

Evaluation of PCBs and Dioxin/Furans (DxFs) Concentrations in Sediment from the Delaware Estuary

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Outline

- Present spatial distribution of PCBs and DxFs concentrations from the Delaware Estuary collected for the Delaware Estuary Benthic Inventory (DEBI) project
- Compare PCB homolog signatures
- Calculate Toxic Equivalents (TEQs) for both PCBs and DxFs
- Technical/Management Implications

DEBI Sediment Sample Collection

- Sediment samples were collected as part of the Delaware Estuary Benthic Inventory (DEBI) Program in Summer of 2008
- Surface grab samples
 - Young stainless steel grab
- 187 samples were received by the DRBC
- Samples were collected in Zones 4, 5 and 6
 - with an emphasis in Zones 5 and 6

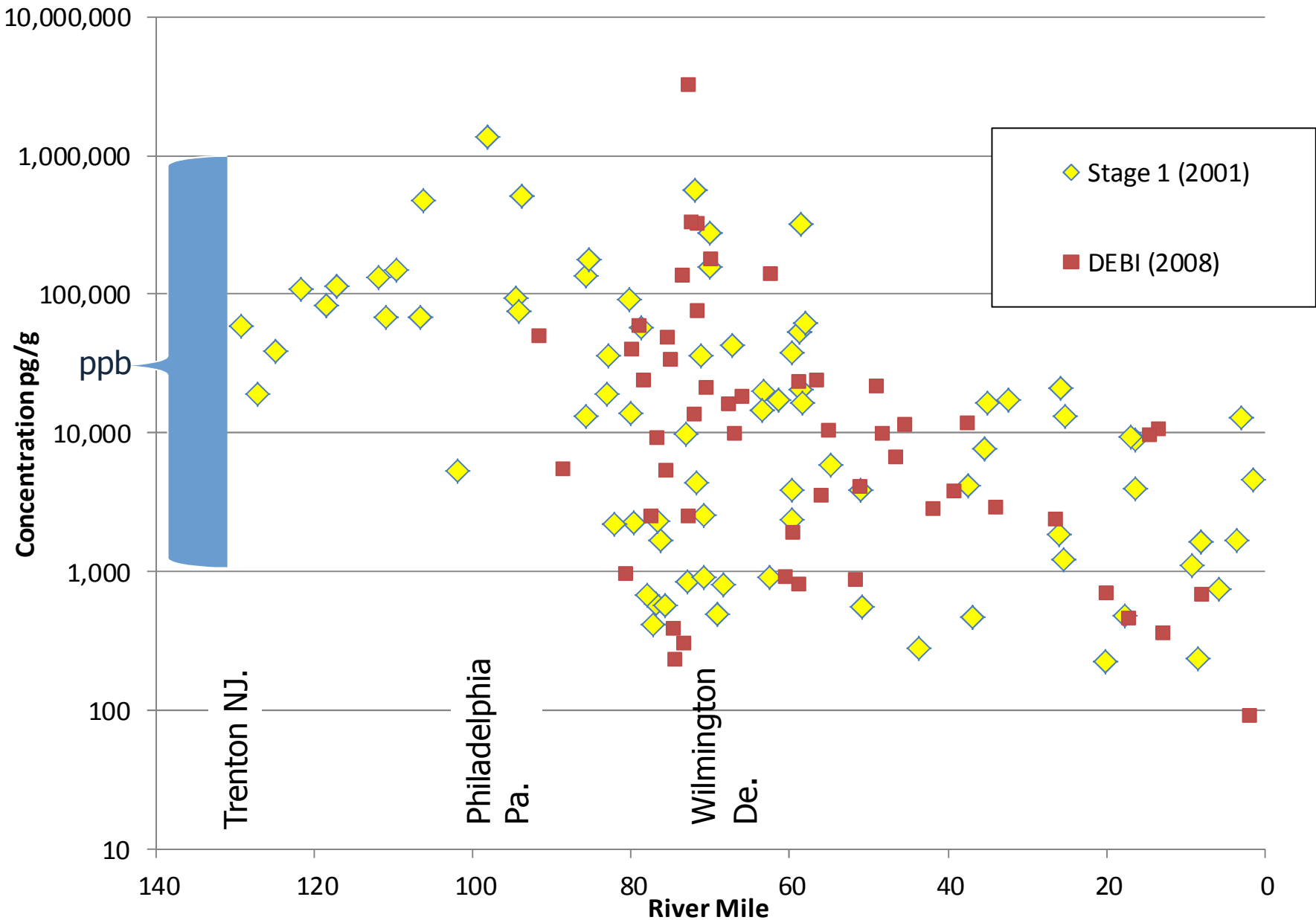
Study Area



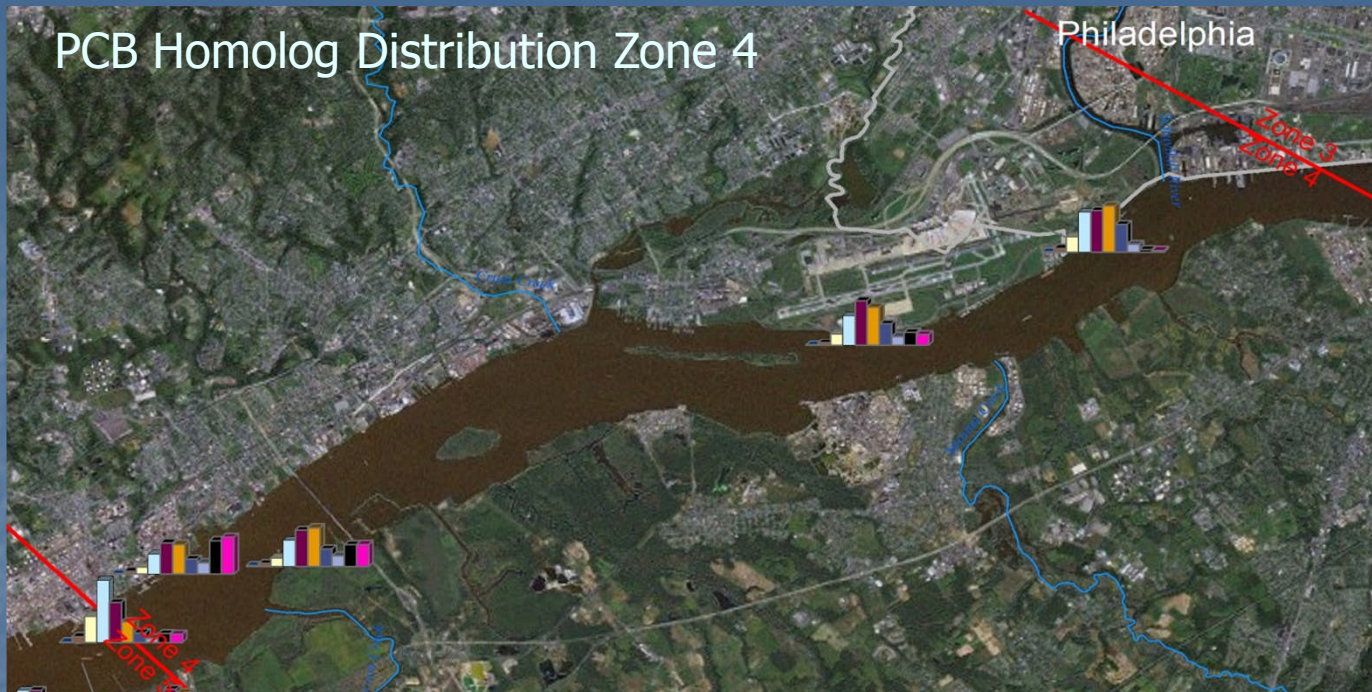
PCB Analysis

- 52 samples were analyzed for PCBs
 - 4 samples analyzed were from Zone 4
 - 34 samples analyzed were from Zone 5
 - 14 samples analyzed were from Zone 6
- PCB samples were analyzed for all 209 congeners using EPA Method 1668 revision A by Axys Analytical Laboratories
 - Analytical results are provided in pg/g dry weight
 - Estimated Detection Limits of <1 pg/g (ppt)
 - 90% of all congeners detected

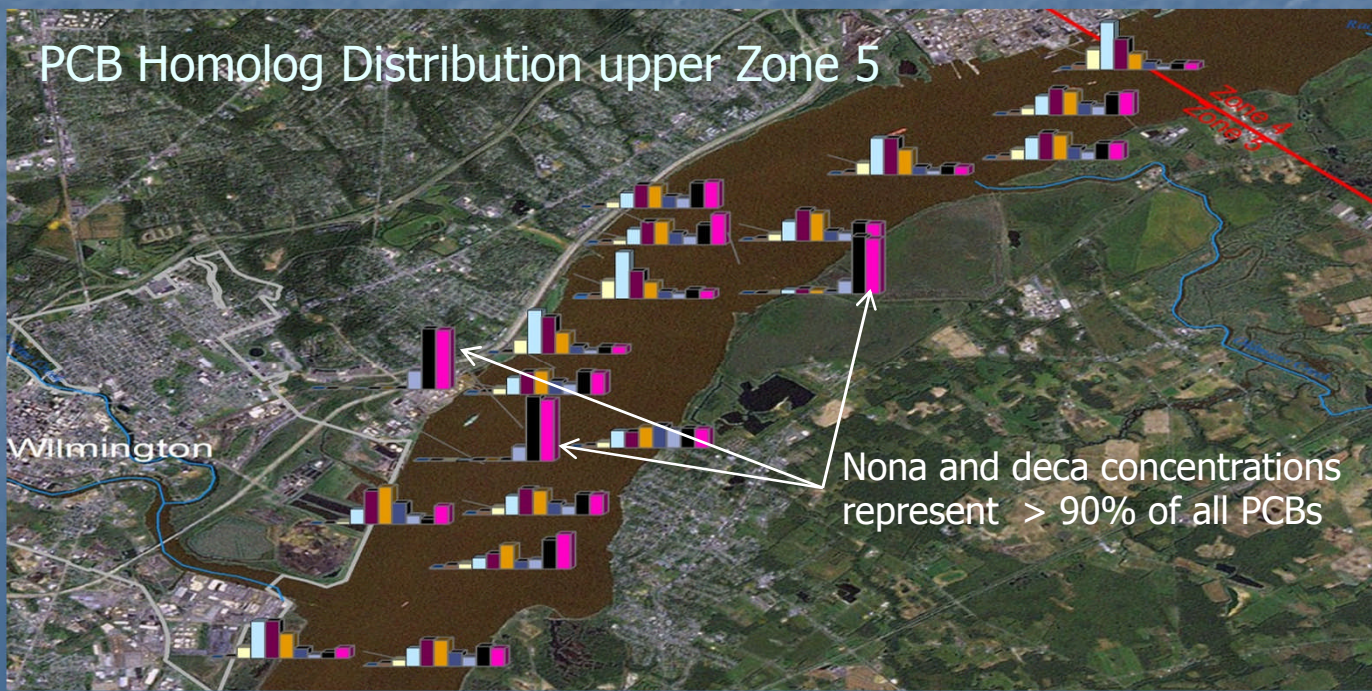
Comparison of PCB Concentrations



PCB Homolog Distribution Zone 4



PCB Homolog Distribution upper Zone 5

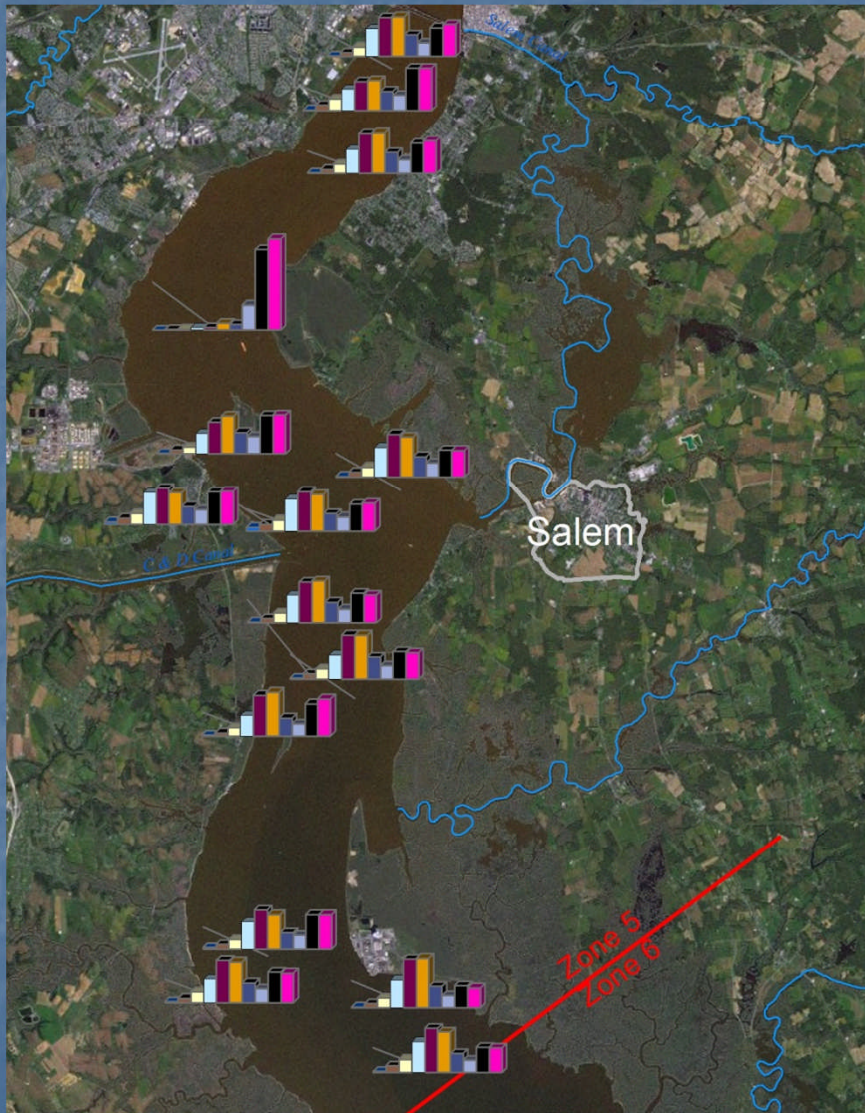


Nona and deca concentrations represent > 90% of all PCBs

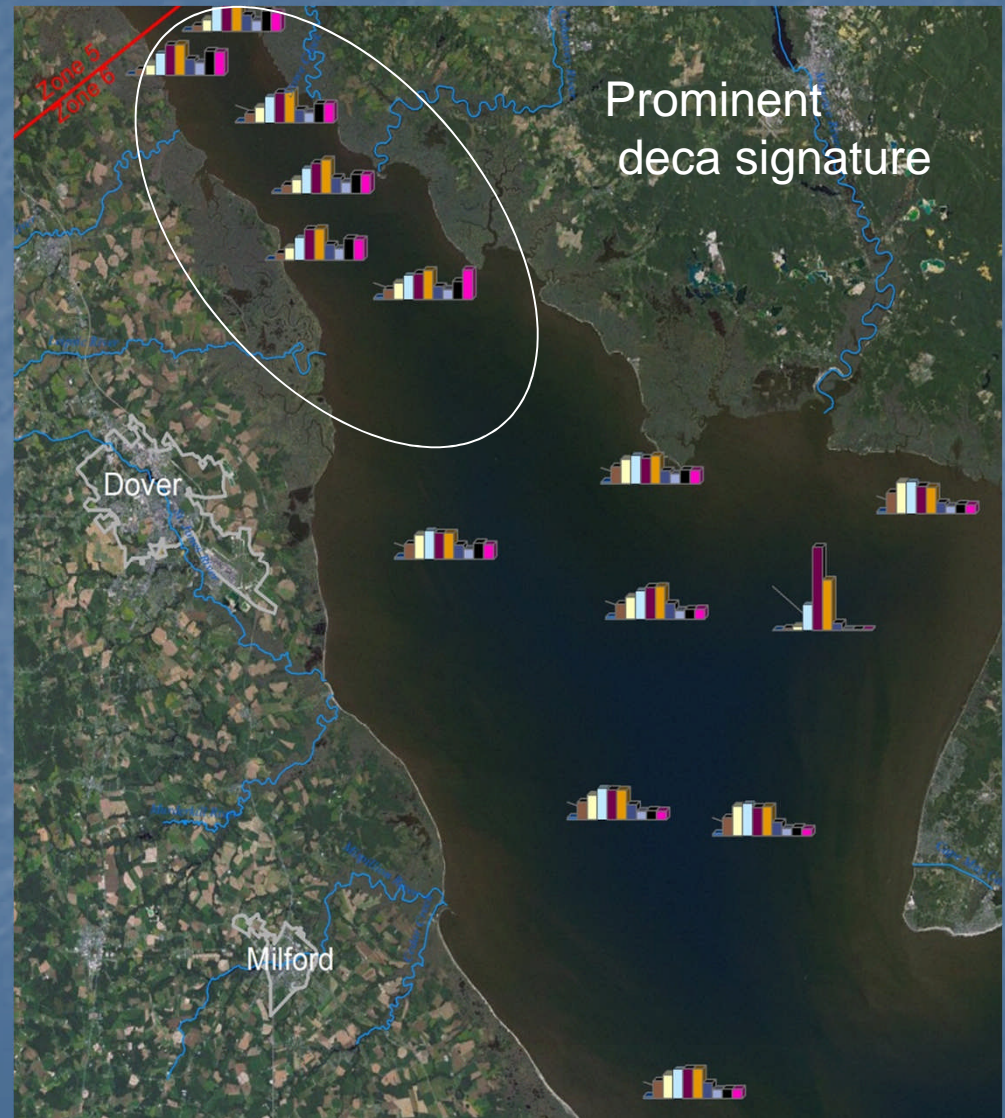
Homologs



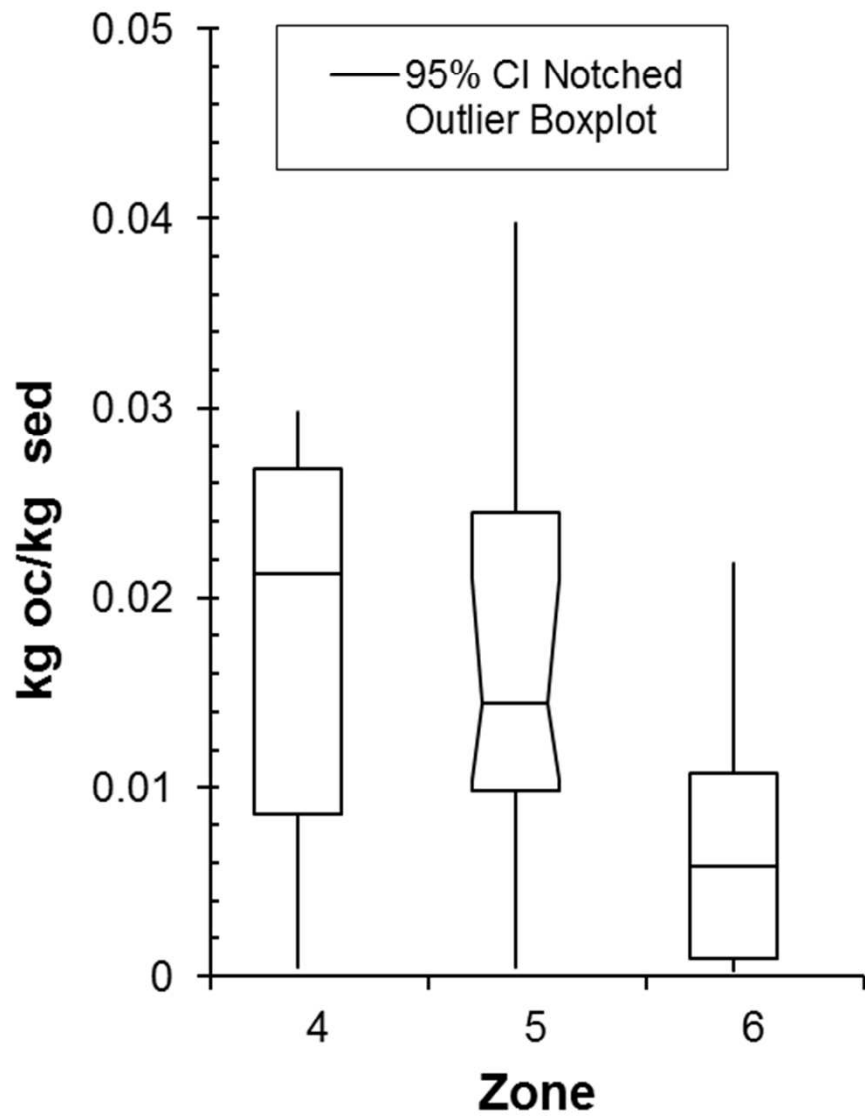
PCB Homolog Distribution lower Zone 5



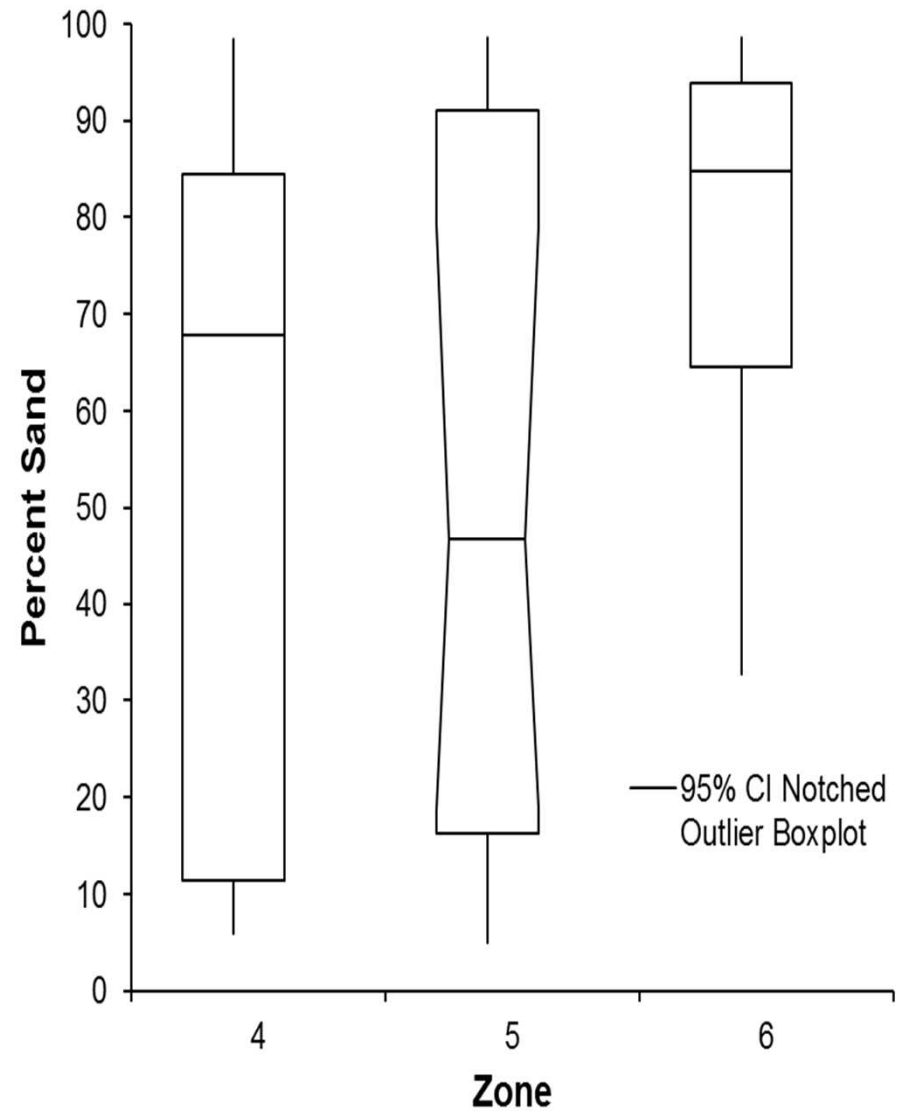
PCB Homolog Distribution Zone 6



Organic Carbon Content of Sediment



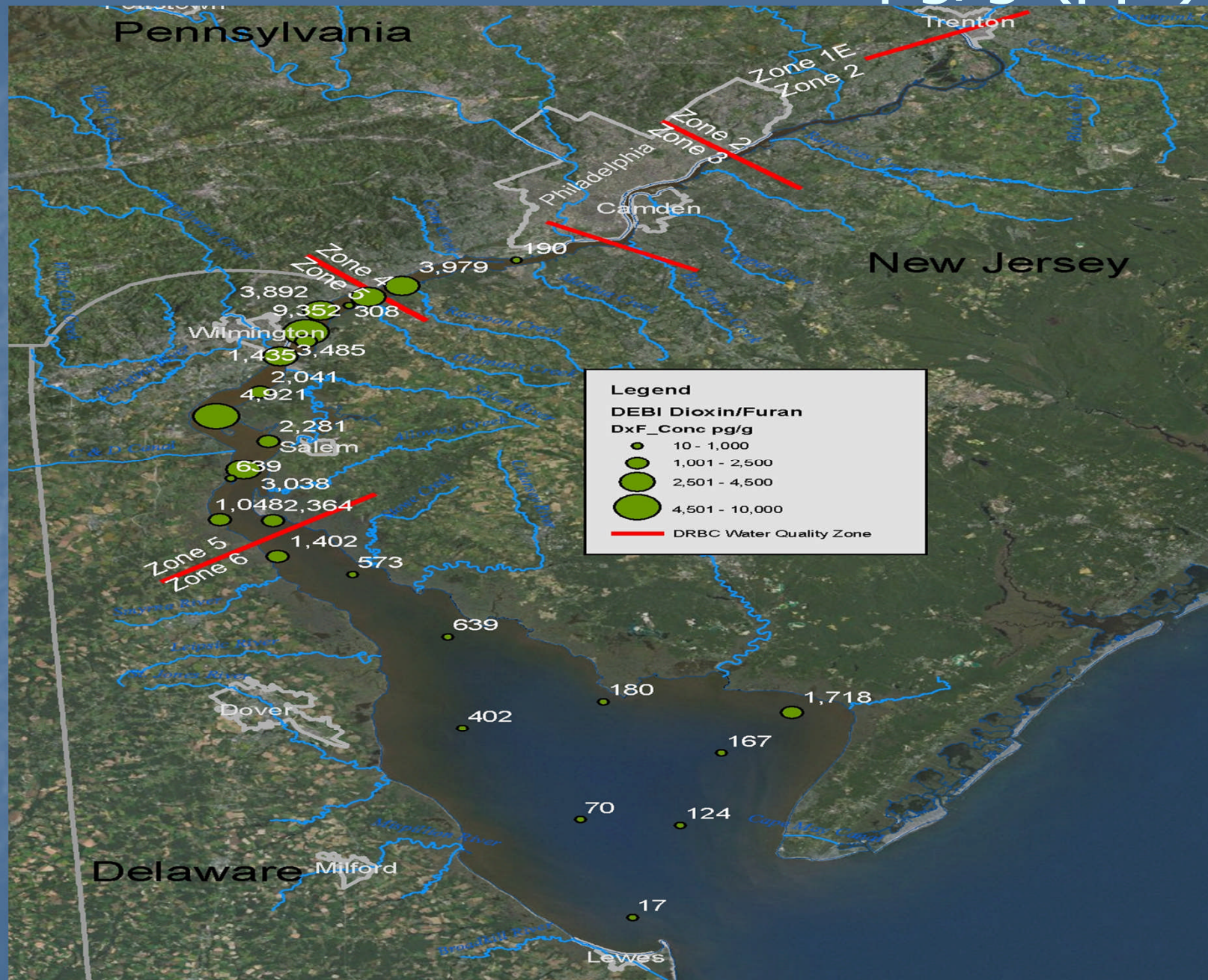
Sand Content of Sediment



Dioxin/Furans (DxFs) Analysis

- 25 samples were analyzed for DxFs
 - 2 samples analyzed were from Zone 4
 - 13 samples analyzed were from Zone 5
 - 10 samples analyzed were from Zone 6
- DxFs samples were analyzed for 15 individual congeners and 5 homologs using EPA Method 1613B by Axys Analytical Laboratories
 - Analytical results are provided in pg/g dry weight
 - Estimated Detection Limits typically < 0.1 pg/g
 - >90% of all congeners detected
 - Analytical cost were provided by Dupont

Total DxFs Concentrations pg/g (ppt)



PCB and DxF *Toxic Equivalent* (TEQ) Analysis

- *The "Toxic Equivalent" (TEQ) scheme weighs the toxicity of the less toxic compounds as fractions of the toxicity of the most toxic compound (in this case TCDD). Each compound is attributed a specific "Toxic Equivalency Factor" (TEF). This factor indicates the degree of toxicity compared to 2,3,7,8-TCDD, which is given a reference value of 1.*
- Prior to calculation all samples were blank corrected
- Equation:
Conc. of PCB or DxF for which a TEF had been developed (pg/g) x TEF = TEQ
- TEQs were calculated for PCBs and DxFs compounds for which the World Health Organizations (WHO) had developed mammalian TEFs.

TEFs for PCBs and DxFs

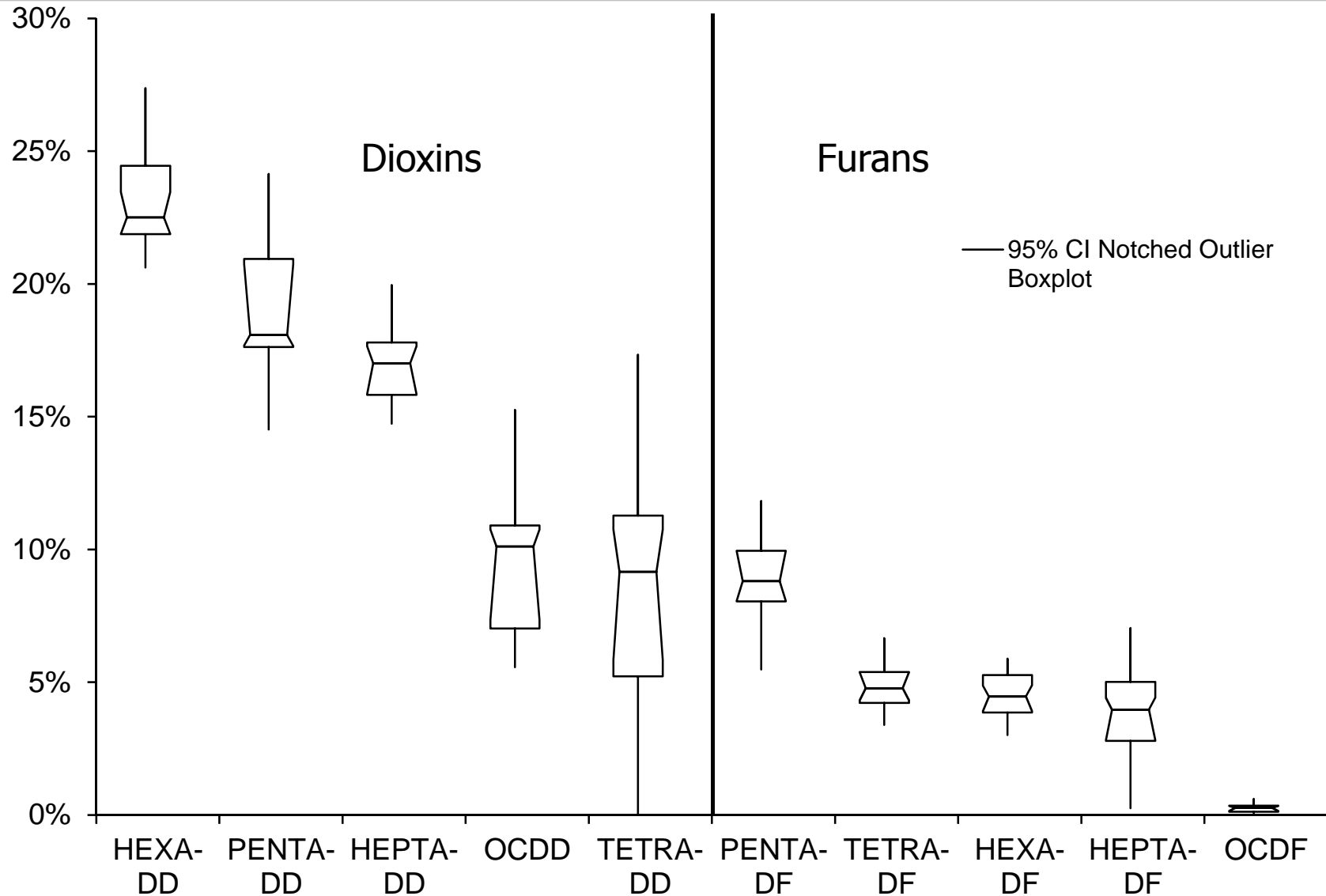
PCB TEFs		DxF TEFs	
Compound	WHO_2005_TEF	Compound	WHO_2005_TEF
3,3',4,4'-TeCB	0.00010	2,3,7,8-TCDD	1.0000
3,4,4',5-TeCB	0.00030	1,2,3,7,8-PeCDD	1.0000
3,3',4,4',5-PeCB	0.10000	1,2,3,4,7,8-HxCDD	0.1000
3,3',4,4',5,5'-HxCB	0.03000	1,2,3,6,7,8-HxCDD	0.1000
2,3,3',4,4'-PeCB	0.00003	1,2,3,7,8,9-HxCDD	0.1000
2,3,4,4',5-PeCB	0.00003	1,2,3,4,6,7,8-HpCDD	0.0100
2,3',4,4',5-PeCB	0.00003	OCDD	0.0003
2',3,4,4',5-PeCB	0.00003	2,3,7,8-TCDF	0.1000
2,3,3',4,4',5-HxCB	0.00003	1,2,3,7,8-PeCDF	0.0300
2,3,3',4,4',5'-HxCB	0.00003	2,3,4,7,8-PeCDF	0.3000
2,3',4,4',5,5'-HxCB	0.00003	1,2,3,4,7,8-HxCDF	0.1000
2,3,3',4,4',5,5'-HpCB	0.00003	1,2,3,6,7,8-HxCDF	0.1000
		1,2,3,7,8,9-HxCDF	0.1000
		2,3,4,6,7,8-HxCDF	0.1000
		1,2,3,4,6,7,8-HpCDF	0.0100
		1,2,3,4,7,8,9-HpCDF	0.0100
		OCDF	0.0003

Source: World Health Organization (WHO) 2005 mammalian TEFs

Dioxin/Furan and PCB TEQs



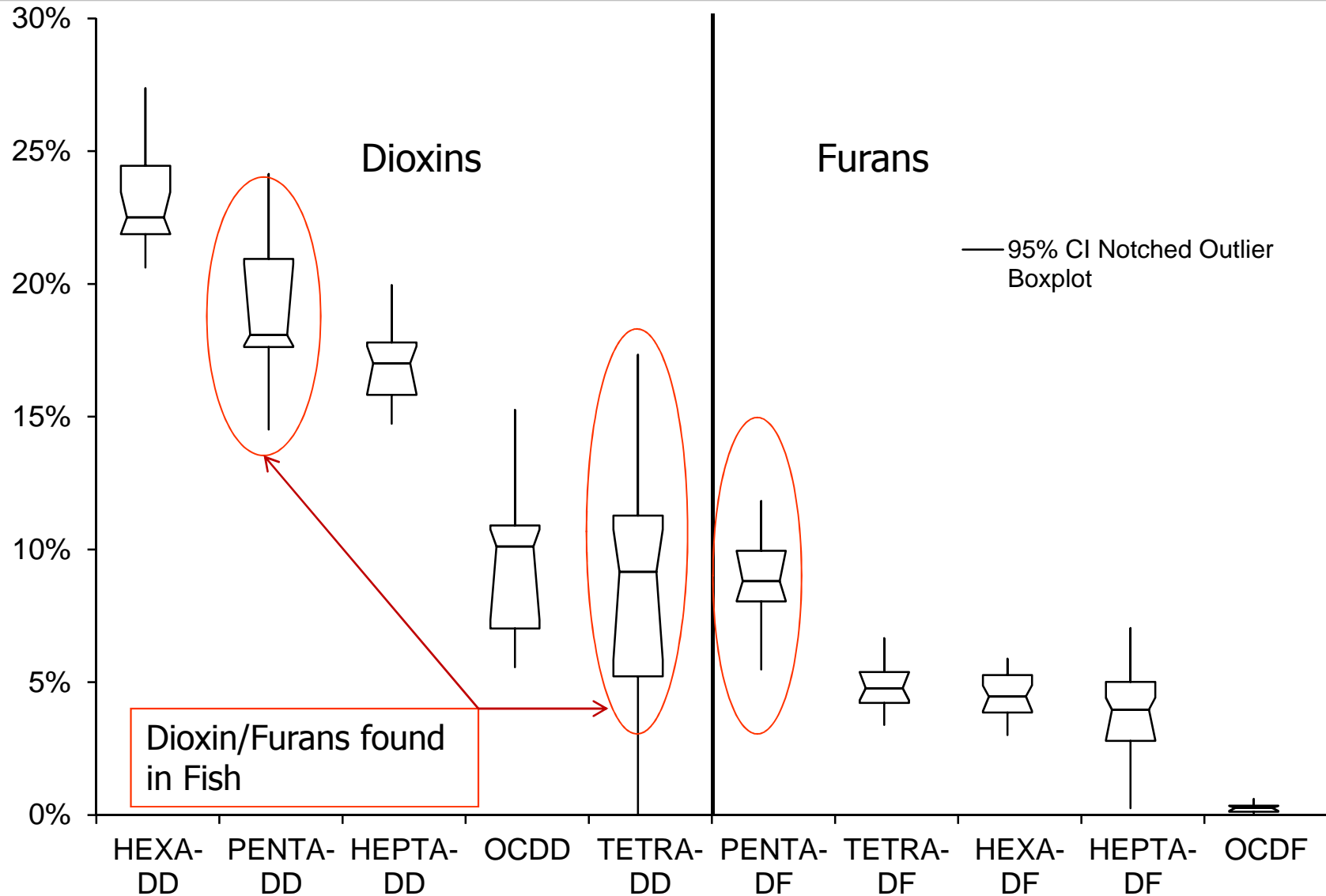
TEQ Contribution to Sediment



Dioxin/Furan and PCB TEQs



TEQ Contribution in Zone 5 Sediment



Conclusion

- Maximum PCB and Dioxin/Furan concentrations and TEQs in upper zone 5 near Wilmington, DE.
 - Limited sampling in Zone 4, and no samples were taken in Zones 2 and 3
 - Previous sediment sampling in 2001 indicated similarly elevated PCB concentrations in Zone 3, near Philadelphia
- PCB concentrations are typically 2 orders of magnitude greater than DxFs
- Prominent nona and deca homolog signatures in zone 5
 - > 90% of total PCB concentrations

Conclusion

- Homolog signatures in Zone 5 near Wilmington, De. suggest unique source(s) of PCBs
- DxF typically represents between 80-99% of the TEQs
- Analytical method 1668A and 1613B are necessary to achieve the detection limits which provide the resolution to calculate homolog concentrations and perform TEQ analysis

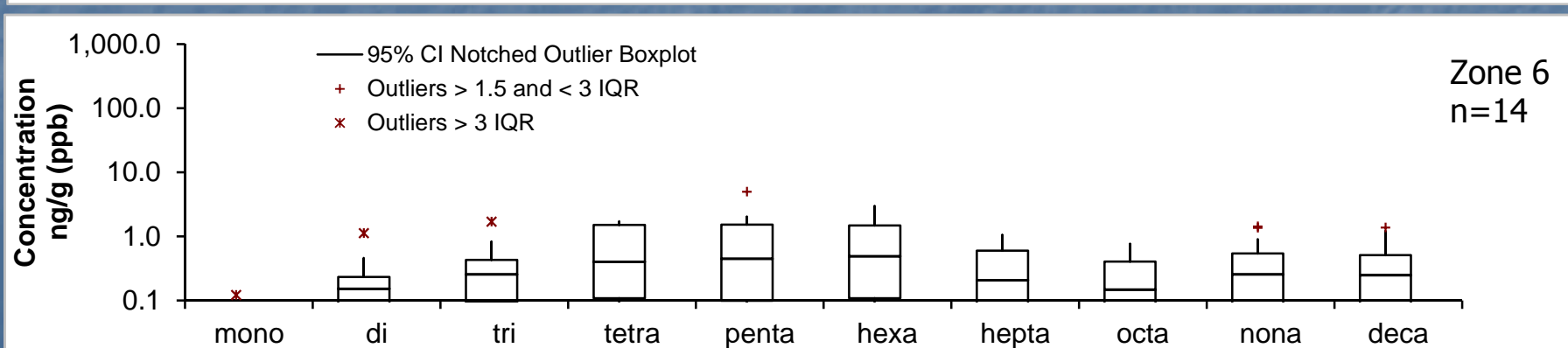
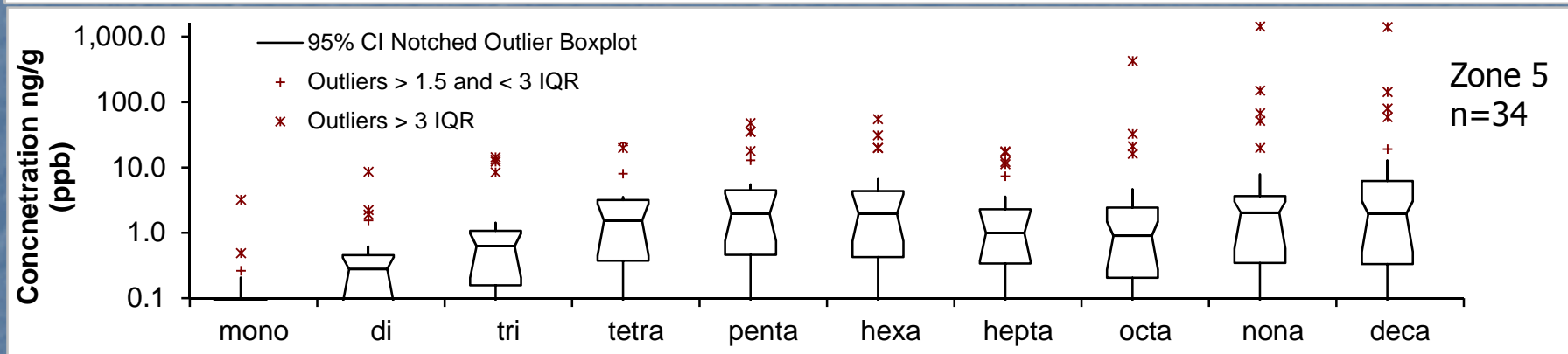
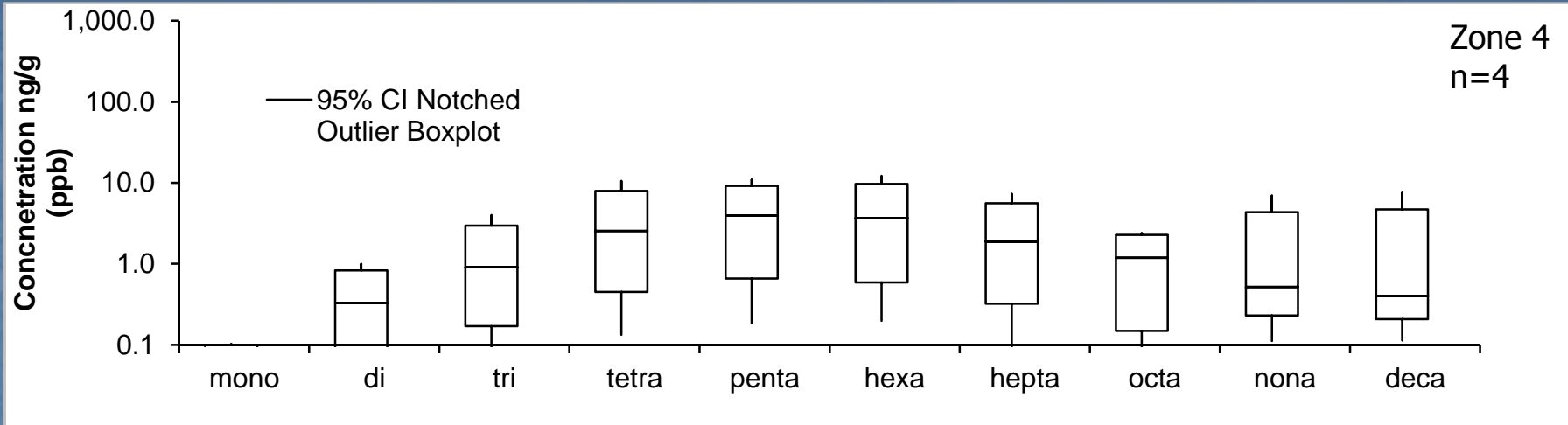
Implications

- DxFs exceed EPA screening levels in fish tissue for consumption advisories
- Homolog proportions of DxFs differs between sediment and fish tissue
- A better understanding of the mechanism by which fish bioaccumulate and/or metabolize DxFs is needed to address management issues
- Additional sediment sampling for PCBs and DxFs has been conducted in Zones 2, 3 and 4

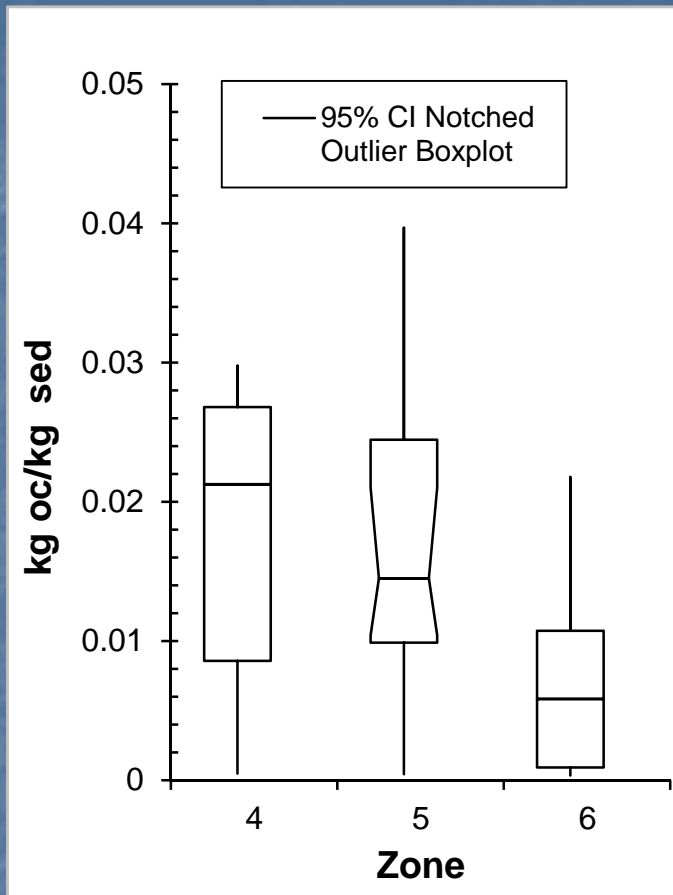
Next Steps

- Analyze sediment samples for PCBs and DxFs in Zones 2, 3, and upper zone 4 to complete spatial distributions in the Delaware Estuary
- Evaluate impact of sediment PCBs and DxFs concentrations on water column and compare to applicable Water Quality Standards
- Develop conceptual framework for fate and transport of DxF
- BSAF

Median Concentration by Zone

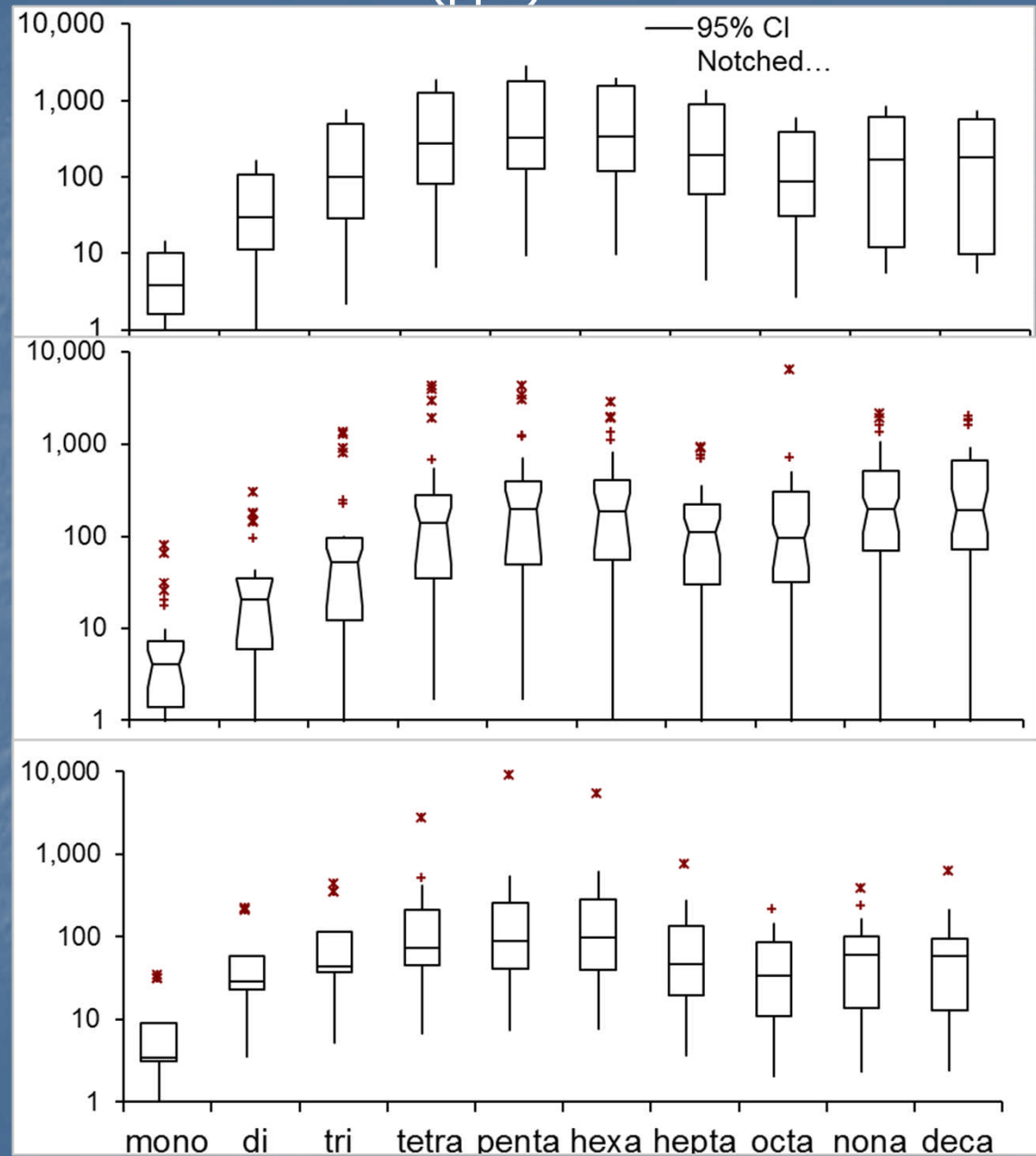


Organic Carbon Content of Sediment



Zone	n	1st Quartile	Median	3rd Quartile
4	4	0.0086	0.0213	0.0268
5	34	0.0099	0.0145	0.0245
6	14	0.0009	0.0058	0.0107

PCB Concentrations OC Normalized ng/g OC (ppb)



Median DxF Concentrations by Homolog and Zone

