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Documentation of the TMAP Parameter "Pollutants in seabird eggs" in The Netherlands in 2017

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).

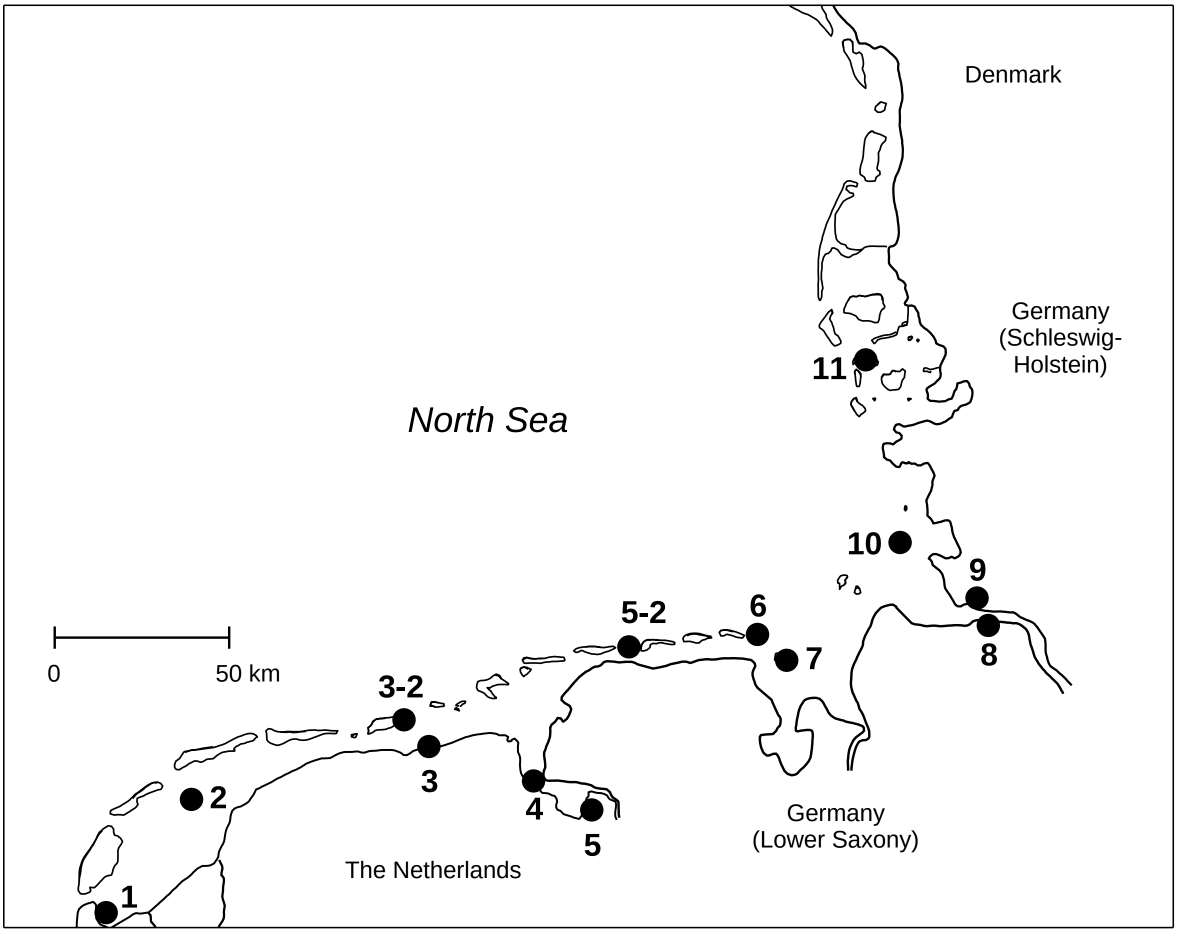

Fig. 1.1: Sampling sites of Oystercatcher and/or Common Tern eggs in the trilateral Wadden Sea.
The Netherlands: 1 Balgzand, 2 Griend, 3 Julianapolder, 3-2 Schiermonnikoog, 4 Delfzijl;
Germany, Lower Saxony: 5 Dollart, 5-2 Baltrum, 6 Minsener Oog (Oldeoog), 7 Mellum (6 and 7 = Jade), 8 Hullen (8 and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

Table 1.1: Number of Oystercatcher and Common Tern eggs sampled per site in 2017

	Species	
Site	Oystercatcher	Common Tern
Balgzand	10	0
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 2017 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.

HEAVY METALS:

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).

Statistics:

For analyzing temporal trends for the years 2013 – 2017, Spearman rank correlations were calculated (two-tailed) for the years 2013 - 2017. To identify potential differences in pollutant concentrations between 2016 and 2017, 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 2017

This year there were unfortunately no nests of Common Terns at the breedingsite near Balgzand at all. So we could not get any eggs from this place and had only eight different locations in the Wadden Sea to compare for Common Terns. We identified in 2017 the following areas with relatively high contamination for this species. 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, Griend, Trischen
HCB:	Elbe, Baltrum, Trischen
DDT:	Elbe, Trischen, Baltrum
HCH:	Trischen, Elbe, Griend,
Chlordane:	Schiermonnikoog, Delfzijl, 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 (Jade, Dollart/Baltrum). In general in 2017 the differences between the two species were again more distinct and similar to the years before, except for the year 2014, when the specific differences between the species were not so clear.

In the following areas relatively high contaminations in 2017 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, Jade
PCB:	Elbe, Dollart, Balgzand
HCB:	Delfzijl, Elbe, Dollart
DDT:	Elbe, Dollart, Trischen
HCH:	Trischen, Elbe, Griend
Chlordane:	Balgzand, Dollart, Julianapolder

In the **Oystercatcher**, the geographical pattern of **Hg** concentrations in 2017 was largely similar to those of the years before (see last reports): **Hg** peaked in the area north of the river Elbe (Trischen, Halligen) and also concentrations at Griend and Jade reached maximum values this year. 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 200 ng/g **Hg** in Oystercatcher eggs from the Wadden Sea. In 2017 the average measured Hg concentration in Oystercatcher eggs from the different investigated areas was 193,9 +/- 103,8 ng/g wet weight (range: 14,7 – 556,2 ng/g) and therefore higher compared to 2016 (average: 188,1 +/- 89,7 ng/g wet weight; range: 38,9 - 699,6 ng/g) and 2015 (average: 171,2 +/- 81,9 ng/g; range: 28,3 – 418,6 ng/g) but in the same dimension.

In 2017 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 equalize at the different locations of the Wadden Sea. In 2017 the average PCB level was 460,2 +/- 227,3 ng wet weight (range: 154,8 – 1.309,8 ng/g) and therefore lower compared to 2016 (average: 578,7 +/- 238,4 ng/g wet weight, range: 159,3 – 1.330,0 ng/g) and also compared to 2015 (average: 560,6 +/- 242,5 ng/g; range: 203,9 – 1.205,0 ng/g).

As in the years before in 2017 the clearly highest concentrations of **HCB** in oystercatcher eggs were measured at Delfzijl. But the values there were again higher than in the year before, after decreasing values in 2015 and 2016. Concentrations at Delfzijl reached in 2017 in average three to six times higher levels compared to levels in Oystercatcher eggs from other areas. But the highest measured amounts of HCB in Common Terns eggs from the river Elbe reached a similar level as these in Oystercatcher eggs at Delfzijl. Two further, but much smaller peaks were recorded in Oystercatcher eggs from the river Elbe, from the Dollart and from Trischen. In 2017 the average HCB level was 3,4 +/- 4,4 ng/g wet weight (range: 0,7 – 26,5 ng/g) and so in the same amount as the levels of 2016 (3,5 +/- 3,0 ng/g wet weight, range: 0,7 – 15,1 ng/g) and 2015 (3,8 +/- 5,2 ng/g wet weight; range: 0,8 – 41,4 ng/g).

For **DDT** the highest concentrations in 2017 were found in Oystercatcher eggs from the river Elbe, from the Dollart and from Trischen. So the geographical pattern is very similar to 2016, with showed also the highest amounts of DDT in the region of the river Elbe. The very high DDT concentrations measured in 2016 in some eggs from Trischen, where values reached up to twenty-two times higher levels than elsewhere, did not occur again, so the average DDT level (27,4 +/- 16,5 ng/g wet weight) and also the variance (range: 6,6 – 78,8 ng/g) was much lower in 2017 compared to 2016 (52,6 +/- 112,8 ng/g wet weight, range: 10,5 – 935,7 ng/g).

In 2017, the geographical pattern and levels of **HCH** was likely similar to those from 2016 with peaks at Trischen, Elbe and Griend as well as HCH levels with an average of 2,3 +/- 3,3 ng/g wet weight and a range from 0,0 – 14,4 ng/g (2016 average: 2,3 +/- 3,3 ng/g wet weight, range: 0,0 – 16,1 ng/g).

For **Chlordanes** high values have been detected in all Oystercatcher eggs from western areas with peaks at Balgzand, Julianapolder and Dollart. In general, levels of Chlordanes were clearly higher in Oystercatcher eggs compared to those from Common Tern eggs. The average Chlordane level in 2017 in Oystercatcher eggs was 1,1 +/- 0,6 ng/g wet weight (range: 0,2 – 2,5 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 2017. 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 2017 the **Hg** concentrations in the Common Tern eggs showed rather equal levels, with peaks at Griend and Elbe as in the year before. The average level of all areas was 310,2 +/- 98,6 ng/g (rang: 150,0 - 685,2 ng/g) and reached a higher value than 2016 (average: 295,1 +/- 105,8 ng/g fresh weight, range 138,1 – 643,3 ng/g).

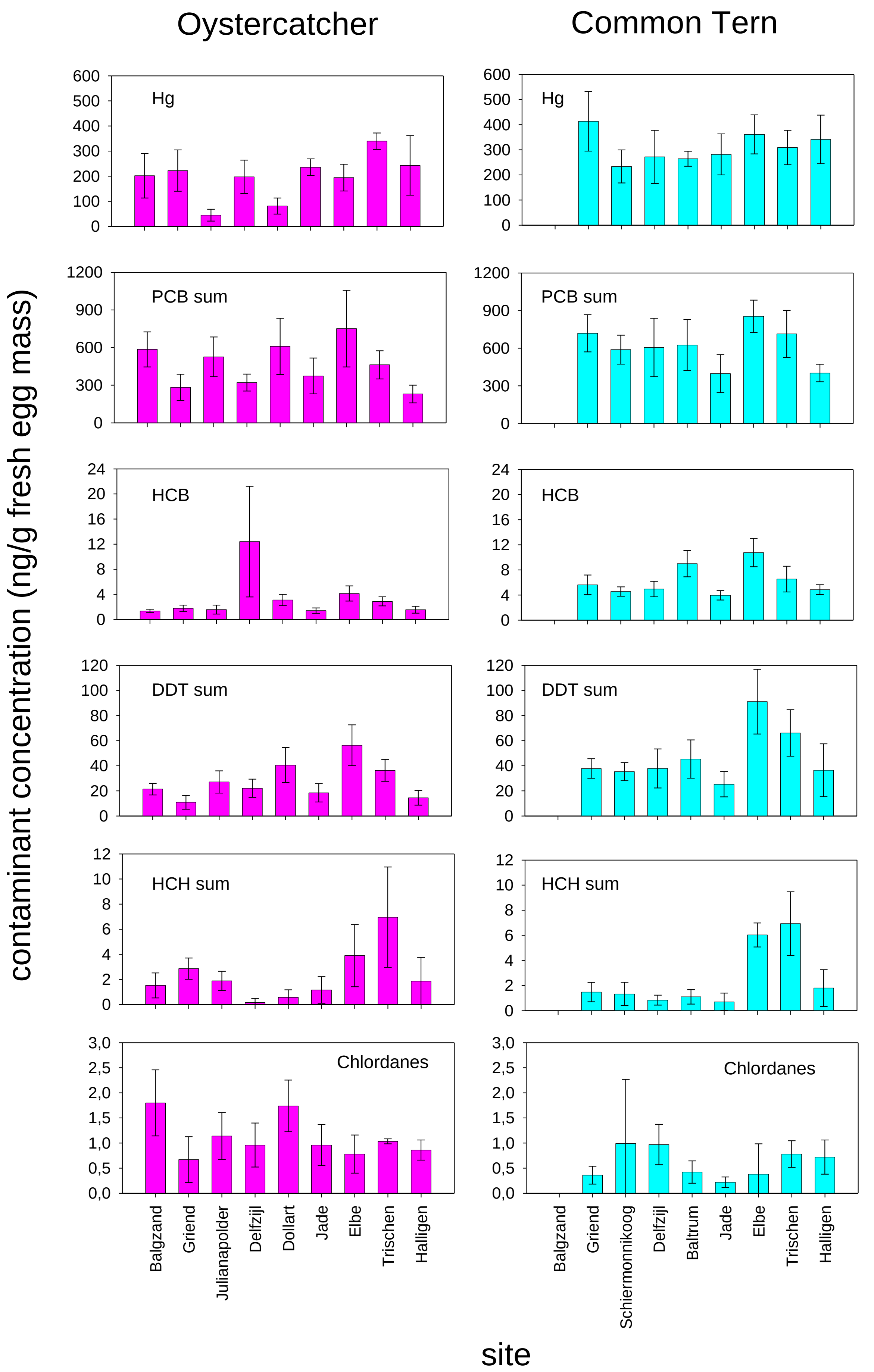

Fig. 5.1.1: Spatial patterns of pollutant concentrations in Oystercatcher and Common Tern eggs from the Wadden Sea in 2017 (means with standard deviations)

For **PCB** we see in 2017 again at all areas rather similar concentrations in Common Tern eggs with an average level of 613,1 +/- 213,7 ng/g wet weight (range: 274,1 – 2.173,3 ng/g). So levels were clearly beyond these from 2016 (average: 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 Griend, but the highest single PCB value was detected in one Common Tern egg from Baltrum.

In 2017 the **HCB** concentrations in Common Tern eggs had an average level of 6,2 +/- 2,7 ng/g fresh weight (range: 2,8 – 15,5 ng/g) and the same amount as 2016 (average: 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 in these areas. In Common Terns maximum HCB levels were measured in eggs from the Elbe (10,8 +/- 2,3 ng/g wet weight, range 6,8 – 15,5 ng/g) with the same amount as maximum HCB levels in Oystercatcher eggs from Delfzijl (12,4 +/- 8,8 ng/g wet weight, range 2,5 – 26,5 ng/g).

In 2017, **DDT** concentrations were in Common Tern eggs rather similar showing an average level of 46,9 +/- 25,6 ng/g wet weight (range: 16,3 – 130,5 ng/g) and a clear peak at the river Elbe. Levels were beyond these of 2016 (average: 58,6 +/- 43,8 ng/g wet weight, range: 17,9 – 231,4 ng/g).

The measured **HCH** levels in Common Tern eggs in 2017 ranged between 0,0 and 12,4 ng/g wet weight with an average of 2,6 +/- 2,63 ng/g and a clear peak at Trischen, Elbe and the surrounding areas, as well as an extra peak at Griend. Levels were clearly higher compared to the year before (2016 average: 1,3 +/- 1,2 wet weight, range: 0,0 – 5,3 ng/g).

Concentrations of **Chlordanes** recorded in 2017 in Common Tern eggs were rather low in all areas and very similar with an average of 0,6 +/- 0,6 ng/g wet weight (range 0,0 – 4,4) but nearly twice as high than in the year before (average 0,3 +/- 0,3 ng/g wet weight).

5.2 Annual variation in pollutant concentration in the period 2013-2017

Mean contamination values for the different substance groups in the period 2013-2017 are given in Figures 8.2.1-8.2.6 in the Appendix. A summarizing overview of short-term (2016-2017) and mid-term (2013-2017) temporal changes in the Dutch and German Wadden Sea are given in Tables 5.2.1 and 5.2.2. An overview of the long-term changes in the levels of the different contaminants in both bird species is given in the new QSR Report of the Wadden Sea (Mattig 2017).

Balgzand

Temporal Trends 2013-2017:

Oystercatcher	Significant **decrease** was detected in HCB and HCH whereas levels of PCB **increased**.
Common Tern	Significant **decrease** occurred in HCB, DDT and HCH (only 2013 to 2016).

In Oystercatcher eggs sampled in 2017 the concentrations of all measured chemicals **did not change** significantly compared to 2016. In 2017 no Common Tern eggs could be sampled, so no comparisons to 2016 could be drawn.

Table 5.2.1: Overview over the development of selected pollutants in eggs of Oystercatcher and Common Tern in the Wadden Sea from 2013-2017, 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 2016-2017, 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		-											+				+	+

<u>Griend</u>

<u>*Temporal Trends* 2013-2017*:*</u>

Oystercatcher — Significant **decrease** was detected in HCB.
Common Tern — Significant **decrease** was identified in levels of HCB whereas levels of Hg **increased**.

Between 2016 and 2017 PCB, HCB, DDT, HCH and Chlordane concentrations **decreased** significantly in Oystercatcher eggs whereas in Common Tern eggs levels of HCB and DDT **increased** in that period.

<u>Julianapolder/Schiermonnikoog</u>

<u>Temporal Trends</u> <u>2013-2017</u>*<u>:</u>*

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

In Oystercatcher eggs from 2017 sampled at Julianapolder, the concentrations of HCH **increased** significantly compared to 2016 whereas levels of Hg **decreased**. In Common Tern eggs from 2017 sampled at Schiermonnikoog HCH levels were significantly **higher** compared to 2016.

<u>Delfzijl</u>

<u>Temporal Trends</u> <u>2013-2017</u>*<u>:</u>*

Oystercatcher	The concentration of PCB, HCB, DDT, HCH and Chlordanes **decreased** significantly whereas concentrations of Hg **increased**.
Common Tern	In the period between 2013 and 2017 significant **decreases** in the concentrations of Hg, HCB and DDT occurred.

Between 2016 and 2017 concentrations of DDT and HCH in Oystercatcher eggs **decreased** significantly. In Common Tern eggs the concentration of DDT was 2016 significantly **lower** compared to the year before whereas concentrations of Chlordanes were **higher**.

6. General Assessment

6.1 Spatial Trends

The concentrations of the mentioned substances in **Oystercatcher** eggs showed in 2017 again only small geographical differences. The conspicuous HCB peak at Delfzijl which vanished in 2016 for the first time since many years occurred again in 2017. Concentrations reached there eight times higher values compared to HCB concentrations in oystercatcher eggs from other sites. Highest levels of PCB and DDT were detected at the River Elbe whereas HCH reached highest levels at Trischen. Compared to 2016 the measured concentrations in Oystercatcher eggs were higher in case of Hg, but tended to be lower in case of PCB and DDT whereas HCB and HCH concentrations were rather similar.

In the **Common Tern**, clearly prominent concentration peaks of PCB, DDT, HCB and HCH were found 2017 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 2017 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 higher compared to 2016 and reached a level of ca. 310 ng/g wet weight. Also the HCH and Chlordane concentrations reached higher levels in 2017.
The HCB concentrations showed in 2017 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 was ca. 6 ng/g fresh weight, which was rather similar compared to 2016. In case of PCB and DDT the concentrations in Common Tern eggs tended to be lower in 2017 than in 2016.

In general, the species-specific spatial contamination patterns in 2017 remained similar to those recorded in 2016 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 and 2016 were clearly lower compared to the previous years, but HCB concentrations reached 2017 again higher levels at Delfzijl.

In the past the main 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 2017 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 2017 higher, and 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 2013-2017** much more decreasing than increasing contamination levels of the measured substances at the different study sites could be seen, there was no clear picture of the resulting temporal trends in some cases, and so the results were sometimes not easy to interpret. For example, at some study sites Hg concentrations increased significantly in eggs of both species, whereas Hg concentrations at other sites significantly decreased in the same period.

In **Oystercatcher** eggs increasing concentrations were detected in case of Hg at three of the nine sampled sites as well as decreasing concentrations at one site. In case of PCB decreasing concentrations occurred at five sites and increasing ones at one. Remarkable were the HCB concentrations, which decreased at all studied sites significantly in the years between 2013 and 2017. In case of HCH decreases were seen at five of the nine sampled sites, and in case of DDT and Chlordane at six sites, respectively. In total we saw only four increases in Oystercatcher eggs in the five years, but 32 decreases and most of them were detected at Delfzijl and Dollart, as well as on

Trischen and Halligen (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 2013-2017 too. We see a decrease of HCB concentrations at eight of nine study sites. In case of DDT decreasing concentrations occurred at seven of nine sampled sites as well as in case of PCB and Hg at three each. HCH and Chlordane concentration decreased each at one of nine study sites whereas HCH and Hg concentrations increased at one, respectively. In total we found 23 significant decreased substance levels in Common Tern eggs in the five-year-period, and most of them were detected at Trischen (four sites) as well as at Delfzijl, Balgzand and Halligen (three each). The only two increases we found were the above mentioned Hg concentrations in the Common Tern eggs from Griend and HCH concentrations in eggs from Trieschen.

When **comparing the year 2017 with 2016** we recorded more contamination decreases (14) than increases (2) 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. All increases were related to the HCH concentrations and occurred at Julianapolder as well as at Trischen. Remarkable were the TEQs in the Oystercatcher eggs, which increased rather uniformly at all of the nine investigated sites between 2016 and 2017 as well as the DDT concentrations which decreased at five, respectively. Most decreases occurred at Griend, where all measured substances except the Hg concentrations decreases between the two years.

Because of lacking breeding success in **Common Terns** at Balgzand in 2017 there were only eight sites to compare for this species between the last two years. Nevertheless clearly more contamination increases (11) than decreases (6) were detected (Tab. 5.2.2.): In contrast to the situation in the Oystercatcher HCH concentrations increased rather consistently at four of the eight study sites in Common Tern eggs as well as the Chlordane concentrations at three. Similar to the Oystercatcher the TEQs increased rather uniformly at all of the investigated sites between 2016 and 2017. Decreases occurred in the DDT concentrations at three sites, but DDT concentrations increased also at one site. Most chemical groups increased at Baltrum (three) as well as at Griend and Trischen (two each) whereas most decreases were found at Jade (three) and Elbe (two) between 2016 and 2017.

6.3 Summarized Assessment

Summarizing, the results from 2017 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 is the high HCH burden in Oystercatcher eggs from Trischen, Elbe and Griend as well as the general very high amount of Chlordane.
The outstanding and particularly high concentrations of HCB in Oystercatcher eggs from Delfzijl were in 2017 again clearly visible.
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 2017 with the previous one, both species showed a higher 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 a bit higher in 2017 compared to 2016, but 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 2017 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 2017 at all investigated areas, whereas the HCH limit values (2 ng/g) only exceeded at the Elbe and Trischen. For the Oystercatcher eggs the limit values of HCH (2 ng/g) were undercut at all investigated sites except at Trischen, Elbe and Griend. Limit values of Hg (100 ng/g) were undercut only at two places (Julianapolder and Dollart) as well as in case of HCB (2 ng/g) at four sites. However, 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 2017

Table 8.1.1: Concentrations of chemicals in Oystercatcher and Common Tern eggs sampled in The Netherlands in 2017. 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	202,0 ± 89,1	222,4 ± 82,4	44,7 ± 23,5	197,4 ± 66,8
6 PCB (law)	252,7 ± 68,6	106,1 ± 50,3	221,2 ± 73,1	124,3 ± 31,9
PCB sum	585,6 ± 139,9	282,8 ± 104,4	525,7 ± 158,6	321,0 ± 67,5
HCB	1,4 ± 0,3	1,8 ± 0,5	1,6 ± 0,7	12,4 ± 8,8
ppDDE	19,1 ± 4,0	8,8 ± 4,5	22,4 ± 7,7	17,1 ± 6,2
ppDDT	0,4 ± 0,8	0,4 ± 1,2	2,9 ± 1,7	3,1 ± 1,4
ppDDD	1,9 ± 0,1	1,7 ± 0,1	1,8 ± 0,0	1,9 ± 0,1
DDT sum	21,4 ± 4,6	10,9 ± 5,5	27,1 ± 8,8	22,1 ± 7,2
alpha-HCH	0,0 ± 0,0	0,0 ± 0,0	0,0 ± 0,0	0,0 ± 0,0
beta-HCH	1,5 ± 1,0	2,7 ± 1,0	1,1 ± 0,6	0,2 ± 0,3
gamma-HCH	0,1 ± 0,2	0,2 ± 0,5	0,7 ± 0,7	0,0 ± 0,0
HCH sum	1,5 ± 1,0	2,9 ± 0,8	1,9 ± 0,8	0,2 ± 0,3
Chlordane sum	1,8 ± 0,7	0,7 ± 0,5	1,1 ± 0,5	1,0 ± 0,4

	Balgzand	Griend	Schiermonnikoog	Delfzijl
Common Tern	**(N=0)**	**(N=10)**	**(N=10)**	**(N=10)**
Hg	- ± -	413,7 ± 118,7	233,5 ± 65,8	271,8 ± 105,9
6 PCB (law)	- ± -	303,0 ± 71,7	238,5 ± 63,0	246,2 ± 100,8
PCB sum	- ± -	719,0 ± 148,3	588,6 ± 115,1	605,5 ± 233,4
HCB	- ± -	5,6 ± 1,6	4,6 ± 0,7	5,0 ± 1,2
ppDDE	- ± -	35,4 ± 7,7	32,3 ± 7,0	35,0 ± 14,2
ppDDT	- ± -	0,4 ± 1,2	0,8 ± 1,6	0,6 ± 1,3
ppDDD	- ± -	2,0 ± 0,2	2,2 ± 0,6	2,2 ± 0,7
DDT sum	- ± -	37,8 ± 7,7	35,3 ± 7,2	37,8 ± 15,6
alpha-HCH	- ± -	0,0 ± 0,0	0,1 ± 0,2	0,0 ± 0,0
beta-HCH	- ± -	1,0 ± 0,2	0,9 ± 0,2	0,8 ± 0,3
gamma-HCH	- ± -	0,4 ± 0,8	0,4 ± 0,7	0,1 ± 0,3
HCH sum	- ± -	1,5 ± 0,8	1,3 ± 0,9	0,8 ± 0,4
Chlordane sum	- ± -	0,4 ± 0,2	1,0 ± 1,3	1,0 ± 0,4

8.2 Temporal trends of pollutant concentrations at different sites during 2013-2017

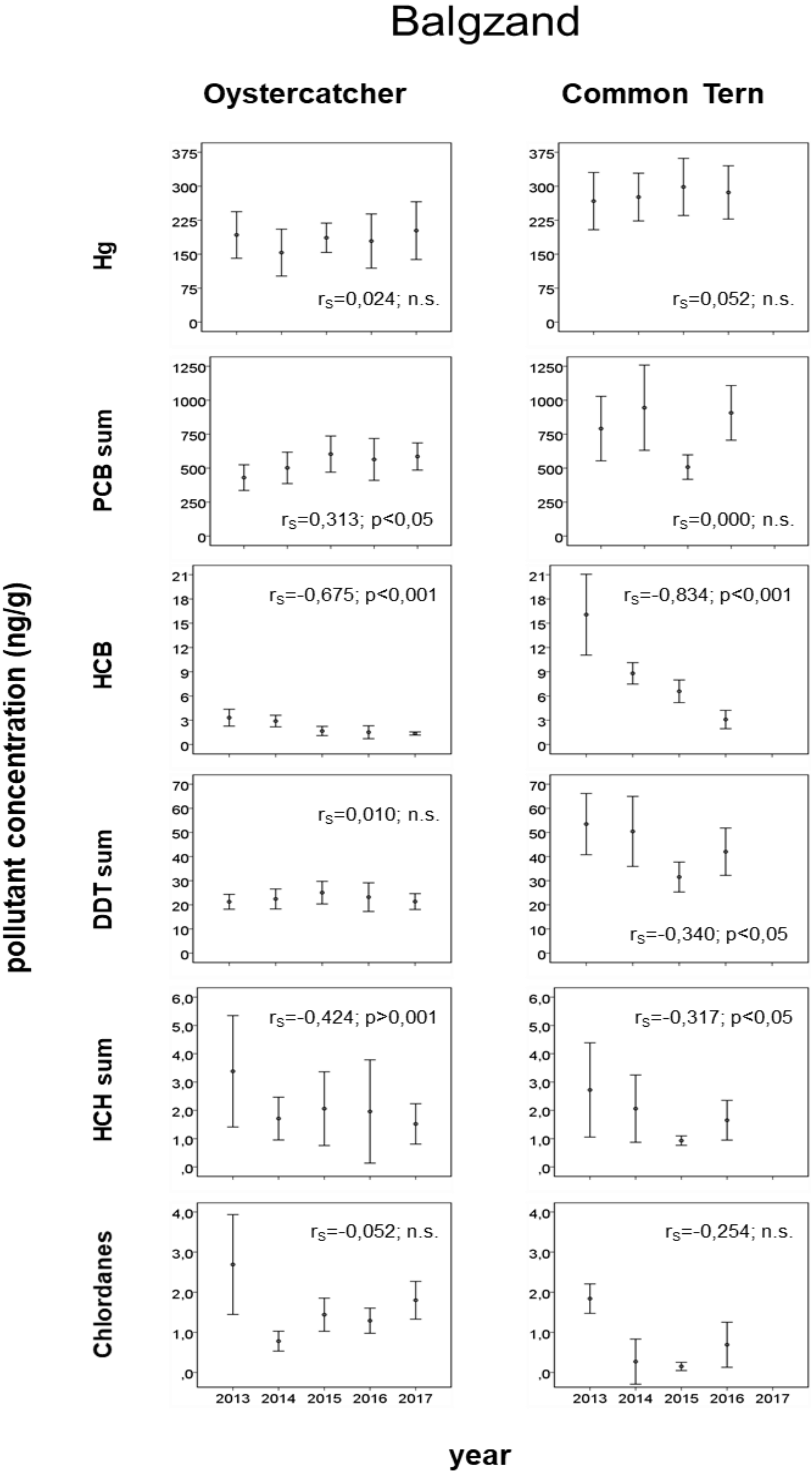

Fig. 8.2.1: Temporal development of pollutant concentrations in Oystercatcher and Common Tern eggs from Balgzand, NL, in the period 2013-2017. Arithmetic means are given with the 95% confidence interval.

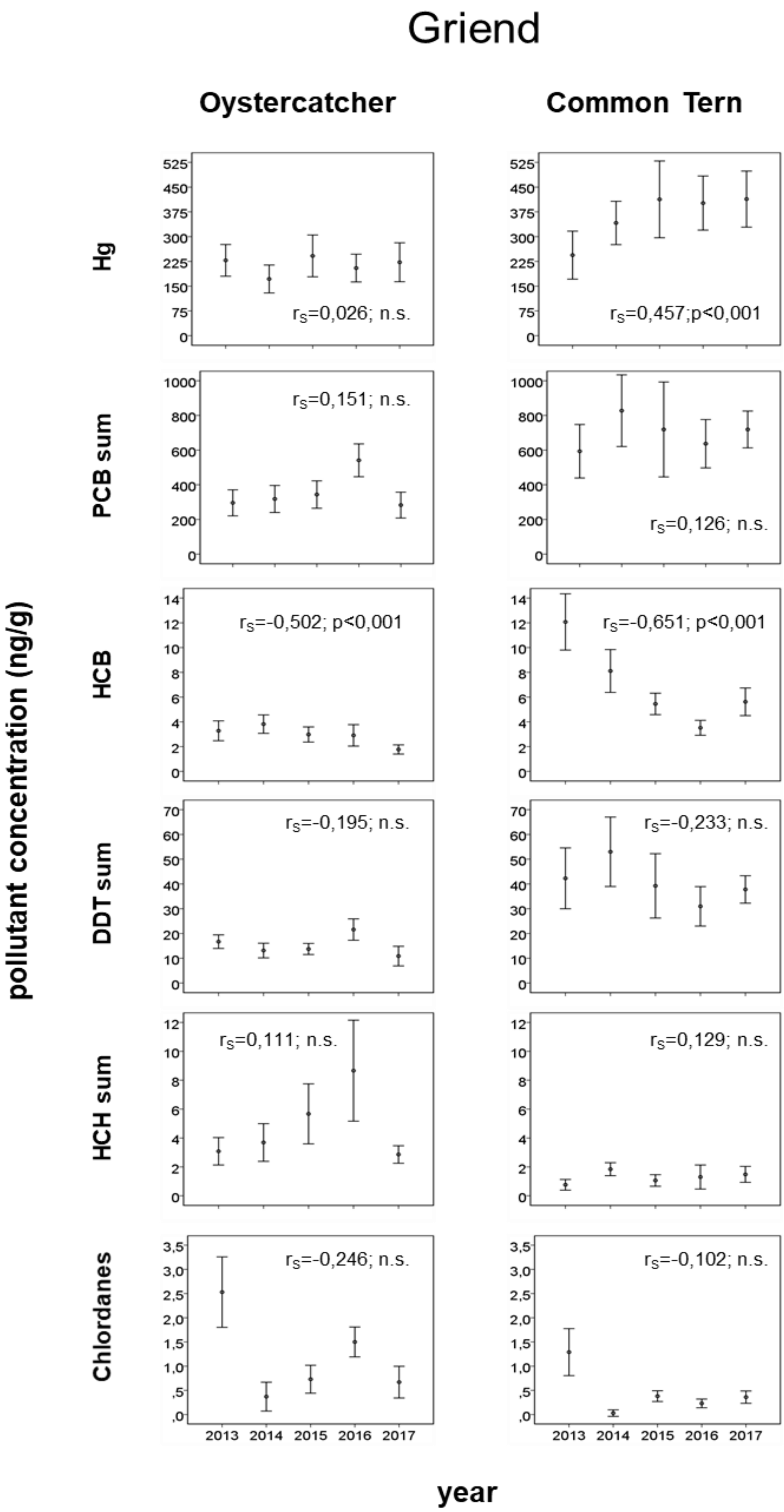

Fig. 8.2.2: Temporal development of pollutant concentrations in Oystercatcher and Common Tern eggs from Griend, NL, in the period 2013-2017. Arithmetic means are given with the 95% confidence interval.

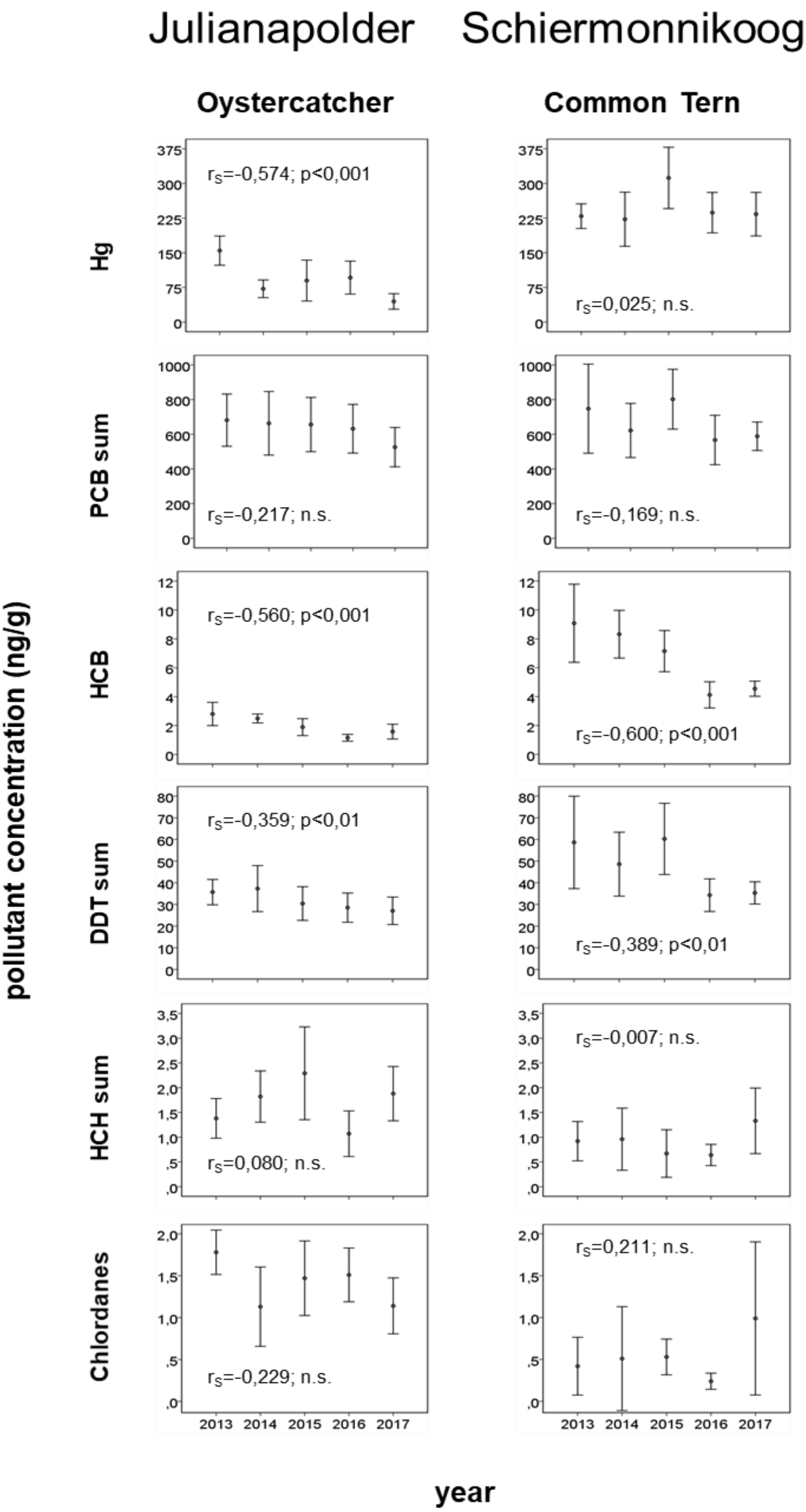

Fig. 8.2.3: Temporal development of pollutant concentrations in Oystercatcher eggs from Julianapolder and in Common Tern eggs from Schiermonnikoog, NL, in the period 2013-2017. Arithmetic means are given with the 95% confidence interval.

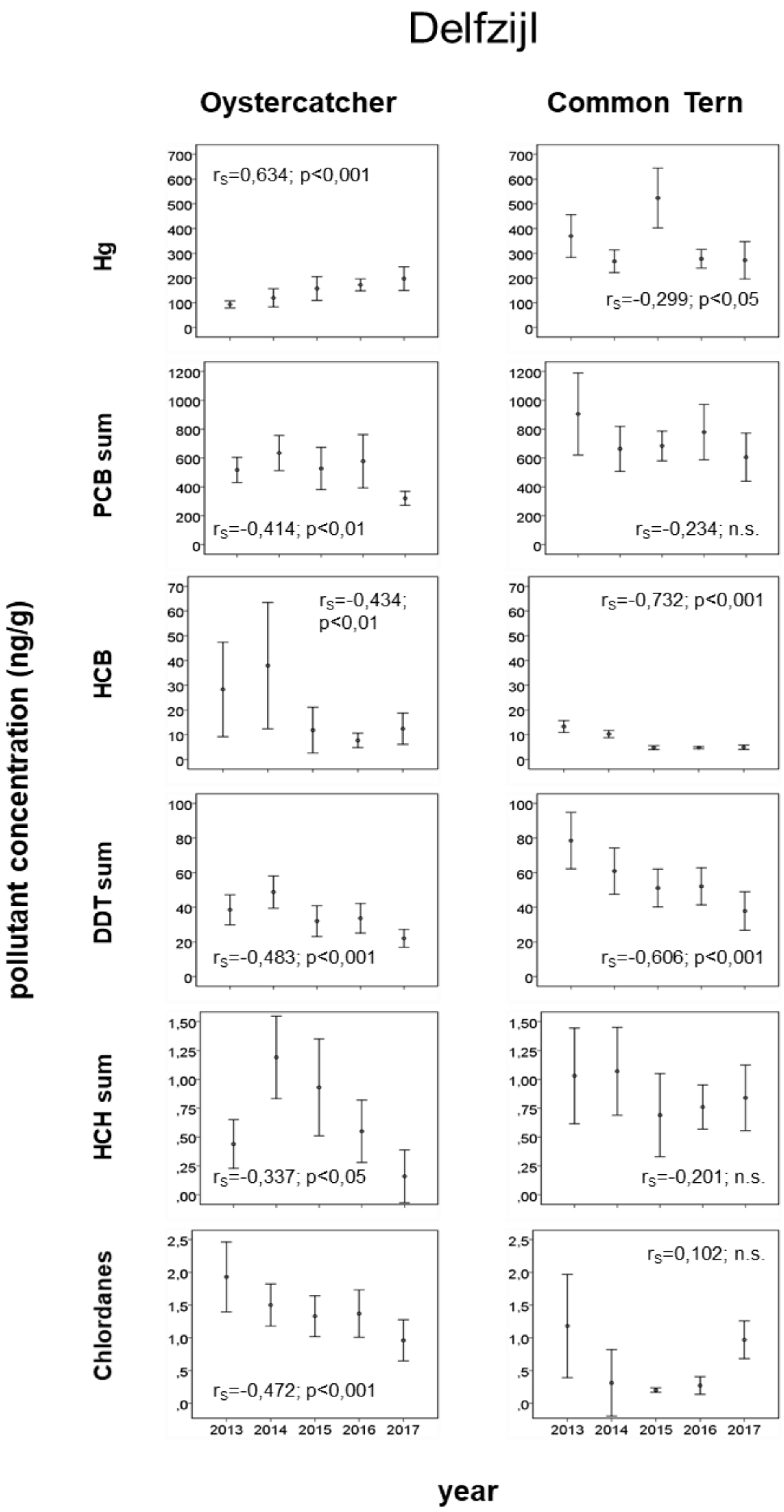

Fig. 8.2.4: Temporal development of pollutant concentrations in Oystercatcher and Common Tern eggs from Delfzijl, NL, in the period 2013-2017. Arithmetic means are given with the 95% confidence interval.