MONITORING OF HAZARDOUS SUBSTANCES IN THE COASTAL AREAS OF THE PECHORA AND WHITE SEAS: HARMONIZATION WITH OSPAR's JOINT MONITORING AND ASSESSMENT PROGRAMME (JAMP)

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Introduction

This JAMP pilot study was initiated by the Joint Norwegian-Russian Environmental Commission as a bi-lateral project on OSPAR harmonisation of monitoring of hazardous substances. Since 2003 joint monitoring surveys have been conducted in different coastal areas of the Barents and White Seas. The aim is to contribute to international harmonisation of Russian monitoring and assessment activities based on the JAMP/OSPAR guidelines for sampling and determination of contaminants, and to establish comparable procedures for a Russian monitoring program. Here we are presenting results from the recent (2006-2007) surveys in the south-western part of the Barents Sea (Pechora Sea) and in the White Sea areas (Figure 1).

Materials and Methods

The sampling programmes were carried out as a continuation of the annual Norwegian JAMP-sampling along the northern coast of Norway and included sampling of surface bottom sediment, fish and blue mussel samples. Seabird samples were collected in addition to the programme. Sampling of bottom sediments and biota was carried out onboard of RV *Professor Vladimir Kuznetsov* according OSPAR/JAMP guidelines[1, 2]. CEC Typhoon (Obninsk) was the primary analytical laboratory for analyses of persistent organic pollutants (POPs). The laboratory has national accreditation within the framework of Russian Analytical Laboratories Accreditation System for POPs in abiotic and biotic environmental media and successfully participated in the QUASIMEME International interlaboratory study on POPs in biological samples. The following POPs were determined in the bottom sediment and biological samples (soft tissues of blue mussels, fish and bird liver samples): DDT-group, HCHs, endrin, dieldrin and mirex; HCB, chlordanes; polychlorinated biphenyls (PCBs) (63 congeners, including non- *and* mono-*ortho* PCBs); polybrominated diphenyl ethers (PBDEs); and polychlorinated dibenzo-*p*-dioxines and furans (PCDD/Fs). Detailed information on standards, chemicals, clean-up, QC/QA procedures, instrumentation and quantification are published elsewhere[3].

Results and Discussion:

Contaminant levels in bottom sediments.

Mirex, endrin, and dieldrin were not detected in the bottom sediments from the study area. Residue levels of all other determined contaminants (PBDE excluded) in sediments from the White Sea were higher as compared to Pechora Sea sediments (Table 1). According the Norwegian Pollution Control Authority (SFT) environmental quality classification system, sediment contamination levels in both areas studied varied from slightly contaminated to moderately contaminated[4]. PBDEs and PCDD/Fs were found in all sediments samples analysed. Tetra- (BDE-47) and penta- (BDE-99) diphenyl ethers were the most abundant PBDE congeners. Their total contribution to ΣPBDE varied in a range from 72 to 78% of ΣPBDE. Octa-clorinated dibenzo-*p*-dioxin prevailed in PCDD/F composition in all samples analysed. PBDE and PCDD/F concentrations detected in marine sediments from the study areas were low or similar to those found in marine sediments from remote sites in Canada and Norway[5].

Contaminant levels in biota

Endrin and dieldrin were not detected in biota samples. Low mirex concentrations were detected in fish from the Pechora Sea and in common eider from the both areas studied. HCB, DDT and Chlordane levels detected in blue mussels and fish from the White Sea were lower compared to those from the Pechora Sea. P,p'-DDE was the most abundant DDT family compound, its contributions into ΣDDT ranged from 70 to 90%. *Trans*-nonachlor and *cis*-nonachlor were dominate chlordane-related compounds in all fish samples analysed while oxychlordane prevailed in bird samples. HCH and PCB levels in blue mussels and fish from the White Sea were 3-10 times higher compared to the Pechora Sea levels. Compositions of dioxin-like PCBs found in all biological samples were quite similar to patterns of Aroclor 1254 (Figure 2a). PBDE levels in both blue mussels and common eiders were similar in two areas studied, while fish from the Pechora Sea have 5 times higher levels compared to those from the White Sea. The congener pattern was dominated by TetraBDE-47, which contributed more than 70% of ΣPBDE in fish and 45-100% of ΣPBDE in blue mussels. In bird liver, hexa-BDE (BDE-100, 154 and 183) prevailed. Hepta-BDE-183 was abundant in hepatic tissues of common eiders from Pechora Sea (Figure 2b). PCDDs were not detected in biological samples; PCDFs were found in all fish and bird samples analysed. TCDF was the most abundant in fish samples, (64% of ΣPCDF), while in liver of birds 2,3,7,8-PeCDF and 1,2,3,4,7,8,9-HpCDF prevailed; total contribution of these congeners into ΣPCDF level ranged from 68 to 92%. In general, PBDE, and PCDF levels in biota from the study area were lower compared to those from Greenland, Canadian and Norwegian Arctic areas[5]. Organochlorine concentrations in blue mussels and fish samples did not exceed current Russian criteria for quality of seafood[6] and can be considered as within the best class according to national food quality criteria and in Class I ("slight contamination") in the SFT environmental quality classification system[4]. Total TCDD toxic-equivalents (Total $TEQ=TEQ_{PCDD/F}+TEQ_{PCB}$) found in liver of fish from compared areas were quite similar; contribution of TCDFs into total TEQ ranged from 68% to 100%. By contrast, total TEQ in liver of common eider from the White Sea was twice higher than in birds from Pechora Sea. In liver of common eiders, PCBs were the major contributors into total TEQ; their contributions were 72% and 69% in birds from the White and Pechora Seas, respectively.

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Figure 1: Sampling locations in the White (2006) and Pechora (2007) seas

Figure 2: Patterns of dioxin-like PCBs (a) and PBDEs (b) in liver of navaga and common eiders, and soft tissues of blue mussels from the White and Pechora Sea.

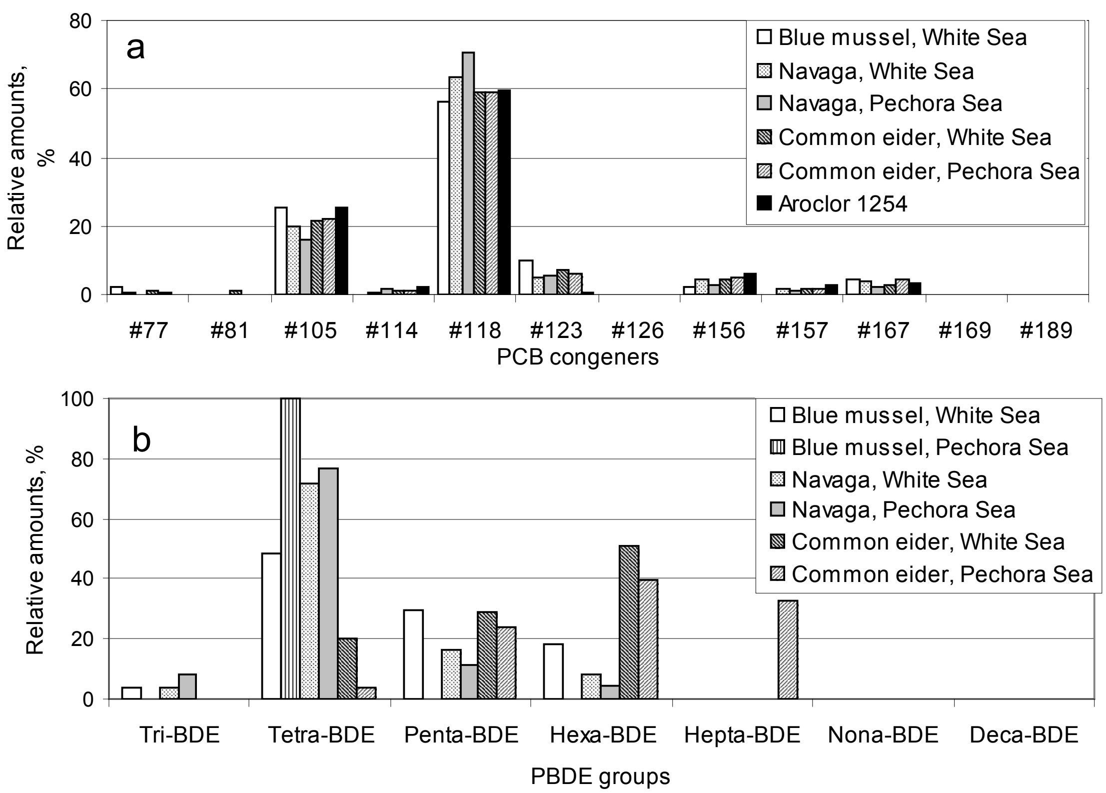

Table 1: Persistent organic pollutant residue levels in bottom sediments and biota from the White Sea and Pechora Sea and TCDD-toxic equivalents calculated for biotic samples according to[7]. Range and mean ± standard deviation.

POPs	Units	Blue mussels		Navaga		Common eider, female		Units	Bottom sediments	
		White Sea	Pechora Sea	White Sea	Pechora Sea	White Sea	Pechora Sea		White Sea	Pechora Sea
		N = 5[1]	N = 3[1]	N = 2[1]	N = 4[1]	N = 7	N = 5		N = 3	N = 5
HCB	ng/g w.w.	<0.03 - 0.110	0.070 - 0.290	4.60 - 5.23	3.95 - 12.6	1.43 - 4.98	2.20 - 3.87	ng/g d.w.	<0.03 - 0.38	<0.03 - 0.16
		0.054 ±0.051	0.180 ±0.155	4.92 ±0.445	8.27 ±6.10	2.71 ±1.18	2.85 ±0.664		0.14 ±0.21	0.09 ±0.06
[2]ΣHCH	ng/g w.w.	<0.05 - 0.520	<0.05 - 0.330	3.52 - 4.48	0.481 - 0.978	0.350 - 0.960	0.024 - 0.310	ng/g d.w.	<0.05 - 0.86	<0.05
		0.228 ±0.189	0.165 ±0.234	4.00 ±0.679	0.730 ±0.352	0.637 ±0.226	0.082 ±0.128		0.29 ±0.50	
[3]ΣCHL	ng/g w.w.	<0.01 - 0.070	0.020 - 0.210	9.69 - 10.9	5.10 - 28.4	0.75 - 3.24	0.310 - 2.46	ng/g d.w.	<0.01 - 0.03	<0.01
		0.018 ±0.030	0.115 ±0.134	10.3 ±0.856	16.8 ±16.5	2.10 ±0.934	1.27 ±0.944		0.01 ±0.02	
[4]ΣDDT	ng/g w.w.	0.040 - 0.200	0.260 - 0.851	41.5 - 51.3	11.3 - 84.1	4.51 - 16.2	2.28 - 7.52	ng/g d.w.	0.06 - 5.23	<0.03
		0.124 ±0.063	0.556 ±0.417	46.4 ±6.93	47.7 ±51.5	8.94 ±4.34	5.41 ±2.29		1.84 ±2.93	
Mirex	ng/g w.w.	<0.03	<0.03	<0.03	0.159 - 0.699	0.190 - 0.460	0.015 - 0.790	ng/g d.w.	<0.03	<0.03
					0.429 ±0.382	0.364 ±0.105	0.170 ±0.347			
[5]ΣPCB	ng/g w.w.	<0.01 - 3.82	<0.01 - 0.160	129 - 133	57.8 - 119	12.4 - 41.0	18.3 - 76.4	ng/g d.w.	2.27 - 7.22	0.05 - 1.34
		1.10 ±1.57	0.080 ±0.113	131 ±2.828	88.4 ±43.3	24.3 ±11.6	53.5 ±21.8		4.11 ±2.71	0.68 ±0.49
[6]ΣPBDE	pg/g w.w.	5.60 - 12.3	12.1 - 25.3	641 - 744	1770 - 6165	70.4 - 266	38.1 - 160	pg/g d.w.	2.73 - 19.3	10.0 - 36.9
		8.00 ±2.69	18.7 ±9.35	693 ±72.8	3967 ±3108	166 ±74.1	105 ±46.5		8.43 ±9.41	20.2 ±10.6
ΣPCDD	pg/g w.w.	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	pg/g d.w.	7.01 - 9.11	4.64 - 12.7
									8.38 ±1.18	6.57 ±3.44
ΣPCDF	pg/g w.w.	<0.10	<0.10	5.96 - 6.91	8.70 - 11.9	2.39 - 9.61	3.04 - 6.13	pg/g d.w.	5.22 - 9.34	0.68 - 3.07
				6.43 ±0.672	10.3 ±2.25	4.97 ±2.75	4.31 ±1.38		6.70 ±2.29	1.49 ±1.04
$TEQ_{PCDD/F}$	pg/g w.w.	<0.01	<0.01	0.343 - 0.394	0.679 - 0.795	1.75 - 8.51	1.38 - 3.16			
				0.369 ±0.036	0.737 ±0.083	3.93 ±2.46	2.05 ±0.678			
TEQ_{PCB}	pg/g w.w.	<0.01 - 0.017	<0.01	0.166 - 0.188	0.001 - 0.001	0.143 - 31.3	0.237 - 12.3			
		0.004 ±0.007		0.177 ±0.016	0.001 ±0.000	10.4 ±13.1	4.67 ±5.87			
Total TEQ	pg/g w.w.	<0.01 - 0.017	<0.01	0.531 - 0.560	0.679 - 0.796	2.07 - 36.5	1.88 - 14.4			
		0.004 ±0.007		0.546 ±0.021	0.738 ±0.083	14.3 ±14.7	6.72 ±6.36			

[1] pooled samples; [2]ΣHCH=sum of α-, β-, and γ-HCH; [3]ΣCHL = sum of heptachlor, heptachlor epoxide, oxychlordane, *trans*-chlordane, *cis*-chlordane, *trans*-nonachlor, and *cis*-nonachlor; [4]ΣDDT = sum of *o,p'*-DDE, *p,p'*-DDE, *o,p'*-DDD, *p,p'*-DDD, *o,p'*-DDT, *p,p'*-DDT; [5]ΣPCB = sum of 63 PCB congeners; [6]ΣPBDE =sum of PBDE-17, 28, 49, 71, 47, 66, 100, 99, 85, 154, 153, 138, 183, 190, 208, 207, 206, and 209.