The use of meiofauna in freshwater sediment assessments: community responses to contamination

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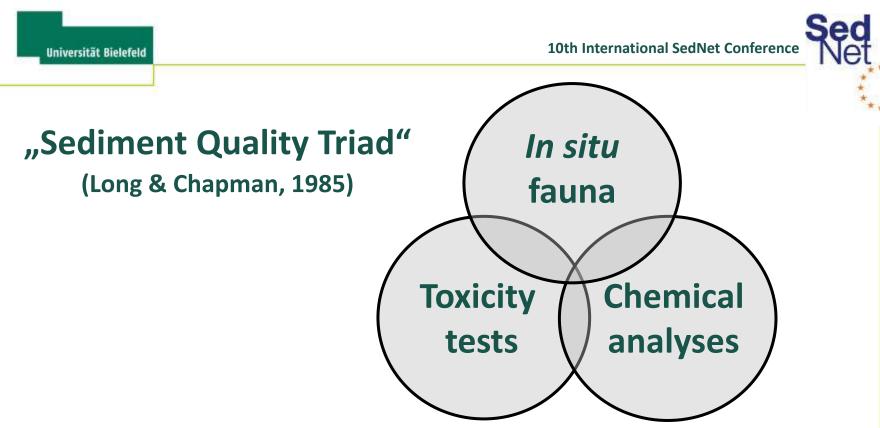






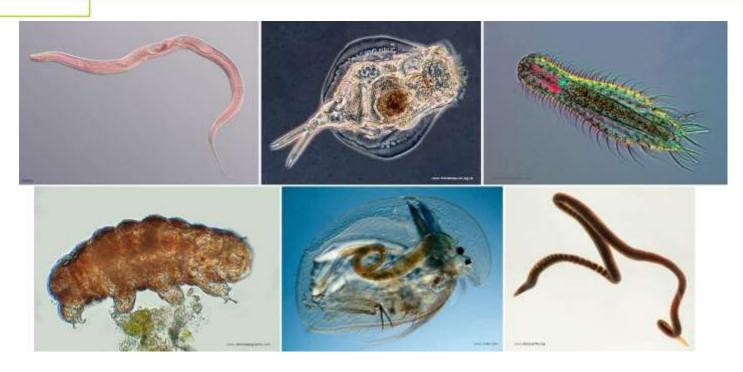


- → Contaminated sediments prevent "good ecological status" (WFD)
- ightarrow Sediments act as sinks and sources
- \rightarrow Soft (fine & sandy) sediments of particular concern



ightarrow "Weight of evidence" approaches highly recommend

- \rightarrow Benthic organisms strongly associated to contaminants
- \rightarrow Widely based on macrofauna (e.g., SPEAR[%]-index)



- \rightarrow Soft sediments host specific invertebrate communities
- \rightarrow Meiofauna > macrofauna
- \rightarrow Meiofauna restricted to interstitial/burrowing lifestyle
- ightarrow Bioindication with meiofauna advantageous



- \rightarrow Nematodes dominant among the meiofauna
- \rightarrow Ubiquitous, very high abundances (>1.000.000/m²)
- ightarrow Key position in benthic food web
- \rightarrow Predestined for bioindication



Objectives of the study:

- → To assess the general sensitivity of meiofaunal communities and particular parameters to chemical contamination
- \rightarrow To evaluate the suitability of nematodes as bioindicators
- → To determine whether lower testing tiers are both representative and capable of estimating the impact of sediment contaminants on higher levels of biological organization





Pristine sediment

Microcosms:

ightarrow 8 substances

- Exp. 1: Cu, Zn & FA
- Exp. 2: Ni, BaP, Met-Mix, PAH-Mix & PAH/Met-Mix
- ightarrow 180 d (3 sampling dates)

Analyses:

- → Meiofauna/Nematodes
 - Abundance
 - Biomass
 - Taxa/Species composition
- Sediment
 - Chemical analyses
 - Toxicity analyses (ISO 10872)



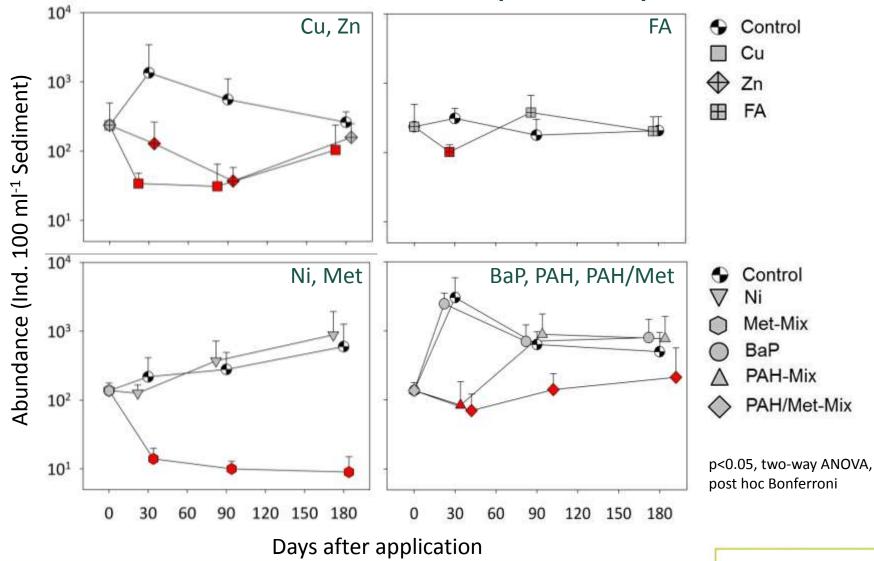


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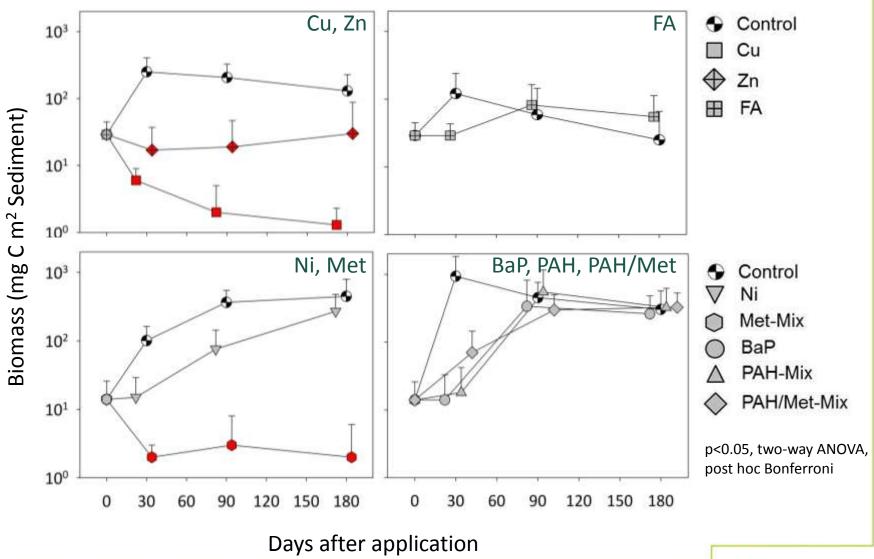
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Abundance meiofauna (mean + sd)



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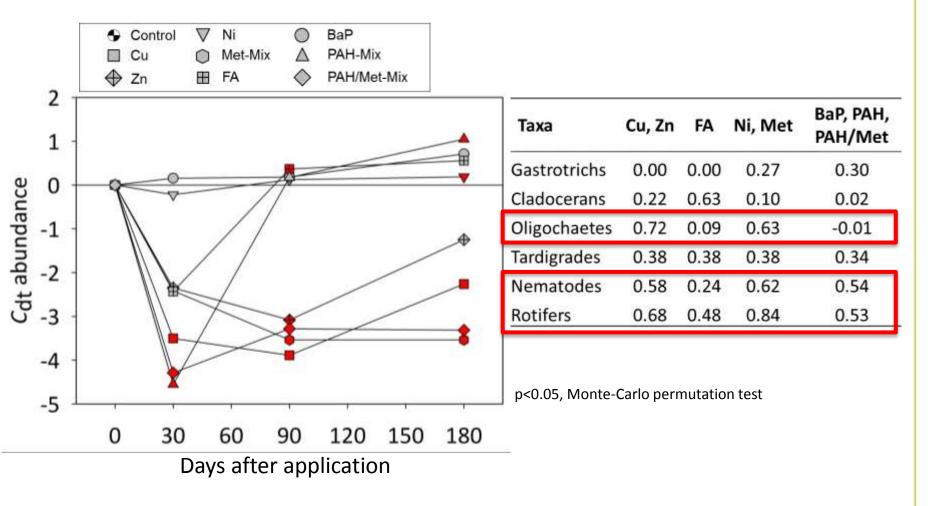
Biomass meiofauna (mean + sd)



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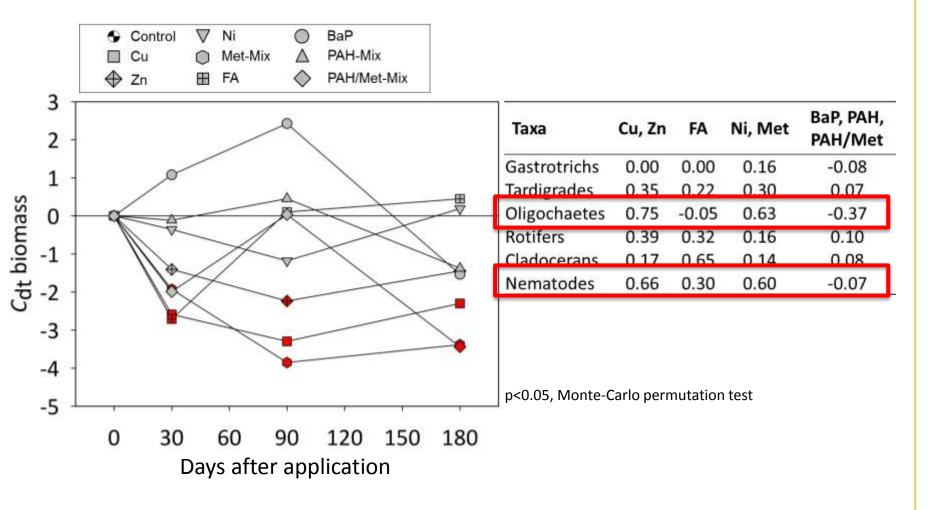


Taxa composition-abundance (mean + sd)

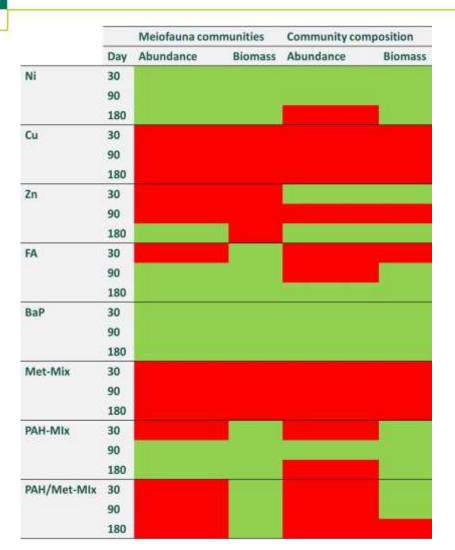




Taxa composition-biomass (mean + sd)







- \rightarrow Meiofauna sensitive to chemical stress
- ightarrow Community composition most susceptible



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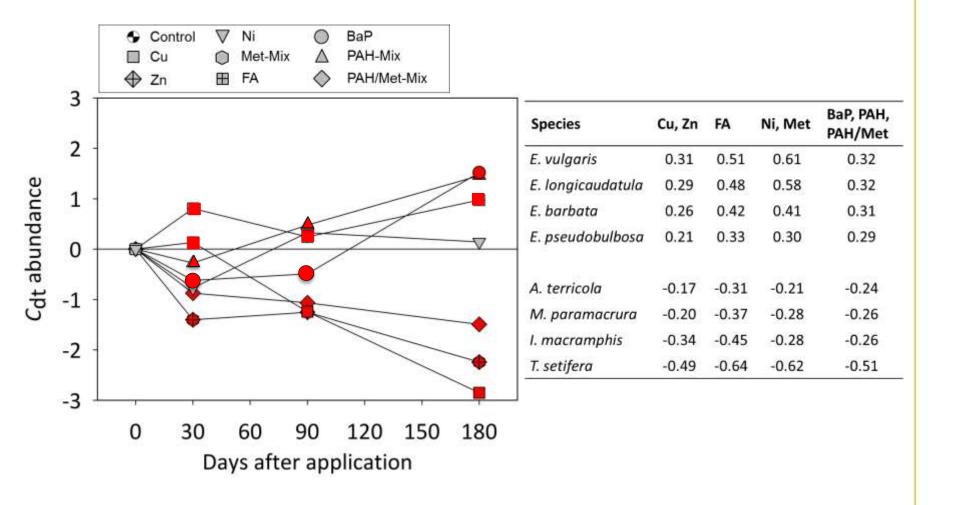
Ranking of the various analysed meiofauna taxa

	Abundance					
metal	organic	total	metal	organic	total	
Cladocerans	Cladocerans	Cladocerans	Cladocerans	Gastrotriches	Gastrotriches	tolerant
Gastrotriches	Gastrotriches	Gastrotriches	Gastrotriches	Tardigrades	Cladocerans	
Tardigrades	Oligochaetes	Tardigrades	Rotifers	Cladocerans	Tardigrades	
Nematodes	Tardigrades	Oligochaetes	Tardigrades	Rotifers	Rotifers	
Oligochaetes	Nematodes	Nematodes	Nematodes	Oligochaetes	Oligochaetes	
Rotifers	Rotifers	Rotifers	Oligochaetes	Nematodes	Nematodes	sensitive

- \rightarrow Effects of spiked sediments highly taxon-specific
- → Oligochaetes, Rotifers & Nematodes most affected
- ightarrow Sensitivity widely independent of the applied compounds
- \rightarrow Nematodes most abundant in contaminated sediments

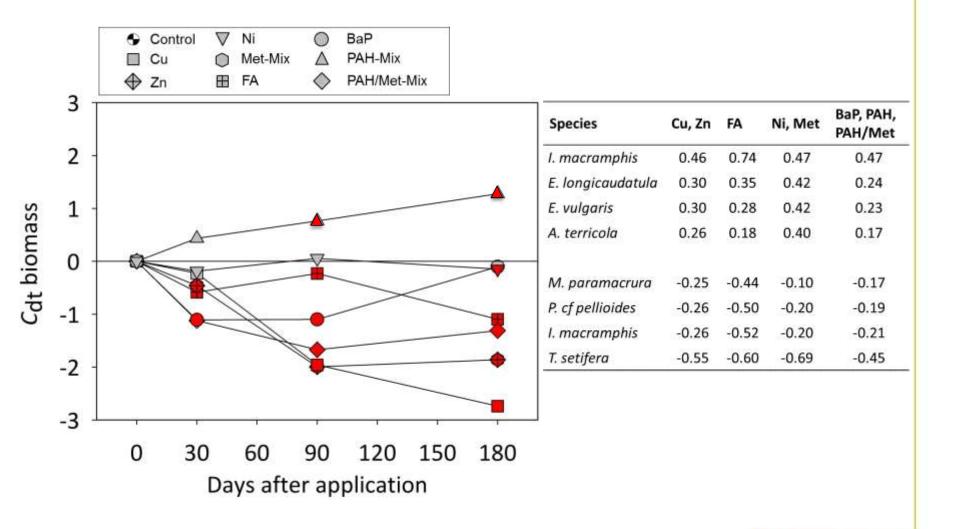


Species composition-abundance (mean + sd)





Species composition-biomass (mean + sd)



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	1	Meiofauna con	nmunities	Community co	mposition	Nematode species composit				
	Day	Abundance	Biomass	Abundance	Biomass	Abundance	Biomass			
Ni	30									
	90									
	180				1.1					
Cu	30									
	90									
	180									
Zn	30									
	90									
	180	6								
FA	30									
	90									
	180									
BaP	30									
	90									
	180	<u> </u>								
Met-Mix	30									
	90									
	180									
PAH-MIx	30									
	90									
	180					-				
PAH/Met-MIx	30									
	90									
	180									

- ightarrow Nematodes among the most sensitive taxa
- $\rightarrow\,$ Species composition most susceptible



Objectives of the study:

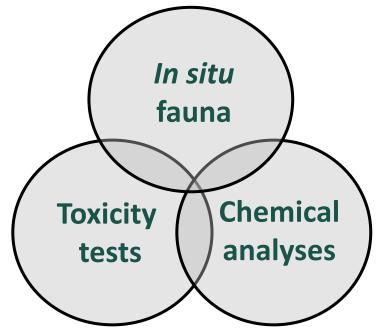
- → To assess the general sensitivity of meiofaunal communities and particular parameters to chemical contamination
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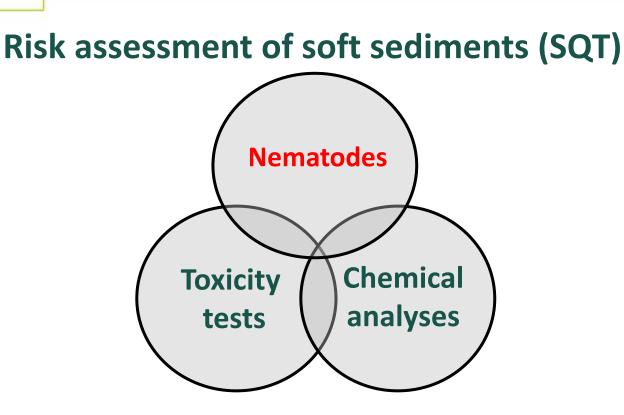
		Meiofauna con	nmunities	Community cor	mposition	Nematode specie	s composition	C. elegans	
	Day	Abundance	Biomass	Abundance	Biomass	Abundance	Biomass	ISO 10872	
Ni	30								
	90				_				
	180				1.				
Cu	30						_		
	90							1	
	180								
Zn	30								
	90		-			10 C		_	
	180								
FA	30				-	10 C			
	90				_ (i _)		-		
BaP	180 30								
Dar	90								
	180							1	
Met-Mix	30					i.			
	90								
	180								
PAH-MIx	30								
	90		-		Ξ.				
	180								
PAH/Met-MIx	30								
	90								
	180								

 \rightarrow Representative of meiofaunal sensitivity

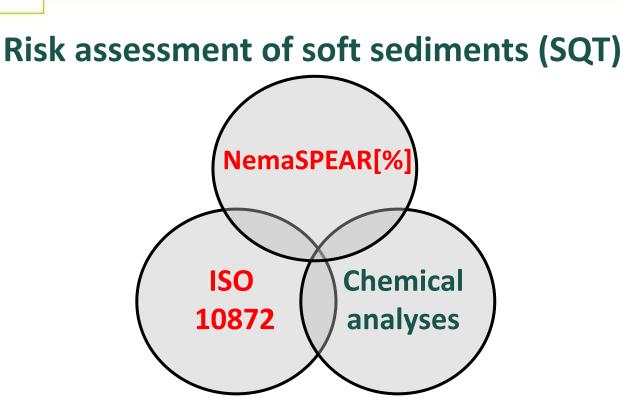


Risk assessment of soft sediments (SQT)





- \rightarrow Nematodes capable to represent meiofaunal communities
- → Bioindication based on nematodes recommended (NemaSPEAR[%]-index)



- \rightarrow Nematodes capable to represent meiofaunal communities
- → Bioindication based on nematodes recommended (NemaSPEAR[%]-index)
- \rightarrow Toxicity test with *C. elegans* (ISO 10872) suitable bioassay

Many thanks to the involved cooperation partners







Parameter	Content/concentration
% water content	18.2
% gravel ^a	2.1
% sand	96.1
% fines (silt and clay)	1.5
% TOC	0.3
As (mg/kg)	< 1
Cd (mg/kg)	< 0.1
Cr (mg/kg)	< 2
Cu (mg/kg)	< 2
Hg (mg/kg)	< 0.05
Ni (mg/kg)	< 2
Pb (mg/kg)	< 5
Zn (mg/kg)	< 10
∑ PAHs (mg/kg) ^b	< 0.2
∑ PCBs (µg/kg)°	< 0.2
∑ HCHs (µg/kg) ^d	< 0.1
∑ DDTs (µg/kg) ^e	< 0.3
HCB (µg/kg)	< 0.05

^a Sediment fraction 2-63 mm
^b 16 PAHs (EPA 610)
^c 7 PCBs: 28, 52, 101, 11, 138, 153, 180
^d α-, β-, γ-HCH
^e o,p'-DDT, -DDD, -DDE

→ Höss et al. (2011) analysed > 200 sediment samples

→ Correlation of specific species with toxic potential of sediments

- → Identification of NemaSPEAR (Nematode SPEcies At Risk)
- \rightarrow NemaSPEAR[%]-index

	霐		International				
	Nematode species at risk of freshwaters	- A metric to a	ssess pollution in soft sediments				
	5. Hilles ^{6,9} , E. Claust ⁶ , P.C. Von de ⁶ fanse classes: 6 leveling screep ⁸ harde benetis of phonology (SE). Magazine for 1.8 ¹⁰ (1): Analogic class in the transmission framework ¹⁰ December 404/2018, Transmission factors, ¹⁰ December	ilia, irranj 11. lanavno / skotnova Reprinsk C. Still & Ale	17 mm m				
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	Beatlands Beatlands Darlander Und patienten Hallowen	embedded index of with the optimized from large strength many of physics chemical pro- entistic strength and the strength optimized in the strength of the approxity interfug the large strength of the strength of the strength optimized in the strength optimized in the strength optimized in the strength optimized states interest production the states. Neurosci (NACC) hashes	Bients, See a F yeer, parket methods consensation, presentation and an endowers of the Consensation of Consensation and Consensation (Section 4) and a segment of an endowers of the section of the section of the section of the Consensation of the Section of Consensation (Section 4) and a section of the Section of Consensation (Section 4) and a section of the Section of the Section of the Section of the Section of the Section of endowers the section (Section 4) and (Section 4) and the Section of the Section of Section (Section 4) and (Section 4) and the Section of the Section 4) and (Section 4) and (Section 4) and a section of the Section 4) and (Section 4) and (Section 4) and in the neuron of the finance on the Section (Section 4) and in the section of the finance on the Section (Section 4) and (Section 4) and anguage polytexies over thereines polyter (to be selected as a consistentiation of the finance of the Section 4). (Section 1) Barrier 10 and (Section 4) and (Section 4) and (Section 4) and (Section 4) and (Section 4) and (Section 4) and (Section				
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		Electri	cal conductivity (µS/cm)	1	emperature (°	C)		O2 (mg/L)			pH	
	Day	С	LC	HC	с	LC	HC	С	LC	HC	С	LC	HC
Ni	30	100.2 ± 5.1	102.7 ± 4.0	106.7 ± 5.8	20.7 ± 0.5	20.9 ± 0.4	20.8 ± 0.3	8.6 ± 0.1	8.5 ± 0.2	8.0 ± 0.6	6.5 ± 1.3	7.3 ± 0.0	7.1 ± 0.0
	90	118.2 ± 8.6	109.5 ± 12.8	97.3 ± 8.0	20.6 ± 0.2	20.9 ± 0.5	21.3 ± 0.2	8.5 ± 0.3	8.3 ± 0.2	8.5 ± 0.2	7.3 ± 0.5	7.5 ± 0.0	$7.6 \pm 0.$
	180	103.5 ± 8.6	105.0 ± 11.2	112.3 ± 14.1	21.1 ± 0.2	21.1 ± 0.4	20.2 ± 0.6	7.6 ± 0.3	7.4 ± 0.4	7.7 ± 0.4	7.5 ± 0.5	7.7 ± 0.4	7.5 ± 0.4
Cu	30	210.0 ± 19.2	207.6 ± 18.2	343.4 ± 15.8*	20.0 ± 0.3	20.1 ± 0.3	19.9 ± 0.3	6.8 ± 0.5	6.7 ± 0.6	6.6 ± 0.3	8.0 ± 0.1	8.1 ± 0.0	7.7 ± 0.0
	90	184.6 ± 11.9	212.6 ± 6.0	323.2 ± 16.1*	20.0 ± 0.3	20.1 ± 0.3	19.9 ± 0.3	6.1 ± 0.2	5.8 ± 0.2	6.0 ± 0.2	7.7 ± 0.4	8.1 ± 0.0	$7.8\pm0.$
	180	196.6 ± 46.1	215.8 ± 34.7	$.363.6 \pm 72.8*$	22.3 ± 0.1	22.4 ± 0.1	22.5 ± 0.1	5.8 ± 0.4	5.7 ± 0.6	5.5 ± 0.4	7.6 ± 0.1	7.9 ± 0.1	7.9 ± 0.2
Zn	30	194.0 ± 5.3	211.8 ± 45.0	279.0 ± 15.4*	20.1 ± 0.4	20.1 ± 0.1	20.8 ± 0.2	7.2 ± 0.6	6.8 ± 0.5	6.7 ± 0.4	7.9 ± 0.1	7.9 ± 0.2	7.5 ± 0.1
	90	195.2 ± 14.8	203.8 ± 28.7	256.3 ± 10.3*	20.1 ± 0.4	20.1 ± 0.1	20.8 ± 0.2	6.0 ± 0.2	5.6 ± 0.6	6.1 ± 0.1	8.1 ± 0.0	8.0 ± 0.1	7.7 ± 0.1
	180	164.6 ± 7.5	196.6 ± 58.6	206.8 ± 33.4	22.4 ± 0.1	22.5 ± 0.2	22.7 ± 0.1	5.6 ± 0.3	5.3 ± 0.4	5.4 ± 0.3	8.0 ± 0.1	7.9 ± 0.1	$7.9 \pm 0.$
FA	- 30	174.6 ± 6.1	176.6±14.3	171.0 ± 9.9	20.0 ± 0.5	19.9 ± 0.5	19.9 ± 0.6	7.1 ± 0.4	6.8 ± 0.3	7.0 ± 0.4	7.8 ± 0.1	7.9 ± 0.1	$7.9 \pm 0.$
	- 90	187.2 ± 11.5	175.2 ± 9.2	181.4 ± 8.8	20.0 ± 0.5	19.9 ± 0.5	19.9 ± 0.6	6.0 ± 0.1	5.7 ± 0.4	5.9 ± 0.3	8.2 ± 0.1	8.2 ± 0.0	8.2 ± 0.0
	180	224.8 ± 122.6	158.6 ± 3.8	162.0 ± 32.6	21.8 ± 0.4	22.1 ± 0.4	22.2 ± 0.2	5.8 ± 0.5	5.6 ± 0.1	5.6 ± 0.2	8.1 ± 0.1	8.0 ± 0.1	7.9 ± 0.0
B(a)P	-30	101.8 ± 5.3	104.2 ± 5.9	99.8 ± 3.4	20.1 ± 0.3	20.3 ± 0.7	19.7 ± 0.4	8.4 ± 0.2	8.1 ± 0.4	8.4 ± 0.1	7.2 ± 0.1	7.3 ± 0.1	$7.4 \pm 0.$
	90	99.7 ± 9.2	100.5 ± 12.3	89.0 ± 37.7	20.7 ± 1.0	19.7 ± 0.7	20.8 ± 0.7	8.5 ± 0.3	8.4 ± 0.4	8.1 ± 0.6	7.9 ± 0.4	7.9 ± 0.2	7.9 ± 0.1
	180	112.7 ± 9.2	114.5 ± 20.8	117.2 ± 10.8	20.2 ± 1.0	20.9 ± 0.4	20.8 ± 0.3	7.6 ± 0.3	7.6 ± 0.2	7.2 ± 0.4	7.3 ± 0.4	7.1 ± 0.4	$7.3\pm0.$
Met-Mix	30	107.5 ± 4.5	133.5 ± 20.1	324.8 ± 19.7*	21.0 ± 0.3	20.9 ± 0.3	21.3 ± 0.1	8.3 ± 0.2	8.0 ± 0.7	8.4 ± 0.1	7.0 ± 0.9	7.1 ± 0.1	6.1 ± 0.1
	90	106.0 ± 14.8	118.5 ± 3.6	$347.2\pm37.0\texttt{*}$	20.4 ± 0.4	20.9 ± 0.4	21.8 ± 0.1	8.2 ± 0.4	8.1 ± 0.5	7.8 ± 0.6	7.7 ± 0.2	7.5 ± 0.0	5.2 ± 0.6
	180	110.3 ± 14.8	152.3 ± 34.0	361.3 ± 47.9	20.6 ± 0.4	20.8 ± 0.6	21.4 ± 0.5	7.7 ± 0.4	7.6 ± 0.4	7.8 ± 0.4	7.5 ± 0.2	7.4 ± 0.4	6.3 ± 0.4
PAH-Mix	30	153.2 ± 21.5	141.3 ± 25.7	138.0 ± 15.8	21.0 ± 0.3	20.0 ± 0.5	20.3 ± 0.2	7.8 ± 0.6	8.4 ± 0.2	7.2 ± 1.4	6.8 ± 0.5	7.4 ± 0.1	5.2 ± 0.1
	90	123.2 ± 11.7	110.8 ± 11.9	113.2 ± 13.0	20.7 ± 0.5	20.6 ± 0.4	20.8 ± 0.3	8.0 ± 0.2	7.6 ± 1.0	8.1 ± 0.3	7.9 ± 0.3	7.2 ± 0.2	$7.5 \pm 0.$

	Ni	Cu	Zn	FA	BaP	Met-Mix					PAH-Mix					PAH/Met-Mix									
						Ni	Cu	Zn	Pb	Cd	BaP	FA	Chr	Phe	Pyr	Ni	Cu	Zn	Pb	Cd	BaP	FA	Chr	Phe	Руг
Nominal Conc.	3.0	100.0	100.0	20.0	10.0	5.92	12.63	105.74	15.08	0.62	1.24	3.30	0.87	2.20	2.40	2.98	6.31	52.87	7.54	0.31	0.62	1.66	0.48	1.08	1.20