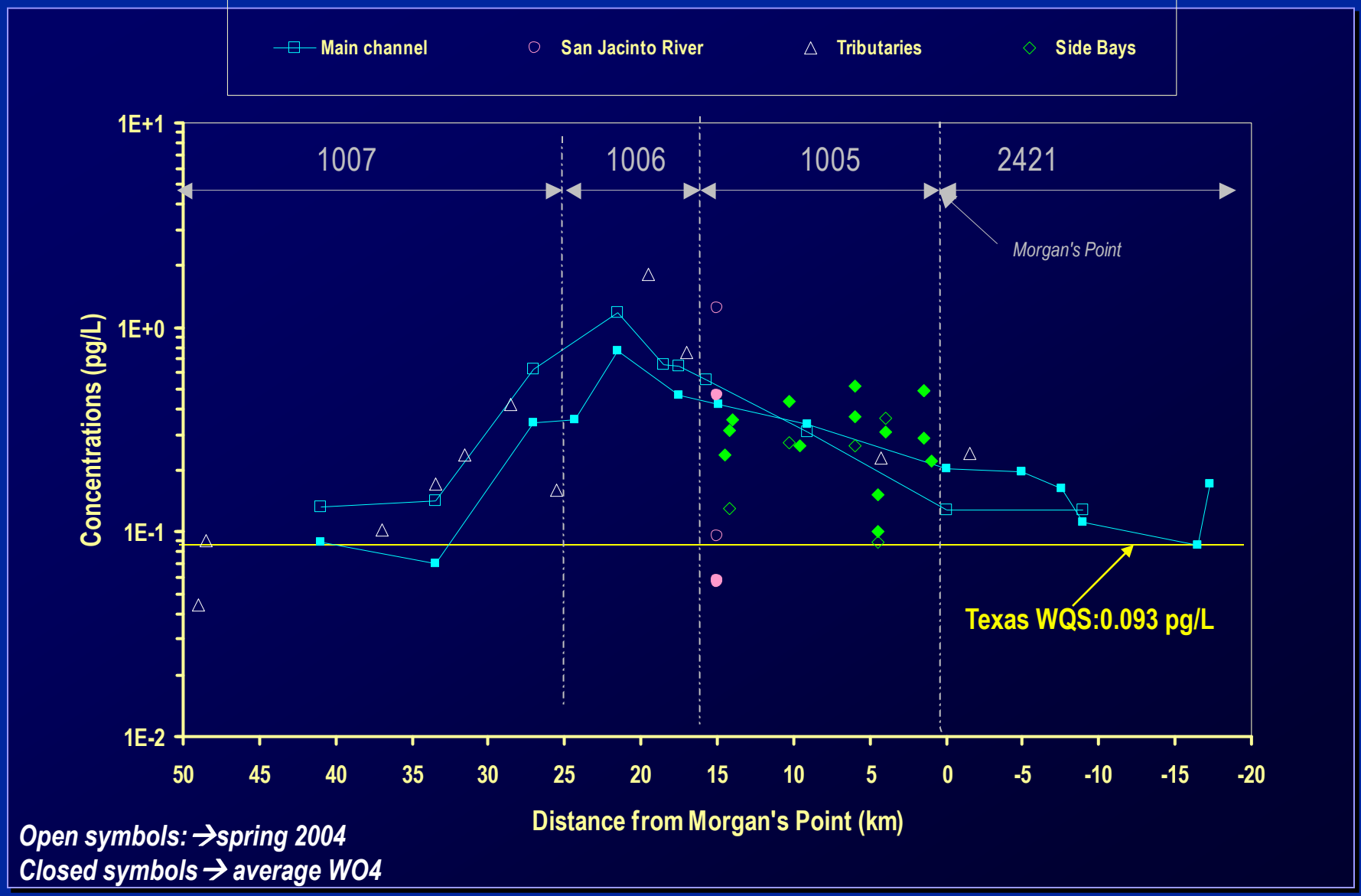
Task 2 – Monitoring and data collection – cont'd

- *Assess major sources*:
  - Ambient water at confluences with main tributaries (11 locations, 2 times)
  - Ambient air, wet/dry/bulk deposition, and particle size at 1 location
  - Runoff sampling at 10 locations once

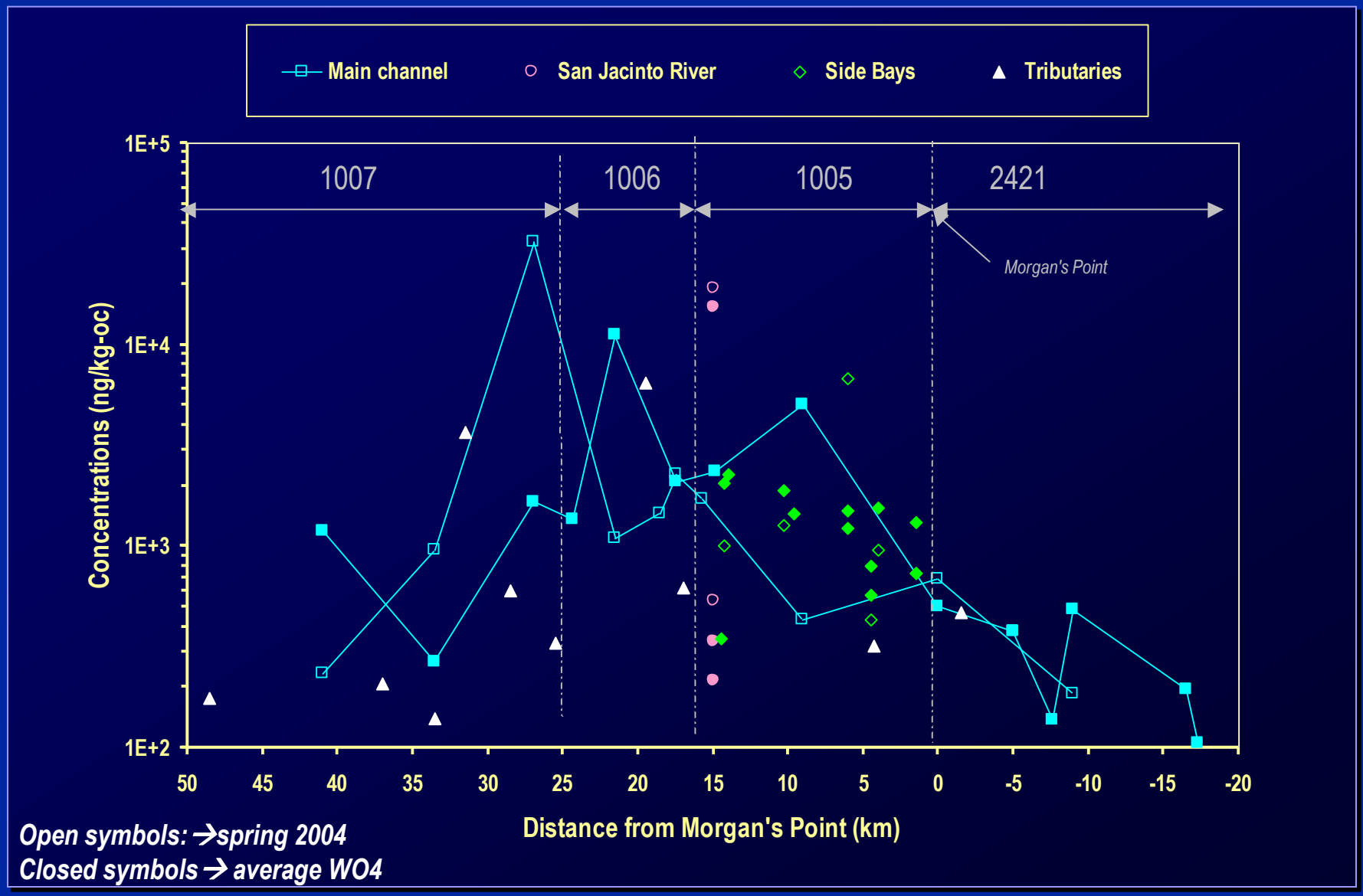
Sampling locations



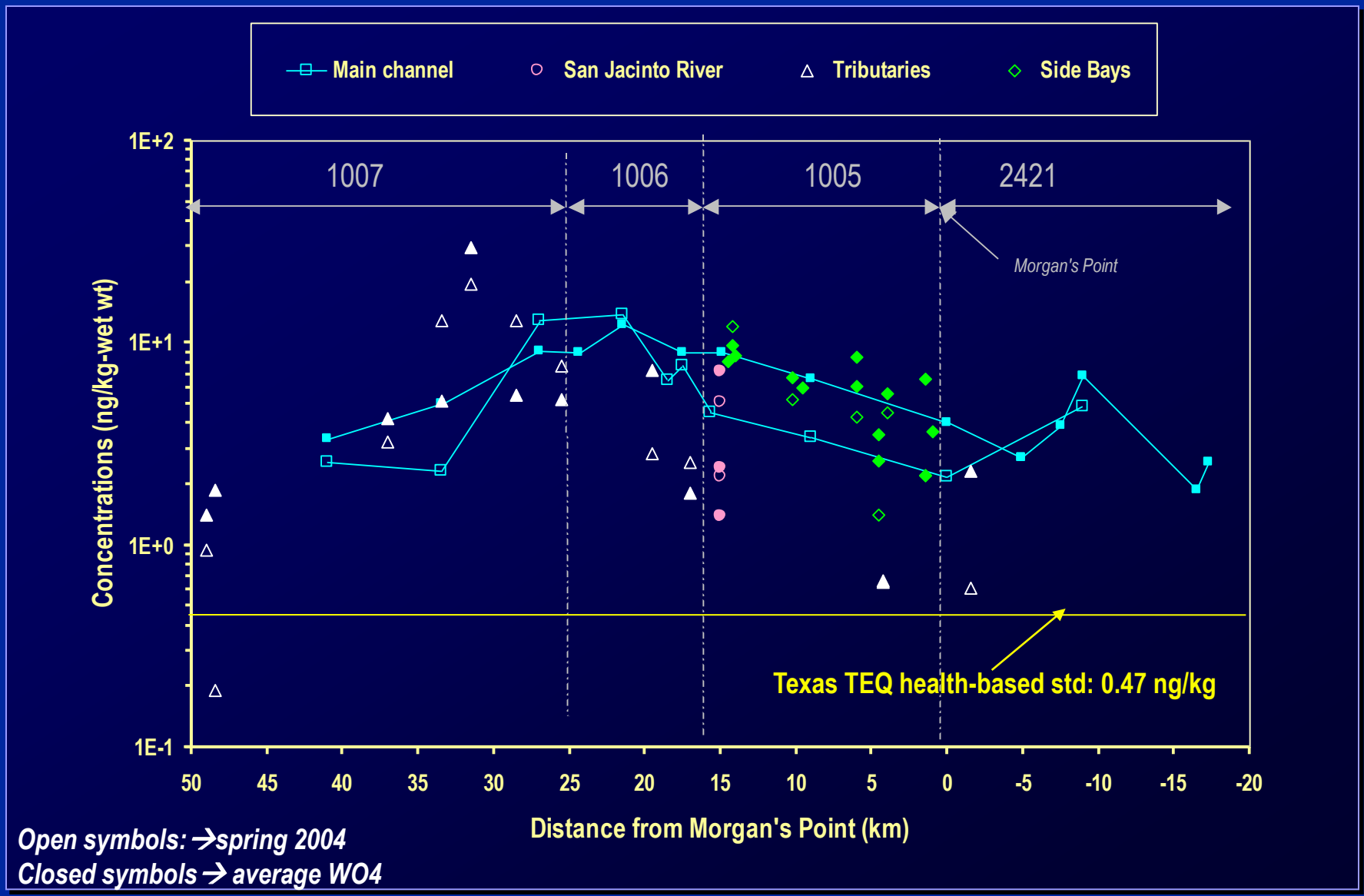
Dioxin in water profiles



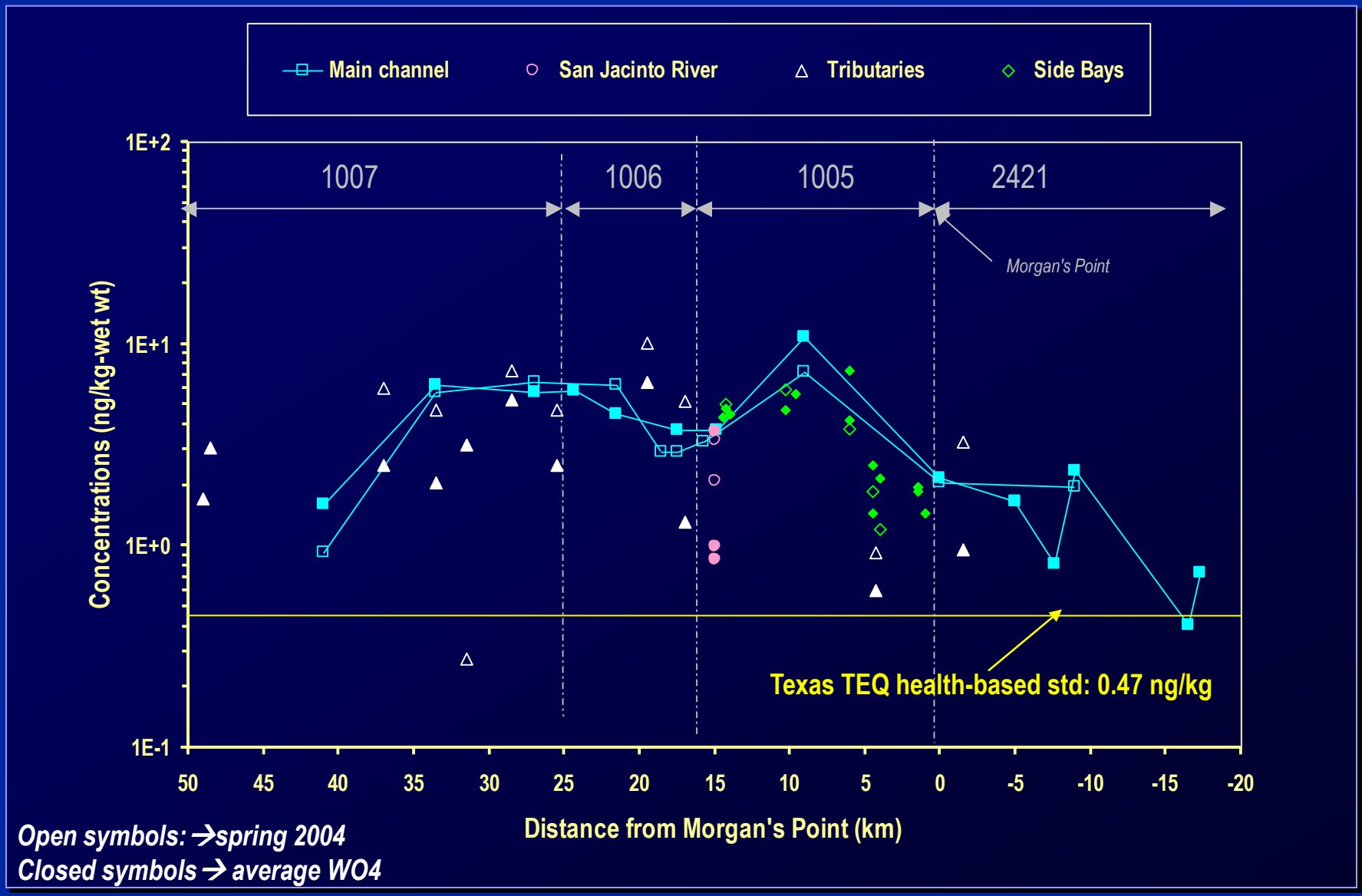
Dioxin in sediment-oc profiles



Dioxin in catfish profiles

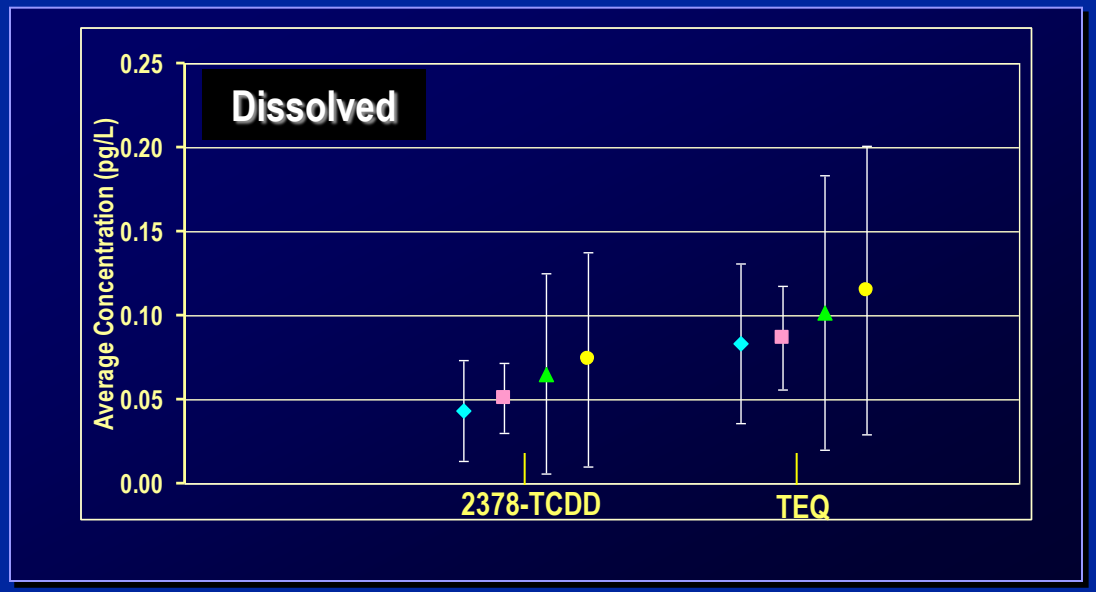


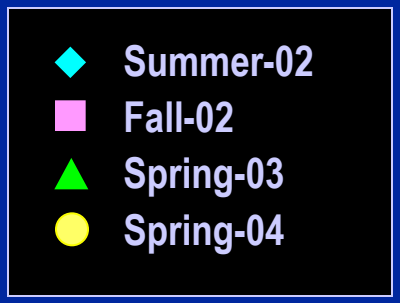
Dioxin in crab profiles

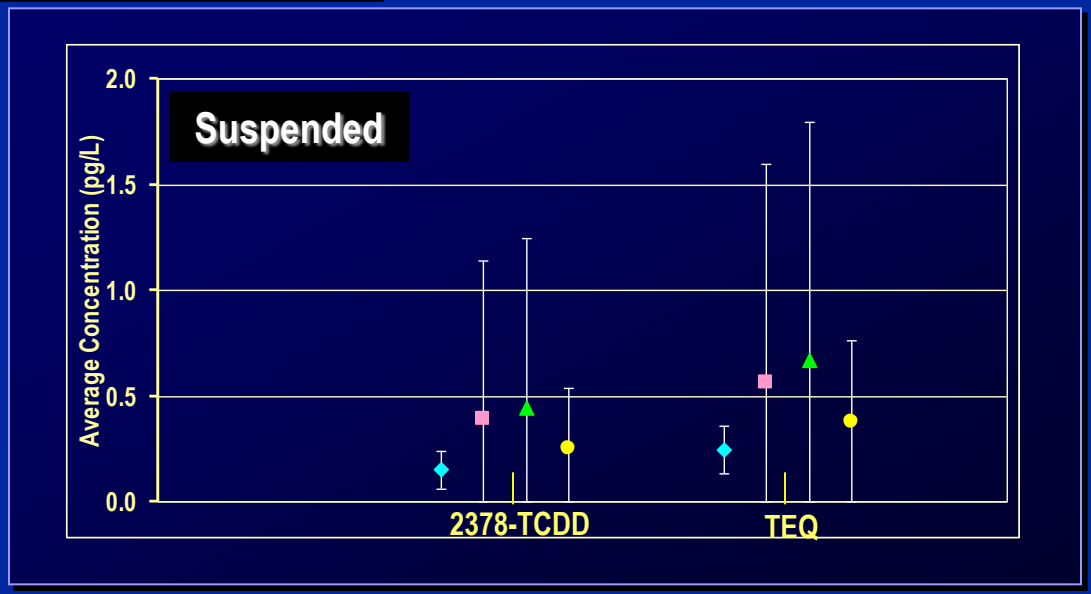


Open symbols: → spring 2004
Closed symbols → average WO4

Seasonal trends in water samples

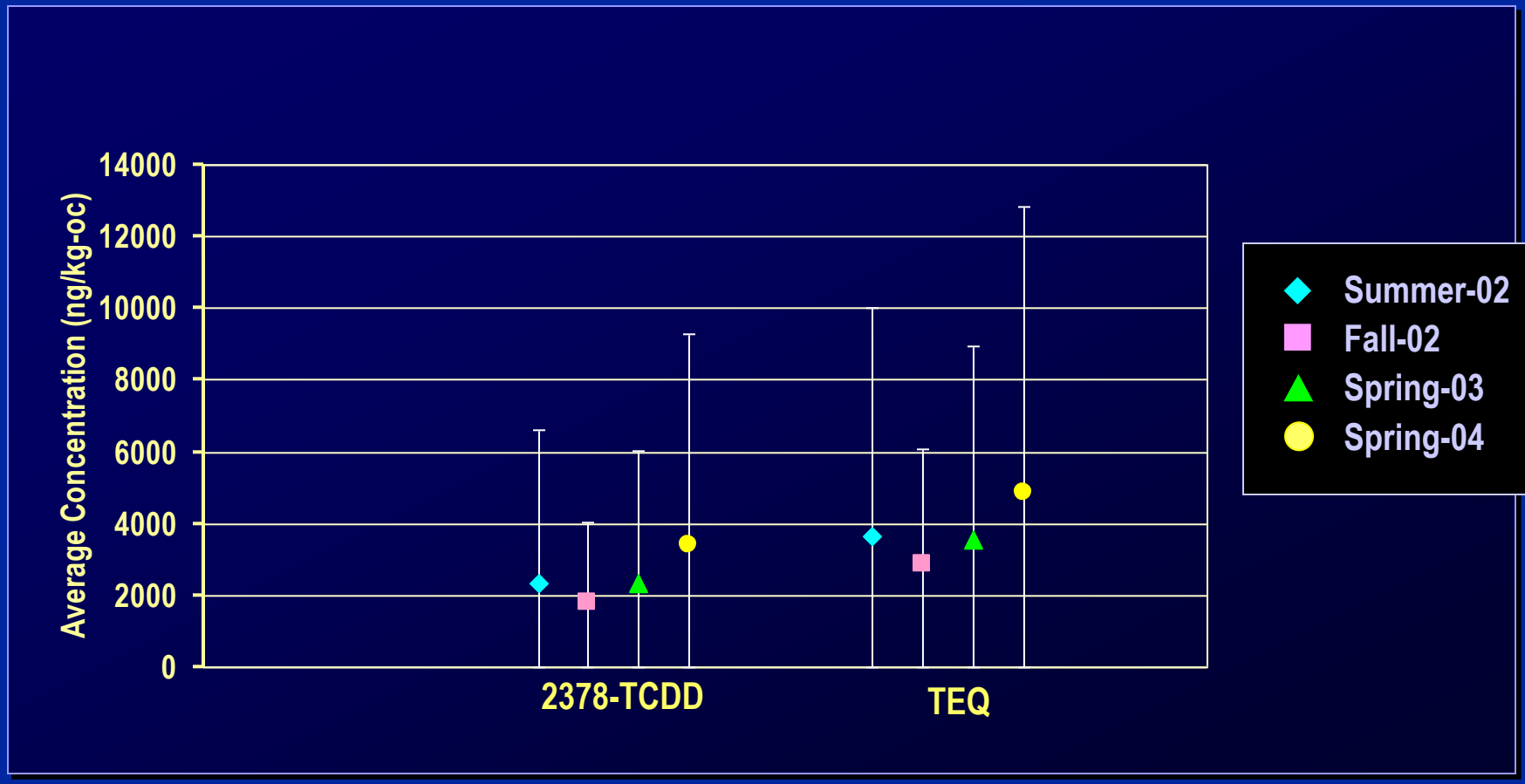






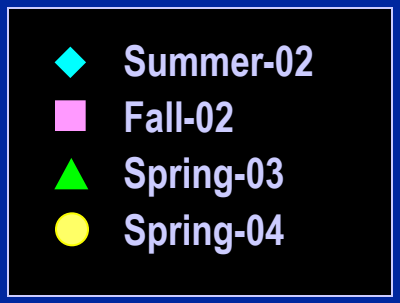
Error bars correspond to the 95 % confidence intervals

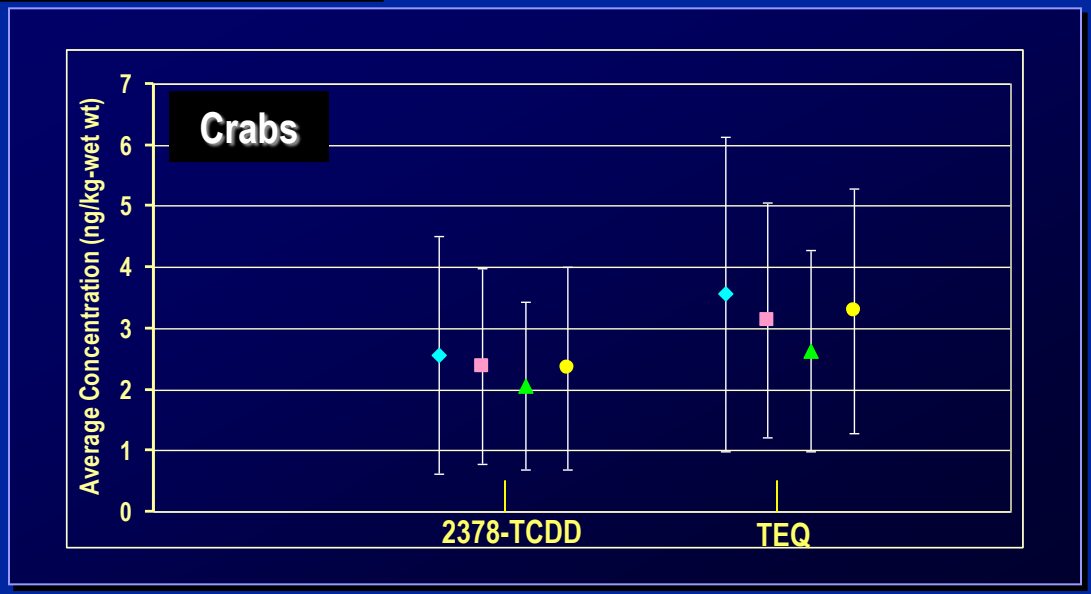
Seasonal trends in sediment-oc samples



Error bars correspond to the 95 % confidence intervals

Seasonal trends in tissue samples





Error bars correspond to the 95 % confidence intervals

Identifying WQ targets

Approach 1:

Water concentration target, relying on hi-vol water sampling

Approach 2:

Tissue-based WQS, using bioaccumulation factors to link water/sediment concentrations to tissue concentrations

Calculating bioaccumulation factors

Approach 1:

Use measures of central tendency of the C_b/C_w and C_b/C_{oc} ratios

Approach 2:

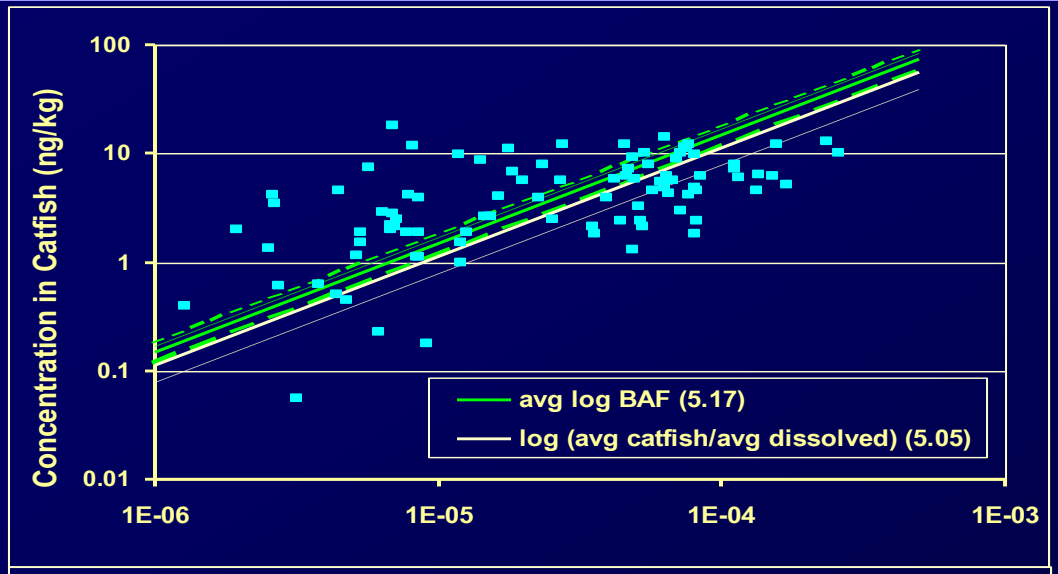
Calculate BAF and BSAF from average concentrations (EPA, 2003)

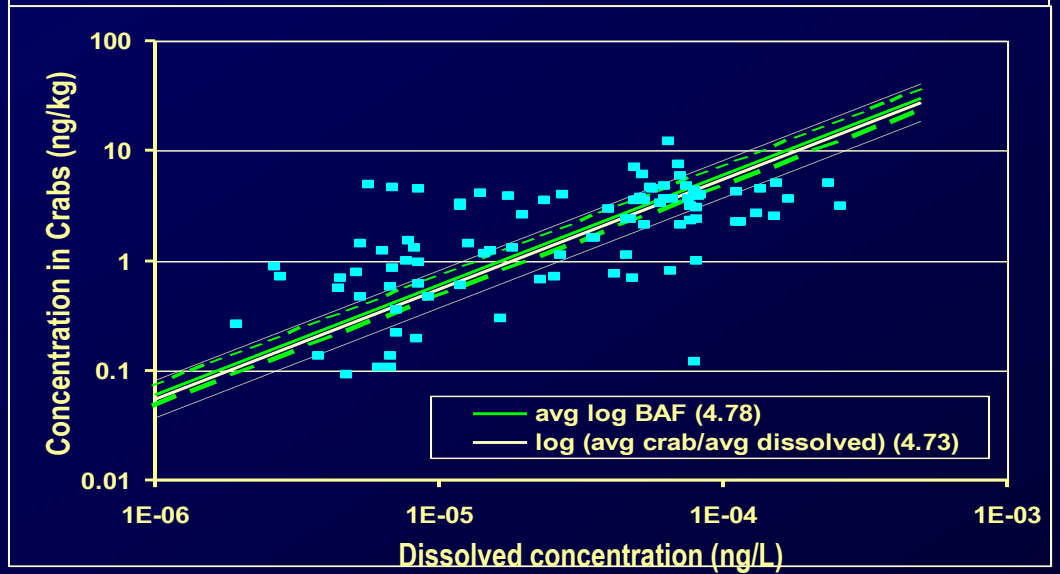
$$BAF = C_b / C_w$$

$$BSAF = C_b / C_{sedOC}$$

C_b=concentration in biota [pg/kg-wet wt]
C_w=concentration in water [pg/L]
C_{oc}=organic-carbon normalized concentration [pg/kg-oc]

2378-TCDD HSC site-specific BAF (C_b/C_w)





Resulting WQ targets for catfish:

App 1: 0.042 pg/L

App 2: 0.045 pg/L

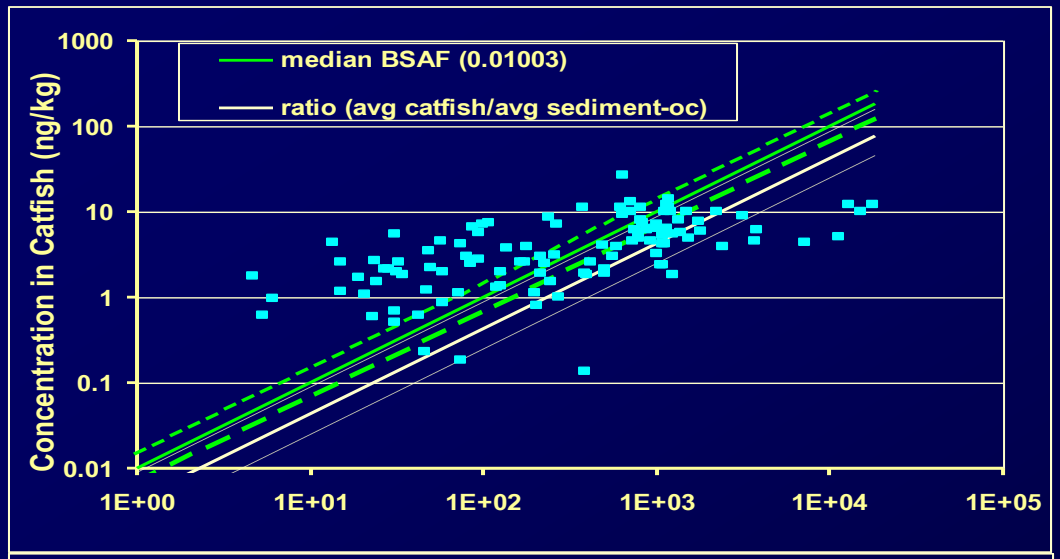
Resulting WQ targets for crab:

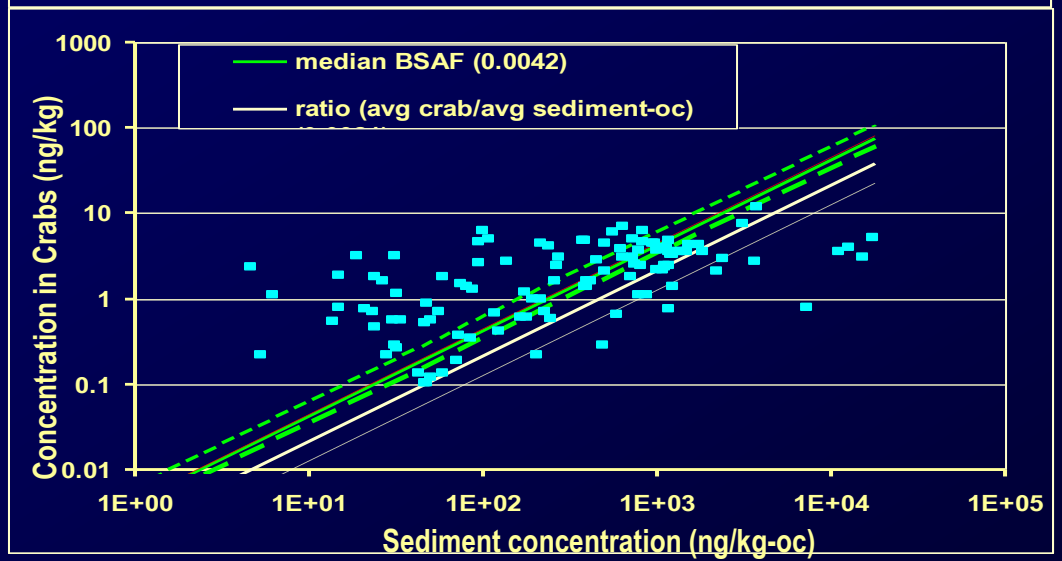
App 1: 0.059 pg/L

App 2: 0. 061 pg/L

Data from 4 events

2378-TCDD HSC site-specific BSAF (C_b/Cs_{oc})





Resulting sediment targets from catfish:

App 1: 72 ng/kg-oc

App 2: 151 ng/kg-oc

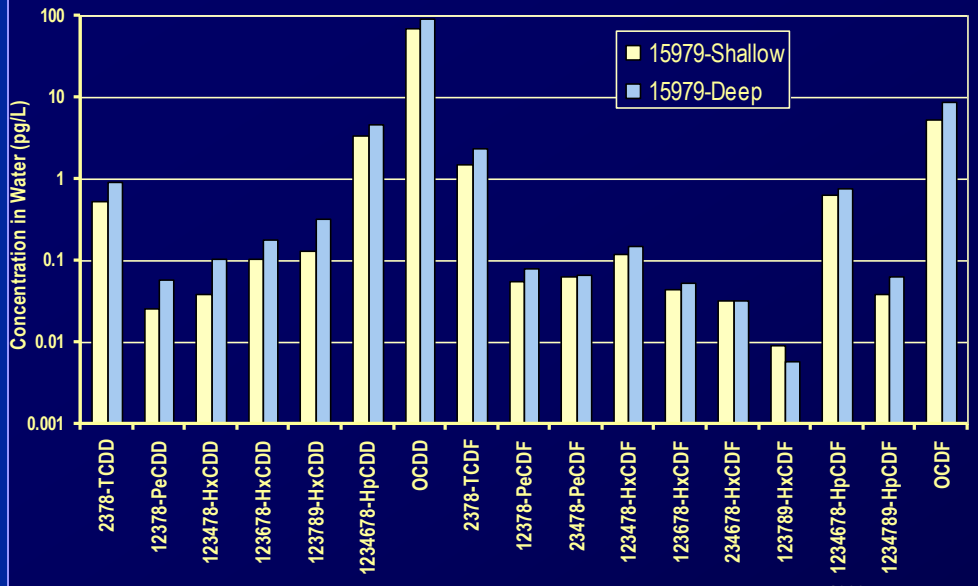
Resulting sediment targets from crab:

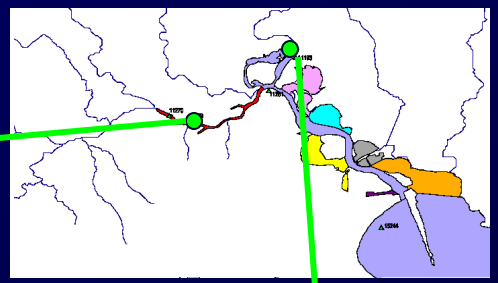
App 1: 126 ng/kg-oc

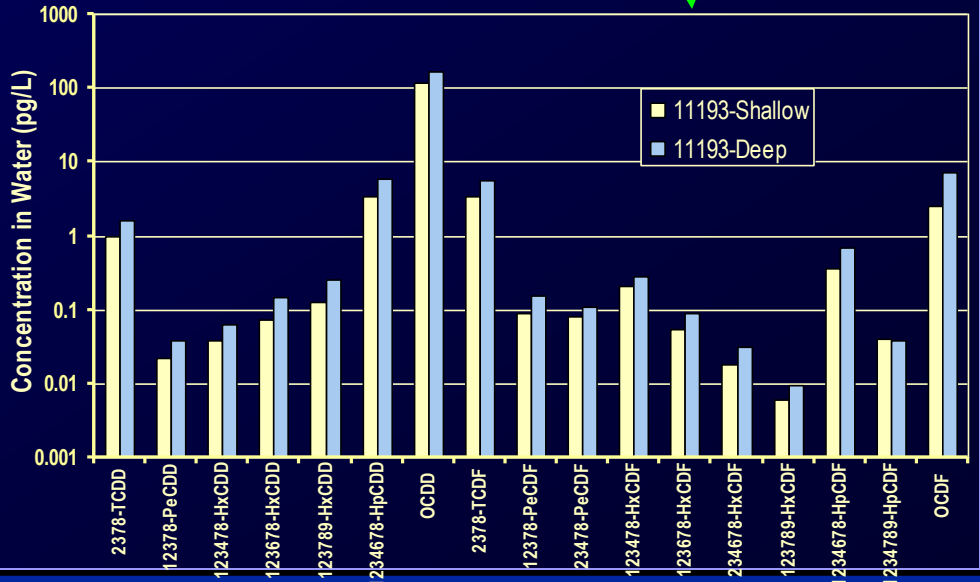
App 2: 253 ng/kg-oc

Data from 4 events

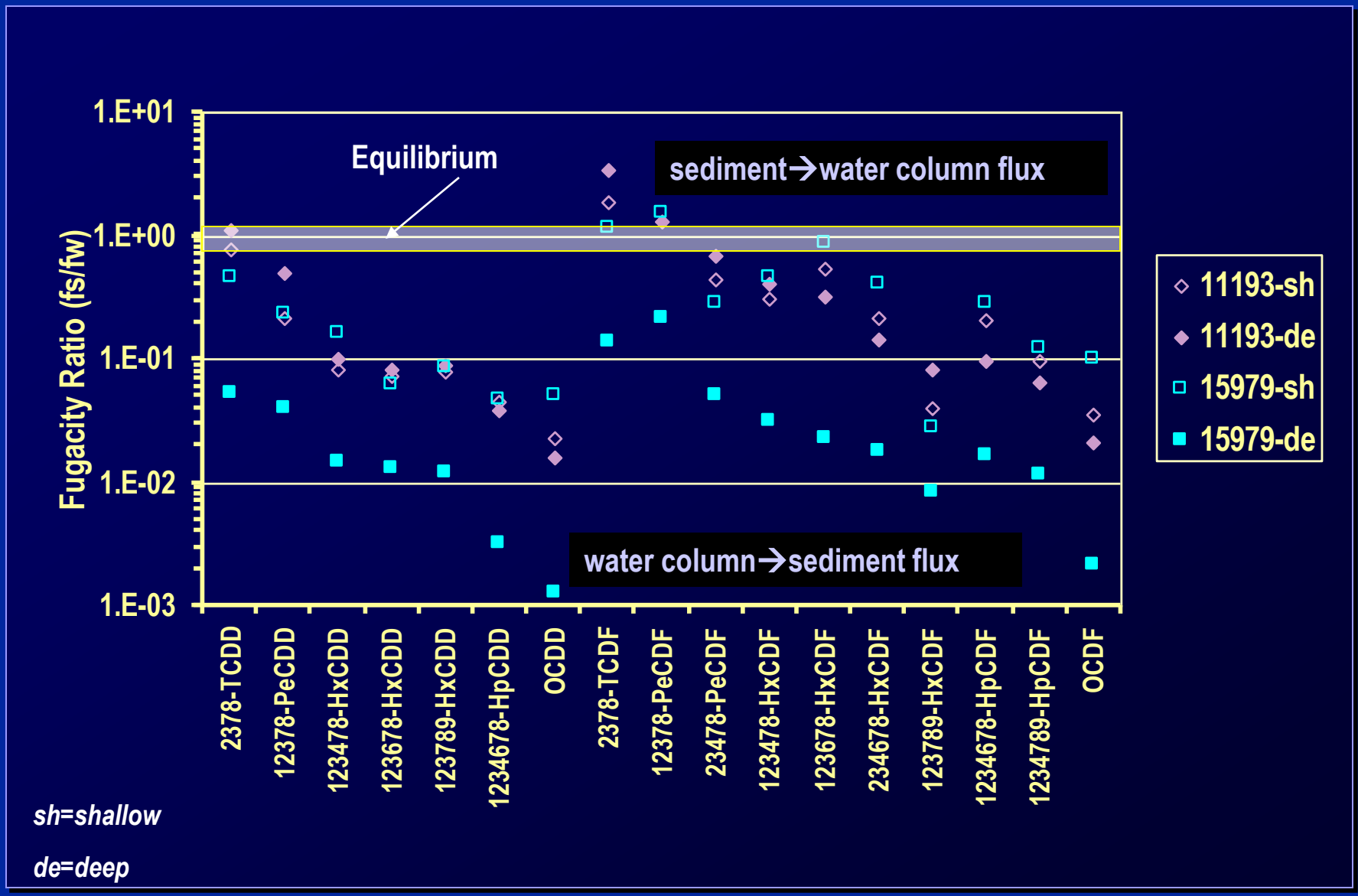
Deep and shallow sample results



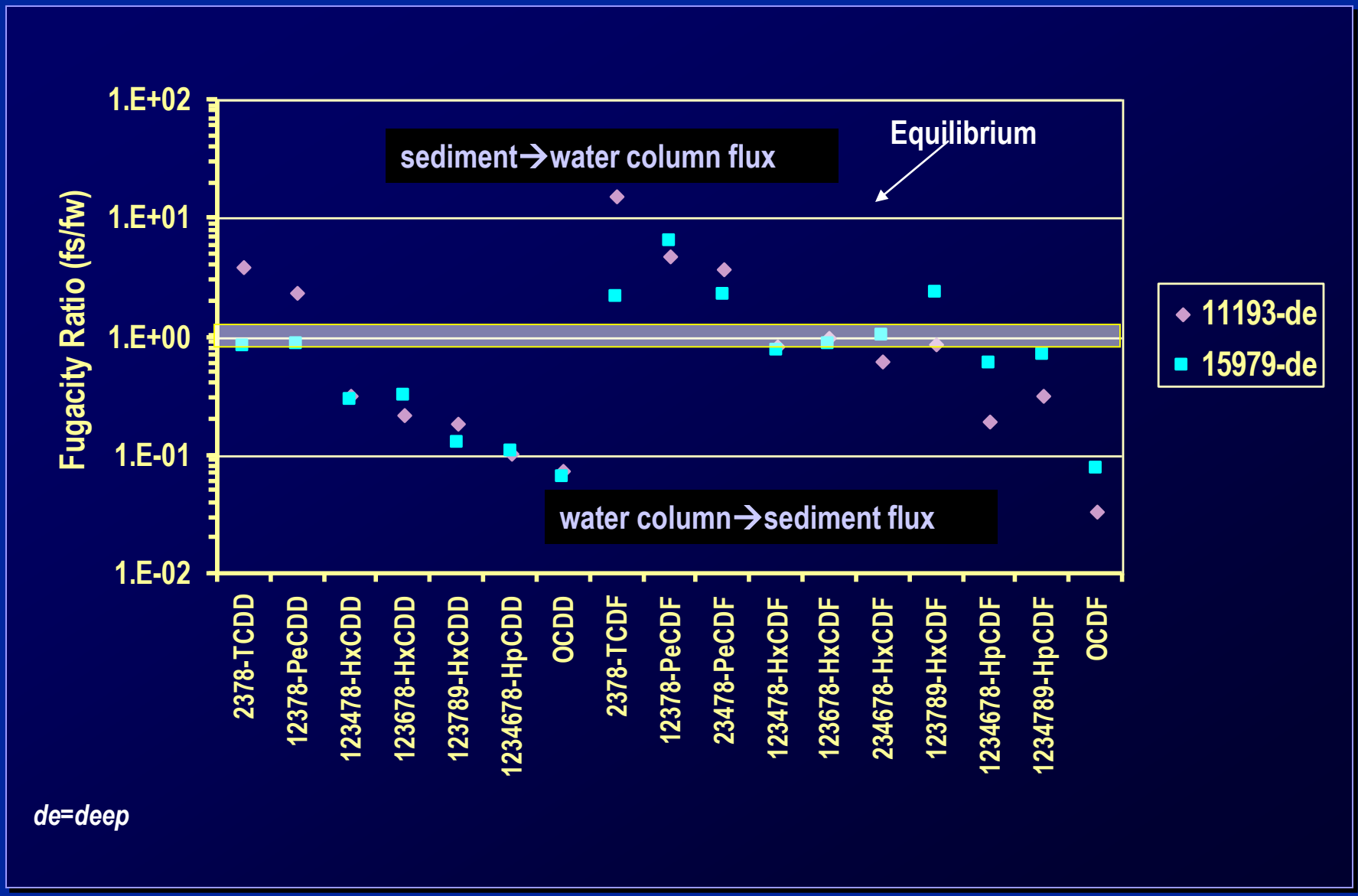




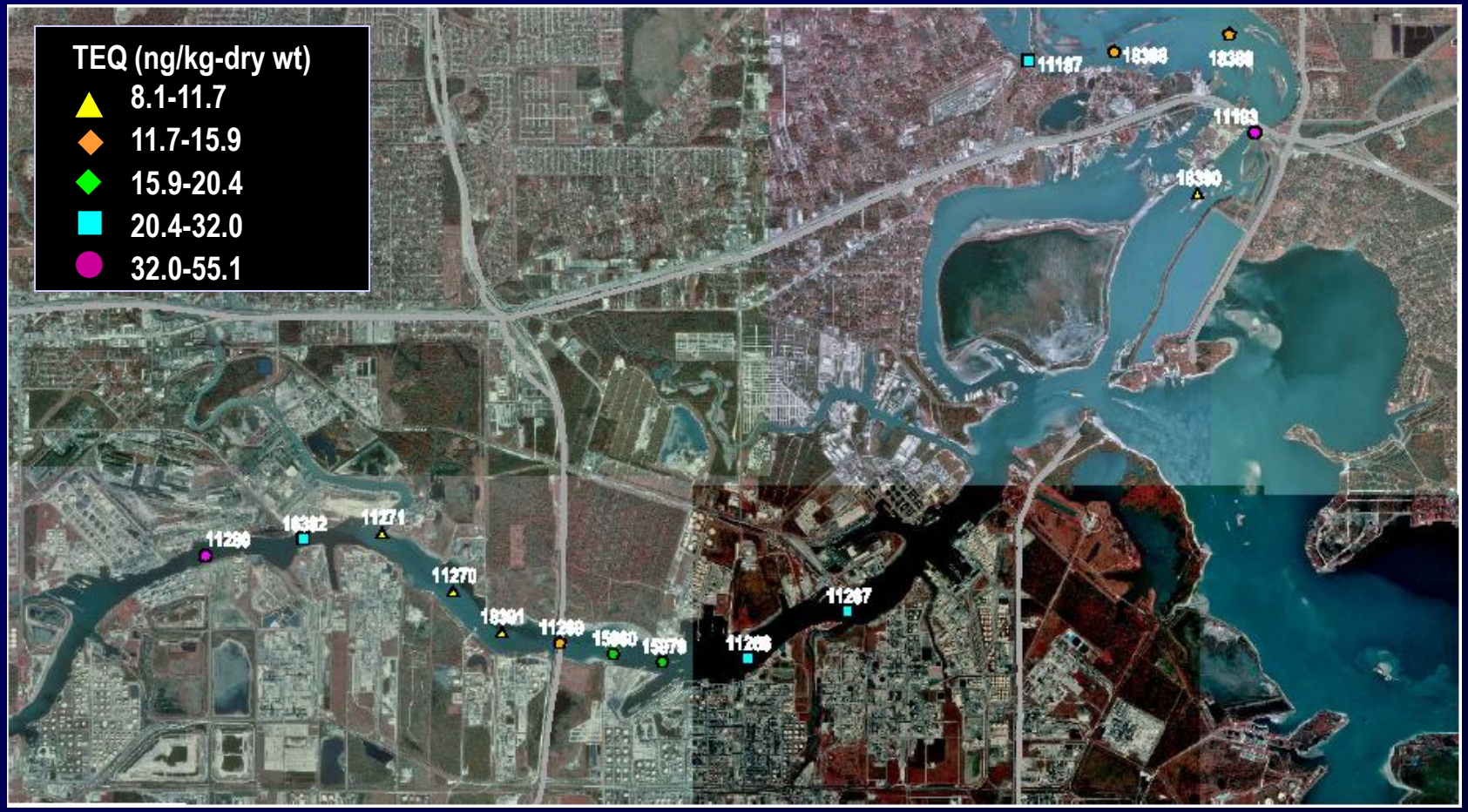
Dissolved-suspended fugacity ratios



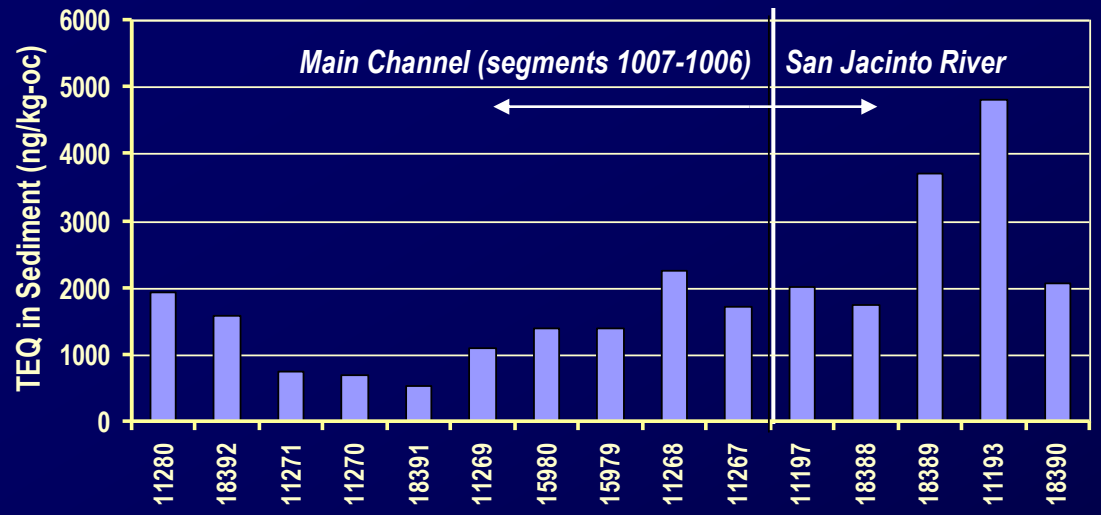
Dissolved-bottom sediment fugacity ratios

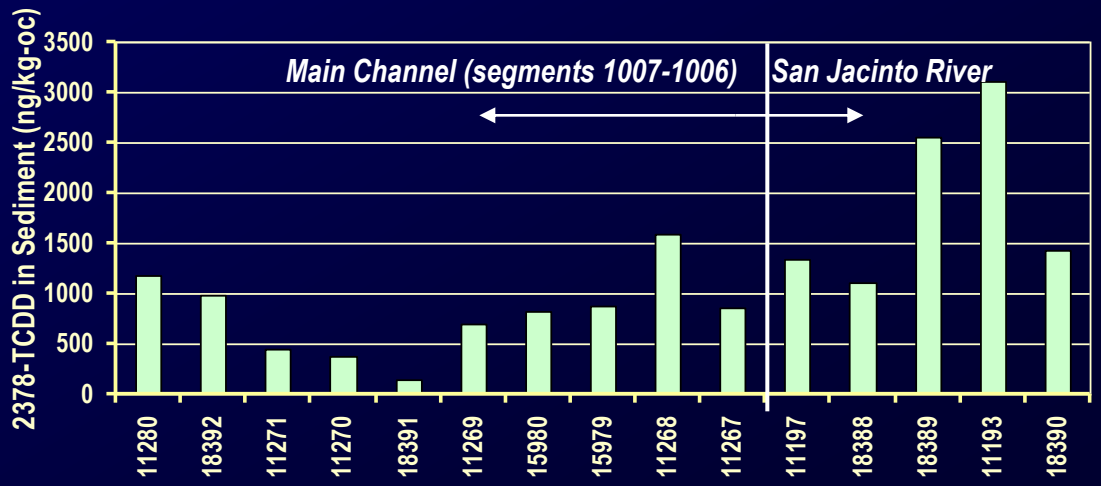


High-resolution sediment sampling

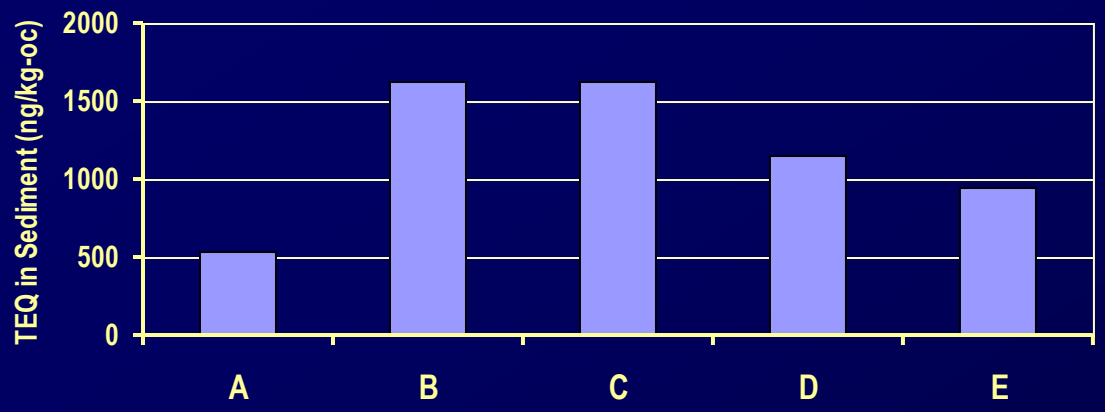


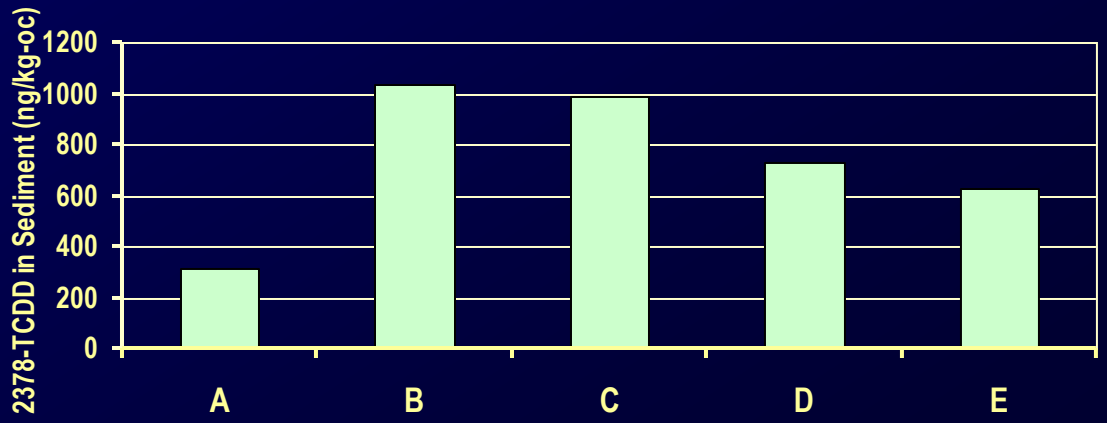
High-resolution sediment sampling results



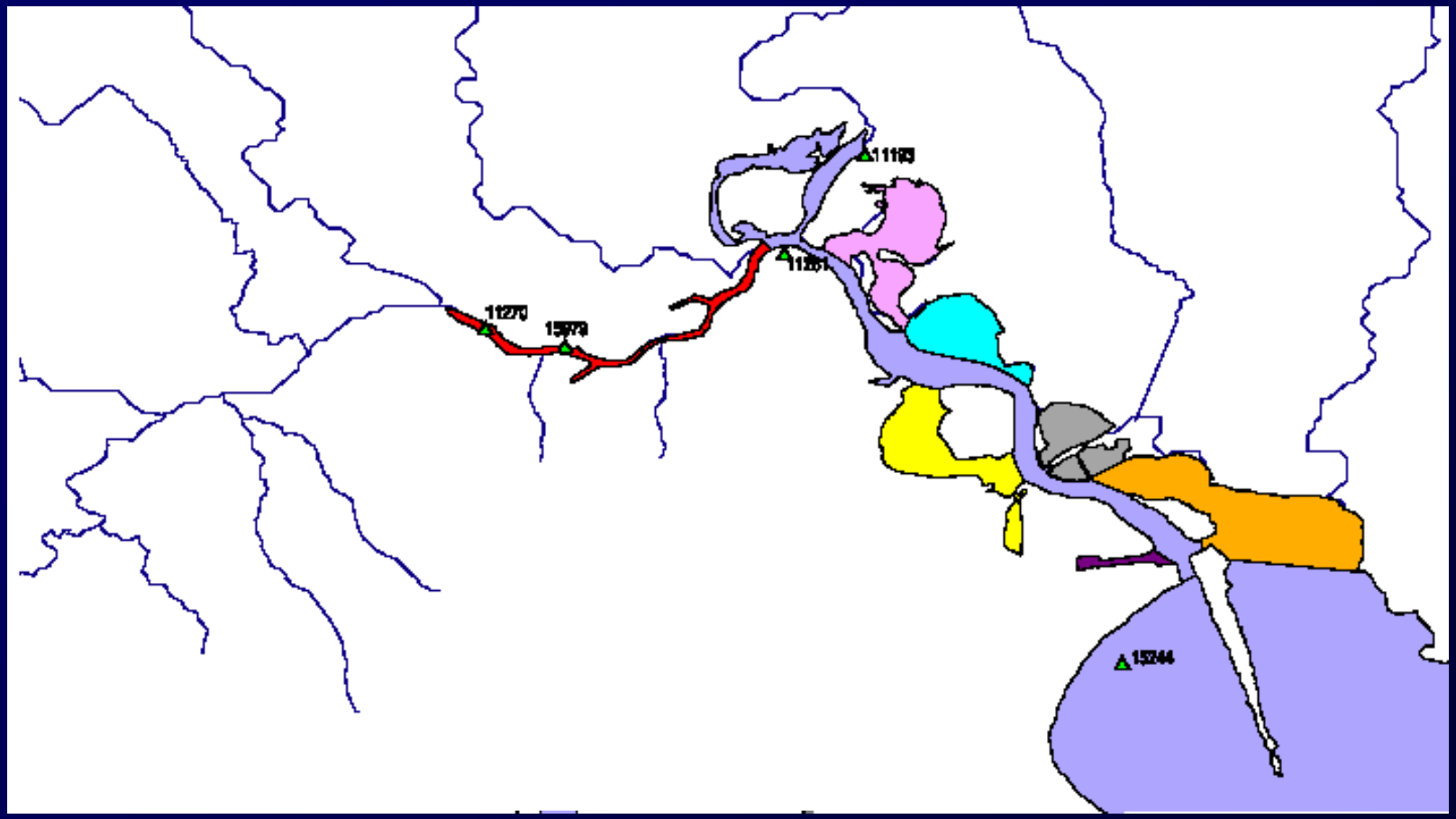


Sediment concentrations along15979 transect



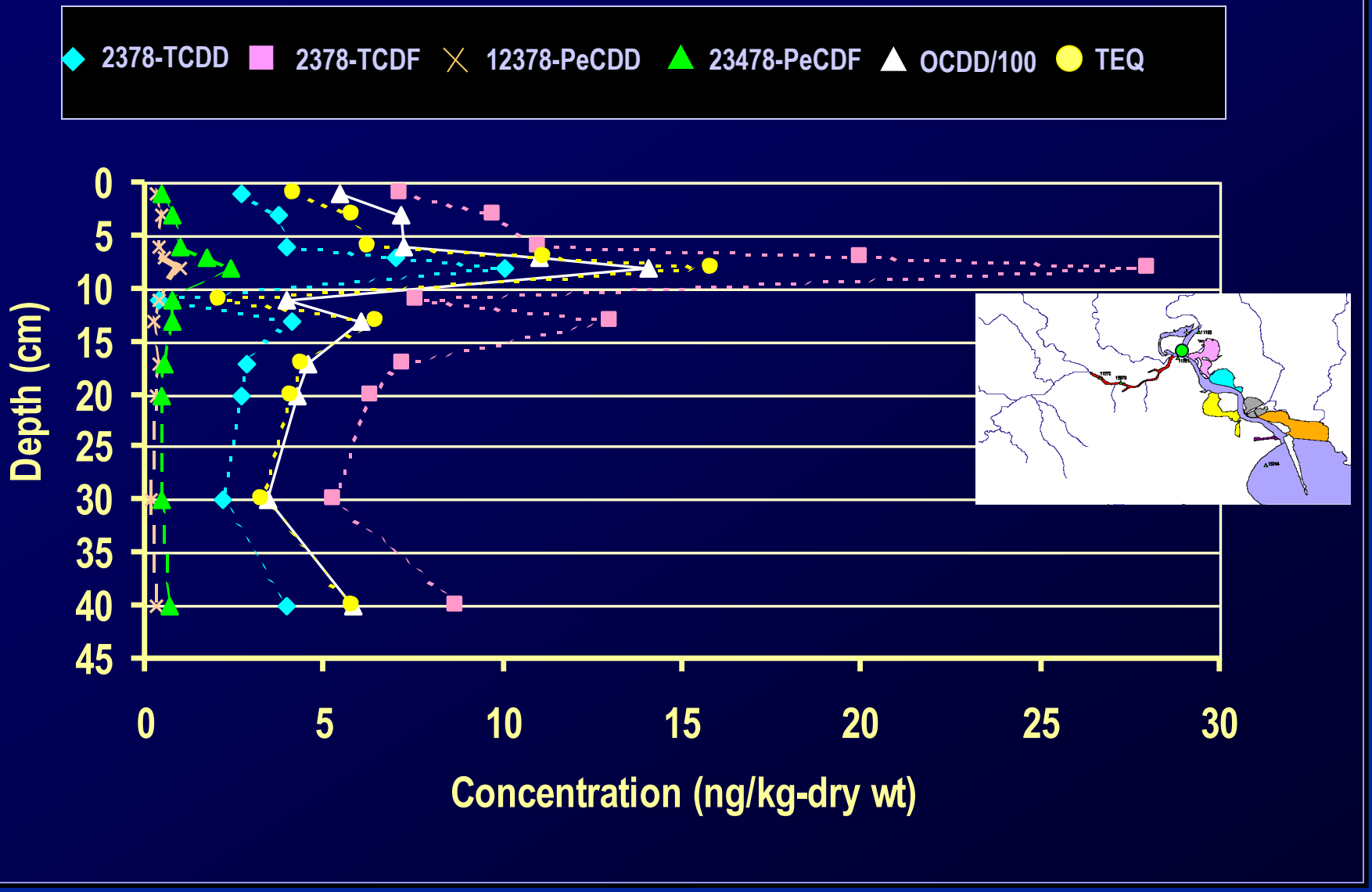


Sediment core locations

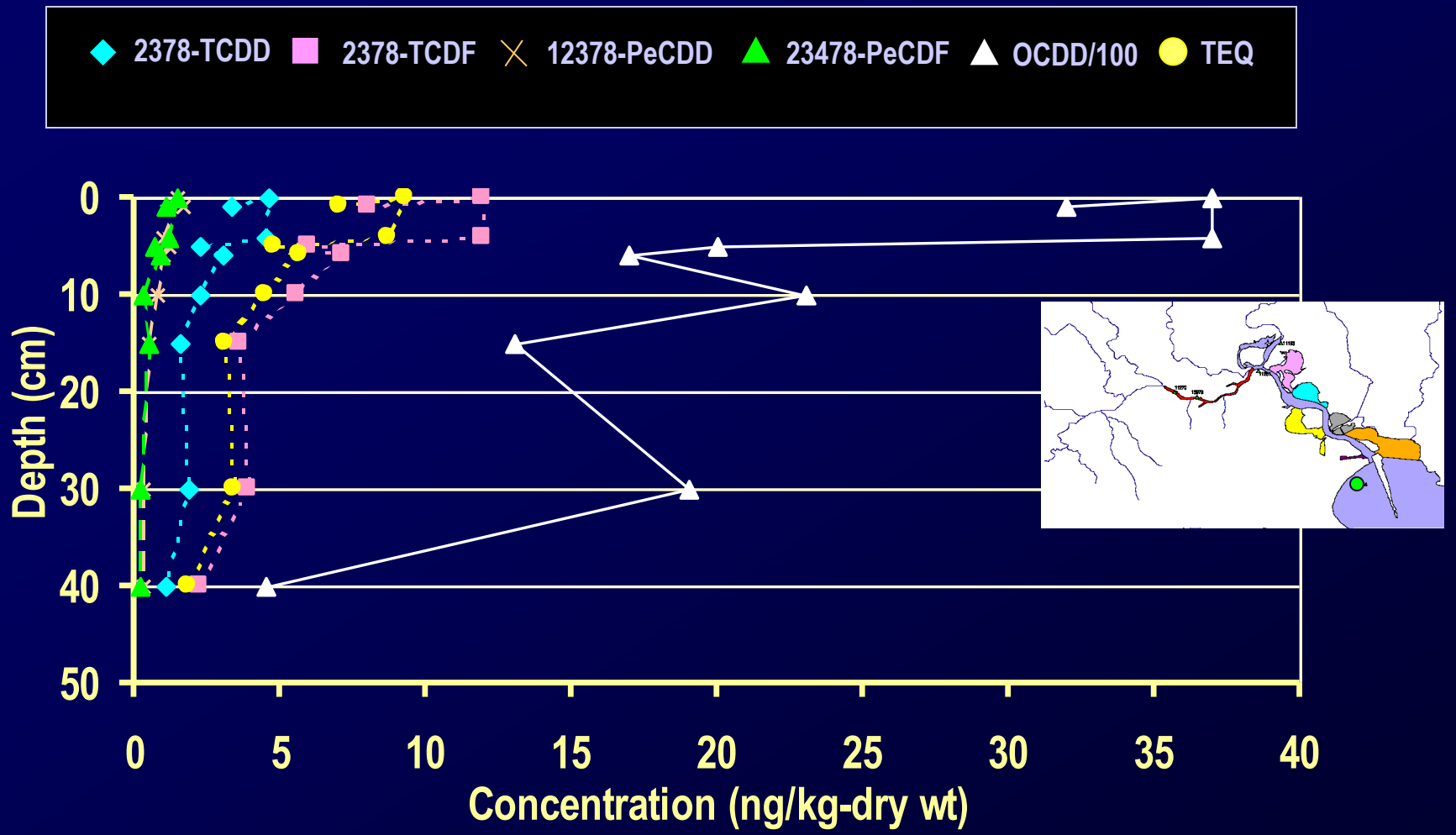


Sediment aging and deposition rate estimates underway

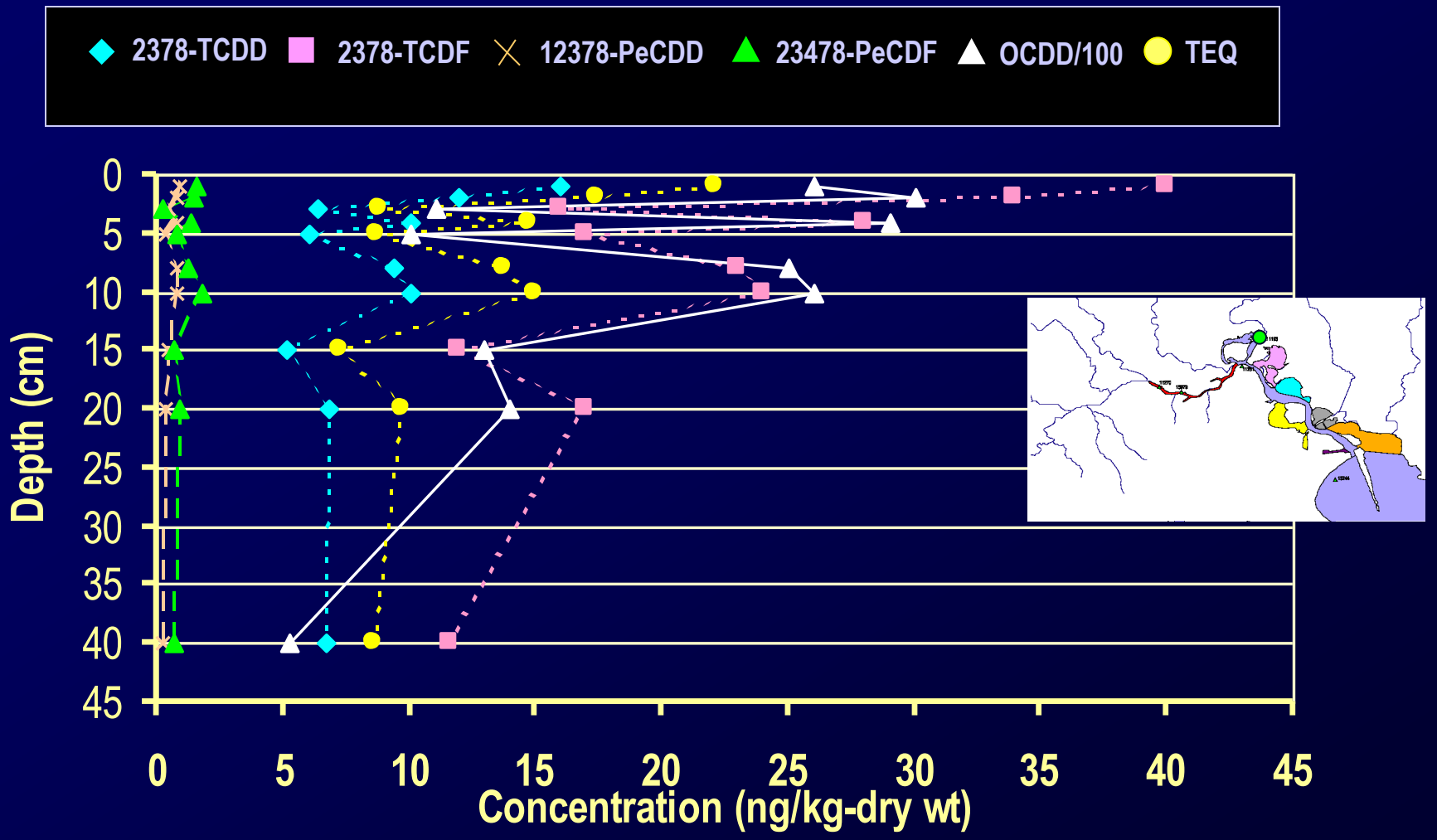
Dioxin concentrations in 11261 core



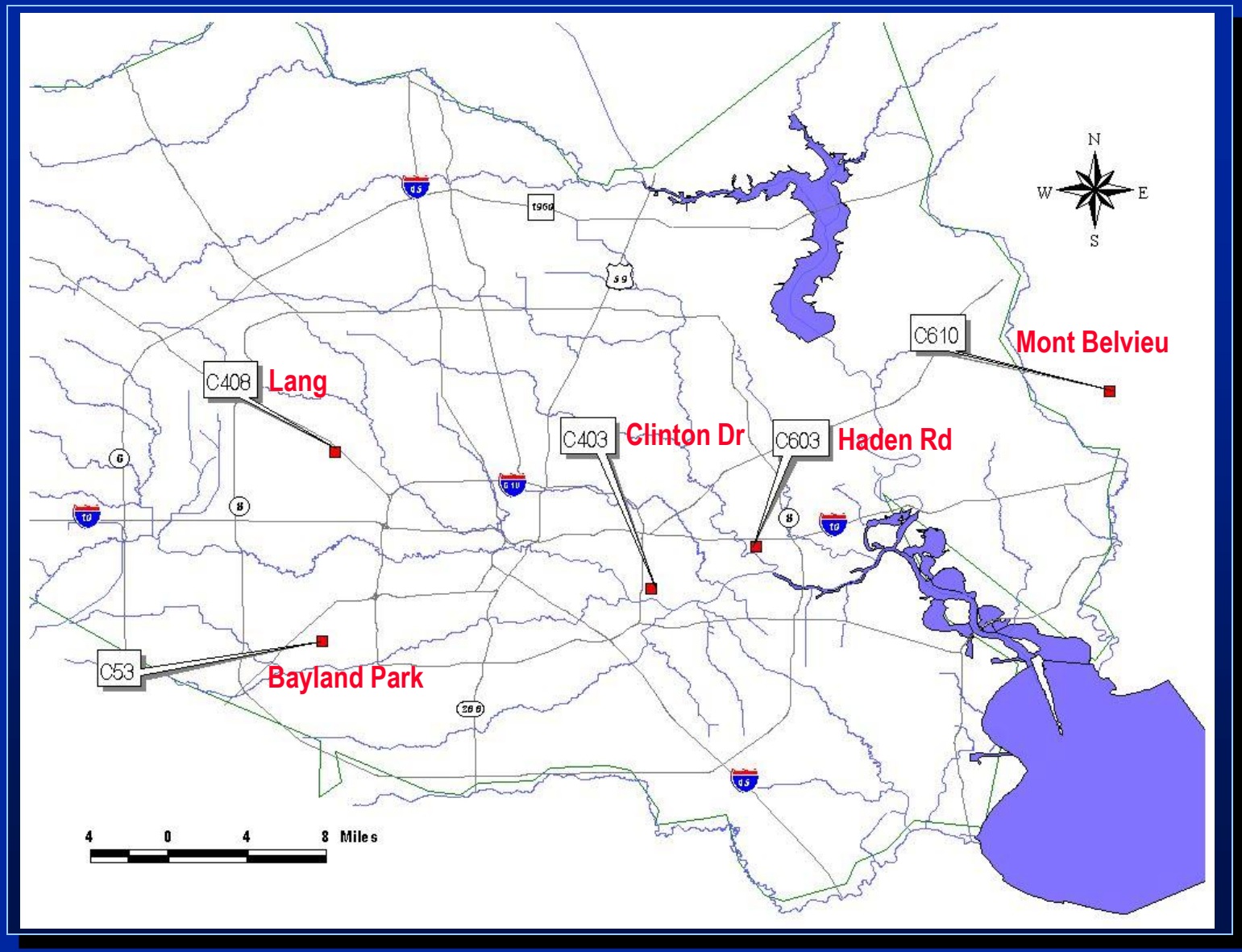
Dioxin concentrations in 15244 core



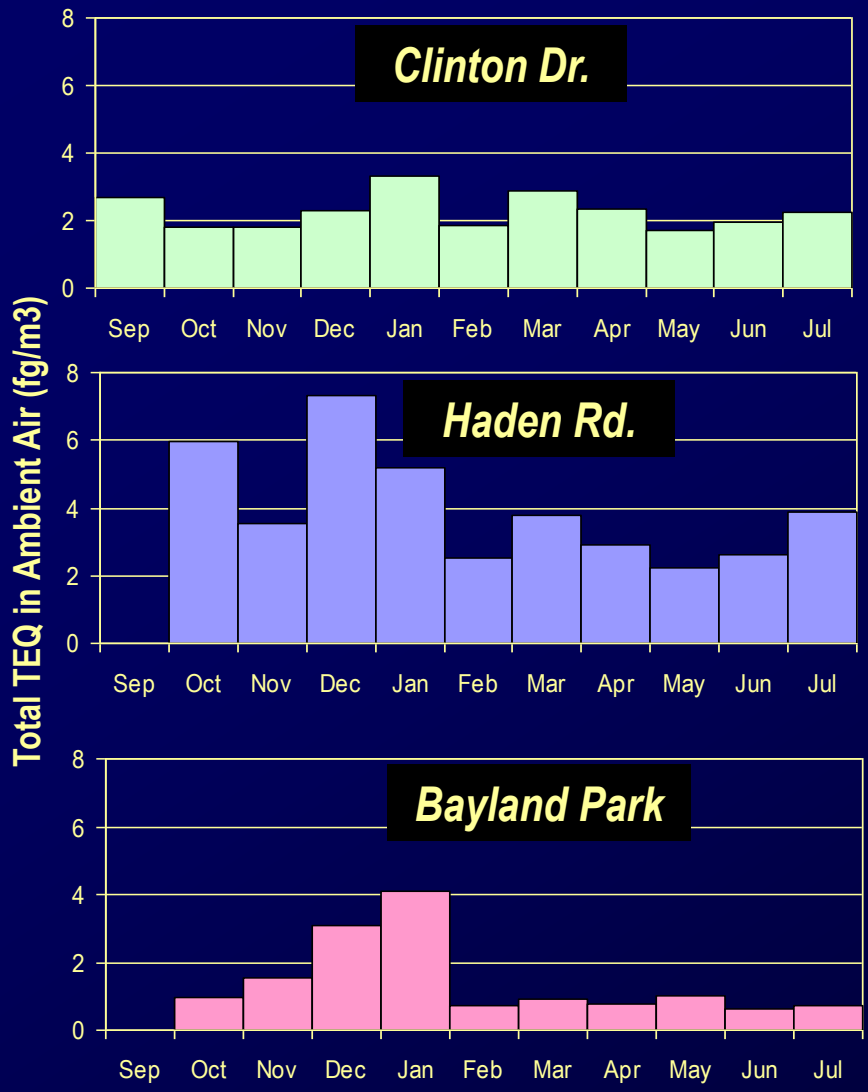
Dioxin concentrations in 11193 core

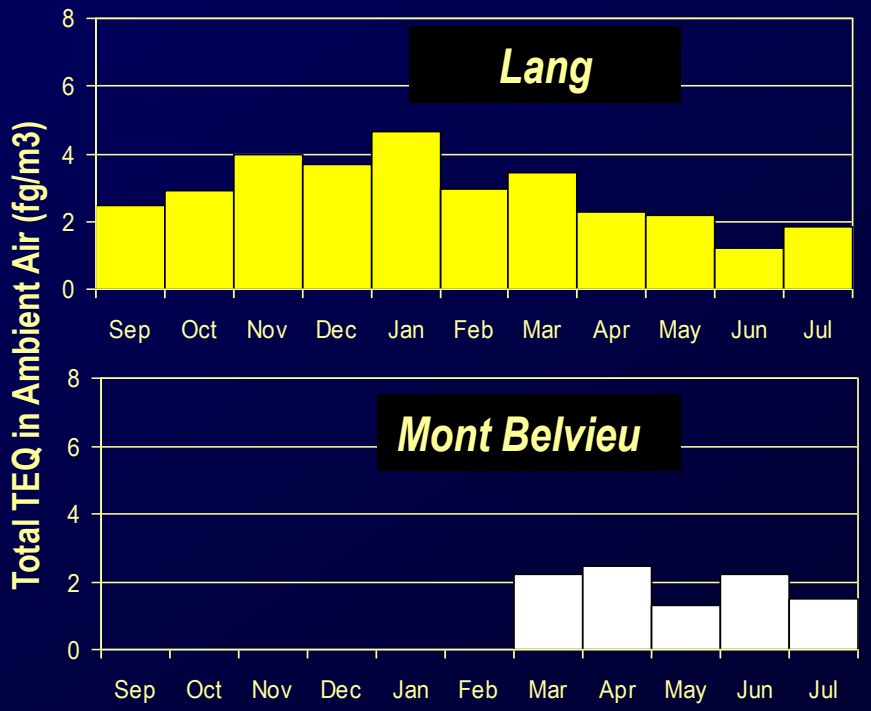


Air monitoring locations

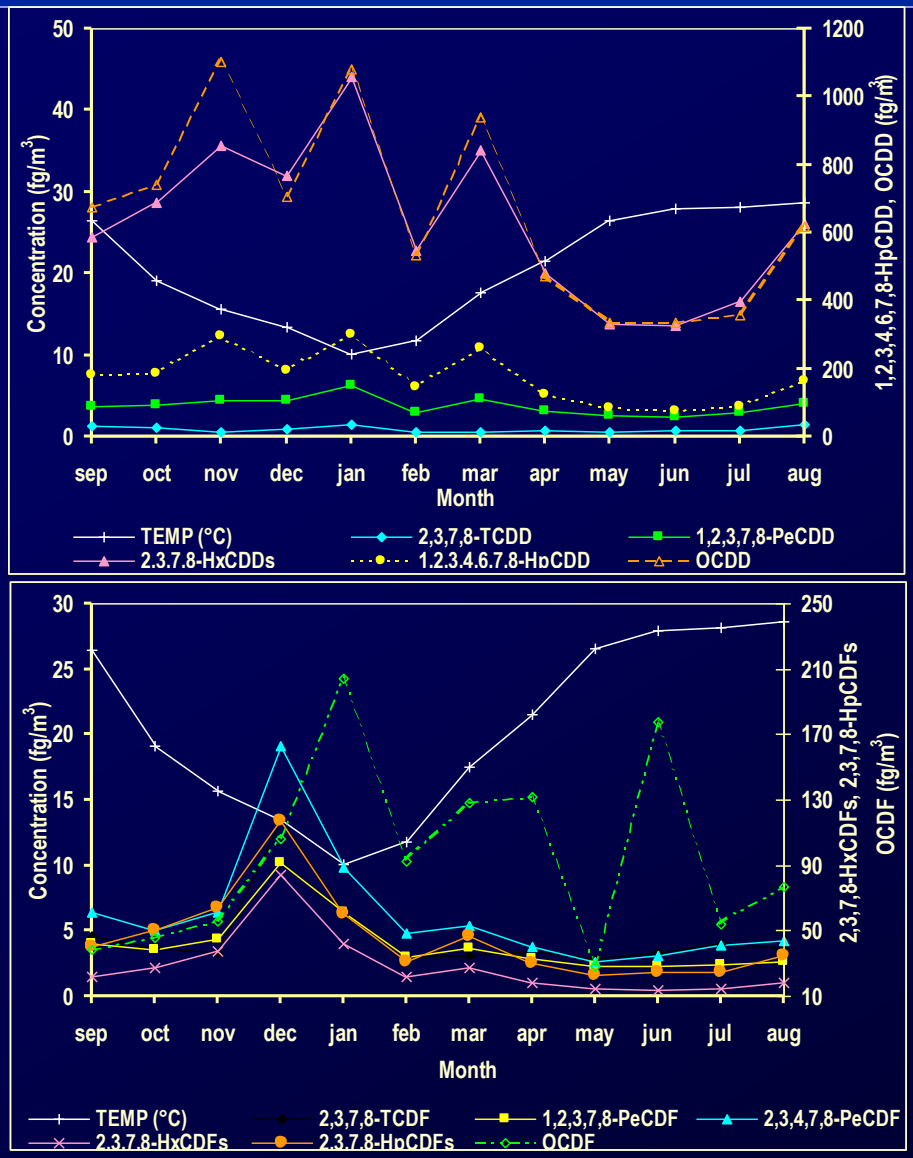


Dioxin in ambient air

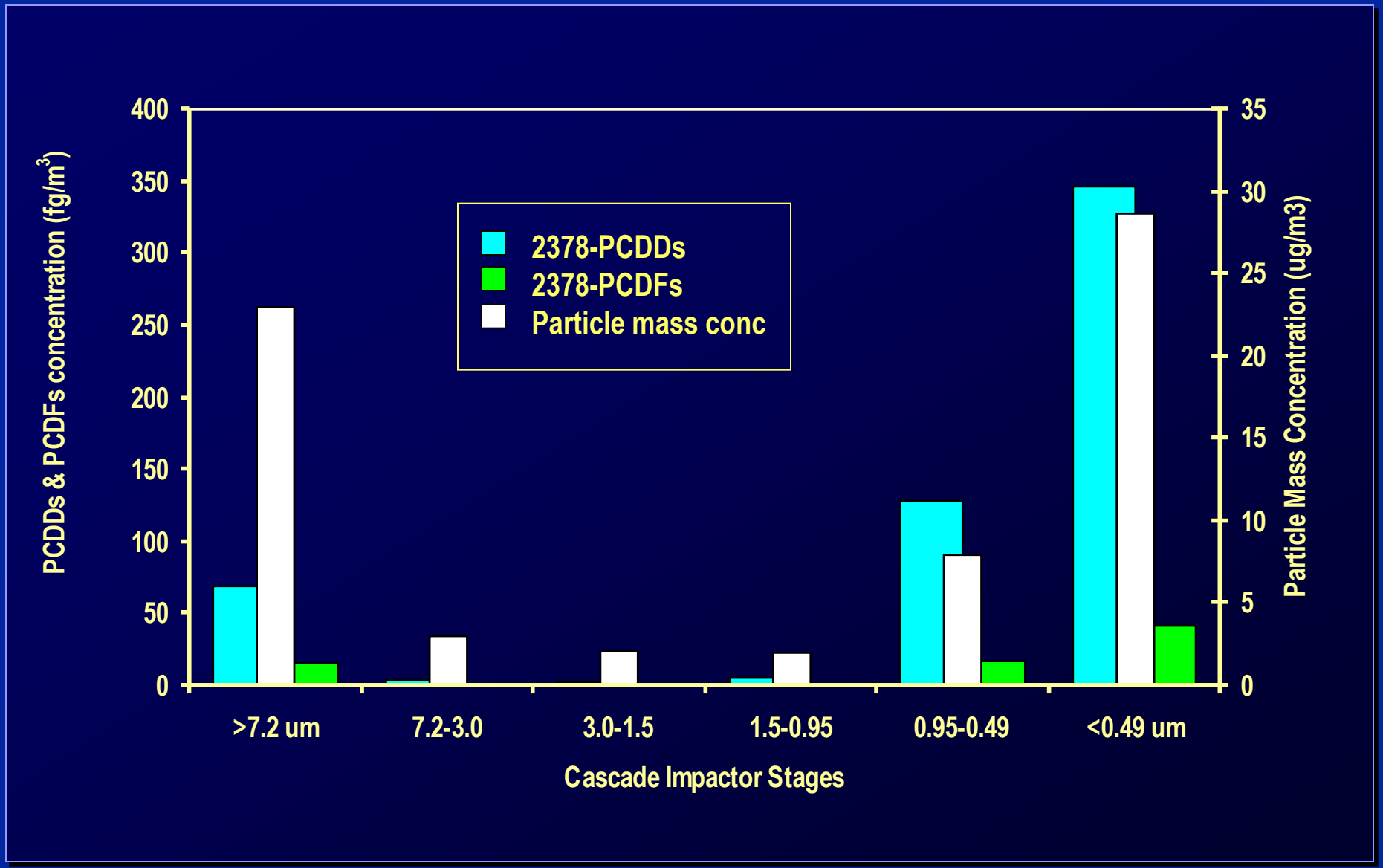




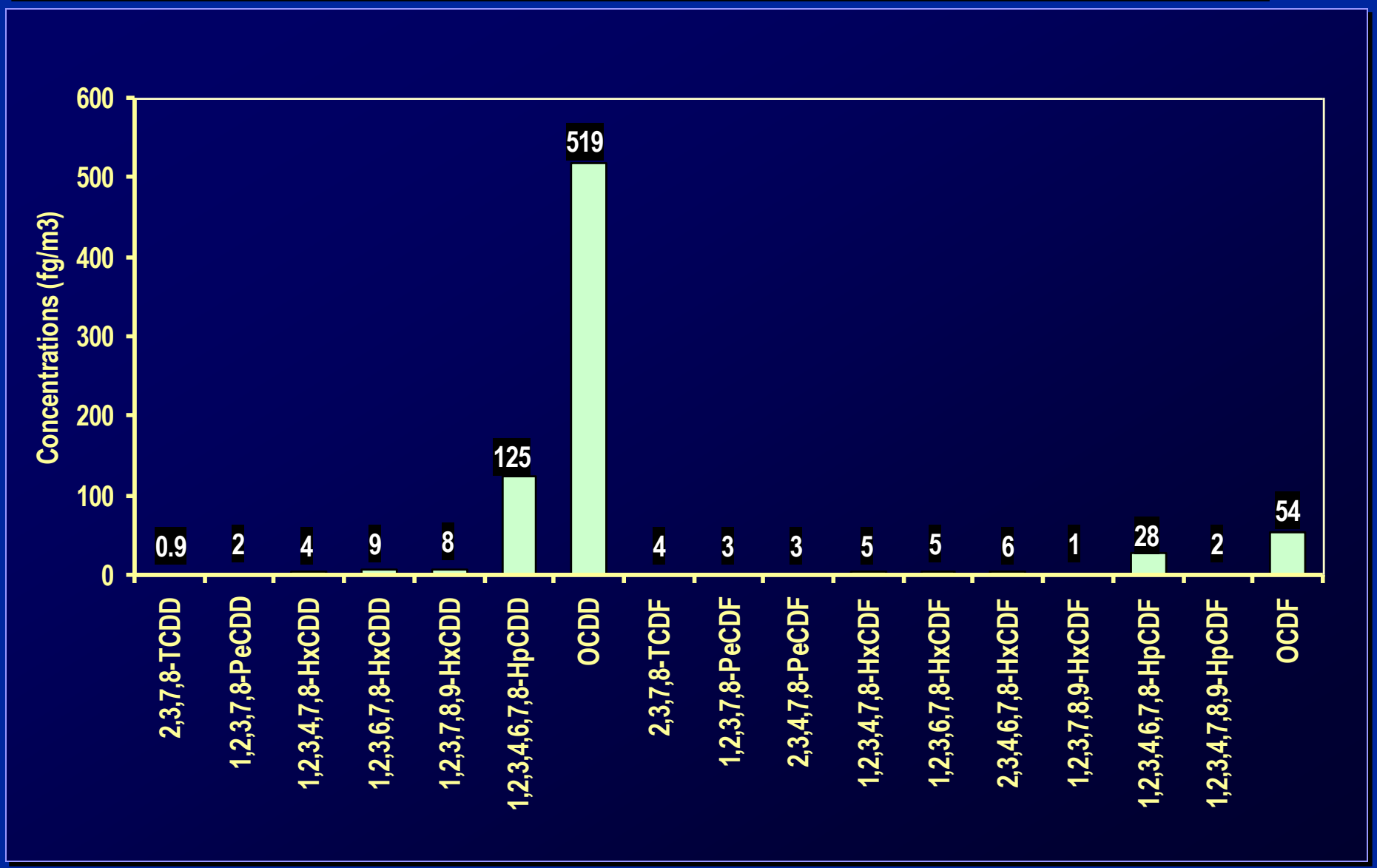
Monthly average concentrations in air



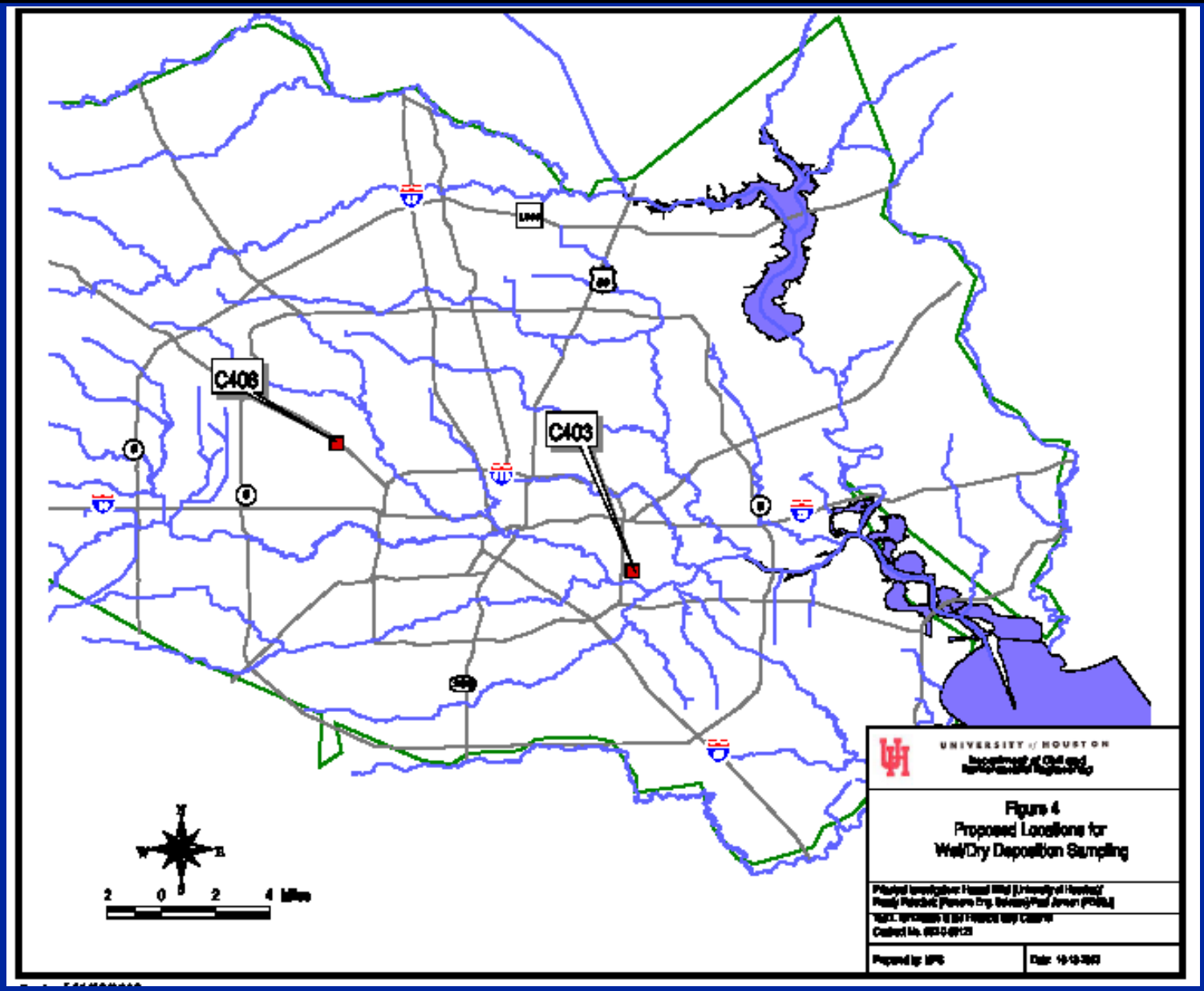
Dioxins by particle size



Dioxin in ambient air (Sept-Oct, 2004)



Air deposition – sampling locations

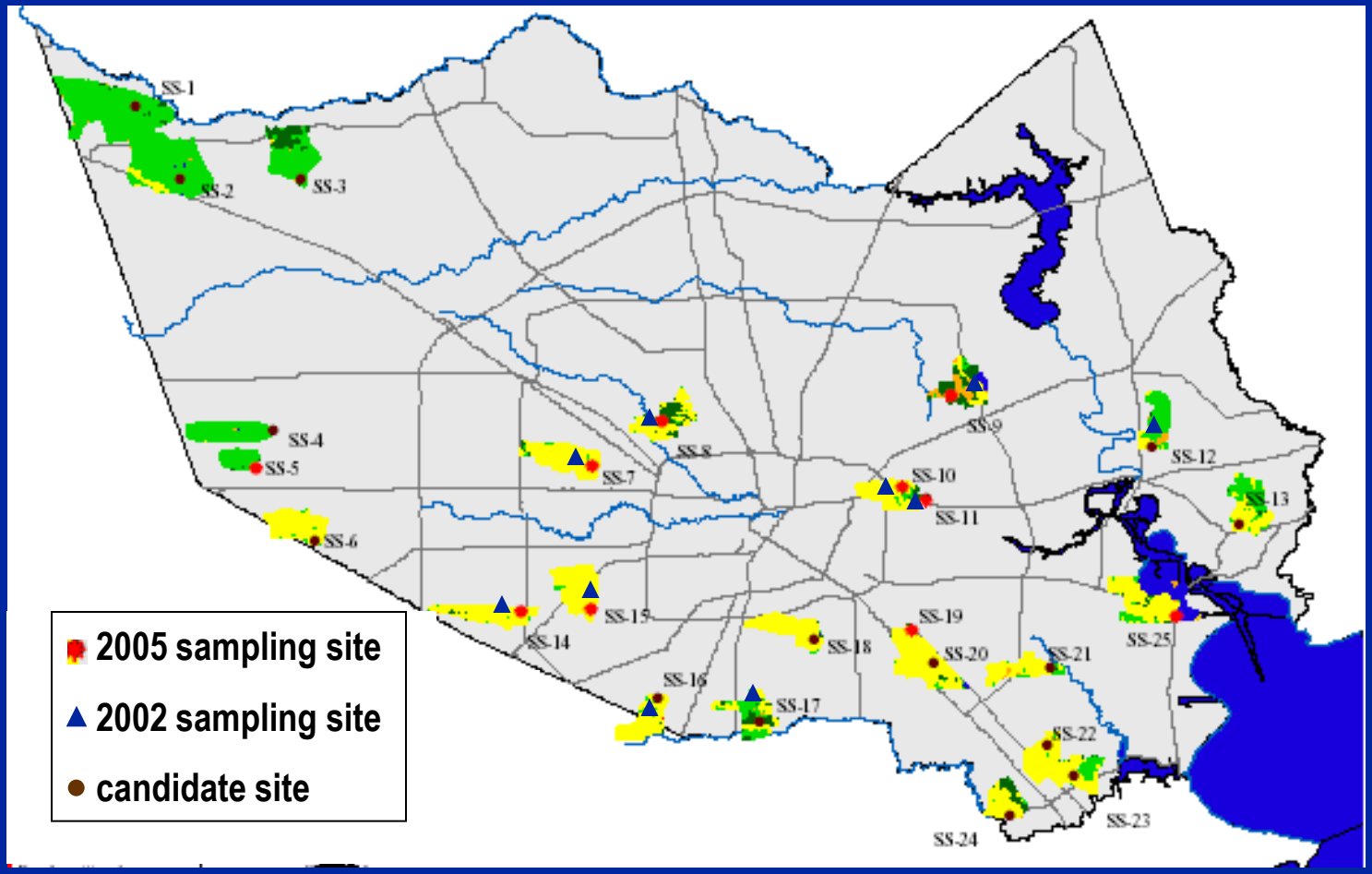


Dry-deposition sampling

Average deposition flux (fg/m^2-hr)	
2378-TCDD	43
OCDD	6,880
2378-TCDF	44
OCDF	410

Average deposition velocity (cm/sec)	
2378-TCDD	4.2
OCDD	0.2
2378-TCDF	1.3
OCDF	0.3

Total TEQ in runoff



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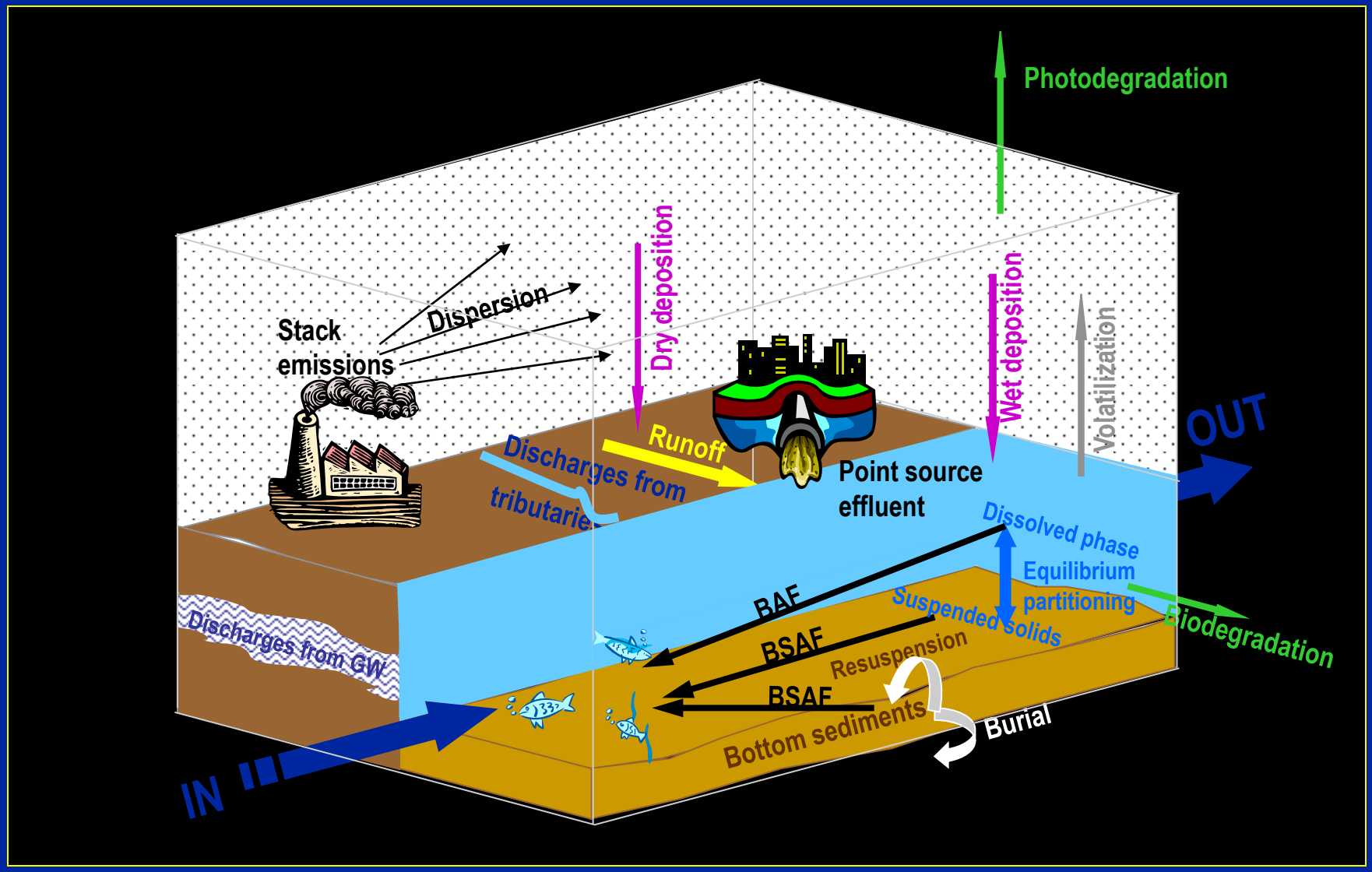
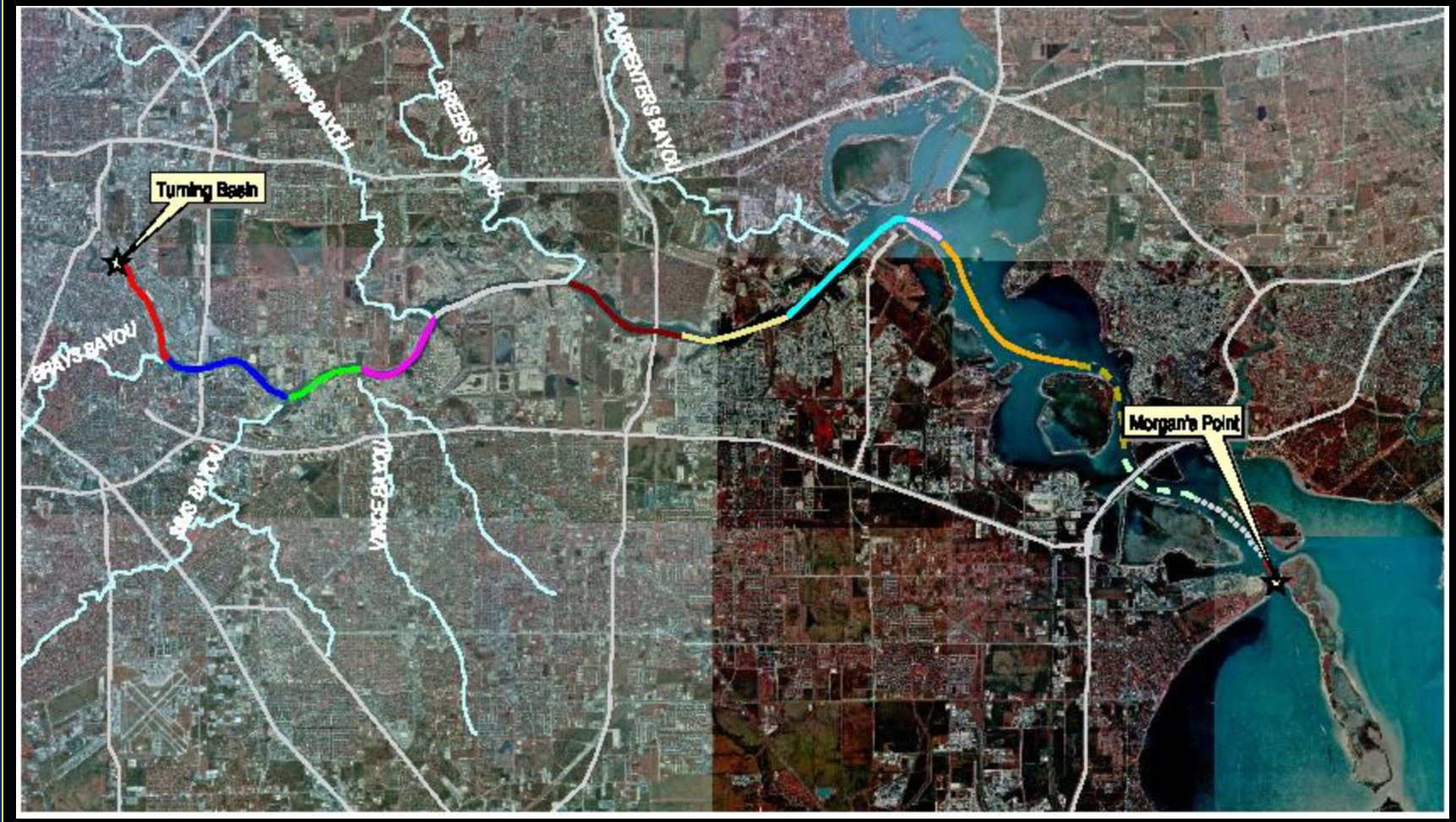
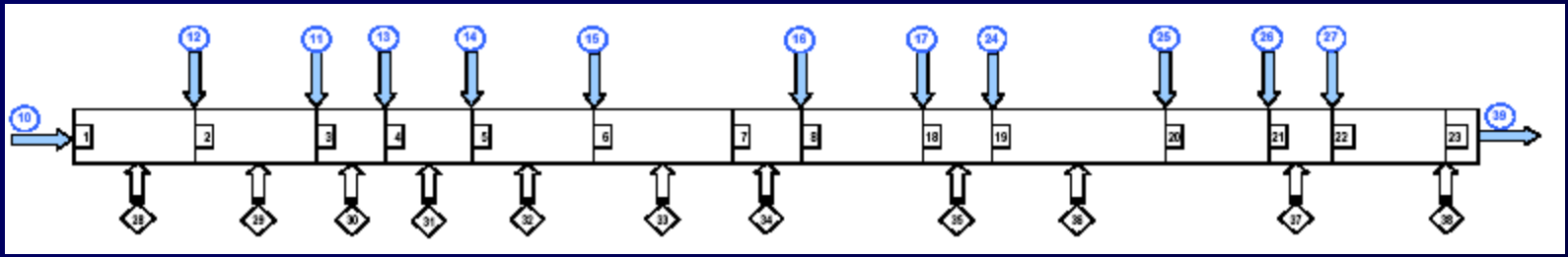
Conceptual model for dioxins in the HSC



Segmentation for simplified model



Loading schematic



1 Main channel segment (14 in total)

1 Boundary segment (13 in total)

1 Loading segment (11 in total)

1 benthic segment (not shown)

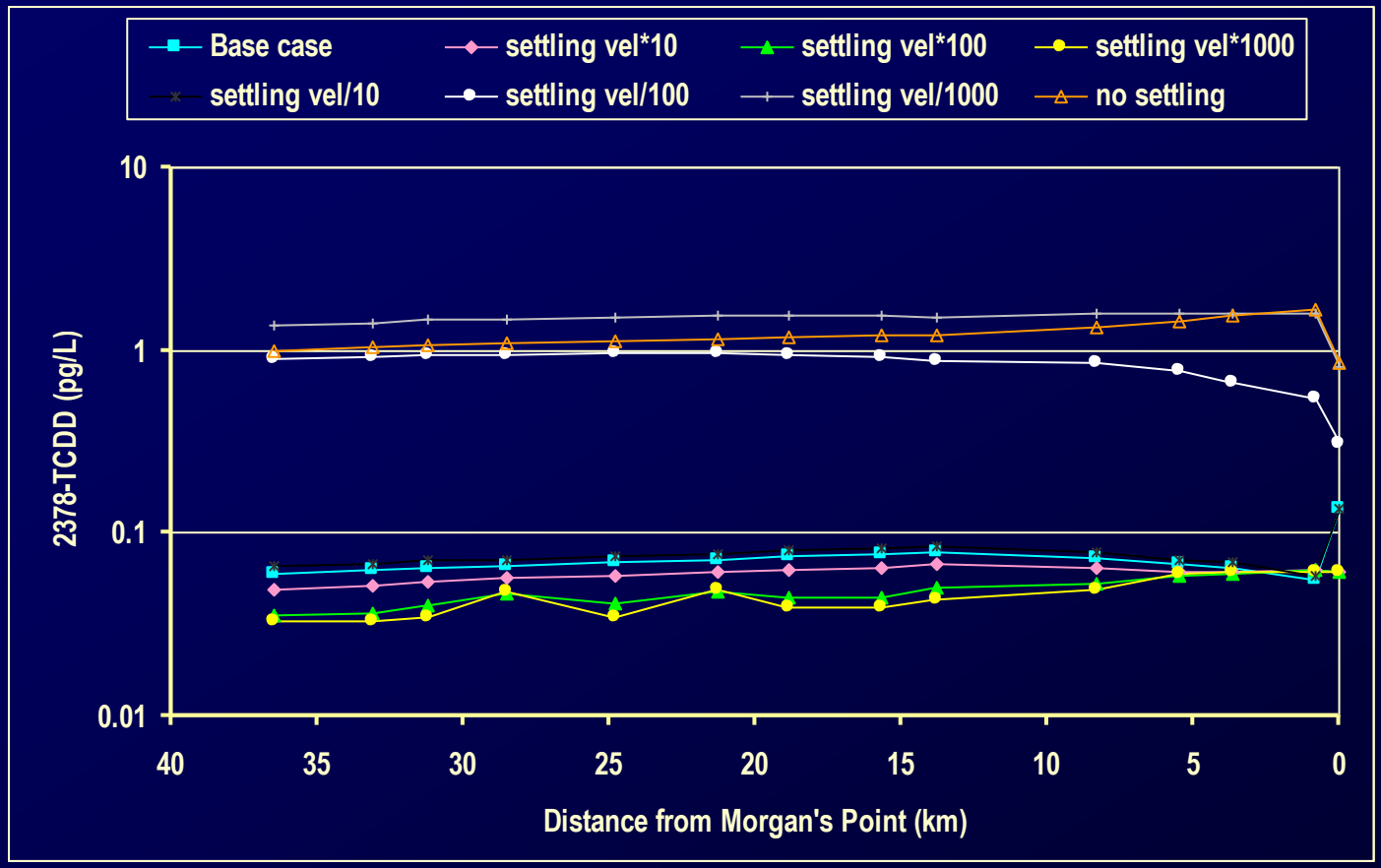
PS for simplified model

Segment	Total flow (m^3/s)	2378-TCDD load (kg/day)	TSS load (kg/day)
1	3.9E-04	5.7E-13	8.9E-03
2	2.5E+00	2.0E-09	1792
3	4.4E-01	2.9E-09	310
4	1.4E+00	5.1E-11	984
5	1.6E+00	1.6E-09	1593
6	9.0E-01	1.7E-09	623
7	1.1E+00	1.3E-08	768
18	5.0E-01	2.7E-09	347
19	1.1E-01	1.4E-09	77
21	1.7E+00	3.3E-09	1173

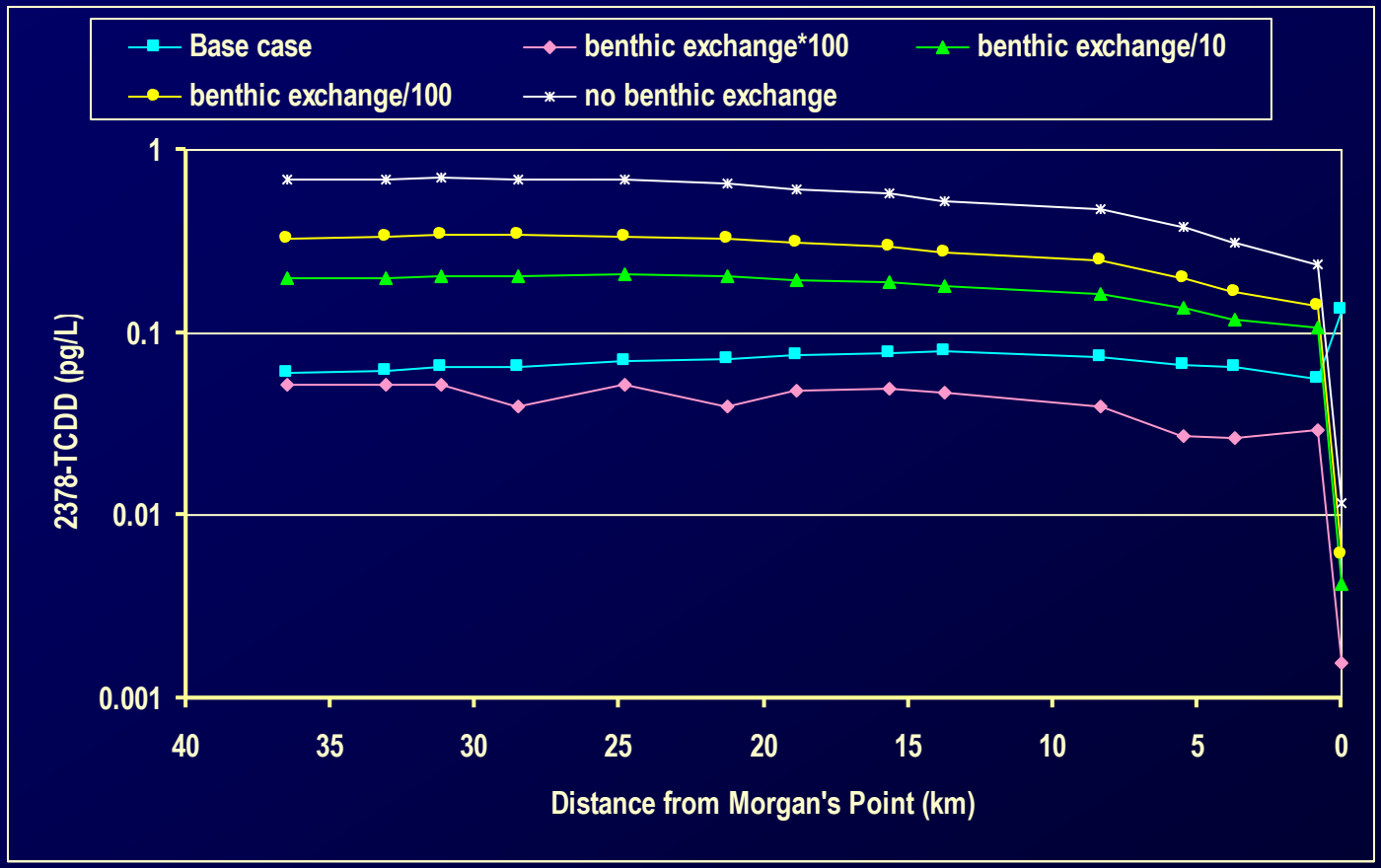
NPS for simplified model

Segment	Area (km^2)	Avg. daily rainfall (in)	2378-TCDD load (kg/day)	TSS load (kg/day)
1	1244	0.13	3.1E-08	46728
2	339	0.13	1.2E-08	30852
3	242	0.14	7.3E-09	10026
4	62	0.13	2.0E-09	3878
5	91	0.16	2.7E-09	5213
6	585	0.14	1.4E-08	55860
7	14	0.14	3.6E-10	1242
8	98	0.17	2.2E-09	7618
18	1125	0.18	1.8E-08	61735
22	85	0.17	2.1E-09	4151
23	50	0.14	1.2E-09	3980

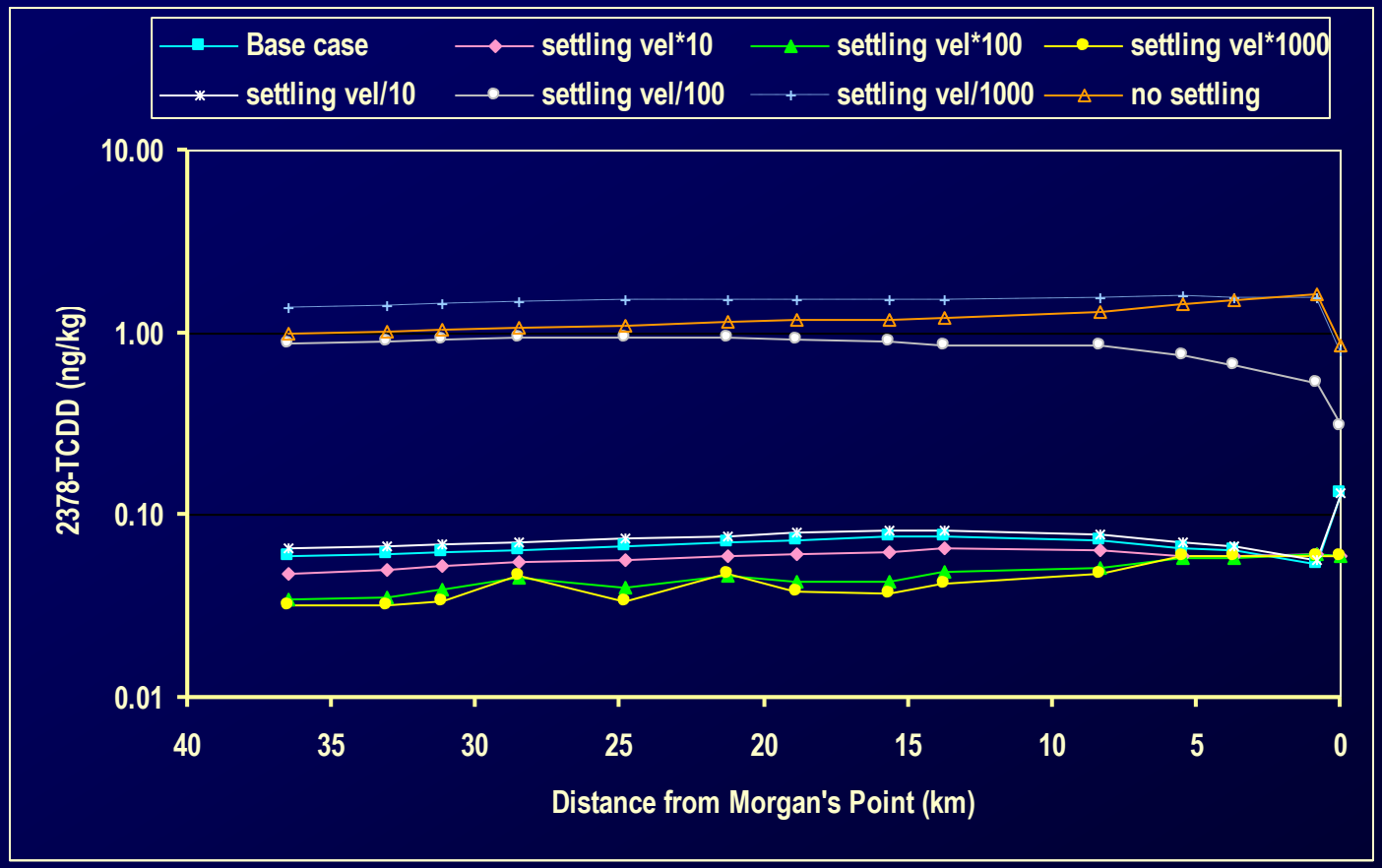
Sensitivity analysis-dissolved



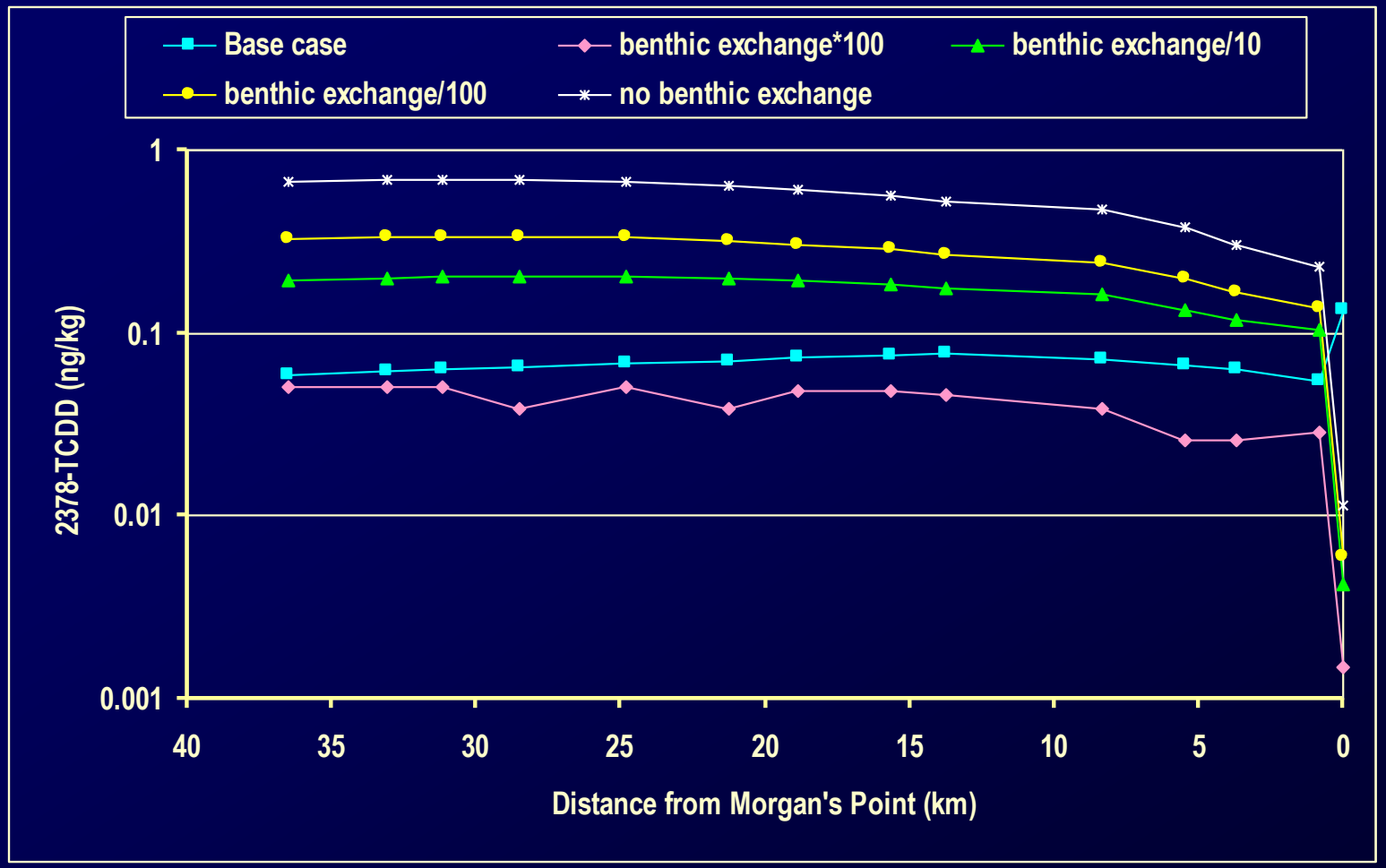
Sensitivity analysis-dissolved



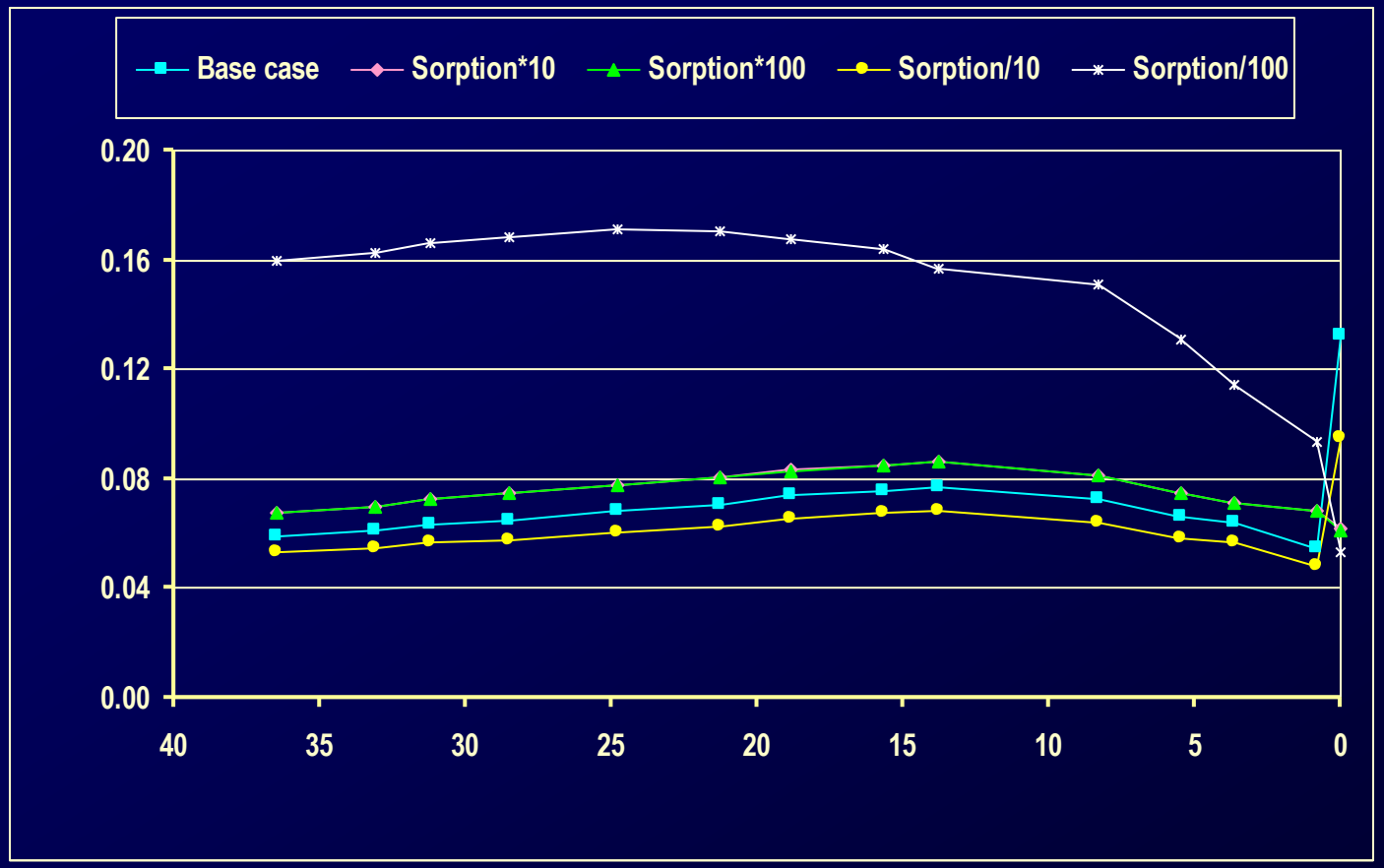
Sensitivity analysis-suspended



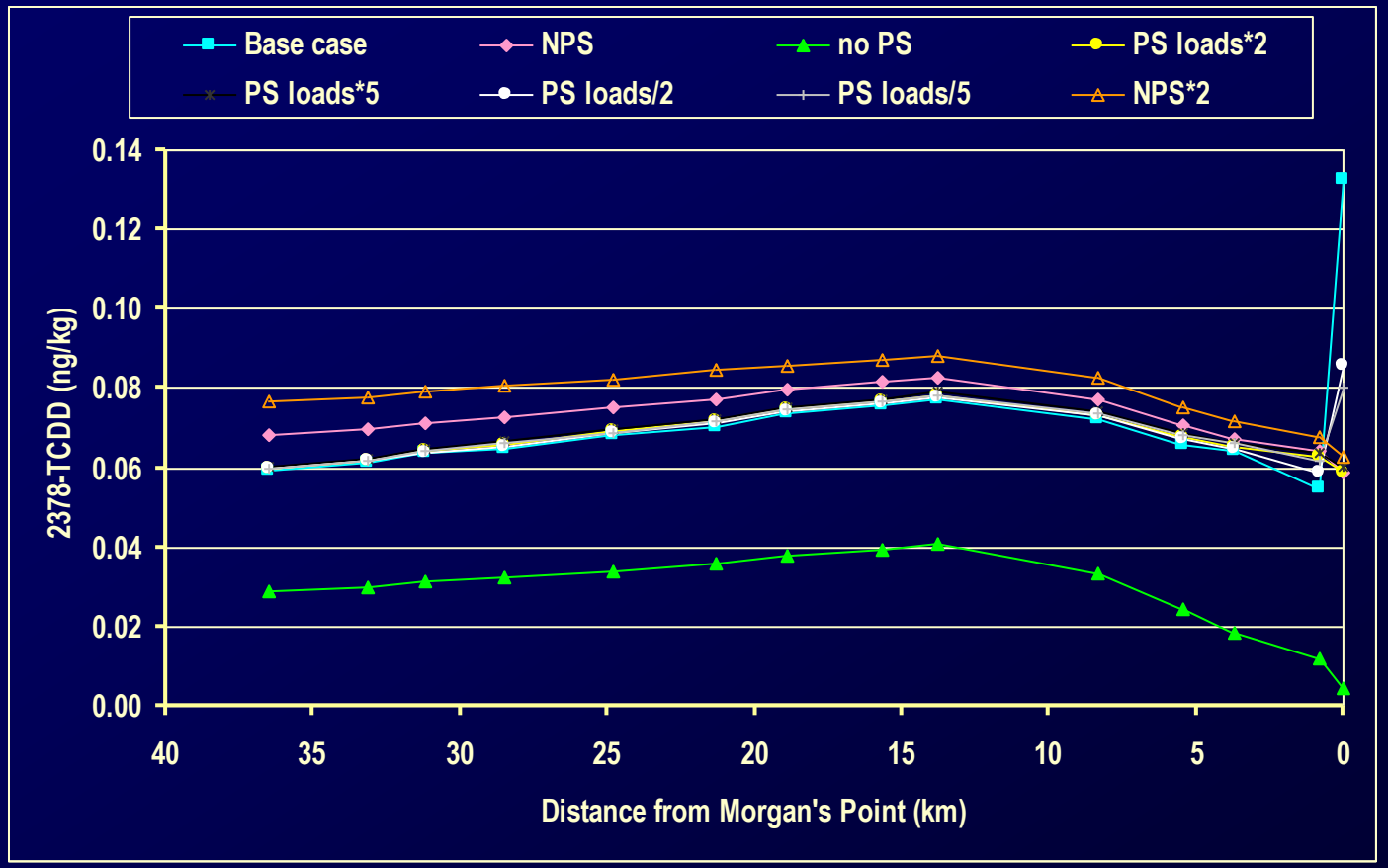
Sensitivity analysis-suspended



Sensitivity analysis-suspended



Sensitivity analysis-suspended



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Stakeholder process participation

- Meeting at Port of Houston Authority on 05/17/2004
- Meeting at UH on 05/24/2004
- Responses to comments from stakeholders
- Technical presentations at
  - The Haden Road CAP on 03/22/2004
  - Board Meeting of the GBEP on 04/22/2004
  - The Baytown Area CAP on 05/17/2004

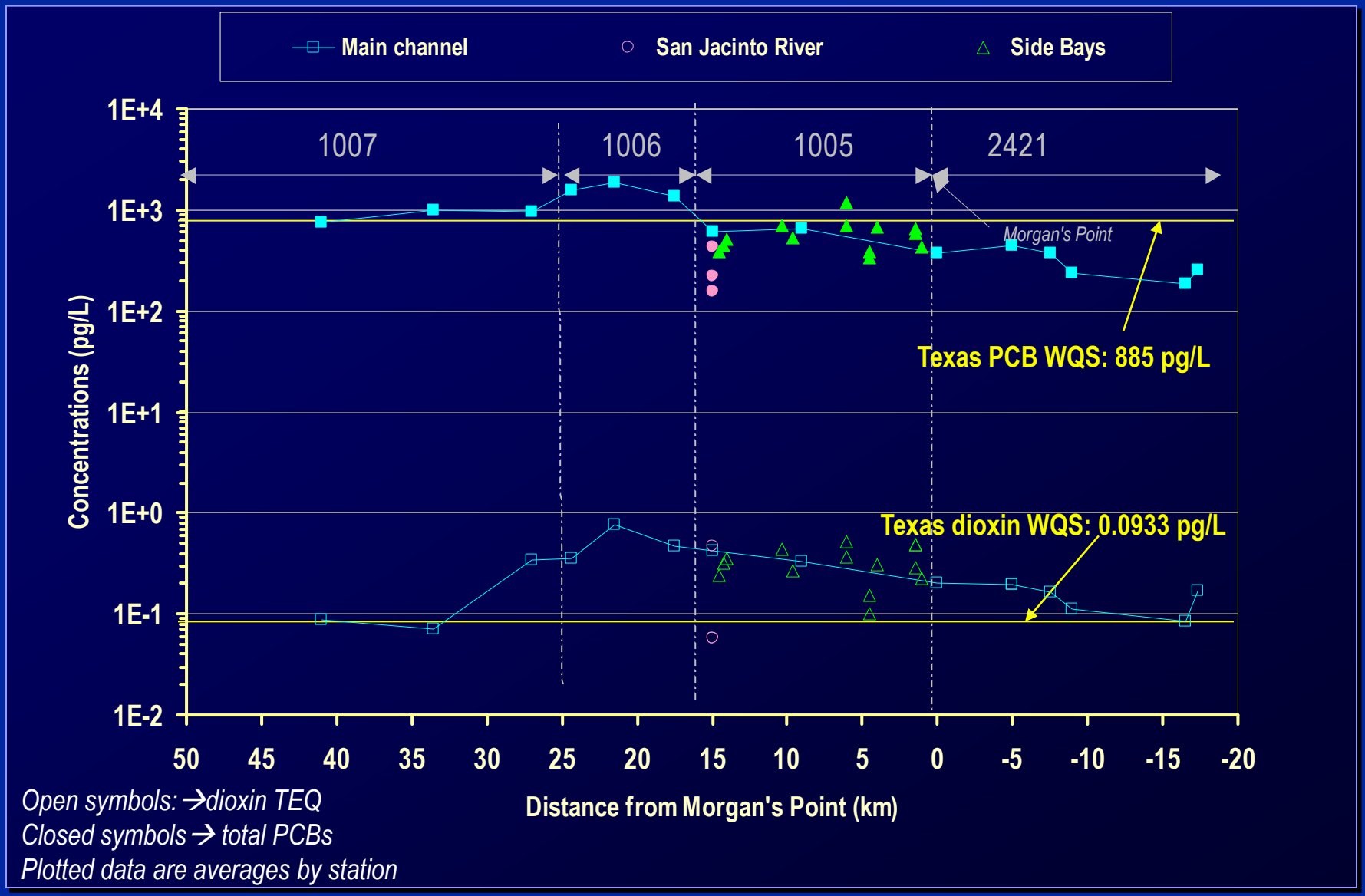
Main tasks Phase III – (WO7)

- Develop a QAPP for additional data collection
- Conduct dioxin monitoring and additional data collection in the HSC
- Model fate and transport of dioxins in the HSC using sophisticated models
- Participate in stakeholder process
- Estimate TMDL allocations
- Evaluate PCB data gathered to date

PCB assessment

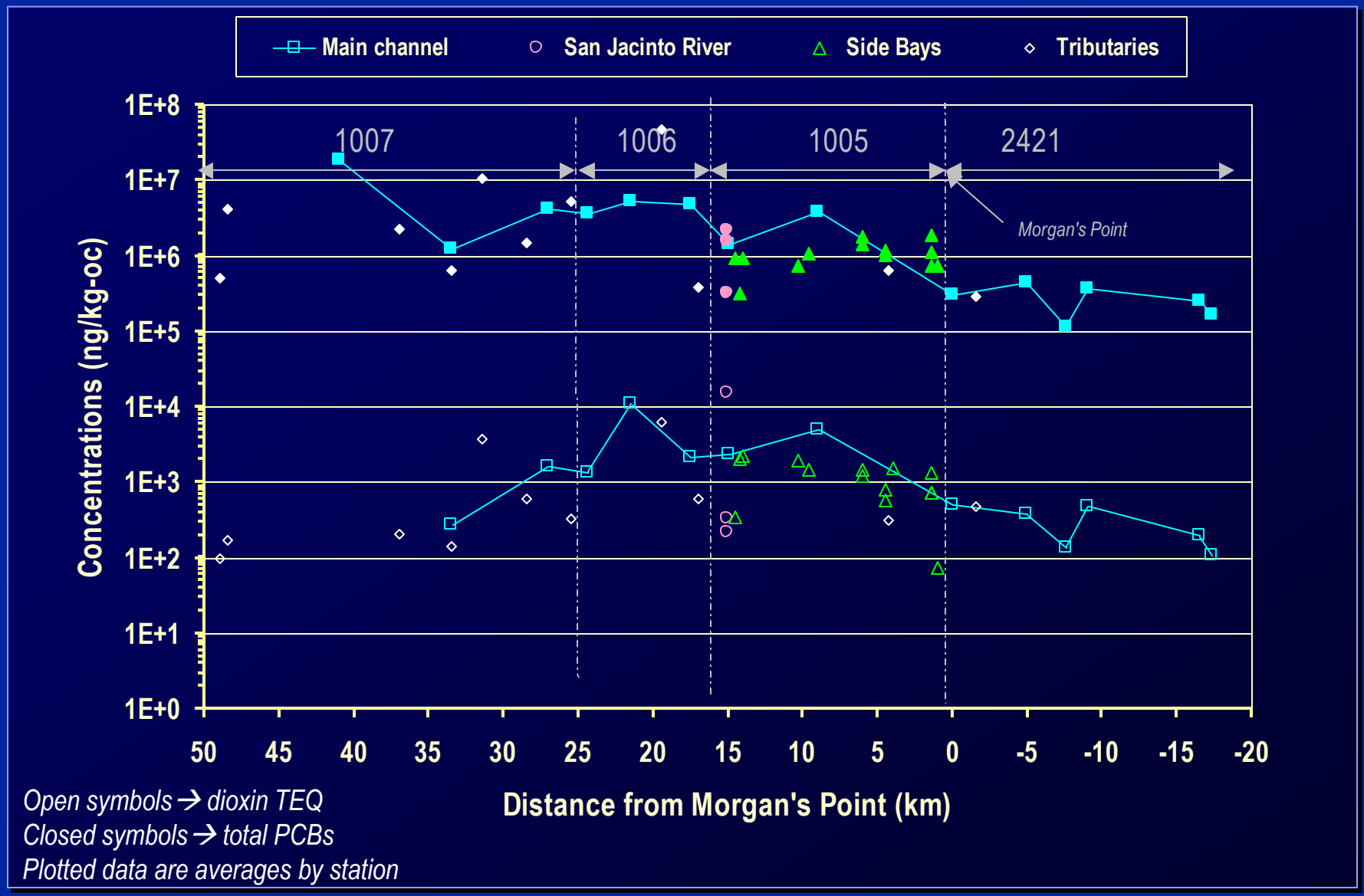
- 209 congeners (EPA 1668A) vs Aroclors (EPA 8082)
- Texas WQS for total PCBs (based on Aroclors)
  - 1.3 ng/L in freshwater
  - 0.885 ng/L in saltwater
- TDH screening value 47 ng/g (based on Aroclors)

PCB and dioxin in water profiles



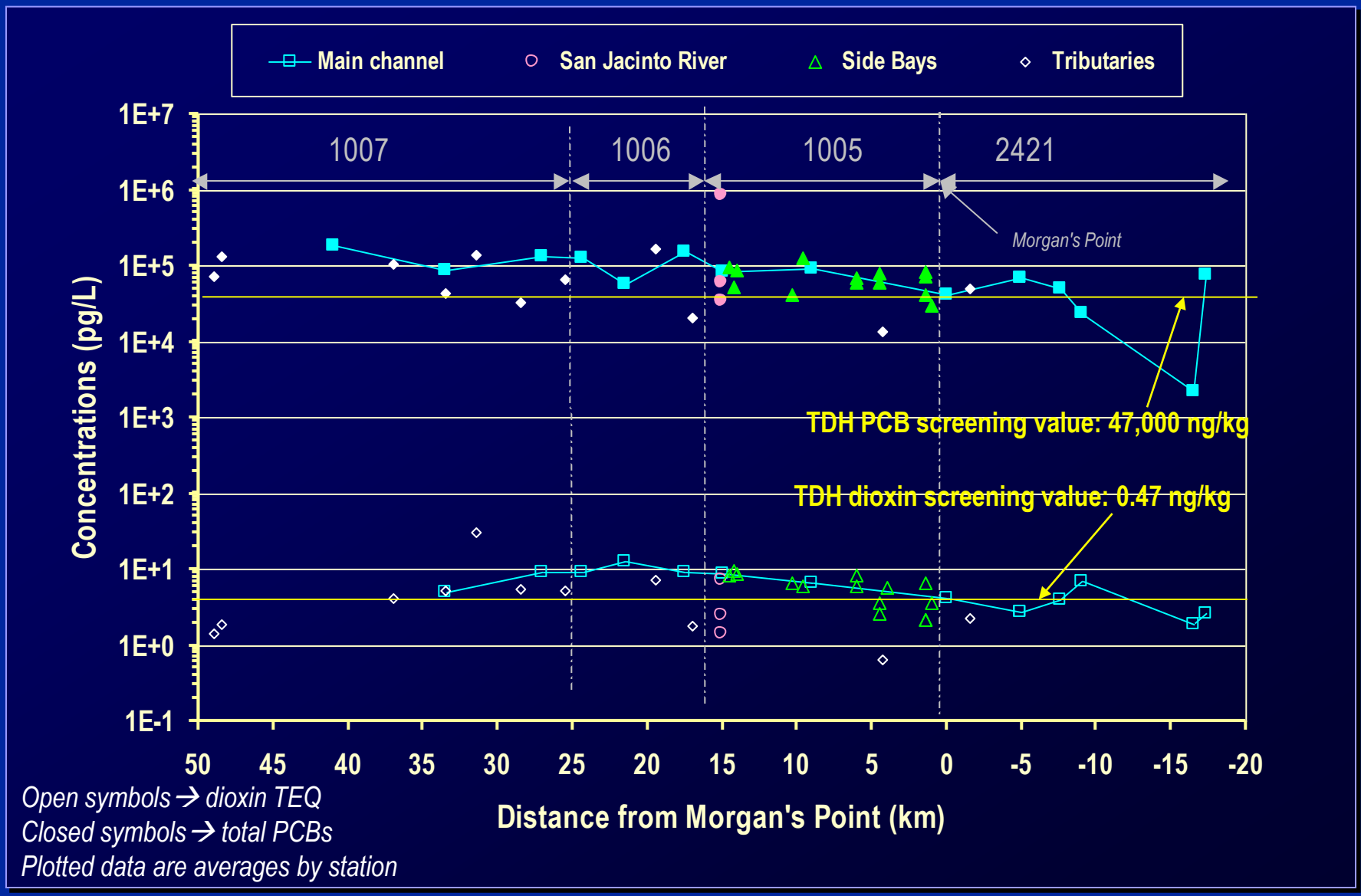
Open symbols: → dioxin TEQ
Closed symbols → total PCBs
Plotted data are averages by station

PCB and dioxin in sediment-oc profiles

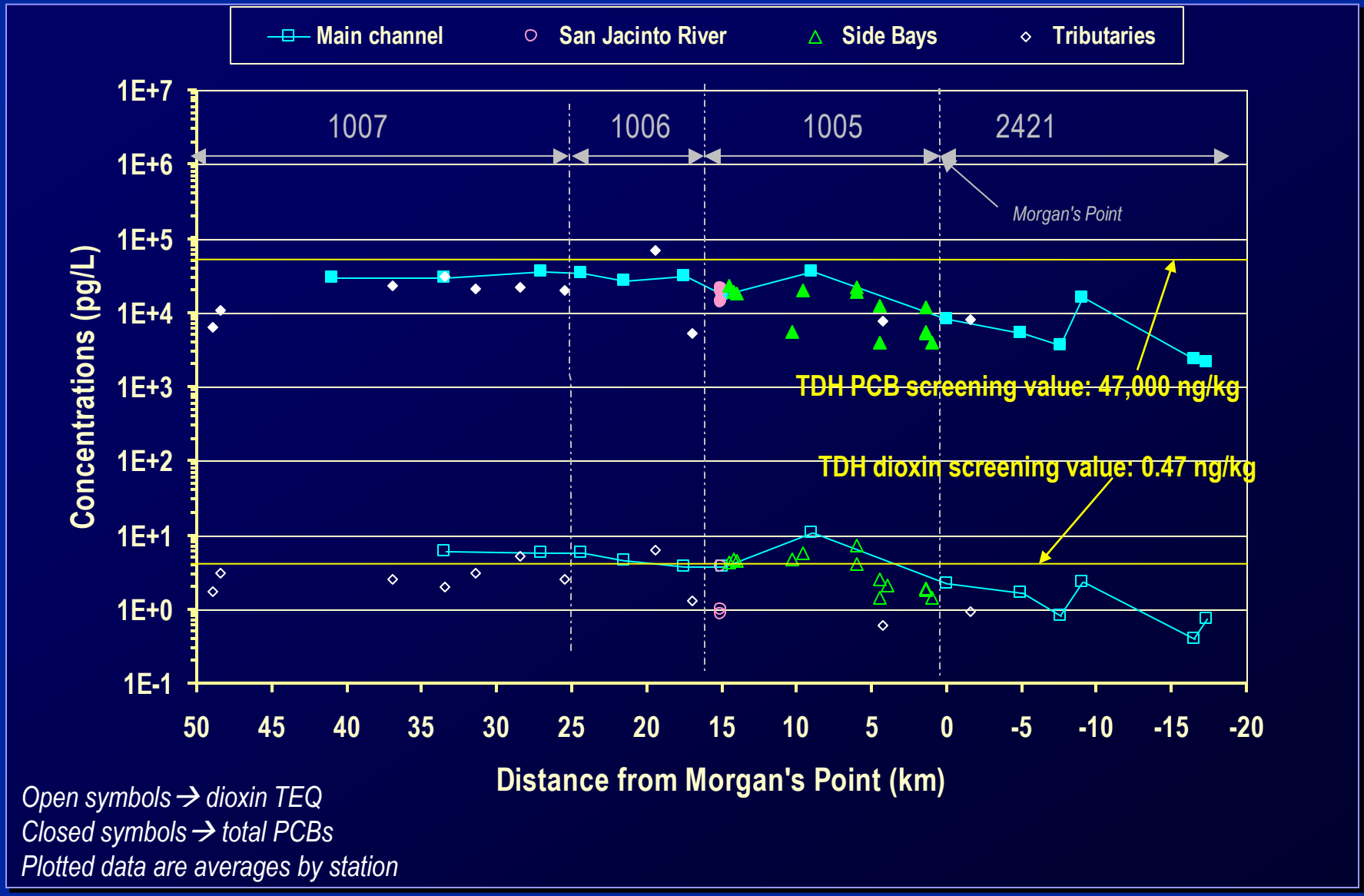


Open symbols → dioxin TEQ
Closed symbols → total PCBs
Plotted data are averages by station

PCB and dioxin in catfish profiles



PCB and dioxin in crab profiles



Open symbols → dioxin TEQ
Closed symbols → total PCBs
Plotted data are averages by station

PCB assessment

- Water concentrations showed a *Tier-1 primary concern* based on congener analysis in segments 1006 and 1007. Aroclor data showed no concern.
- Tissue data confirms a concern for PCBs in catfish in segments 1001, 1006, and 1007 (congener data). Aroclor data showed concern in 1001 only.
- Congener data in catfish showed potential concerns in Sims Bayou, Vince Bayou, Patrick Bayou, Buffalo Bayou, and Whiteoak Bayou.
- Need to evaluate Aroclor and congener data and determine listings and define methodology to compare congener data and to establish criteria to assess use support.

Total number of dioxin samples

Media	Phase II #sites	Phase II #samples	Phase III #sites	Phase III #samples
In-stream water	33	87	28	71
Sediment	45	115	17	68
Catfish	45	117	28	53
Crab	45	108	28	47
Sludge	69	75	-	-
Effluent	45	47	-	-

Total number of dioxin samples-cont'd

Media	Phase II		Phase III	
	#sites	#samples	#sites	#samples
Sediment cores	-	-	6	70
Runoff	10	11	3	71
Ambient air	5	87	2	68
Dry deposition	-	-	2	53
Wet deposition	-	-	2	47
Bulk deposition	-	-	1	1
Particulate	-	-	1	18