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Documentation of the TMAP Parameter "Pollutants in seabird eggs" in The Netherlands in 2016

1. Egg sampling

Eggs were sampled according to OSPAR (1997), Becker et al. (2001) and VDI (2009). In general, per year, species and site, 10 eggs were sampled (cf. Fig. 1.1 and Table 1.1).

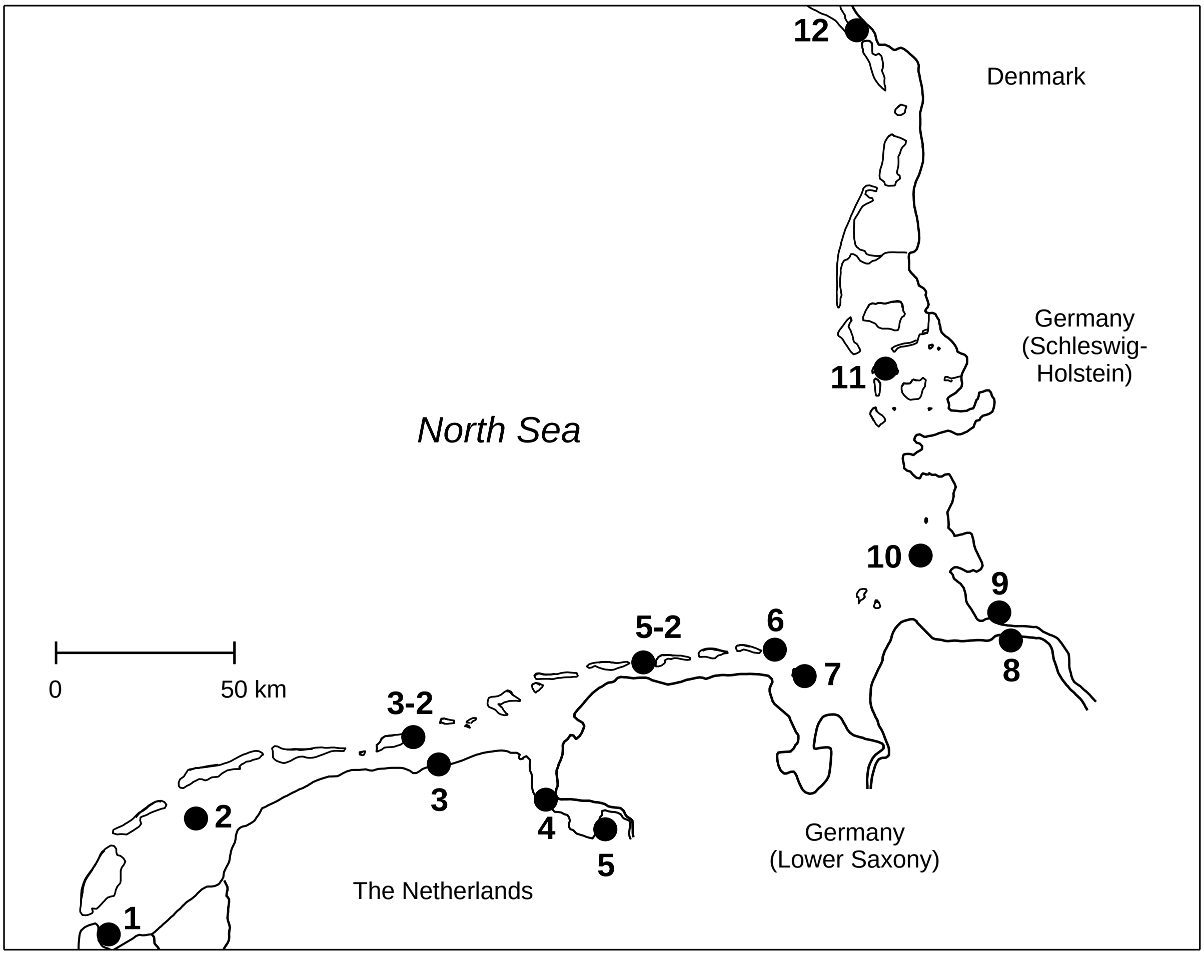

Fig. 1.1: Sampling sites of Oystercatcher and/or Common Tern eggs in the trilateral Wadden Sea.
The Netherlands: 1 Balgzand, 2 Griend, 3 Julianapolder, 3-2 Schiermonnikoog, 4 Delfzijl;
Germany, Lower Saxony: 5 Dollart, 5-2 Baltrum, 6 Minsener Oog (Oldeoog), 7 Mellum (6 and 7 = Jade), 8 Hullen (8 and 9 = Elbe estuary);
Germany, Schleswig Holstein: 9 Neufelderkoog (8 and 9 = Elbe estuary), 10 Trischen, 11 Norderoog/Hallig Hooge (Halligen).
Denmark: 12 Langli
At sites 3, 5, 7, 8 and 12 only Oystercatcher eggs, at sites 3-2, 6 and 9 only Common Tern eggs were taken.

Table 1.1: Number of Oystercatcher and Common Tern eggs sampled per site in 2016

	Species	
Site	Oystercatcher	Common Tern
Balgzand	10	10
Griend	10	10
Julianapolder	10	-
Schiermonnikoog	-	10
Delfzijl	10	10

2. Chemical analytics

The samples were analyzed as shortly described by OSPAR (1997), Sommer et al. (1997) and Becker et al. (2001). You can get a detailed description of methods on request.

3. Documentation of data, description of the EXCEL-file and of the variables

The data from The Netherlands in 2016 are documented in an EXCEL-file (already sent per mail). The variables in the EXCEL-file are explained in the file-head.

4. Assessment of the results

To present a short assessment of the data, we prepared and presented statistics for the following most important chemicals or chemical groups:

ORGANOCHLORINES:

PCB sum: 62 congeners

6PCBs: 6 PCB-congeners (PCB28, PCB52, PCB101, PCB138, PCB153, PCB180)

HCB

HCH sum: α-HCH, β-HCH, γ-HCH

DDT sum: p,p'-DDE, p,p'-DDT, p,p'-DDD

Chlordane sum: Sum of Chlordan and Nonachlor-compounds: trans-Chlordan, cis-Chlordan, trans-Nonachlor, cis-Nonachlor

To make the following text more readable, for "PCB sum" the simplifying term "PCB", for "DDT sum" the term "DDT", for "HCH sum" the term "HCH" and for "Chlordane sum" the term "Chlordanes" is used.

To calculate TEQs (Toxic Equivalents) of non- and mono-ortho PCB congeners, bird-specific 2,3,7,8-TCDD toxic equivalency factors (TEF) proposed by the WHO (Van den Berg et al., 1998) were used. Non-ortho congeners detected were PCB 126 and 169, mono-ortho congeners were PCB105, 114, 118, 123,156, 157, 167 and 189.

<u>HEAVY METALS:</u>

Hg (mercury)

All concentrations are given in ng/g fresh weight of the eggs with an accuracy of one digit after the decimal point (which is shown as a comma).

<u>Statistics:</u>

For analyzing temporal trends for the years 2012 – 2016, Spearman rank correlations were calculated (two-tailed) for the years 2012 - 2016. To identify potential differences in pollutant concentrations between 2015 and 2016, Mann-Whitney-U-tests were conducted. In the figures, arithmetic means ± 95% confidence intervals are presented. If the confidence intervals do not overlap, significance of at least $p < 0.05$ is indicated.

5 Results

5.1 Spatial patterns of selected contaminants in the Wadden Sea in 2016

For the Common Tern, we identified the following areas with relatively high contamination. They are listed in order of mean contamination level, beginning with the highest (see Fig. 5.1.1; Tab. 8.1.1):

Hg:	Griend, Elbe, Halligen
PCB:	Elbe, Balgzand, Jade
HCB:	Elbe, Jade, Baltrum
DDT:	Elbe, Trischen, Jade
HCH:	Elbe, Balgzand, Trischen,
Chlordane:	Balgzand, Jade, Trischen

In Common Tern eggs, concentrations of Hg, PCB, HCB and DDT tended to be higher at most sites than in Ostercatcher eggs, whereas HCH and Chlordane concentrations tended to be lower. But the PCB conentrations reached equal values in some areas (Julianapolder, Dollart/Baltrum). In general in 2016 the differences between the two species were again more distinct and similar to the years before, except the year 2014, where the specific differences between the species were not so clear.

In the following areas relatively high contaminations of Oystercatcher eggs were detected (given in the order of contamination level, beginning with the highest average level, see Fig. 5.1.1; Tab. 8.1.1):

Hg:	Trischen, Halligen, Griend
PCB:	Elbe, Dollart, Trischen
HCB:	Delfzijl, Elbe, Trischen
DDT:	Trischen, Elbe, Dollart
HCH:	Griend, Elbe, Trischen
Chlordane:	Dollart, Julianapolder, Griend

In the **Oystercatcher**, the geographical pattern of **Hg** concentrations in 2016 was largely similar to those of the years before (see last reports): **Hg** peaked at Griend but this year reached maximum values in the area north of the river Elbe (Trischen, Halligen). Again we see the same trend as the years before: Because of the rising concentrations in formerly lower contaminated areas the differences between the areas seemed to be lower. This development may result in an established level of a little less than 200 ng/g **Hg** in Oystercatcher eggs from all investigated areas of the Wadden Sea. In 2016 the average measured Hg concentration in Oystercatcher eggs from the Wadden Sea was 188,1 +/- 89,7 ng/g wet weight (range: 38,9 - 699,6 ng/g) and therefore a little higher compared to 2015 (171,2 +/- 81,9 ng/g; range: 28,3 – 418,6 ng/g) but in the same dimension.

In 2016 a prominent concentration peak of **PCB** was recognized at the river Elbe and a second peak occurred in Oystercatcher eggs from the Dollart. Both peaks were also seen in the years before, as well as the trend that the PCB concentrations equalise at the different locations of the Wadden Sea. In 2016 the average PCB level was 578,7 +/- 238,4 ng/g wet weight (range: 159,3 – 1.330,0 ng/g) and so a little above the level of 2015 (560,6 +/- 242,5 ng/g; range: 203,9 – 1.205,0 ng/g).

As in the years before in 2016 the clearly highest concentrations of **HCB** in oystercatcher eggs were measured at Delfzijl. But the values were the second time obviously lower than in the year before. Concentrations at Delfzijl reached in average “only” one point five to six times higher levels compared to levels in Oystercatcher eggs from other areas. The amount of HCB in Common Terns eggs from most tested areas reached a similar or clearly higher level as these in Oystercatcher eggs at Delfzijl. Two further, but much smaller peaks were recorded in Oystercatcher eggs from the river Elbe and Trischen. In 2016 the average HCB level was 3,5 +/- 3,0 ng/g wet weight (range: 0,7 – 15,1 ng/g) and so clearly beyond the level of 2015 (3,8 +/- 5,2 ng/g; range: 0,8 – 41,4 ng/g).

For **DDT** the highest concentrations in 2016 were found in Oystercatcher eggs from Trischen and the river Elbe. Remarkable were very high DDT concentrations in three eggs from Trischen, where values reached up to twenty-two times higher levels than elsewhere. The average DDT level was 52,6 +/- 112,8 ng/g wet weight (range: 10,5 – 935,7 ng/g).

The geographical pattern of **HCH** was 2016 likely similar to those from 2015 with a very strong peak at Griend as well as some lower ones at Elbe and Trischen. The high levels from Griend resulted of four eggs with very high β-HCH levels. But in general the HCH levels with an average of 2,3 +/- 3,3 ng/g wet weight (range: 0,0 – 16,1 ng/g) were similar to those from last year (average: 2,4 +/- 2,2 ng/g, range: 0,0 – 9,9 ng/g).

For **Chlordanes** high values have been detected in all Oystercatcher eggs from western areas with peaks at Dollart, Julianapolder and Griend. In general levels of Chlordanes were clearly higher in Oystercatcher eggs compared to those from Common Tern eggs. The average Chlordane level in 2016 in Oystercatcher eggs was 1,3 +/- 0,6 ng/g wet weight (range: 0,0 – 3,1 ng/g).

In **Common Tern eggs** the main contamination area of **Hg**, **PCB**, **DDT**, **HCB** and **HCH** was again clearly located at the river Elbe in 2016. In general, the contamination patterns were similar to those of the years before, showing mainly peak values at the river Elbe and surrounding areas which are influenced by the water of the Elbe.

In 2016 the **Hg** concentrations in the Common Tern eggs showed rather equal levels, with peaks at Griend and Elbe. The average level of all areas was 295,1 +/- 105,8 ng/g fresh weight (range 138,1 – 643,3 ng/g).

For **PCB** we see at all areas rather similar concentrations in Common Tern eggs with an average level of 722,9 +/- 324,8 ng/g wet weight (range: 274,1 – 2.173,3 ng/g). Small peaks occurred at Elbe and surrounding areas as well as at Balgzand and Delfzijl, but the highest single PCB value was detected in one Common Tern egg from the Jade.

In 2016 the **HCB** concentrations in Common Tern eggs had an average level of 5,9 +/- 3,9 ng/g fresh weight (range: 0,6 – 21,5 ng/g). Except Delfzijl, the HCB concentrations were at all areas clearly higher than concentrations in Oystercatcher eggs at these areas. In Common Terns maximum HCB levels were measured in eggs from the Elbe (15,2 +/- 4,4 ng/g) witch reached twice the amount of maximum HCB levels in Oystercatcher eggs from Delfzijl (7,7 +/- 4,1 ng/g).

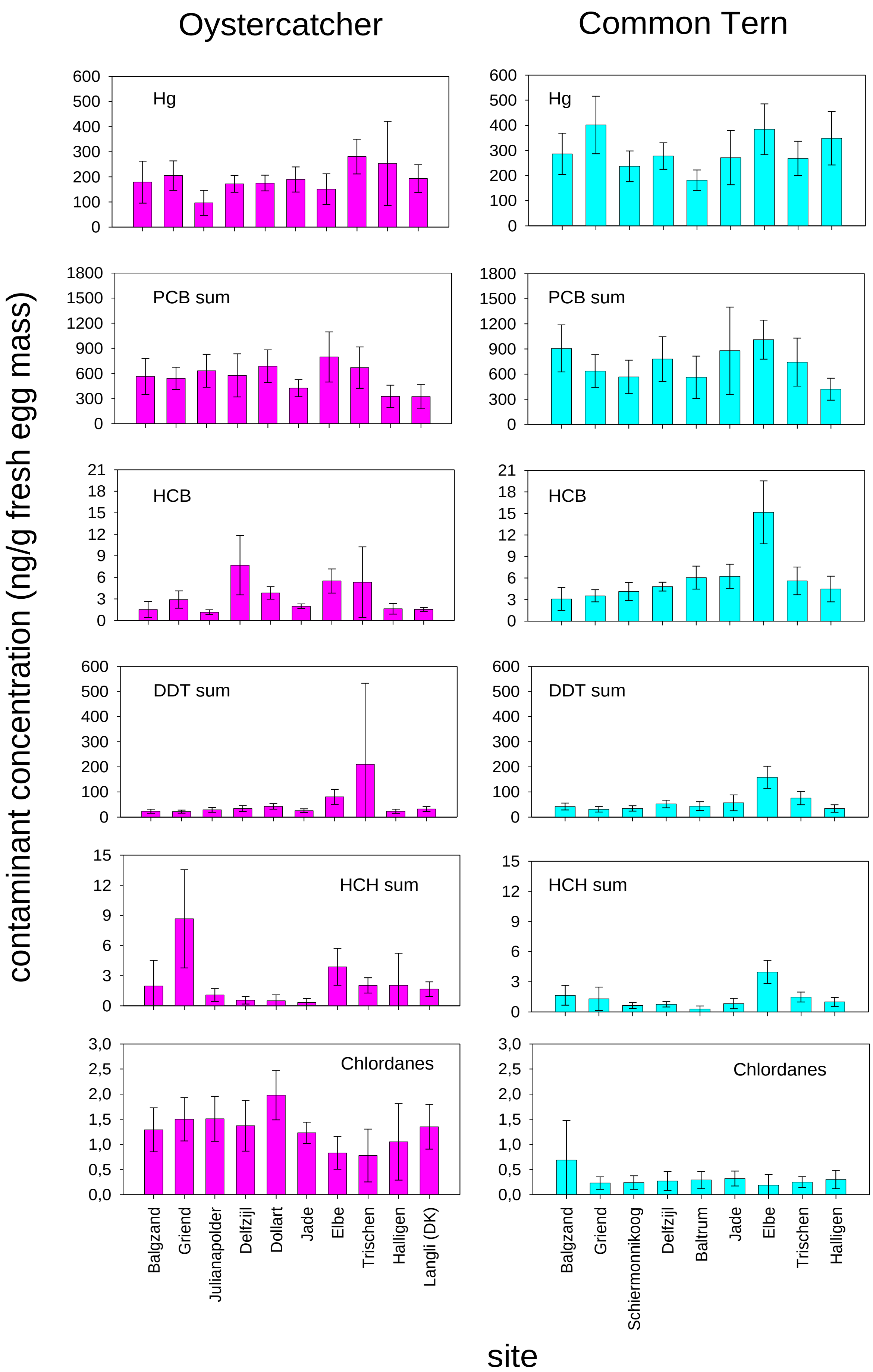

Fig. 5.1.1: Spatial patterns of pollutant concentrations in Oystercatcher and Common Tern eggs from the Wadden Sea in 2016 (means with standard deviations)

DDT concentrations in Common Tern eggs were 2016 rather similar showing an average level of 58,6 +/- 43,8 ng/g wet weight (range: 17,9 – 231,4 ng/g) and a clear peak at the river Elbe.

The measured **HCH** levels in Common Tern eggs ranged between 0,0 and 5,3 ng/g wet weight with an average of 1,3 +/- 1,2 ng/g and a clear peak at the river Elbe.

Concentrations of **Chlordanes** recorded in 2016 in Common Tern eggs were rather low in all areas and very similar with an average of 0,3 +/- 0,3 ng/g. Only in two eggs from Balgzand higher Chlordane values were measured.

5.2 Annual variation in pollutant concentration in the period 2012-2016

Mean contamination values for the different substance groups in the period 2012-2016 are given in Figures 8.2.1-8.2.6 in the Appendix. A summarizing overview of short-term (2015-2016) and mid-term (2012-2016) temporal changes in the Dutch and German Wadden Sea are given in Tables 5.2.1 and 5.2.2.

Balgzand

Temporal Trends 2012-2016:

Oystercatcher Significant **decrease** was detected in HCB, DDT, HCH and Chlordanes.
Common Tern Significant **decrease** occurred in HCB, HCH and Chlordanes.

In Oystercatcher eggs sampled in 2016 the concentrations of all measured chemicals **did not change** significantly compared to 2015. In Common Tern eggs concentration of HCB was **lower** in 2016 compared to 2015 whereas levels of PCB and Chlordanes **increased.**

Griend

Temporal Trends 2012-2016*:*

Oystercatcher Significant **increase** was detected in HCH.
Common Tern Significant **decrease** was identified in levels of HCB and DDT.

Between 2015 and 2016 PCB, DDT and Chlordane concentrations **increased** significantly in Oystercatcher eggs whereas in Common Tern eggs levels of HCB and Chlordanes **decreased** in that period.

Julianapolder/Schiermonnikoog

Temporal Trends 2012-2016*:*

Oystercatcher Significant **decreases** in the concentrations of Hg, HCB, DDT, HCH and Chlordane were identified at Julianapolder.
Common Tern Significant **decreases** in the concentrations of HCB, DDT and HCH were detected at Schiermonnikoog.

In Oystercatcher eggs from 2016 sampled at Julianapolder, the concentrations of HCH **decreased** significantly compared to 2015. In Common Tern eggs from 2016 sampled at Schiermonnikoog all measured chemicals exept HCH were significantly **lower** compared to 2015.

<u>Delfzijl</u>

<u>*Temporal Trends* 2012-2016*:*</u>

Oystercatcher — The concentration of HCB, DDT, HCH and Chlordanes **decreased** significantly whereas concentrations of Hg **increased**.

Common Tern — In the period between 2012 and 2016 significant **decreases** in the concentrations of HCB, DDT and HCH occurred.

Between 2015 and 2016 concentrations of all measured chemicals in Oystercatcher eggs **did not change** significantly. In Common Tern eggs concentration of Hg was 2016 significantly **lower** compared to the year before.

Table 5.2.1: Overview over the development of selected pollutants in eggs of Oystercatcher and Common Tern in the Wadden Sea from 2012-2016, according to Spearman rank correlations. -: significant decline, +: significant increase.

	Oystercatcher									Common Tern								
	Balgzand	Griend	Julianapolder	Delfzijl	Dollart	Jade	Hullen	Trischen	Halligen	Balgzand	Griend	Schiermonnikoog	Delfzijl	Baltrum	Jade	Neufelderkoog	Trischen	Halligen
Hg			-	+										-		-	-	
PCB Summe					-	-										-	-	-
HCB	-		-	-	-		-	-	-	-	-	-	-	-	-	-	-	-
DDT Summe	-		-	-	-	-		-	-		-	-	-			-	-	-
HCH Summe	-	+	-	-	-			-	-	-		-	-	-	-	-	-	
Chlordan-Nonachlor-Summe	-		-	-	-	-	-	-	-	-				-		+		

Table 5.2.2: Overview over the development of selected pollutants in eggs of Oystercatcher and Common Tern in the Wadden Sea from 2015-2016, according to Mann-Whitney-U-tests. -: significant decline, +: significant increase.

	Oystercatcher									Common Tern								
	Balgzand	Griend	Julianapolder	Delfzijl	Dollart	Jade	Hullen	Trischen	Halligen	Balgzand	Griend	Schiermonnikoog	Delfzijl	Baltrum	Jade	Neufelderkoog	Trischen	Halligen
Hg					+	-		+				-	-	-		-		-
PCB Summe		+								+		-				-		-
HCB										-	-	-						
DDT Summe		+										-				-		-
HCH Summe			-		-	-								-	-	-	-	-
Chlordan-Nonachlor-Summe		+								+	-	-						

6. General Assessment

6.1 Spatial Trends

The concentrations of the mentioned substances in **Oystercatcher** eggs showed in 2016 again only small geographical differences. For the first time since many years the conspicuous HCB peak at Delfzijl had vanished. Here HCB concentrations in oystercatcher eggs were found in the same amount as in eggs from Elbe or Trischen and clearly lower compared to concentrations in Common Tern eggs. In Oystercatcher eggs highest levels of PCB were detected at the River Elbe whereas HCH reached highest levels at Griend and DDT at Trischen. Compared to 2015 the measured concentrations were slightly higher in case of Hg, PCB, DDT and Chlordanes, but tended to be lower in case of HCB and HCH.

In the **Common Tern**, clearly prominent concentration peaks of PCB, DDT, HCB and HCH were found 2016 again at the Elbe estuary. Consequently, a continuous decrease of pollution was recorded with increasing distance from the Elbe estuary which is in accordance to the observations from previous years. So we found the second highest levels mostly at Trischen, as the area is influenced most by the waters of the river Elbe. But beside the river Elbe we found high Hg concentrations also in the western part of the Wadden Sea. Highest Hg concentrations in 2016 were observed at Griend. But there was no visible geographical pattern of the Hg concentrations in Common Tern eggs. The average Hg level over all investigated areas of the Wadden Sea was clearly lower compared to 2015 and reached a level of ca. 300 ng/g wet weight.
The HCB concentrations showed in 2015 only small geographical differences compared to the other contaminants, but in 2016 we saw again a strong influence of the river Elbe. Average level in Common Tern eggs were ca. 6 ng/g fresh weight, which was lower compared to 2015 - but clearly higher in comparison with the Oystercatcher eggs. Also in case of PCB, DDT and HCH the concentrations in Common Tern eggs tended to be lower in 2016 than in 2015 whereas in case of Chlordane they were rather similar.

In general, the species-specific spatial contamination patterns in 2016 remained similar to those recorded in 2015 and the years before: The contamination pattern of the Common Tern again showed clear concentration peaks at the river Elbe. In contrast the contamination pattern of the Oystercatcher was inconsistent, showing different geographical peaks for each component. The species-specific patterns may have been influenced by differences in the feeding ecology, with the Oystercatcher possibly foraging to a higher degree in terrestrial habitats at some sites. This might explain why in particular at the river Elbe, no maximum concentrations have been found in the Oystercatcher but in the Common Tern. Furthermore, for the benthic feeding Oystercatcher, contaminants bound to sediment particles which might have been transported previously, are probably more important than for the pelagic feeding Common Tern. In addition, the partly whole-year presence of the Oystercatcher in the Wadden Sea might have affected the contamination patterns recorded. In general, the data underline the importance of the large rivers Elbe and Ems for the influx of several contaminants into the Wadden Sea. For Hg, PCB, HCB and DDT, contamination levels tended to be higher in the Common Tern than those in the Oystercatcher (except for HCB at Delfzijl), reflecting the higher trophic level of the piscivorous Common Tern with an even more effective bioaccumulation of pollutants. However, at most study sites Chlordane concentrations were clearly higher in Oystercatcher eggs than in Common Tern eggs.

The mentioned concentration peak of HCB in Oystercatcher eggs from Delfzijl could be seen since many years and may be caused by contaminated water and sediment in the Sea Harbour Channel in Delfzijl (Eggens & Bakker 2001). In the period 2008-2012 (see TMAP reports 2011 and 2012) increasing concentrations were evident after the HCB concentration had decreased until 2000 (Eggens & Bakker 2001). After an increase in 2014 the concentrations in 2015 were clearly lower compared to the previous years. Fortunately, we could see in 2016 again decreasing levels and concentrations at Delfzijl were in a similar amount as at the river Elbe or at Trischen.

In the past the mainly influx of Hg into the Wadden Sea took place over the rivers. Most important thereby was the river Elbe. In the last years we saw a reduction impact of rivers and in 2016 for both species a distinct discharge of Hg into the Wadden Sea was not clearly visible. There was no geographical difference in Hg concentrations of the eggs in both species. Of course the Hg levels tended to be higher in the Common Tern eggs than those in Oystercatchers, reflecting the higher trophic level. But for both species there was an established level of Hg in all investigated areas of the Wadden Sea. The reason for this trend may be the success of the environmental constraints of the river waters on the one hand and the still high Hg influx over the atmosphere on the other hand. The most important process for the man-made Hg emission into the atmosphere is coal burning. Compared to the year before the Hg concentrations in Common Tern were 2016 lower, but at all areas still above the Ecological Quality Objectives (EcoQOs) of 160 ng/g Hg for this species (e.g. Dittmann et al. 2012).

6.2 Temporal trends

Although for both species during the **five-year-period 2012-2016** much more decreasing than increasing contamination levels of the measured substances at the different study sites could be seen, there was in some cases no clear picture of the resulting temporal trend, and so the results were sometimes not easy to interpret. For example, all measured substances in Common Tern eggs from the Elbe between 2012 and 2016 decreased significantly, except the Chlordane concentrations. Latter increased significantly in the same period.

In **Oystercatcher** eggs decreasing concentrations were detected in case of Hg at one of the nine sampled sites as well as increasing also at one site. In case of PCB decreasing concentrations occurred at two and in case of DDT and HCB at seven sites, respectively. Remarkable were the concentrations of Chlordane, which decreased at eight of the nine investigated areas. In case of HCH decreases were seen at six of the nine sampled sites, but HCH increased also at one area. In total we saw only two increases in Oystercatcher eggs in 2016, but 31 decreases and most of them were detected at Julianapolder and at the Dollart (in each case five). In general, in most cases the measured de- or increases were only small although constant (see figures at 8.2).

In the **Common Tern** eggs we detected more significant de- than increases in the period during 2012-2016 too. We see a decrease of HCB concentrations at all nine study sites. In case of HCH decreasing concentrations occurred at seven of the nine sampled sites and in case of DDT at six, as well as in the case of Hg and PCB at three sites each. The Chlordane concentrations decreased at two sites, respectively. In total we found 30 significant decreased substance levels in Common Tern eggs in the five-year-period, and most of them were detected at Elbe and Trischen (five at each site) as well as at Baltrum (four). The only increase we found was the above mentioned Chlordane concentrations in the Common Tern eggs from the Elbe.

When **comparing the year 2016 with 2015** we recorded more contamination increases (5) than decreases (4) in **Oystercatcher** eggs (Tab. 5.2.2.). But there was no visible pattern in the data. De- and increases occurred at different places of the Wadden Sea and in different chemical groups. Most increases occurred at Griend (3) as well as at Dollart and Trischen (one each). Remarkable were the TEQs in the Oystercatcher eggs, which decreased rather uniformly at five of the nine investigated sites between 2015 and 2016 as well as the HCH concentrations at three, respectively. The Hg concentrations showed a mixed picture, with decreases at one site as well as increases at two other sites.

In **Common Tern** eggs clearly more contamination decreases (21) than increases (2) were detected (Tab. 5.2.2.): rather consistently the Hg and the HCH concentrations decreased at five of the nine study sites each as well as the level of TEQs decreased at seven of nine sites. Most chemical groups decreased at Schiermonnikoog (five) as well as at Elbe and Halligen (four each). All increases were found at Balgzand were significant rising concentrations of PCB and Chlordanes occurred between 2015 and 2016.

6.3 Summarized Assessment

Summarizing, the results from 2016 indicate similar species-specific spatial contamination patterns as in the previous years. Whereas the Elbe is again the most prominent site of contamination in the Common Tern eggs, the spatial contamination peaks as well as the total burden of environmental chemicals are lesser in Oystercatcher eggs. An exception are the high HCH burdens in Oystercatcher eggs from Griend and very high amounts of DDT in three Oystercatcher eggs from Trischen. For the first time since many years the particularly high concentrations of HCB in Oystercatcher eggs from Delfzijl was not clearly visible in 2016. The HCB concentration showed in both species a statistically significant decrease at many sites of the Wadden Sea in the past five years, too.
When comparing the year 2016 with the previous one, Common Tern showed a gently lower Hg burden in their eggs, whereas concentrations in Oystercatcher eggs tended to be higher. In contrast the HCB concentrations were lower, after a steady increase in the previous years until 2014 (Becker et al 2001, Mattig et al. 2014). In general, the concentrations of the measured environmental chemicals were 2016 a bit lower compared to 2015, but nearly in the same dimension. Our data show that the contamination levels in the eggs of the two species remained firm at the higher level after a constant increase until 2011/2012. Even with the data from 2016 the question if the contamination level of the environmental chemicals showed fluctuations around established levels in birds (cf. Becker & Dittmann 2009) could not finally be answered. This is also of interest against the background of the Ecological Quality Objectives (EcoQOs) defined by OSPAR in recent years for coastal bird eggs from the North Sea area (Dittmann et al. 2012). For Common Tern eggs the limit values of Hg (160 ng/g), PCB (20 ng/g), HCB (2 ng/g) and DDT (10 ng/g) were exceeded in 2016 at all investigated areas, whereas the HCH limit values (2 ng/g) only exceeded at the Elbe. For the Oystercatcher eggs the limit values of HCH (2 ng/g) were undercut at all investigated sites except at Elbe and Griend. Limit values of Hg (100 ng/g) were exceeded at one place as well as in case of HCB (2 ng/g) at four sites. However, the results of PCB (20 ng/g) and DDT (10 ng/g) exceeded the EcoQO levels at all investigated places. These results underline that the target aims defined by OSPAR were fulfilled nearly nowhere.

7. Literature

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This report was compiled by Frank R. Mattig, Ursula Pijanowska and Peter Schupp.

Wilhelmshaven, 17 February 2017

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(Prof. Dr. Peter Schupp)

8. Appendix

8.1 Concentrations of selected contaminants in eggs of Oystercatcher and Common Tern at different sites of the Dutch Wadden Sea 2016

Table 8.1.1: Concentrations of chemicals in Oystercatcher and Common Tern eggs sampled in The Netherlands in 2016. Mean concentrations in ng/g (fresh mass of egg content), standard deviations and number of samples are presented.

	Balgzand			Griend			Julianapolder			Delfzijl		
Oystercatcher	**(N=10)**			**(N=10)**			**(N=10)**			**(N=10)**		
Hg	178,9	±	83,6	204,8	±	58,8	96,2	±	49,8	172,2	±	33,8
6 PCB (law)	254,8	±	105,5	236,4	±	63,0	281,6	±	93,4	261,8	±	122,5
PCB sum	564,1	±	215,5	541,2	±	132,6	631,8	±	196,1	577,3	±	257,8
HCB	1,5	±	1,1	2,9	±	1,2	1,2	±	0,3	7,7	±	4,1
ppDDE	19,7	±	7,5	19,4	±	5,9	26,6	±	8,8	29,0	±	11,3
ppDDT	1,9	±	1,4	0,6	±	0,8	0,3	±	1,0	2,9	±	1,0
ppDDD	1,7	±	0,1	1,6	±	0,0	1,6	±	0,1	1,8	±	0,2
DDT sum	23,2	±	8,3	21,6	±	6,0	28,5	±	9,4	33,6	±	12,0
alpha-HCH	0,0	±	0,0	0,0	±	0,0	0,0	±	0,0	0,0	±	0,0
beta-HCH	1,8	±	2,6	8,1	±	5,1	0,9	±	0,6	0,6	±	0,4
gamma-HCH	0,1	±	0,3	0,6	±	0,5	0,1	±	0,3	0,0	±	0,0
HCH sum	2,0	±	2,6	8,7	±	4,9	1,1	±	0,6	0,6	±	0,4
Chlordane sum	1,3	±	0,4	1,5	±	0,4	1,5	±	0,4	1,4	±	0,5

	Balgzand			Griend			Schiermonnikoog			Delfzijl		
Common Tern	**(N=10)**			**(N=10)**			**(N=10)**			**(N=10)**		
Hg	286,3	±	82,2	401,6	±	114,6	236,8	±	61,1	277,9	±	52,8
6 PCB (law)	407,3	±	133,5	288,4	±	93,8	244,4	±	88,8	353,0	±	122,3
PCB sum	906,8	±	281,3	636,9	±	195,0	566,9	±	199,6	778,9	±	268,2
HCB	3,1	±	1,6	3,5	±	0,8	4,1	±	1,3	4,8	±	0,6
ppDDE	40,3	±	13,1	29,3	±	11,2	32,2	±	10,1	50,0	±	14,6
ppDDT	0,0	±	0,0	0,0	±	0,0	0,3	±	0,9	0,0	±	0,0
ppDDD	1,7	±	1,0	1,7	±	0,2	1,7	±	0,4	2,1	±	0,6
DDT sum	42,0	±	13,7	31,0	±	11,1	34,3	±	10,5	52,1	±	15,0
alpha-HCH	0,0	±	0,0	0,0	±	0,0	0,0	±	0,0	0,0	±	0,0
beta-HCH	1,6	±	0,9	0,8	±	0,1	0,5	±	0,4	0,7	±	0,3
gamma-HCH	0,0	±	0,1	0,6	±	1,1	0,1	±	0,2	0,0	±	0,1
HCH sum	1,7	±	1,0	1,3	±	1,2	0,6	±	0,3	0,8	±	0,3
Chlordane sum	0,7	±	0,8	0,2	±	0,1	0,2	±	0,1	0,3	±	0,2

8.2 Temporal trends of pollutant concentrations at different sites during 2012-2016

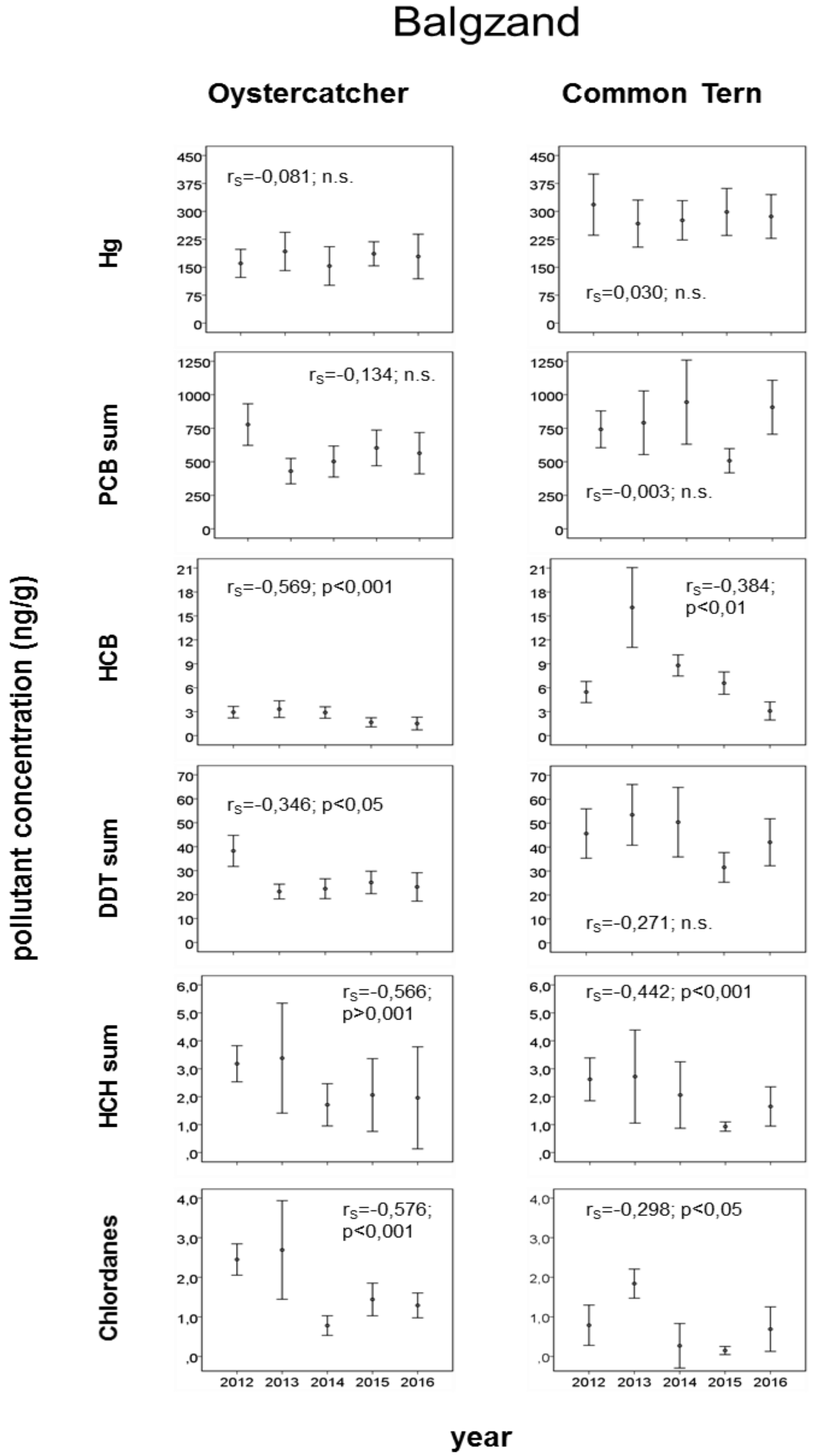

Fig. 8.2.1: Temporal development of pollutant concentrations in Oystercatcher and Common Tern eggs from Balgzand, NL, in the period 2012-2016. Arithmetic means are given with the 95% confidence interval.

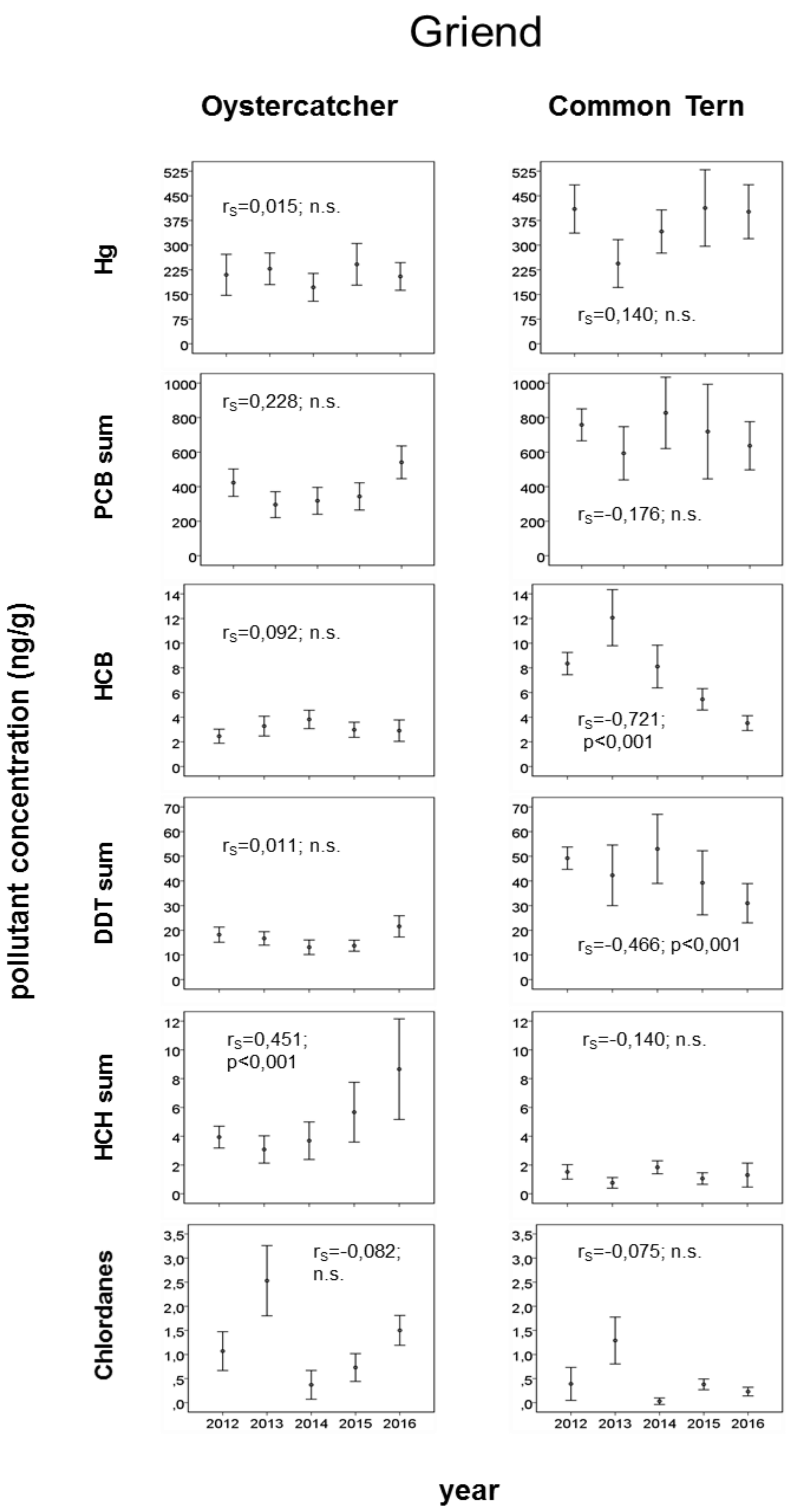

Fig. 8.2.2: Temporal development of pollutant concentrations in Oystercatcher and Common Tern eggs from Griend, NL, in the period 2012-2016. Arithmetic means are given with the 95% confidence interval.

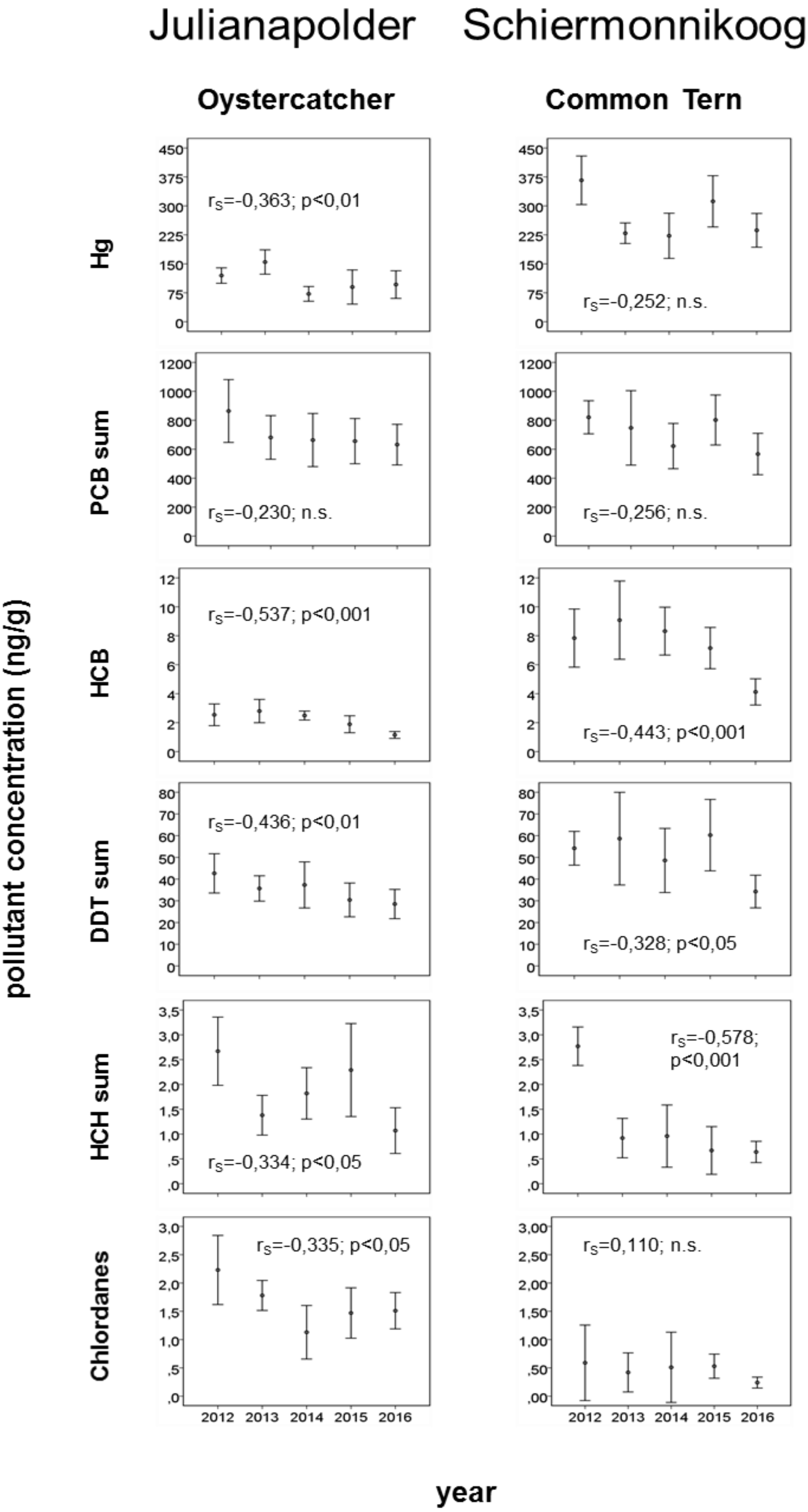

Fig. 8.2.3: Temporal development of pollutant concentrations in Oystercatcher eggs from Julianapolder and in Common Tern eggs from Schiermonnikoog, NL, in the period 2012-2016. Arithmetic means are given with the 95% confidence interval.

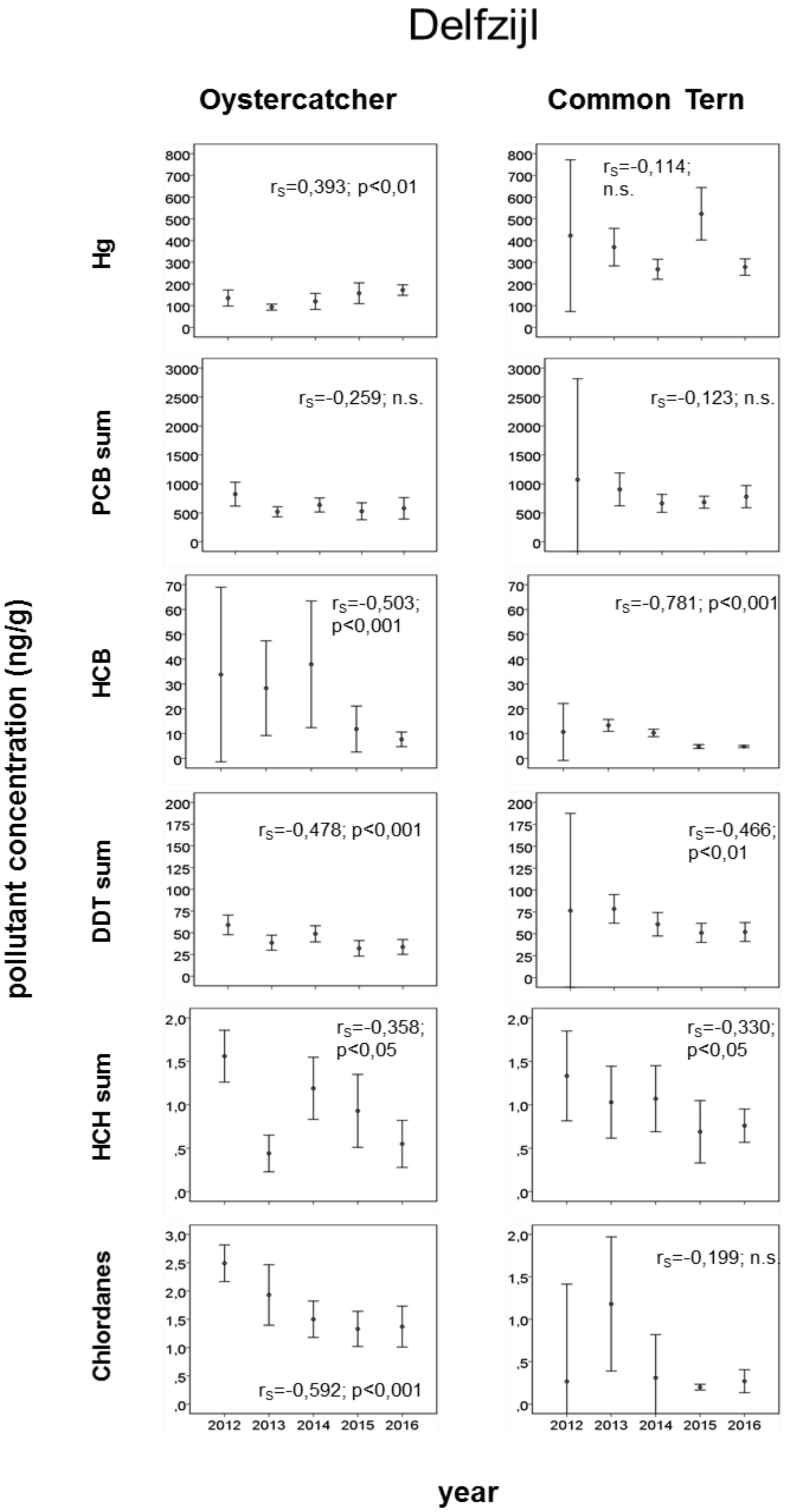

Fig. 8.2.4: Temporal development of pollutant concentrations in Oystercatcher and Common Tern eggs from Delfzijl, NL, in the period 2012-2016. Arithmetic means are given with the 95% confidence interval.