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Documentation of the TMAP Parameter "Pollutants in seabird eggs" in The Netherlands in 2020

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).

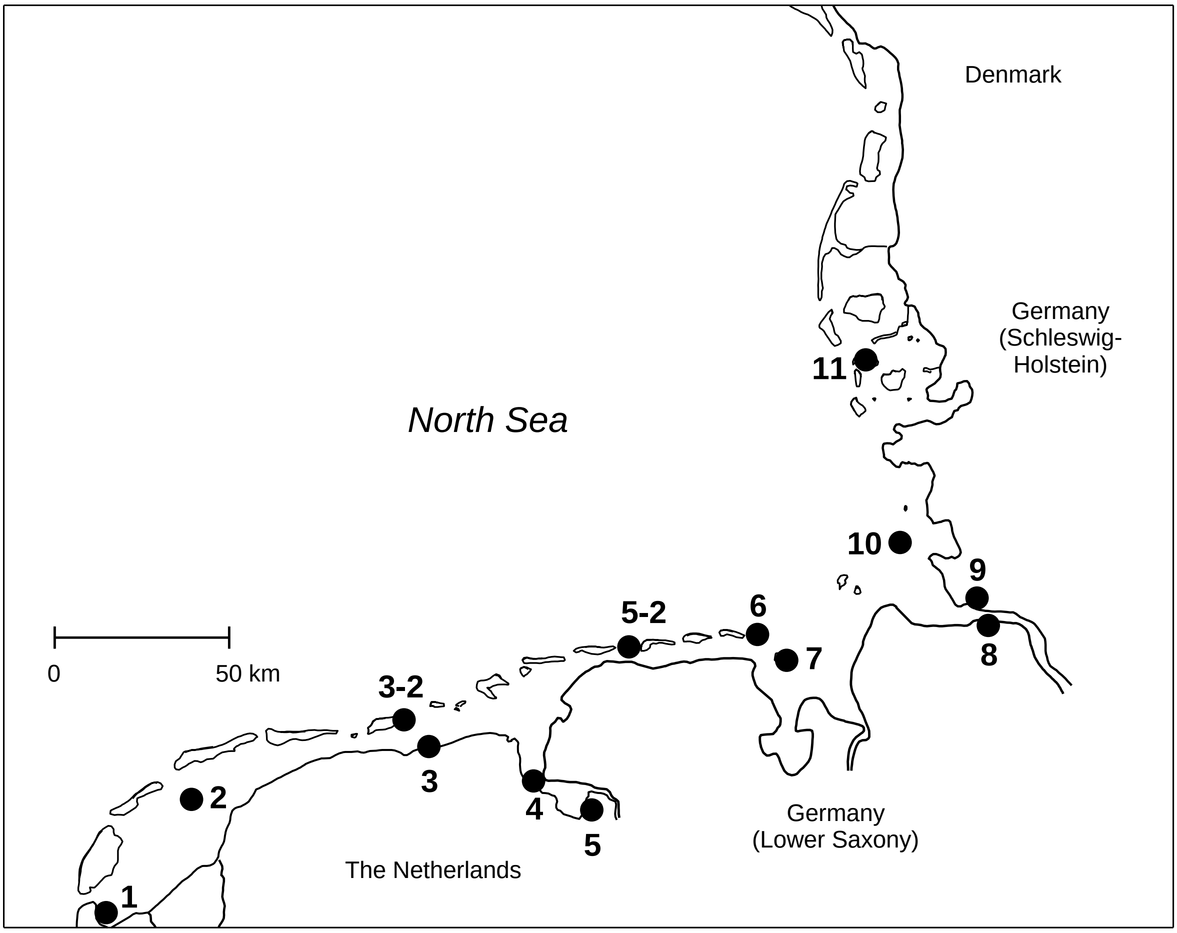

Fig. 1.1: Sampling sites of Oystercatcher and/or Common Tern eggs in the trilateral Wadden Sea.
The Netherlands: 1 Balgzand, 2 Griend, 3 Julianapolder, 3-2 Schiermonnikoog, 4 Delfzijl;
Germany, Lower Saxony: 5 Dollart, 5-2 Baltrum, 6 Minsener Oog (Oldeoog), 7 Mellum (6 and 7 = Jade), 8 Hullen (8 and 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 2020

	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) Becker et al. (2001) and Goutner et al. (2015). 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 2020 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 2016 – 2020, Spearman rank correlations were calculated (two-tailed) for the years 2016 - 2020. To identify potential differences in pollutant concentrations between 2019 and 2020, 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 2020

This year there were unfortunately no eggs of Common Terns at the breedingsite near Shirmonnikoog at all. The numbers of breeding Common Terns declined in the last years (2017-2019, resp. 25, 26 and 3 breeding pairs) and the nests failed in all years at an early stage. So we could not get any eggs from this place and had only eight different locations in the Wadden Sea to compare Common Terns. In 2020 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:	Griend, Jade, Halligen
PCB:	Balgzand, Griend, Trischen
HCB:	Halligen, Trischen, Balgzand
DDT:	Elbe (Neufelderkoog), Trischen, Halligen
HCH:	Trischen, Elbe (Neufelderkoog), Balgzand
Chlordane:	Balgzand, Jade, Griend

This year there were again 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 Ostercatchers at all. In the following areas relatively high contaminations of Oystercatcher eggs were detected in 2020 (given in the order of contamination level, beginning with the highest average level, see Fig. 5.1.1; Tab. 8.1.1):

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

In **Common Tern eggs**, concentrations of Hg, PCB, HCB and DDT tended to be higher at most sites than in Ostercatcher eggs, whereas Chlordane concentrations tended to be lower. But the PCB conentrations reached equal values in some areas (Elbe). In general in 2020 the differences between the two species were more distinct compared to the year before, when the specific differences between the species were not so clear.

In **Oystercatcher**, the geographical pattern of **Hg** concentrations in 2020 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 further concentrations at Balgzand 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 2020 the average measured Hg concentration in Oystercatcher eggs from all different investigated areas was 185,3 +/- 113,5 ng/g wet weight (range 2020: 18,8 – 618,7 ng/g wet weight) and therefore a little lower compared to 2019 (167,0 +/- 86,3 ng/g wet weight; range 2019: 16,0 – 415,5 ng/g wet weight). The data of the last years were all in the same dimension (see Tab. 8.2.1.).

In 2020 a concentration peak of **PCB** was recognized at the river Elbe, as in the years before and contradicting to 2018, where PCB concentrations tended to equalize at the different locations of the Wadden Sea. In 2020 the average PCB level was 520,1 +/- 263,3 ng/g wet weight (range 2020: 178,0 – 1.346,8 ng/g wet weight) and therefore lower compared to 2019 with an average PCB level of 572,1 +/- 320,5 ng/g wet weight (range 2019: 119,7 – 1.762,6 ng/g wet weight) but clearly higher compared to some years before (see Tab. 8.2.1.)

As in the years before in 2020 the clearly highest concentrations of **HCB** in Oystercatcher eggs were measured at Delfzijl. On average the concentrations at Delfzijl reached up to five times higher levels compared to other areas and even levels in Oystercatcher eggs from the Elbe reached only half the amounts of HCB as at Delfzijl. In 2020 the average HCB level in the whole Wadden Sea in Oystercatcher eggs was 2,9 +/- 3,8 ng/g wet weight (range 2020: 0,1 – 24,2 ng/g wet weight) and so a little lower compared to 2019 (average: 3,1 +/- 3,8 ng/g wet weight; range 2019: 0,9 – 24,9 ng/g wet weight) and years before (see Tab. 8.2.1.).

For **DDT** the highest concentrations in 2020 were found in Oystercatcher eggs from the river Elbe and from Delfzijl. So the geographical pattern is very similar to the years before, which showed also the highest amounts of DDT in the region of the river Elbe. The average DDT levels in 2020 of 24,2 +/- 15,1 ng/g wet weight (range 2020: 7,0 - 81,8 ng/g wet weight) were slightly higher compared to 2019 with 23,7 +/- 16,4 ng/g wet weight (range 2019: 6,9 – 104,3 ng/g wet weight) but lower compared to former years (see Tab. 8.2.1.).

In 2020 the **HCH** concentrations showed concentration peaks at Trischen, Jade and Balgzand. The HCH concentrations in oystercatcher eggs showed no further extreme values in their geographical pattern and were rather similar to the years before. Average levels reached clearly lower values (2020 average: 0,3 +/- 0,5 ng/g wet weight, range: 0,0 – 2,2 ng/g wet weight) compared to former years (see Tab. 8.2.1.).

For **Chlordanes** high values in 2020 have been detected in Oystercatcher eggs from Delfzijl. In general, levels of Chlordanes were clearly higher in Oystercatcher eggs compared to those from Common Tern eggs. The average Chlordane levels in 2020 in Oystercatcher eggs were 0,6 +/- 0,5 ng/g wet weight (range 2020: 0,0 – 2,7 ng/g wet weight) and therefore in the same value as the years before (see Tab. 8.2.1.).

In 2020 again, the main contamination area of **PCB**, **DDT, HCB** and **HCH** in **Common Tern eggs** was clearly located in the surrounding of the river Elbe. 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 in contrast to all the years before there was a different **Hg** pattern. Concentrations showed rather equal levels, with low levels at the Elbe and peaks at Griend and Halligen.

The average **Hg** concentration in the Common Tern eggs of all areas in 2020 was 226,2 +/- 72,8 ng/g wet weight (rang 2020: 118,4 – 513,6 ng/g) and reached clearly lower values than in 2019 (328,4 +/- 150,9 ng/g wet weight; rang 2019: 130,6 – 871,4 ng/g) or former years. (see Tab. 8.2.1.).

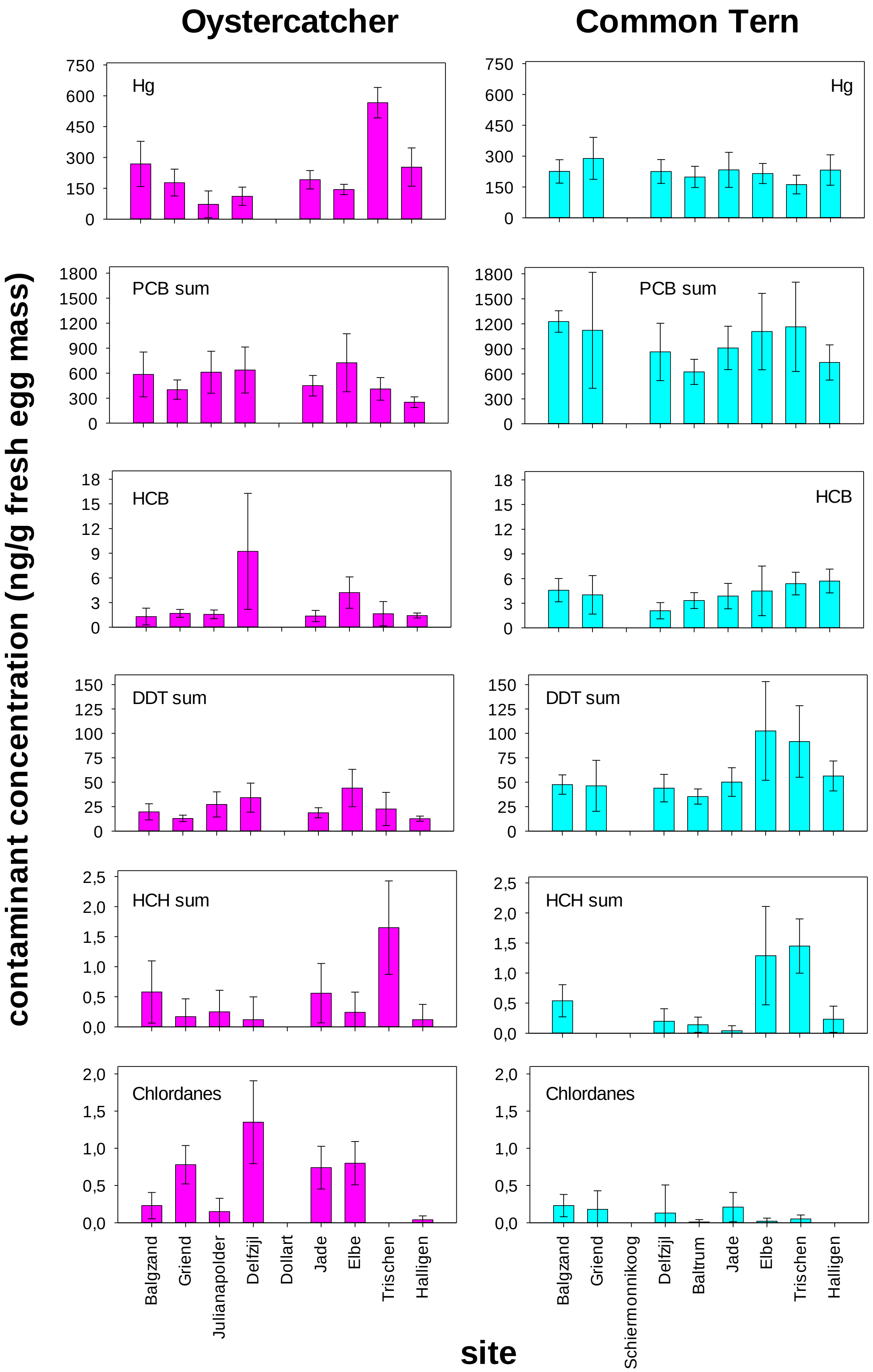

Fig. 5.1.1: Spatial patterns of pollutant concentrations in Oystercatcher and Common Tern eggs from the Wadden Sea in 2020 (means with standard deviations)

For **PCB** we see in 2020 again at all areas rather similar concentrations in Common Tern eggs with an average level of 961,5 +/-422,4 ng/g wet weight (range 2020: 347,7 – 2.552,1 ng/g). So levels were higher than 2019 (average: 800,3 +/- 350,3 ng/g wet weight; range 2019: 231,1 – 1.404,6 ng/g) and former years (see Tab. 8.2.1.). Small peaks occurred at Elbe and Trischen as well as at Balgzand and Griend.

In 2020 the **HCB** concentrations in Common Tern eggs had an average level of 4,1 +/- 2,7 ng/g fresh weight (range 2020: 0,0 – 10,7 ng/g wet weight) and were lower than values in 2019 with an average level of 6,1 +/- 3,7 ng/g fresh weight (range 2019: 1,8 – 25,2 ng/g wet weight). Also in former years higher HCB values were measured (see Tab. 8.2.1.). In 2020 the HCB concentrations were at all areas higher than concentrations in Oystercatcher eggs in these areas. In Common Terns maximum HCB levels were measured in eggs from Halligen.

In 2020, **DDT** concentrations in Common Tern eggs were more or less in a similar range, showing an average level of 57,6 +/- 32,8 ng/g wet weight (range 2020: 16,5 – 204,1 ng/g wet weight) and a clear peak at the river Elbe. Average levels were clearly higher as in former years (average level 2019: 39,9 +/- 25,8 ng/g wet weight; range 2019: 12,5 - 156,3 ng/g wet weight; see Tab. 8.2.1.).

The measured **HCH** levels in Common Tern eggs in 2020 ranged between 0,0 and 2,6 ng/g wet weight with an average of 0,4 +/- 0,6 ng/g and a peak at the Elbe and Trischen. In general, HCH levels were 2020 rather low and ranged clearly beyond levels of former years (see Tab. 8.2.1.).

Concentrations of **Chlordanes** recorded in 2020 in Common Tern eggs were rather low in all areas with an average of 0,1 +/- 0,2 ng/g wet weight (range 2020: 0,0 – 1,2 ng/g wet weight). Values in 2020 were clearly lower as in former years (see Tab. 8.2.1.).

5.2 Annual variation in pollutant concentrations in the period 2016-2020

Mean contamination values for the different substance groups in the period 2016-2020 are given in Figures 8.2.1-8.2.6 in the Appendix. A summarizing overview of short-term (2019-2020) and mid-term (2016-2020) 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 2016-2020:

Oystercatcher	In the period between 2016 and 2020 a significant **decrease** was detected in DDT, HCH and Chlordanes concentration levels.
Common Tern	A significant **increase** occurred in PCB and HCB levels.

In Oystercatcher eggs sampled in 2020 concentration of Hg were significantly **higher** compared to 2019 whereas concentration of chlordanes **decreased**. In Common Tern eggs levels of Hg and HCH **decreased** in that period whereas levels of DDT **increased**.

Griend

Temporal Trends 2016-2020:

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

Between 2019 and 2020 HCH concentrations **decreased** significantly in Oystercatcher eggs and in Common Tern eggs level of Hg were significantly lower in 2020 compared to 2019.

Table 5.2.1: Overview over the development of selected pollutants in eggs of Oystercatcher and Common Tern in the Wadden Sea from 2016-2020, according to Spearman rank correlations. -: 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	-		-		/	-		-	-		-	/		-		-	-	-

Table 5.2.2: Overview over the development of selected pollutants in eggs of Oystercatcher and Common Tern in the Wadden Sea from 2019-2020, 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	-		-	+	/			-	-			/	-	-				-

Julianapolder/Schiermonnikoog

Temporal Trends 2016-2020:

Oystercatcher — Significant **decreases** in the concentrations of HCH and Chlordanes were identified at Julianapolder.

Common Tern — Since 2018 no Common Tern eggs could be sampled at Schirmonnikoog, so no comparisons could be drawn.

In Oystercatcher eggs from 2020 sampled at Julianapolder, the concentrations of DDT and HCH **increased** significantly compared to 2019, whereas concentrations of Chlordanes **decreased**.
In 2019 and 2020 no Common Tern eggs could be sampled, so no comparisons could be drawn.

Delfzijl

Temporal Trends 2016-2020:

Oystercatcher	In the period between 2016 and 2020 significant **decreases** in the concentrations of HCH occurred.
Common Tern	The concentrations of Hg and HCH **decreased** significantly since 2016.

Between 2019 and 2020 concentrations of Hg and Chlordanes in Oystercatcher eggs **increased** significantly. In Common Tern eggs the concentrations of DDT were significantly **higher** in 2020 compared to the year before, whereas concentrations of HCB and Chlordanes were **lower**.

6. General Assessment

6.1 Spatial Trends

Unfortunately there were not enough nests of Oystercatchers at the breedingsite Dollart to collect eggs there. We also didn't manage to collect eggs of Common Terns at Schiermonnikoog. The numbers of breeding pairs declined in the last years and the nests failed in all years at an early stage.

In 2020 again, the concentrations of the mentioned substances in **Oystercatcher** eggs showed only small geographical differences. After vanishing in 2018 the conspicuous HCB peak at Delfzijl was again clearly visible as in 2019. Highest levels of PCB and DDT were detected at the River Elbe and Trischen whereas HCH reached highest levels at Griend. Compared to 2019 the measured concentrations in Oystercatcher eggs were lower in 2020 in case of PCB and HCH whereas concentrations of Hg tended to be higher; HCB and DDT concentrations ranged in the same value.

In the **Common Tern** concentration peaks of PCB, DDT and HCH were found in 2020 again in the Elbe estuary at the locations Elbe or Trischen, which is in accordance with the observations from previous years. But high Hg concentrations were found in the western part of the Wadden Sea. So highest Hg concentrations were observed in eggs from Balgzand and Griend. The average Hg level over all investigated areas of the Wadden Sea was a little lower compared to 2019, but reached with ca. 225 ng/g wet weight a level clearly above the limit value of 160 ng/g.

In general, the species-specific spatial contamination patterns in 2020 remained similar to those recorded in 2019 and the years before: The contamination pattern of the Common Tern again showed concentration peaks at the river Elbe, but in 2019 as well as in 2020 not in case of Hg. On the other hand, the contamination pattern of the Oystercatcher was in 2020 in some parts similar to the Common Tern, but showing different geographical peaks for Hg and HCB. 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 Chlordane and sometimes HCH concentrations were clearly higher in Oystercatcher eggs than in Common Tern eggs.

The decreasing Hg levels in Common Tern eggs from the river Elbe may be due to a changed feeding behaviour of the local colony. In the past the Common terns there captured exclusively the European smelt located in the river. So the obtained data of the environmental chemicals reflected the local situation of the river. Due to changed water engineering of the river the European smelt population there declined and changed. The Common Terns from the local colony were forced to pray herring from the North Sea for a few years now (Hennig pers. com.). So the obtained Hg data reflect the global situation of the North Sea and not the local situation of the river Elbe.

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 but in 2020 they were up to three times higher in Delfzijl compared to the other places.

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 average Hg concentrations in Common Tern are at a high level, 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 2016-2020**, 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 the study sites Halligen Hg concentrations increased significantly in Common Tern eggs between 2016 and 2020, whereas Hg concentrations in Common Tern eggs decreased significantly at the Elbe in the same period.

In **Oystercatcher** eggs statistically significant increasing concentrations were not detected in the years between 2016 and 2020. The HCH concentrations decreased significantly at six of the eight studied sites in the years between 2016 and 2020 as well as the DDT and the Chlordane concentrations at five sites, respectively. In case of Hg and HCB decreases were seen at one of the eight sampled. In total we recognized 18 decreases and most of them were detected at the Halligen and Balgzand (three). At all other sites in each case two decreases were detected.

In the **Common Tern** eggs we detected more significant de- than increases in the period during 2016-2020 too. We saw a decrease in concentrations of Chlordanes at five and in case of HCH at three of eight study sites. Hg decreased at two of the eight sampled site, as well as the HCB and DDT concentrations. But HCB concentrations increased at two other sites and DDT at one. The PCB concentrations increased significant at three sites. In total we found six increased and 14 significant decreased substance levels in Common Tern eggs in the five-year-period. Most of decreases were detected at the Elbe (Hg, HCB, DDT HCH and Chlordanes) and most of the increases were found in Common Tern eggs from Halligen (PCB, HCB and DDT) and Balgzand (PCB and HCB). In general, in most cases the measured de- or increases were only small although constant (see figures at 8.2). The calculated TEQs (toxic dioxin like PCB) increased at four sites during the five-year period in Common Tern eggs and at one site in Oystercatcher eggs, respectively.

Because of lacking breeding success in **Oystercatchers** at Dollart in 2020 there were only eight sites to compare for this species between the last two years. When **comparing the year 2020 with 2019** we recorded more contamination decreases (eight) than increases (five) 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. Decreases were related mostly to Chlordane concentrations at four of the eight investigated locations but they increased at Delfzijl. Remarkable were the TEQs which decreased Oystercatcher eggs at five locations but increased at those from the Elbe between 2019 and 2020.

Because of the dwindling colony of **Common Terns** at Schirmonnikoog there were only eight sites to compare for this species between the last two years. Nevertheless, clearly more contamination decreases (16) than increases (six) were detected (Tab. 5.2.2.): In contrast to the situation in the Oystercatcher DDT concentrations increased rather consistently at six of the eight study sites as well as the Hg and HCH concentrations decrease rather uniformly at five sites each. Similar to the Oystercatcher the Chlordane concentrations decreased in Common Tern eggs at three of the investigated sites between 2019 and 2020. Also the HCB concentrations decreases at three sites as well as the TEQs. Most decreased chemical groups between 2019 and 2020 were found at Baltrum (four) and Halligen (three). At both places also an increase occurred.

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 2020 indicate similar species-specific spatial contamination patterns as in the previous years. Whereas the Elbe is again an important 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 Hg and HCH burden in Oystercatcher eggs from Trischen as well as the general high amount of Chlordane. The outstanding and particularly high concentrations of HCB in Oystercatcher eggs from Delfzijl were again clearly visible in 2020.
When comparing the year 2020 with the previous one, Common Terns showed a lower Hg burden in their eggs, whereas concentrations in Oystercatcher eggs tended to be higher. In contrast the DDT concentrations were again higher in Common Tern eggs. In both species HCB levels were again lower, after a steady increase in the previous years until 2014 (Becker et al 2001, Mattig et al. 2014) followed by a slowly decrease (TMAP 2019). And in both species HCH levels were declining. Our data show that the contamination levels in the eggs of the two species remained firm at a higher level after a constant increase until 2011/2012. Even with the data from 2020 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 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 2020 at all investigated areas, whereas HCH limit values (2 ng/g) were undercut at all places. For the Oystercatcher eggs we got the same result: the limit value of HCH (2 ng/g) were undercut at all investigated sites, whereas limit values of Hg (100 ng/g), PCB (20 ng/g), HCB (2 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.

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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 2020

Table 8.1.1: Concentrations of chemicals in Oystercatcher and Common Tern eggs sampled in The Netherlands in 2020. 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	268,6	±	110,0	178,2	±	65,4	72,6	±	64,5	111,5	±	44,3
6 PCB (law)	233,8	±	111,5	149,2	±	52,6	239,9	±	102,1	265,9	±	128,0
PCB sum	585,7	±	268,1	402,0	±	115,7	612,0	±	251,7	637,6	±	276,6
HCB	1,3	±	1,0	1,7	±	0,5	1,6	±	0,5	9,2	±	7,0
ppDDE	19,3	±	8,1	12,9	±	3,3	26,8	±	12,4	33,1	±	14,6
ppDDT	0,0	±	0,0	0,0	±	0,0	0,1	±	0,3	0,0	±	0,0
ppDDD	0,4	±	0,2	0,1	±	0,1	0,4	±	0,3	1,1	±	0,5
DDT sum	19,7	±	8,3	13,0	±	3,3	27,3	±	12,8	34,2	±	15,0
alpha-HCH	0,0	±	0,0	0,0	±	0,0	0,0	±	0,0	0,0	±	0,0
beta-HCH	0,5	±	0,5	0,2	±	0,3	0,3	±	0,4	0,1	±	0,4
gamma-HCH	0,0	±	0,1	0,0	±	0,0	0,0	±	0,0	0,0	±	0,0
HCH sum	0,6	±	0,5	0,2	±	0,3	0,3	±	0,4	0,1	±	0,4
Chlordane sum	0,2	±	0,2	0,8	±	0,3	0,2	±	0,2	1,4	±	0,6

	Balgzand			Griend			Schiermonnikoog			Delfzijl		
Common Tern	**(N=10)**			**(N=10)**			**(N=0)**			**(N=10)**		
Hg	226,1	±	57,0	289,5	±	102,1	-	±	-	225,5	±	57,8
6 PCB (law)	511,6	±	67,3	492,9	±	301,0	-	±	-	358,8	±	157,3
PCB sum	1.227,0	±	129,3	1.121,7	±	694,8	-	±	-	862,6	±	343,5
HCB	4,6	±	1,4	4,0	±	2,3	-	±	-	2,1	±	1,0
ppDDE	46,1	±	9,3	45,6	±	26,0	-	±	-	43,6	±	13,7
ppDDT	0,0	±	0,0	0,0	±	0,0	-	±	-	0,0	±	0,0
ppDDD	1,5	±	2,0	0,8	±	1,6	-	±	-	0,4	±	0,6
DDT sum	47,6	±	9,9	46,4	±	26,1	-	±	-	44,0	±	14,1
alpha-HCH	0,0	±	0,0	0,0	±	0,0	-	±	-	0,0	±	0,0
beta-HCH	0,5	±	0,2	0,0	±	0,0	-	±	-	0,2	±	0,2
gamma-HCH	0,0	±	0,1	0,0	±	0,0	-	±	-	0,0	±	0,0
HCH sum	0,5	±	0,3	0,0	±	0,0	-	±	-	0,2	±	0,2
Chlordane sum	0,2	±	0,1	0,2	±	0,2	-	±	-	0,1	±	0,4

8.2 Temporal trends of pollutant concentrations at different sites during 2016-2020

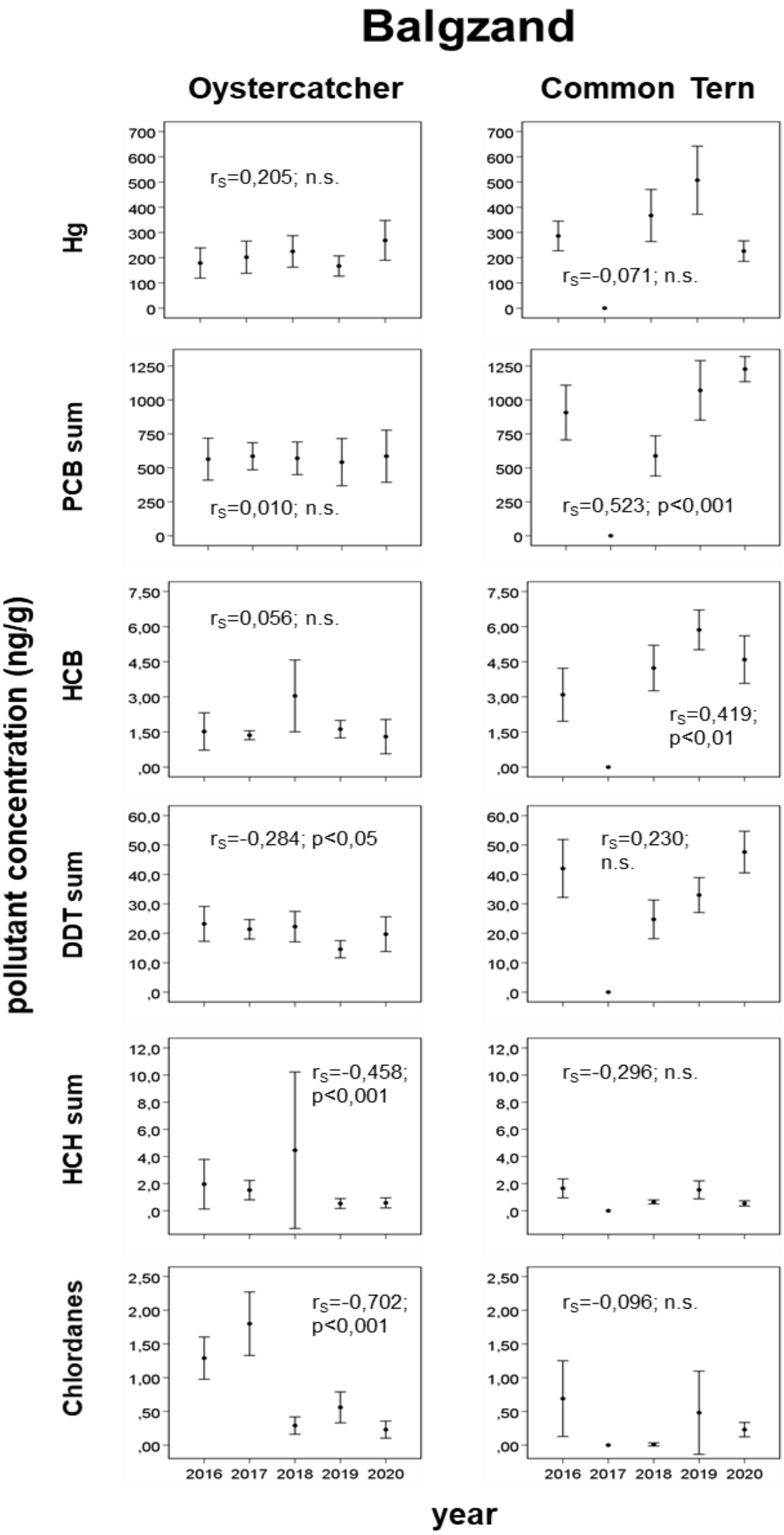

Fig. 8.2.1: Temporal development of pollutant concentrations in Oystercatcher and Common Tern eggs from Balgzand, NL, in the period 2016-2020. Arithmetic means are given with the 95% confidence interval.

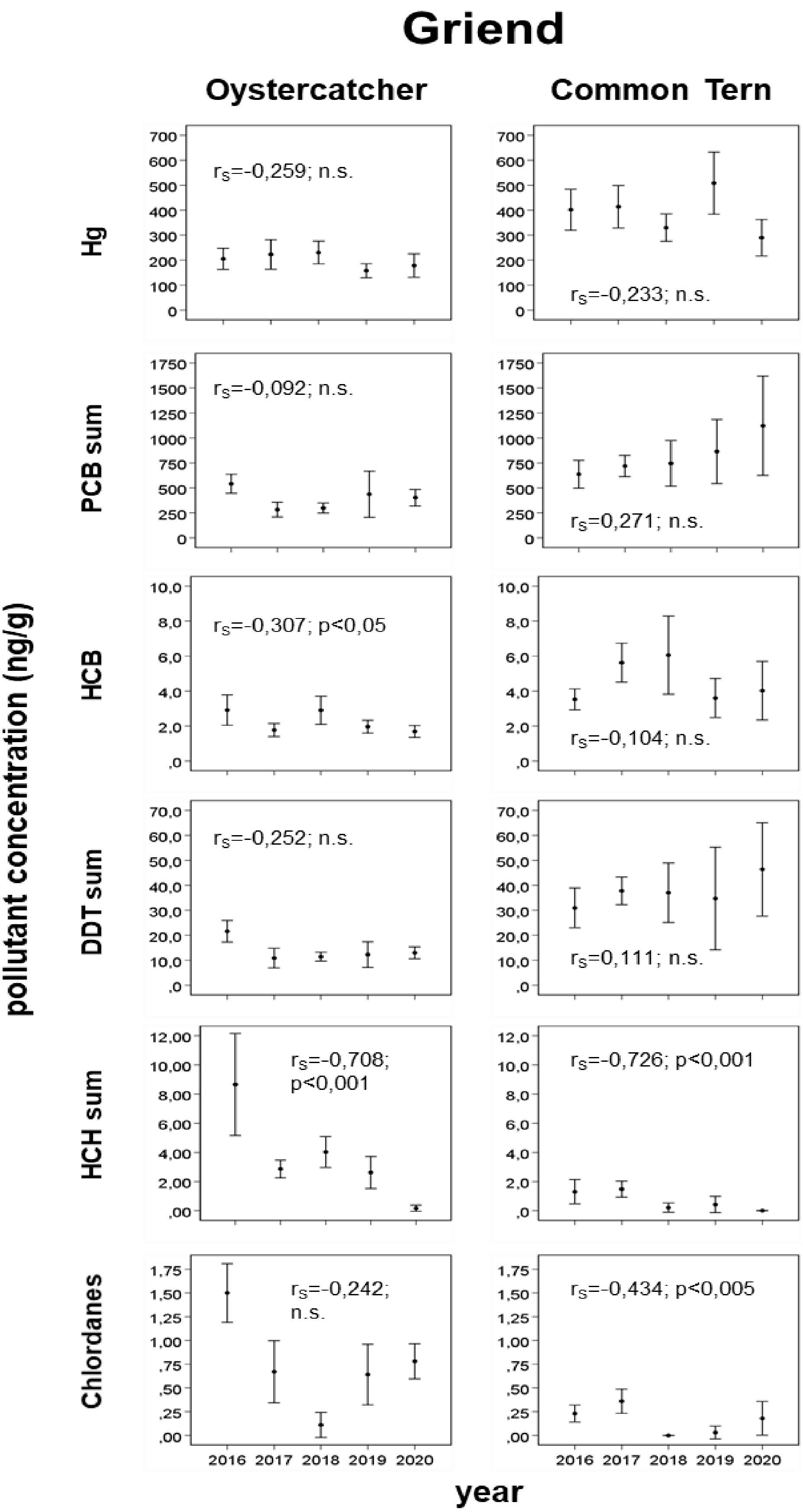

Fig. 8.2.2: Temporal development of pollutant concentrations in Oystercatcher and Common Tern eggs from Griend, NL, in the period 2016-2020. Arithmetic means are given with the 95% confidence interval.

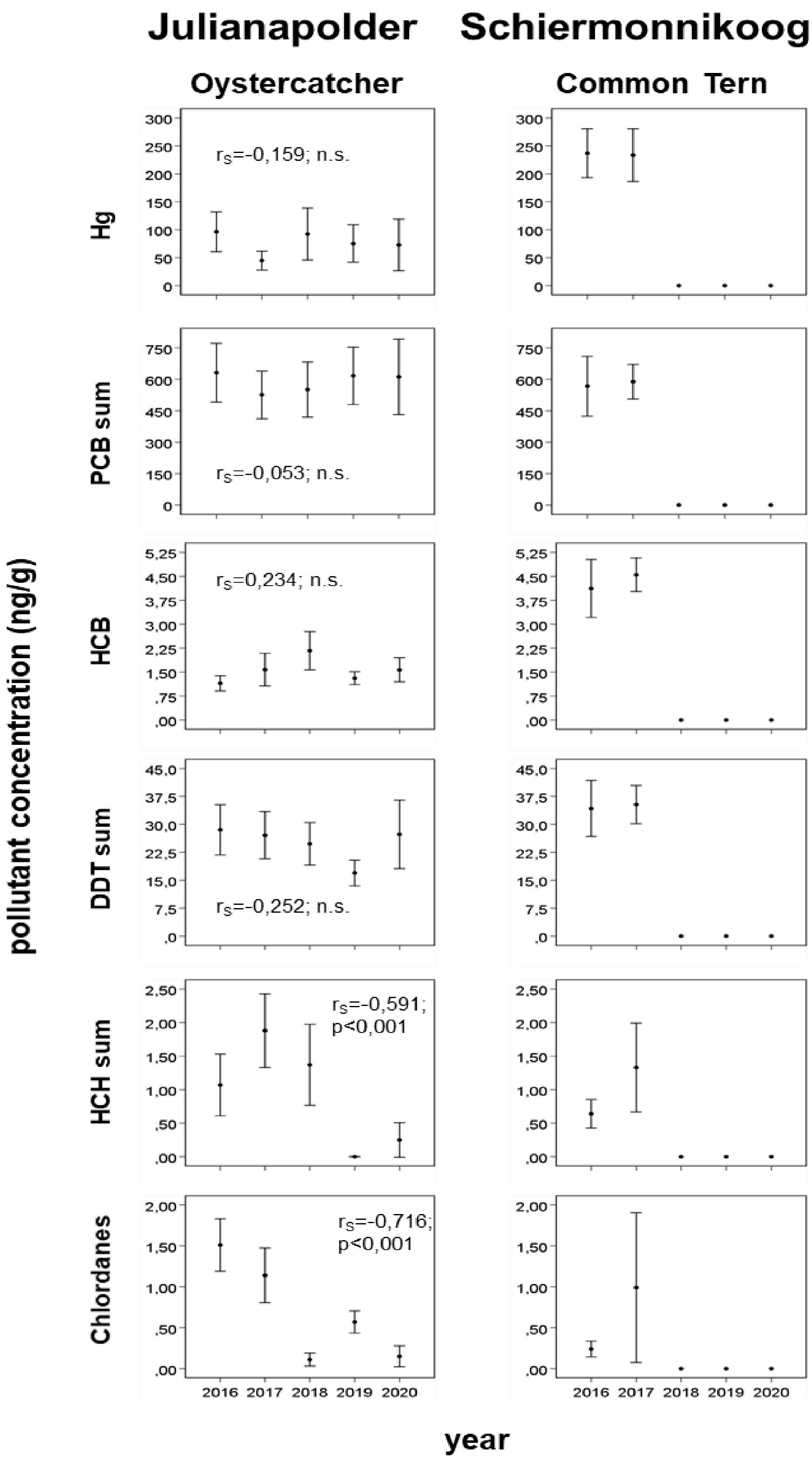

Fig. 8.2.3: Temporal development of pollutant concentrations in Oystercatcher eggs from Julianapolder and in Common Tern eggs from Schiermonnikoog, NL, in the period 2016-2020. Arithmetic means are given with the 95% confidence interval.

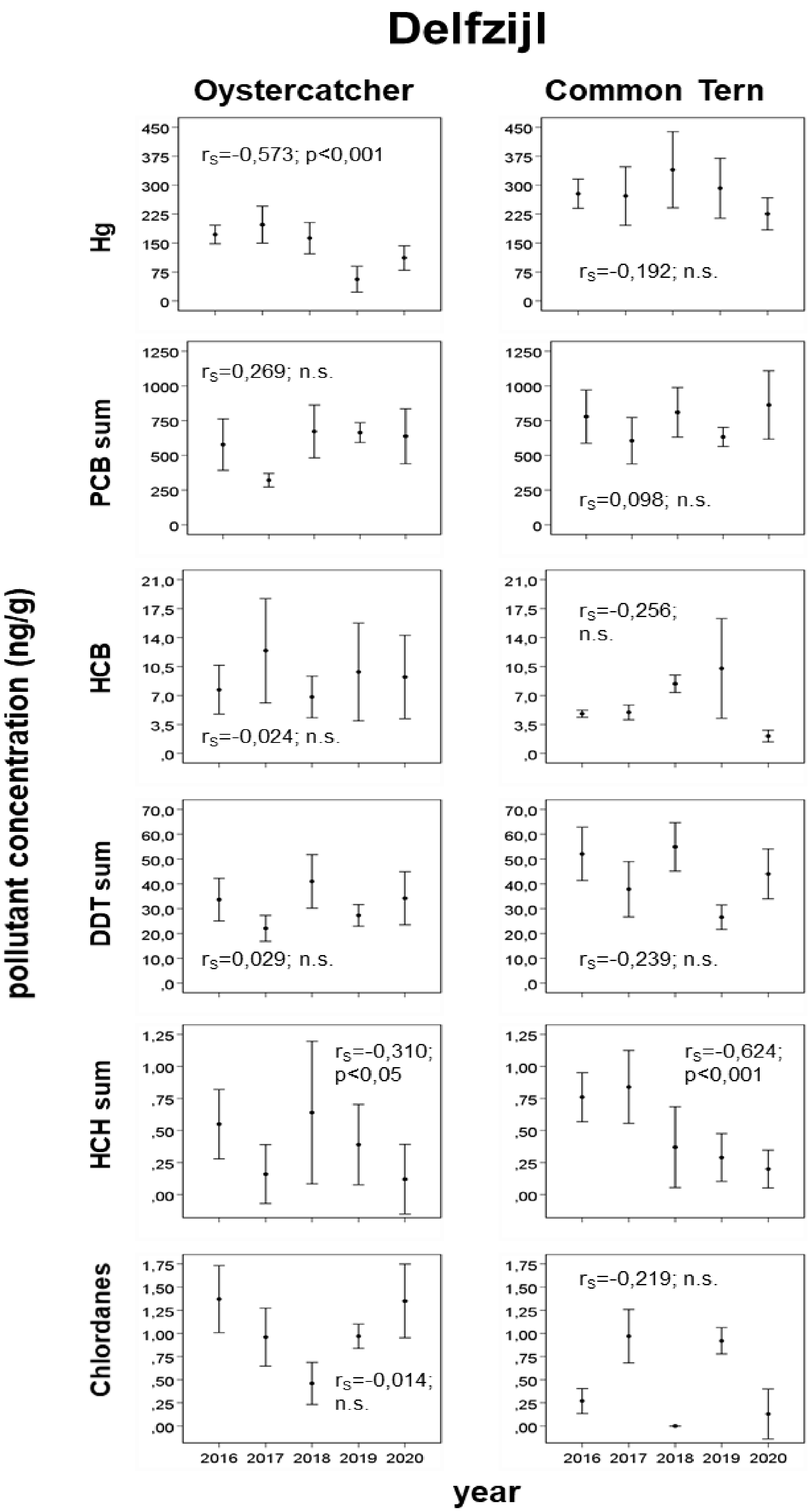

Fig. 8.2.4: Temporal development of pollutant concentrations in Oystercatcher and Common Tern eggs from Delfzijl, NL, in the period 2016-2020. Arithmetic means are given with the 95% confidence interval.

Table 8.2.1: Concentrations of chemicals in Oystercatcher and Common Tern eggs sampled in The Netherlands in 2020. Mean concentrations in ng/g (fresh mass of egg content), standard deviations and number of samples are presented.

		Oystercatcher					Common Tern				
Stoffgruppe	**Jahr**	**Mittelwert**	**Stdw.**	**Min**	**Max**	**N**	**Mittelwert**	**Stdw.**	**Min**	**Max**	**N**
Hg	**2016**	188,1	89,7	38,9	699,6	89,0	295,1	105,8	138,1	643,3	90,0
	2017	193,9	103,8	14,7	556,2	89,0	310,2	98,6	150,0	685,2	79,0
	2018	206,8	85,6	28,3	429,8	80,0	341,5	110,9	171,8	644,4	74,0
	2019	167,0	86,3	16,0	415,5	90,0	328,4	150,9	130,6	871,4	79,0
	2020	185,3	113,5	18,8	618,7	72,0	226,2	72,8	118,4	513,6	75,0
PCB	**2016**	578,7	238,4	159,3	1.330,0	89,0	722,9	324,8	274,1	2.173,3	90,0
	2017	460,2	227,3	154,8	1.309,8	89,0	613,1	213,7	295,1	1.141,9	79,0
	2018	525,1	273,2	129,3	1.683,9	80,0	684,7	287,4	231,0	1.404,6	74,0
	2019	572,1	320,5	119,7	1.762,6	90,0	800,3	350,3	284,1	2.058,3	79,0
	2020	520,1	263,3	178,0	1.346,8	72,0	961,5	422,4	347,7	2.552,1	75,0
HCB	**2016**	3,5	3,0	0,7	15,1	89,0	5,9	3,9	0,6	21,5	90,0
	2017	3,4	4,4	0,7	26,5	89,0	6,2	2,7	2,8	15,5	79,0
	2018	4,1	2,4	1,2	14,9	80,0	7,8	3,1	2,5	14,9	74,0
	2019	3,1	3,8	0,9	24,9	90,0	6,1	3,7	1,8	25,2	79,0
	2020	2,9	3,8	0,1	24,2	72,0	4,1	2,0	0,0	10,7	75,0
DDT	**2016**	52,6	112,8	10,5	935,7	89,0	58,6	43,8	17,9	231,4	90,0
	2017	27,4	16,5	6,6	78,8	89,0	46,9	25,6	16,3	130,5	79,0
	2018	32,1	21,9	7,1	91,2	80,0	50,4	27,8	10,5	120,9	74,0
	2019	23,7	16,4	6,9	104,3	90,0	39,9	25,8	12,5	156,3	79,0
	2020	24,2	15,1	7,0	81,8	72,0	57,6	32,8	16,5	204,1	75,0
HCH	**2016**	2,3	3,3	0,0	16,1	89,0	1,3	1,2	0,0	5,3	90,0
	2017	2,3	2,6	0,0	14,4	89,0	2,6	2,6	0,0	12,4	79,0
	2018	3,2	3,7	0,0	25,1	80,0	0,7	0,7	0,0	2,8	74,0
	2019	1,1	1,3	0,0	5,5	90,0	1,6	1,7	0,0	8,5	79,0
	2020	0,3	0,5	0,0	2,2	72,0	0,4	0,6	0,0	2,6	75,0
Chlordane	**2016**	1,3	0,6	0,0	3,1	89,0	0,3	0,3	0,0	2,8	90,0
	2017	1,1	0,6	0,2	2,5	89,0	0,6	0,6	0,0	4,4	79,0
	2018	0,2	0,3	0,0	1,1	80,0	0,1	0,6	0,0	4,8	74,0
	2019	0,6	0,3	0,1	1,8	90,0	0,3	0,4	0,0	2,9	79,0
	2020	0,6	0,5	0,0	2,7	72,0	0,1	0,2	0,0	1,2	75,0