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Documentation of the TMAP Parameter "Pollutants in seabird eggs" in The Netherlands in 2018

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).

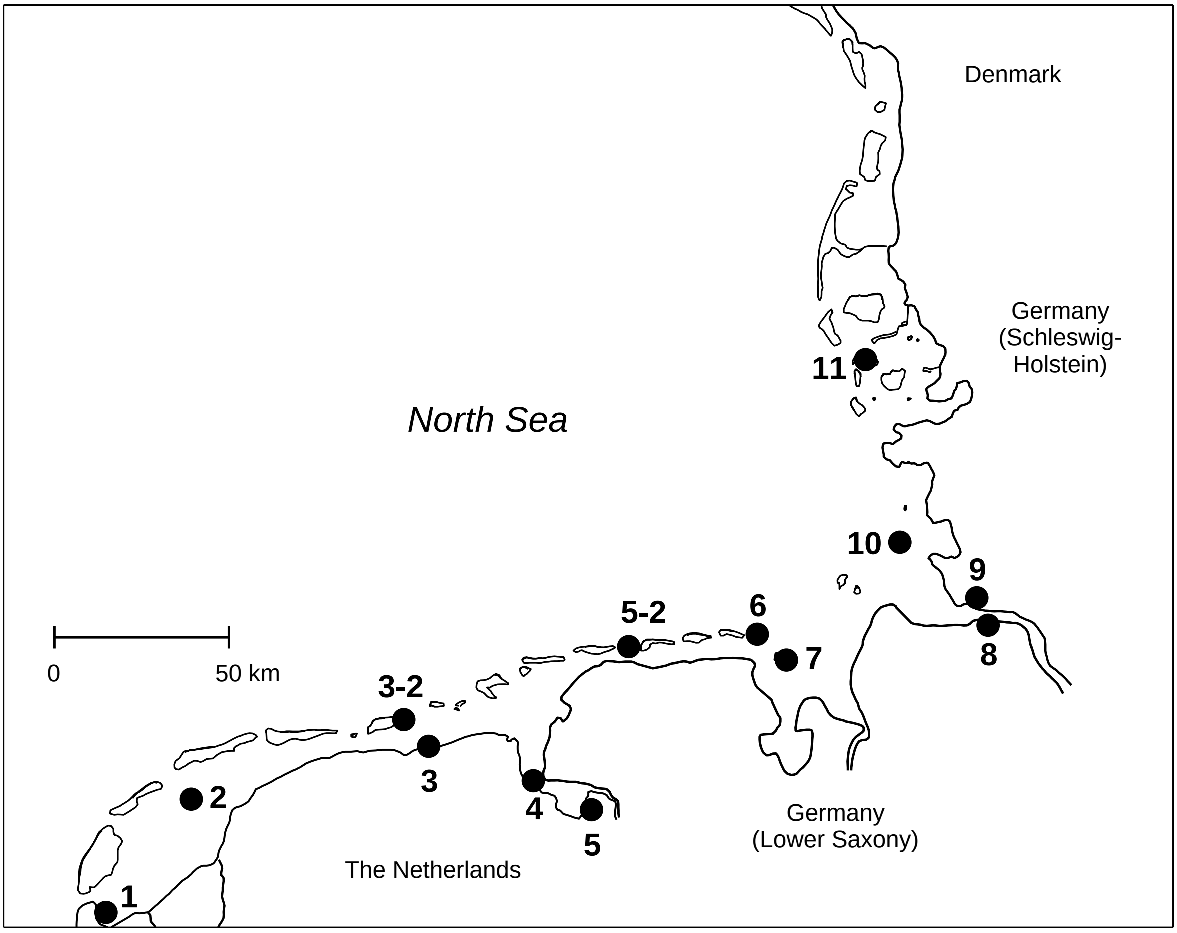

Fig. 1.1: Sampling sites of Oystercatcher and/or Common Tern eggs in the trilateral Wadden Sea.
The Netherlands: 1 Balgzand, 2 Griend, 3 Julianapolder, 3-2 Schiermonnikoog, 4 Delfzijl;
Germany, Lower Saxony: 5 Dollart, 5-2 Baltrum, 6 Minsener Oog (Oldeoog), 7 Mellum (6 and 7 = Jade), 8 Hullen (8 and 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 2018

	Species	
Site	Oystercatcher	Common Tern
Balgzand	10	10
Griend	10	10
Julianapolder	10	-
Schiermonnikoog	-	0
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 2018 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).

Statistics:

For analyzing temporal trends for the years 2014 – 2018, Spearman rank correlations were calculated (two-tailed) for the years 2014 - 2018. To identify potential differences in pollutant concentrations between 2017 and 2018, 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 2018

This year there were unfortunately no eggs of Common Terns at the breedingsite near Shirmonnikoog at all. Due to spring-tide the nests there were flushed away. 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. In 2018 we identified 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:	Trischen, Halligen, Balgzand
PCB:	Trischen, Baltrum, Delfzijl
HCB:	Baltrum, Jade, Halligen
DDT:	Neufelderkoog, Trischen, Delfzijl
HCH:	Neufelderkoog, Jade, Balgzand
Chlordane:	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 (Elbe). In general in 2018 the differences between the two species were not so distinct and similar to the year 2014, when the specific differences between the species were not so clear either.

This year there were unfortunately not enough nests of Oystercatcher at the breedingsite Dollart to collect eggs there. So we had only eight different locations in the Wadden Sea to compare for Ostercatcher at all. In the following areas relatively high contaminations in 2018 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, Griend, Halligen
PCB:	Elbe, Trischen, Delfzijl
HCB:	Delfzijl, Elbe, Trischen
DDT:	Elbe, Trischen, Delfzijl
HCH:	Halligen, Balgzand, Griend
Chlordane:	Delfzijl, Balgzand, Trischen

In the **Oystercatcher**, the geographical pattern of **Hg** concentrations in 2018 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 reached maximum values this year. Again we see the same trend as in 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 in the Wadden Sea of 200 ng/g **Hg**. In 2018 the average measured Hg concentration in Oystercatcher eggs from all different investigated areas was 206,8 +/- 85,6 ng/g wet weight (range: 28,3 – 429,8 ng/g) and therefore higher compared to 2017 (average: 193,9 +/- 103,8 ng/g wet weight; range: 14,7 – 556,2 ng/g), 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). The data were in the same dimension, but there was a steady increase in the Hg concentrations.

In 2018 a prominent concentration peak of **PCB** was recognized at the river Elbe, as in the years before. The 2017 detected second peak in Oystercatcher eggs from the Dollart could 2018 not be verified, because of the poor breeding success there. As in the years before also in 2018 the PCB concentrations tended to equalize at the different locations of the Wadden Sea. In 2018 the average PCB level was 525,1 +/- 273,2 ng wet weight (range: 129,3 – 1.683,9 ng/g) and therefore higher compared to 2017 with an average PCB level of 460,2 +/- 227,3 ng wet weight (range: 154,8 – 1.309,8 ng/g) but 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 2018 the clearly highest concentrations of **HCB** in Oystercatcher eggs were measured at Delfzijl. But the values there were lower compared to 2017. On average the concentrations at Delfzijl reached only up to three times higher levels compared to other areas and even levels in Oystercatcher eggs from the Elbe reached the same amounts of HCB as at Delfzijl. In 2018 the average HCB level in the whole Wadden Sea in Oystercatcher eggs was 4,1 +/- 2,4 ng/g wet weight (range: 1,2 – 14,9 ng/g) and so clearly higher compared to 2017 (average: 3,4 +/- 4,4 ng/g wet weight; range: 0,7 – 26,5 ng/g), 2016 (average: 3,5 +/- 3,0 ng/g wet weight; range: 0,7 – 15,1 ng/g) and 2015 (average: 3,8 +/- 5,2 ng/g wet weight; range: 0,8 – 41,4 ng/g).

For **DDT** the highest concentrations in 2018 were found in Oystercatcher eggs from the river Elbe and from Trischen. So the geographical pattern is very similar to 2017, which showed also the highest amounts of DDT in the region of the river Elbe. The average DDT levels in 2018 of 32,1 +/- 21,9 ng/g wet weight (range: 7,1 – 91,2 ng/g) was much higher compared to 2017 (average: 27,4 +/- 16,5 ng/g wet weight; range: 6,6 – 78,8 ng/g), but lower compared to 2016 (52,6 +/- 112,8 ng/g wet weight, range: 10,5 – 935,7 ng/g).

In 2018 the **HCH** concentrations showed no clear geographical pattern in oystercatcher eggs, and the levels were rather similar at all locations, except for two eggs from Balgzand. In these, β-HCH levels reached 12 resp. 25 times higher values than in the remaining eggs there. In 2018 average levels reached higher values (2018 average: 3,2 +/- 3,7 ng/g wet weight, range: 0,0 – 25,1 ng/g) compared to 2017 (average: 2,3 +/- 3,3 ng/g wet weight; range: 0,0 – 14,4 ng/g) and 2016 (average: 2,3 +/- 3,3 ng/g wet weight, range: 0,0 – 16,1 ng/g).

For **Chlordanes** high values in 2018 have been detected in Oystercatcher eggs from western areas. In general, levels of Chlordanes were clearly higher in Oystercatcher eggs compared to those from Common Tern eggs. But the average Chlordane levels in 2018 in Oystercatcher eggs were only 0,2 +/- 0,3 ng/g wet weight (range: 0,0 – 1,1 ng/g) and clearly lower compared to 2017 (average: 1,1 +/- 0,6 ng/g wet weight; range: 0,2 – 2,5 ng/g).

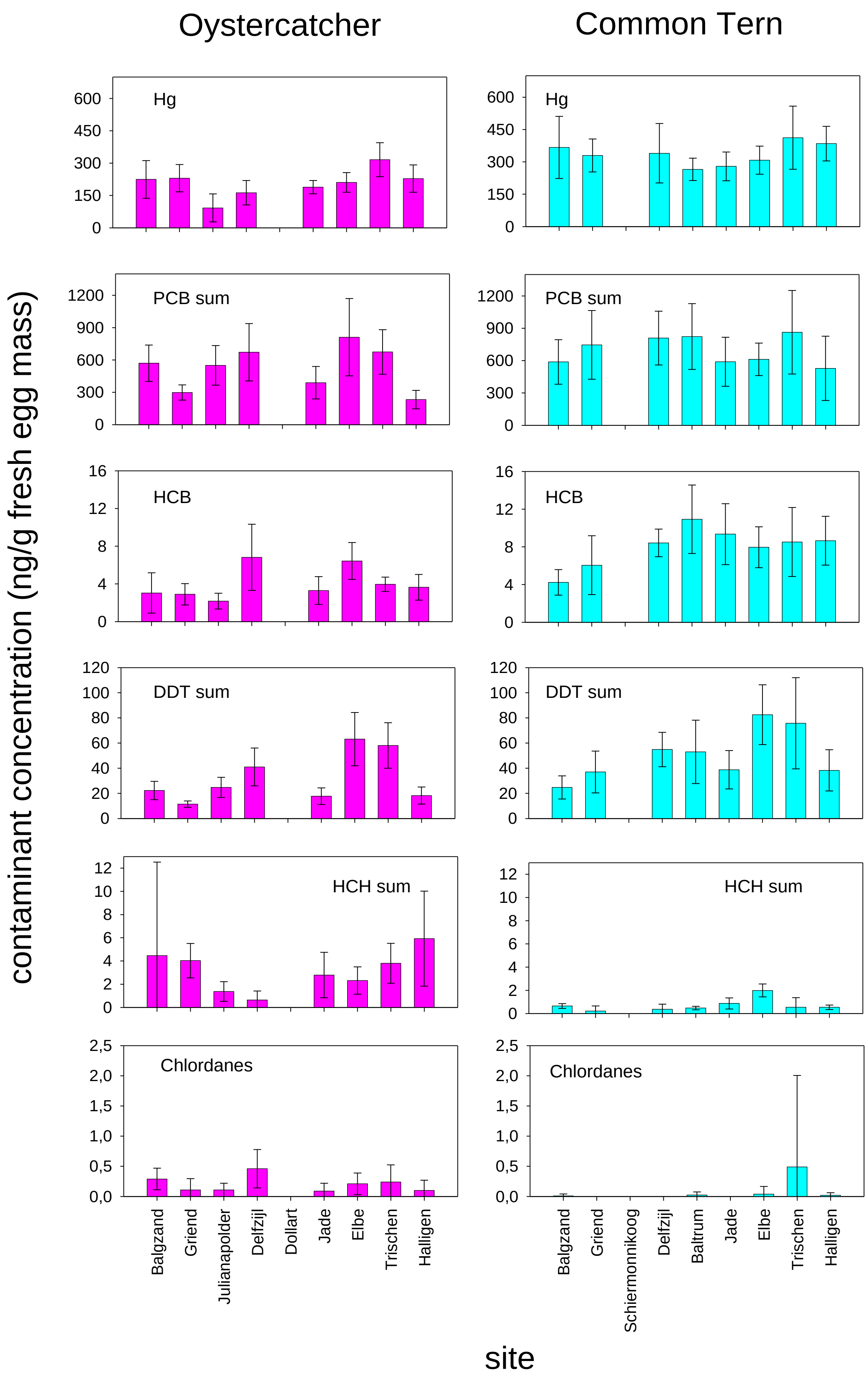

Fig. 5.1.1: Spatial patterns of pollutant concentrations in Oystercatcher and Common Tern eggs from the Wadden Sea in 2018 (means with standard deviations)

Unfortunately we didn’t manage to collect eggs of Common Terns at Schiermonnikoog. Due to spring-tide the eggs there were flushed away. So for analysing the geographical pattern only eight locations were available.
In 2018 again, the main contamination area of **Hg**, **PCB**, **DDT** and **HCH** in **Common Tern eggs** was clearly located in the surrounding of the river Elbe with a second lower peak at Baltrum. In general, the contamination patterns were rather 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, but the distinctions were not so clear in 2018.

In 2018 the **Hg** concentrations in the Common Tern eggs showed rather equal levels, with peaks at Trischen and Halligen. The average level in 2018 of all areas was 341,5 +/- 110,9 ng/g wet weight; rang: 171,8 - 644,4 ng/g) and reached clearly higher values than in 2017 (average: 310,2 +/- 98,6 ng/g wet weight; rang: 150,0 - 685,2 ng/g) or in 2016 (average: 295,1 +/- 105,8 ng/g wet weight, range 138,1 – 643,3 ng/g).

For **PCB** we see in 2018 again at all areas rather similar concentrations in Common Tern eggs with an average level of 684,7 +/- 287,4 ng/g wet weight (range: 231,1 – 1.404,6 ng/g). So levels were higher than 2017 (average: 613,1 +/- 213,7 ng/g wet weight; range: 274,1 – 2.173,3 ng/g) but 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 Baltrum.

In 2018 the **HCB** concentrations in Common Tern eggs had an average level of 7,8 +/- 3,1 ng/g fresh weight (range: 2,5 – 14,9 ng/g) and were higher than values in 2017 (average: 6,2 +/- 2,7 ng/g fresh weight; range: 2,8 – 15,5 ng/g) and 2016 (average: 5,9 +/- 3,9 ng/g fresh weight, range: 0,6 – 21,5 ng/g). In 2018 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 island of Baltrum.

In 2018, **DDT** concentrations in Common Tern were eggs in a rather similar range, showing an average level of 50,4 +/- 27,8 ng/g wet weight (range: 10,5 – 120,9 ng/g) and a clear peak at the river Elbe and Trischen. Average levels were above these of 2017 (average: 46,9 +/- 25,6 ng/g wet weight; range: 16,3 – 130,5 ng/g) but 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 2018 ranged between 0,00 and 2,8 ng/g wet weight with an average of 0,73 +/- 0,71 ng/g and a peak at the Elbe. Levels were clearly lower compared to the years before (average 2017: 2,6 +/- 2,6 wet weight; range: 0,0 – 12,4 ng/g and average 2016: 1,3 +/- 1,2 wet weight; range: 0,0 – 5,3 ng/g).

Concentrations of **Chlordanes** recorded in 2018 in Common Tern eggs were rather low in all areas with an average of 0,08 +/- 0,56 ng/g wet weight (range 0,0 – 4,8). Values in 2018 were clearly beyond these of 2017 (average: 0,6 +/- 0,6 ng/g wet weight; range 0,0 – 4,4) or 2016 (average 0,3 +/- 0,3 ng/g wet weight; range 0,0 – 2,8).

5.2 Annual variation in pollutant concentration in the period 2014-2018

Mean contamination values for the different substance groups in the period 2014-2018 are given in Figures 8.2.1-8.2.6 in the Appendix. A summarizing overview of short-term (2017-2018) and mid-term (2014-2018) 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 2014-2018:

Oystercatcher In the period between 2014 and 2018 **no** significant **changes** in the concentration levels of all measured chemicals occurred.

Common Tern A Significant **decrease** occurred in HCB, DDT and HCH.

In Oystercatcher eggs sampled in 2018 the concentrations of HCB was significantly **higher** compared to 2017, whereas concentrations of Chlordanes were **lower**. In 2017 no Common Tern eggs could be sampled, so no comparisons to 2018 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 2014-2018, 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 2017-2018, according to Mann-Whitney-U-tests. -: significant decline, +: significant increase, /: no data available.

	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	+	-	-	-	/	-	-	-	-	/	-	/	-	-	-		-	-

Griend

Temporal Trends 2014-2018*:*

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

Between 2017 and 2018, HCB concentrations **increased** significantly in Oystercatcher eggs whereas levels of Chlordane **decreased**. In Common Tern eggs levels of HCH and Chlordanes **decreased** in that period.

Julianapolder/Schiermonnikoog

Temporal Trends 2014-2018*:*

Oystercatcher	Significant **decreases** in the concentrations of HCB were identified at Julianapolder.
Common Tern	Significant **decreases** in the concentrations of HCB and DDT were detected at Schiermonnikoog (only 2014 to 2017).

In Oystercatcher eggs from 2018 sampled at Julianapolder, the concentrations of Chlordanes **decreased** significantly compared to 2017.
In 2018 no Common Tern eggs could be sampled, so no comparisons to 2017 could be drawn.

Delfzijl

Temporal Trends 2014-2018*:*

Oystercatcher	In the period between 2014 and 2018 significant **decreases** in the concentrations of HCB, HCH and Chlordanes occurred.
Common Tern	The concentrations of HCH **decreased** significantly.

Between 2017 and 2018 concentrations of PCB, DDT and HCH in Oystercatcher eggs **increased** significantly, whereas concentrations of Chlordanes **decreased**. In Common Tern eggs the concentrations of HCB and DDT were significantly **higher** in 2017 compared to the year before whereas concentrations of HCH and Chlordanes were **lower**.

6. General Assessment

6.1 Spatial Trends

Unfortunately there were not enough nests of Oystercatcher at the breedingsite Dollart to collect eggs there. We also didn’t manage to collect eggs of Common Terns at Schiermonnikoog. Due to spring-tide the eggs there were flushed away.

In 2018 again, the concentrations of the mentioned substances in **Oystercatcher** eggs showed only small geographical differences. The conspicuous HCB peak at Delfzijl vanished nearly completely. Highest levels of PCB and DDT were detected at the River Elbe and Trischen whereas HCH reached highest levels at the Halligen. Compared to 2017 the measured concentrations in Oystercatcher eggs were higher in 2018 in case of Hg, HCB and HCH whereas concentrations of PCB, DDT and Chlordanes tended to be lower.

In the **Common Tern** concentration peaks of Hg, PCB, DDT and HCH were found in 2018 again in the Elbe estuary at the locations Elbe or Trischen, which is in accordance with the observations from previous years. But beside the river Elbe we found high Hg concentrations also in the western part of the Wadden Sea. So in 2018 high Hg concentrations were observed at Balgzand. But there was no visible clear 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 2017 and reached a level of ca. 340 ng/g wet weight. Also the HCB and HCH concentrations reached higher levels in 2018 compared to 2017. The HCB concentrations showed only small geographical differences compared to the other contaminants. In case of PCB, DDT and Chlordanes the concentrations in Common Tern eggs tended to be lower in 2018 than in 2017.

In general, the species-specific spatial contamination patterns in 2018 remained similar to those recorded in 2017 and the years before: The contamination pattern of the Common Tern again showed concentration peaks at the river Elbe, but in 2018 not as clearly as in the past. On the other hand 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, reflecting the higher trophic level of the piscivorous Common Tern with an even more effective bioaccumulation of pollutants. However, at most study sites HCH and 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 for 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 at Delfzijl. In 2018 the conspicuous HCB concentrations peak nearly vanished there.

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 2018 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 higher in 2018, 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 much more decreasing than increasing contamination levels of the measured substances could be seen at the different study sites for both species during the **five-year-period 2014-2018**, 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 in case of PCB at four sites. The HCB concentrations decreased significantly at three of the nine studied sites in the years between 2014 and 2018 as well as the DDT at six and the Chlordane concentrations at seven sites, respectively. In case of HCH decreases were seen at two of the nine sampled sites. In total we saw only three increases in Oystercatcher eggs in the five years, but 22 decreases and most of them were detected at the Dollart (five), as well as by Delfzijl, Jade, Trischen and Halligen (in each case three).
In the **Common Tern** eggs we detected more significant de- than increases in the period during 2014-2018 too. We saw a decrease of DDT concentrations at six and in case of HCH at five of nine study sites. Chlordanes decreased at three as well as the PCB and HCB concentrations at two of the nine sampled sites whereas Hg decreased only at one site. In total we found one increased and 19 significant decreased substance levels in Common Tern eggs in the five-year-period, and most of them were detected at the Elbe (four sites) as well as at Balgzand, Jade and Halligen (three each). The only increases we found were PCB concentrations in the Common Tern eggs from Baltrum.
In general, in most cases the measured de- or increases were only small although constant (see figures at 8.2). In both species the calculated TEQs (toxic dioxin like PCB) increased at most sites (Oystercatcher: six sites; Common Tern: five sites).

Because of lacking breeding success in **Oystercatchers** at Dollart in 2018 there were only eight sites to compare for this species between the last two years. When **comparing the year 2018 with 2017** we recorded more contamination increases (13) than decreases (10) 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. Increases were related to the HCB concentrations at six of the eight investigated locations and to the HCH concentrations at three respectively. They occurred at Delfzijl as well as at Trischen. Remarkable were the Chlordane concentrations in the Oystercatcher eggs, which decreased rather uniformly at all of the eight investigated sites between 2017 and 2018 as well as the TEQs which decreased at six, respectively.

Because of lacking breeding success in **Common Terns** at Balgzand in 2017 and of the destroyed nests at Schirmonnikoog due to a spring-tide in 2018 there were only seven sites to compare for this species between the last two years. Nevertheless clearly more contamination decreases (12) than increases (6) were detected (Tab. 5.2.2.): In contrast to the situation in the Oystercatcher HCH concentrations decreased rather consistently at four of the seven study sites in Common Tern eggs as well as the Chlordane concentrations at six. Similar to the Oystercatcher the TEQs decreased rather uniformly at six of the investigated sites between 2017 and 2018. Increases occurred in the HCB concentrations at three sites, but they decreased also at one site. DDT increased at two sites and in case of PCB each one de- and increase occurred. Most chemical groups increased at Jade (three) and Delfzijl (two), whereas most decreases were found at the Elbe (three) between 2017 and 2018.

In the two year comparison it is obvious that the trend of many parameters is converse from year to year. One year there is an increase followed by a decrease in the next year. This may be an indication that the contamination level of the different environmental chemicals showed a fluctuation around an established level in the bird eggs.

6.3 Summarized Assessment

Summarizing, the results from 2018 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 high amount of Chlordane. The outstanding and particularly high concentrations of HCB in Oystercatcher eggs from Delfzijl vanished in 2018 nearly completely. 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 2018 with the two previous ones, 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).
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 2018 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, 07 February 2019

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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 2018

Table 8.1.1: Concentrations of chemicals in Oystercatcher and Common Tern eggs sampled in The Netherlands in 2018. 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	224,8	±	224,8	230,3	±	63,4	92,3	±	64,9	162,8	±	56,6
6 PCB (law)	260,8	±	260,8	131,0	±	32,2	259,6	±	92,0	309,3	±	124,8
PCB sum	570,4	±	570,4	298,5	±	70,7	550,9	±	184,0	672,3	±	265,7
HCB	3,0	±	3,0	2,9	±	1,1	2,2	±	0,8	6,8	±	3,5
ppDDE	20,8	±	20,8	10,8	±	2,5	23,6	±	7,7	39,2	±	14,7
ppDDT	0,6	±	0,6	0,0	±	0,0	0,3	±	0,5	0,8	±	0,5
ppDDD	0,9	±	0,9	0,7	±	0,3	0,9	±	0,1	1,0	±	0,1
DDT sum	22,3	±	22,3	11,4	±	2,5	24,8	±	8,0	41,0	±	15,1
alpha-HCH	0,0	±	0,0	0,0	±	0,0	0,0	±	0,0	0,0	±	0,0
beta-HCH	4,5	±	4,5	3,6	±	1,9	1,4	±	0,8	0,6	±	0,8
gamma-HCH	0,0	±	0,0	0,4	±	0,6	0,0	±	0,0	0,0	±	0,0
HCH sum	4,5	±	4,5	4,0	±	1,5	1,4	±	0,8	0,6	±	0,8
Chlordane sum	0,3	±	0,3	0,1	±	0,2	0,1	±	0,1	0,5	±	0,3

	Balgzand			Griend			Schiermonnikoog			Delfzijl		
Common Tern	**(N=10)**			**(N=10)**			**(N=0)**			**(N=10)**		
Hg	367,3	±	144,1	329,8	±	76,6	-	±	-	340,0	±	137,8
6 PCB (law)	274,4	±	95,7	344,8	±	150,8	-	±	-	374,2	±	120,2
PCB sum	588,0	±	206,7	746,1	±	319,0	-	±	-	809,8	±	249,3
HCB	4,2	±	1,4	6,1	±	3,1	-	±	-	8,4	±	1,5
ppDDE	23,8	±	9,1	35,8	±	16,3	-	±	-	53,9	±	13,8
ppDDT	0,0	±	0,0	0,1	±	0,4	-	±	-	0,0	±	0,1
ppDDD	0,9	±	0,3	1,1	±	0,4	-	±	-	1,0	±	0,2
DDT sum	24,7	±	9,2	37,0	±	16,6	-	±	-	54,9	±	13,7
alpha-HCH	0,0	±	0,0	0,0	±	0,0	-	±	-	0,0	±	0,0
beta-HCH	0,7	±	0,2	0,2	±	0,4	-	±	-	0,2	±	0,2
gamma-HCH	0,0	±	0,0	0,0	±	0,0	-	±	-	0,2	±	0,4
HCH sum	0,7	±	0,2	0,2	±	0,4	-	±	-	0,4	±	0,4
Chlordane sum	0,0	±	0,0	0,0	±	0,0	-	±	-	0,0	±	0,0

8.2 Temporal trends of pollutant concentrations at different sites during 2014-2018

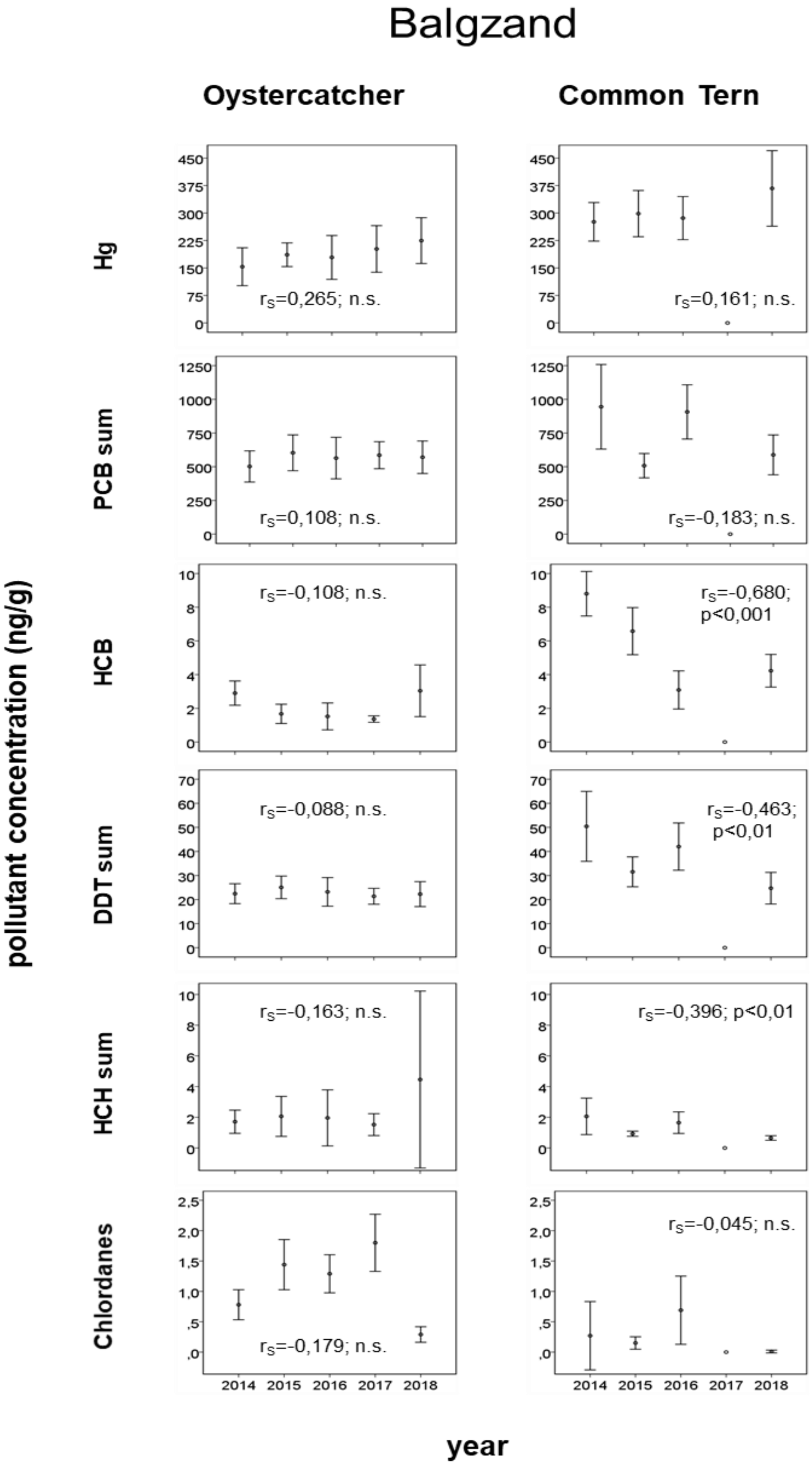

Fig. 8.2.1: Temporal development of pollutant concentrations in Oystercatcher and Common Tern eggs from Balgzand, NL, in the period 2014-2018. Arithmetic means are given with the 95% confidence interval.

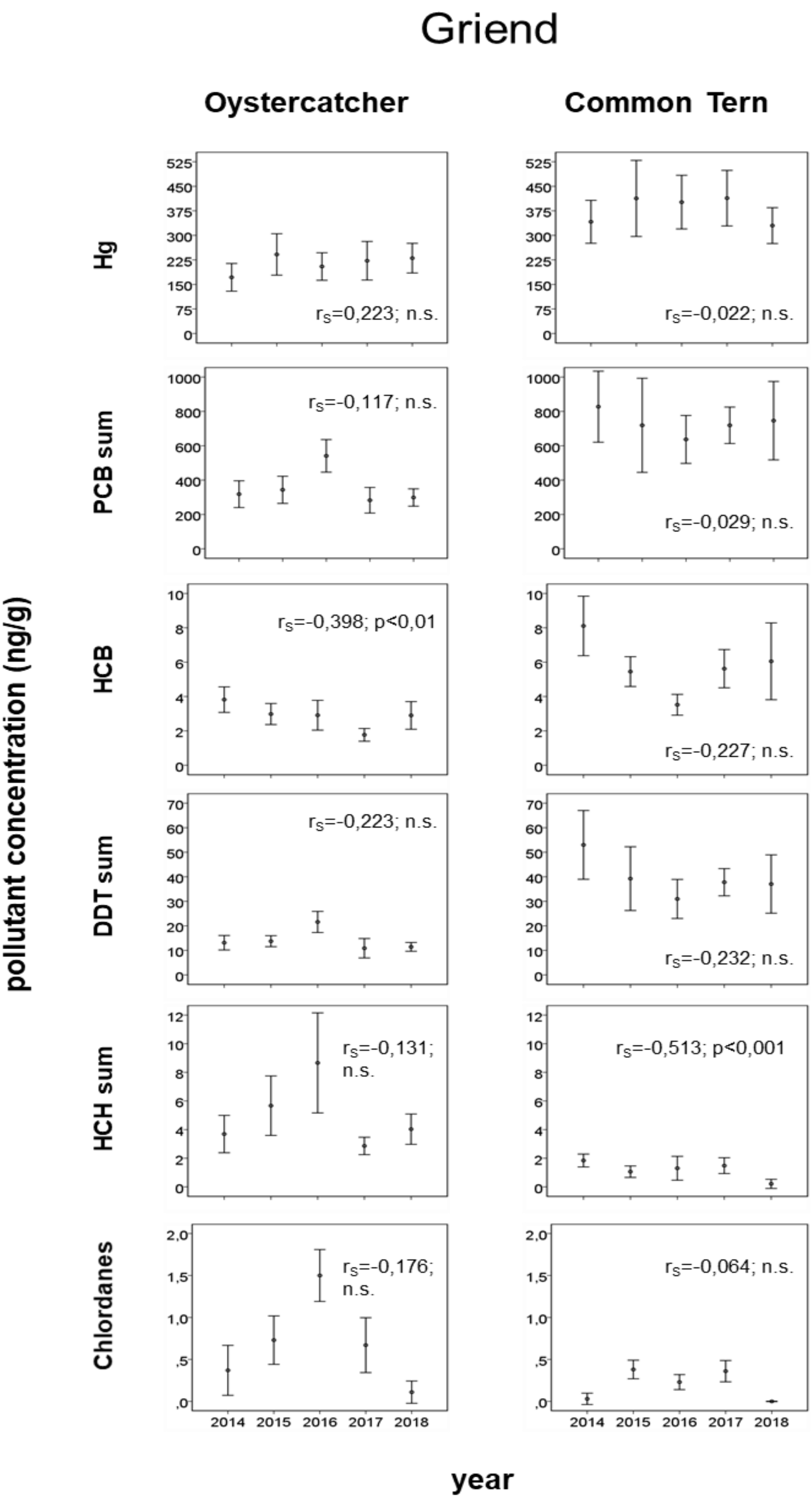

Fig. 8.2.2: Temporal development of pollutant concentrations in Oystercatcher and Common Tern eggs from Griend, NL, in the period 2014-2018. Arithmetic means are given with the 95% confidence interval.

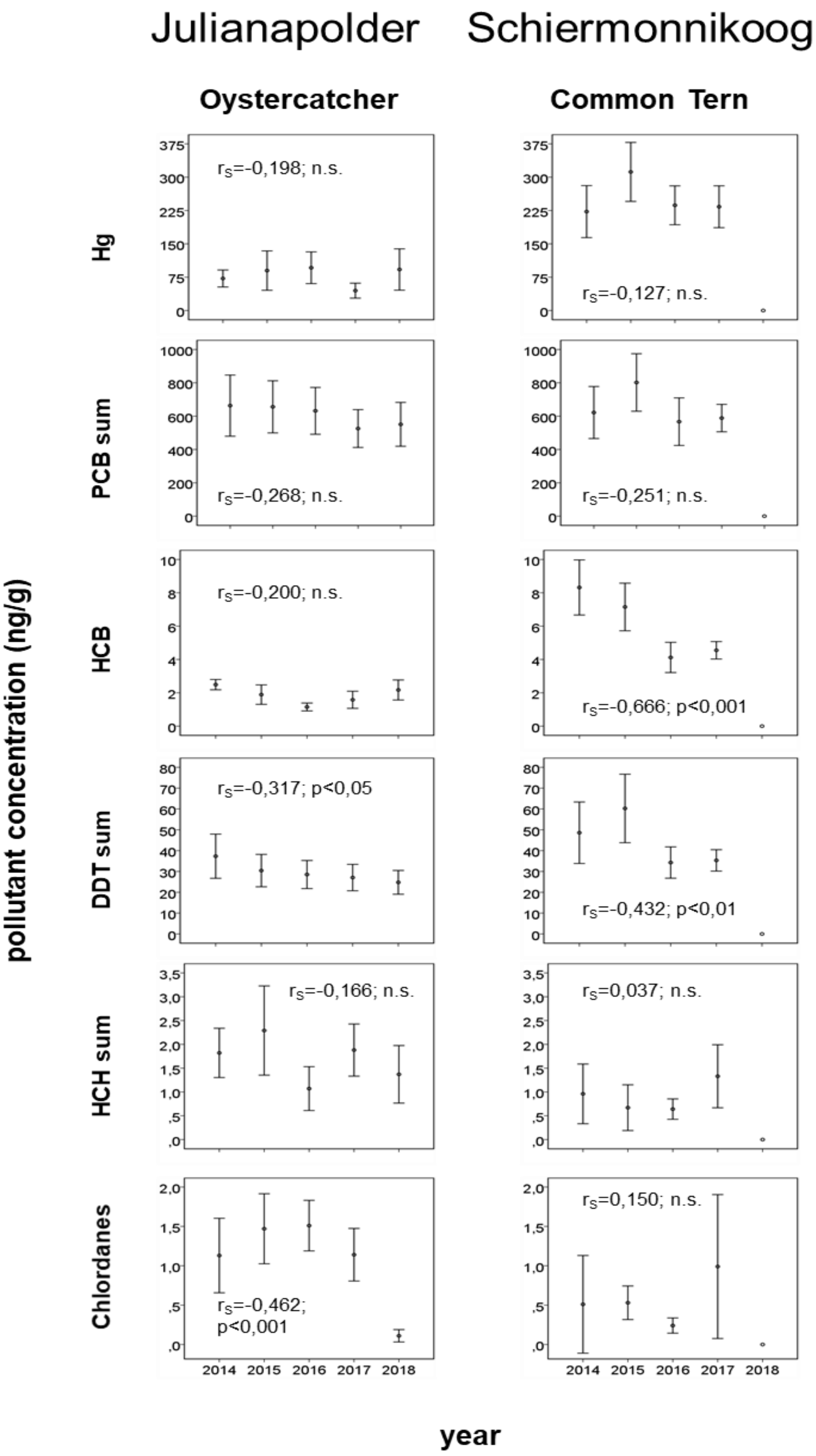

Fig. 8.2.3: Temporal development of pollutant concentrations in Oystercatcher eggs from Julianapolder and in Common Tern eggs from Schiermonnikoog, NL, in the period 2014-2018. Arithmetic means are given with the 95% confidence interval.

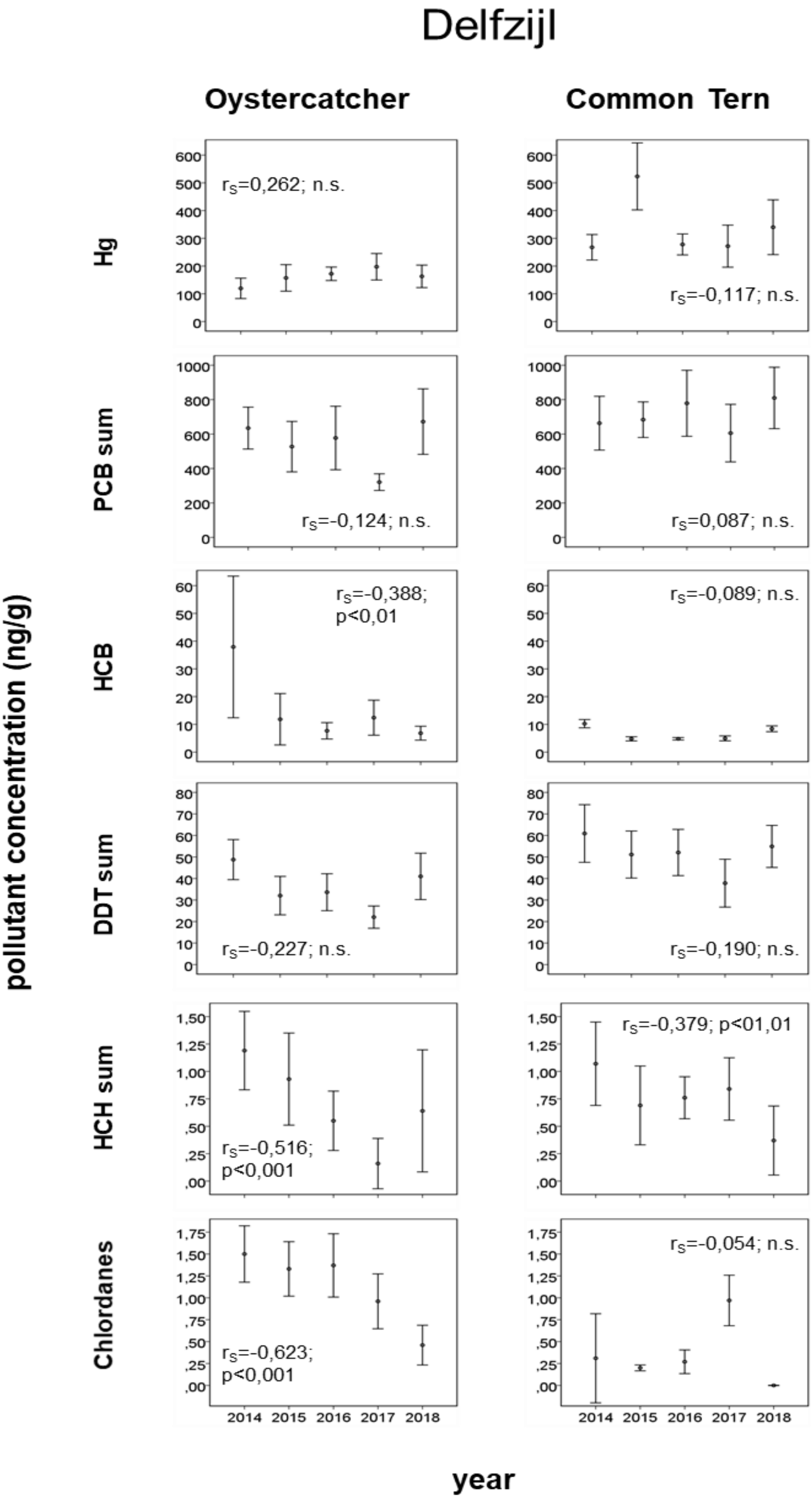

Fig. 8.2.4: Temporal development of pollutant concentrations in Oystercatcher and Common Tern eggs from Delfzijl, NL, in the period 2014-2018. Arithmetic means are given with the 95% confidence interval.