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# Documentation of the TMAP Parameter "Pollutants in seabird eggs" in The Netherlands in 2019

## 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).

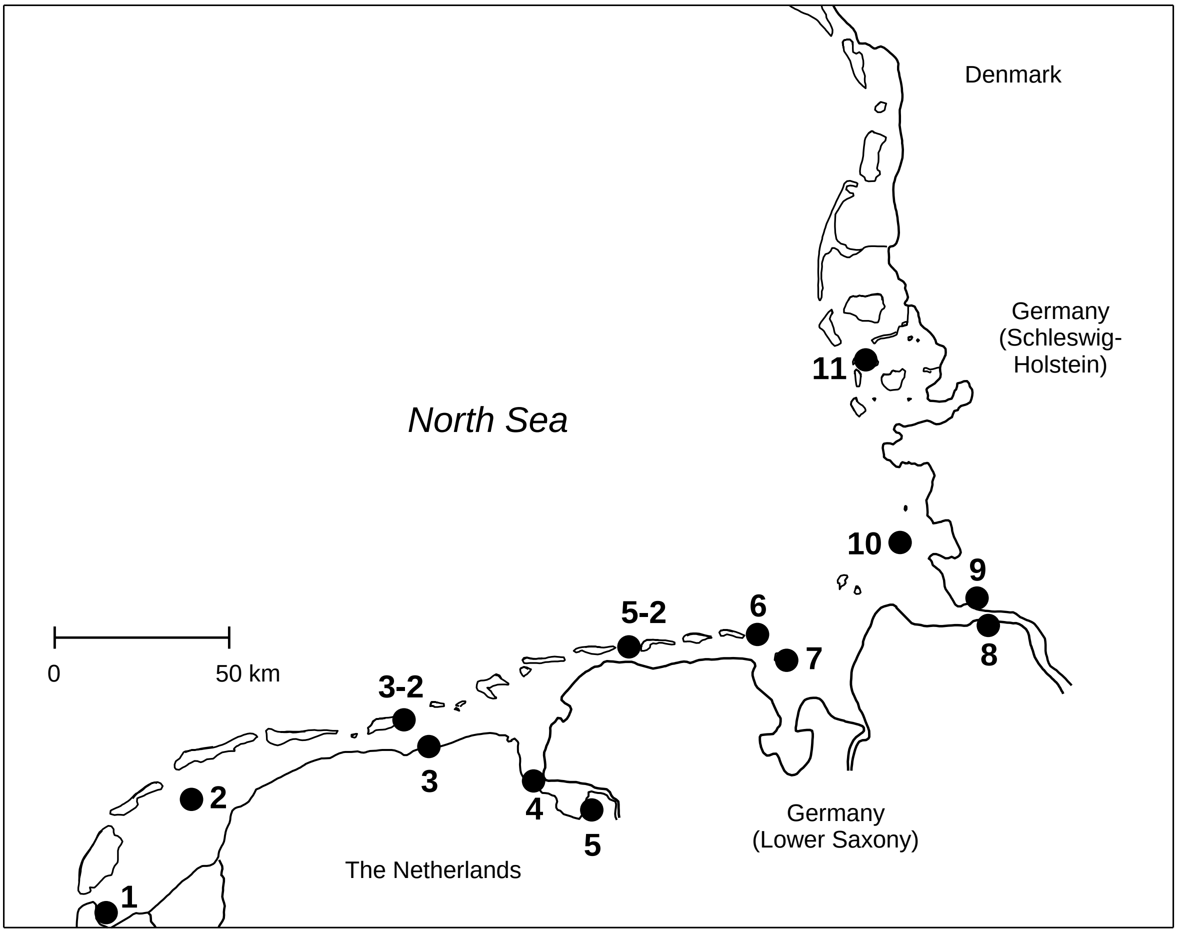


Fig. 1.1: Sampling sites of Oystercatcher and/or Common Tern eggs in the trilateral Wadden Sea.
The Netherlands: 1 Balgzand, 2 Griend, 3 Julianapolder, 3-2 Schiermonnikoog, 4 Delfzijl;
Germany, Lower Saxony: 5 Dollart, 5-2 Baltrum, 6 Minsener Oog (Oldeoog), 7 Mellum (6 and 7 = Jade), 8 Hullen (8 and 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 2019

| | 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 2019 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:

***<u>ORGANOCHLORINES:</u>***

PCB sum 62 congeners

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

HCB

HCH sum α-HCH, β-HCH, γ-HCH

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

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

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

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

***<u>HEAVY METALS:</u>***

Hg (mercury)

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

**<u>Statistics:</u>**

For analyzing temporal trends for the years 2015 – 2019, Spearman rank correlations were calculated (two-tailed) for the years 2015 - 2019. To identify potential differences in pollutant concentrations between 2018 and 2019, 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 2019

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 2019 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, Balgzand, Halligen |
| PCB: | Balgzand, Elbe (Neufelderkoog), Griend |
| HCB: | Delfzijl, Elbe (Neufelderkoog), Halligen |
| DDT: | Elbe (Neufelderkoog), Trischen, Halligen |
| HCH: | Elbe (Neufelderkoog), Halligen, Trischen |
| Chlordane: | Delfzijl, Balgzand |

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 2019 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 Ostercatchers at all. In the following areas relatively high contaminations of Oystercatcher eggs were detected in 2019 (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, Langli |
| PCB: | Elbe, Trischen, Delfzijl |
| HCB: | Delfzijl, Elbe, Trischen |
| DDT: | Elbe, Trischen, Delfzijl |
| HCH: | Griend, Elbe, Trischen |
| Chlordane: | Delfzijl, Langli, Griend |

In **Oystercatcher**, the geographical pattern of **Hg** concentrations in 2019 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 the river Elbe itself 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 2019 the average measured Hg concentration in Oystercatcher eggs from all different investigated areas was 167,0 +/- 86,3 ng/g wet weight (range 2019: 16,0 – 415,5 ng/g wet weight) and therefore a little lower compared to 2018 (average: 206,8 +/- 85,6 ng/g wet weight; range: 28,3 – 429,8 ng/g), 2017 (average: 193,9 +/- 103,8 ng/g wet weight; range: 14,7 – 556,2 ng/g wet weight), 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 wet weight). The data were in the same dimension, but there was a steady increase in the Hg concentrations.

In 2019 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 neither be verified in 2018 nor in 2019, because of the poor breeding success there. Contradicting to 2018, where PCB concentrations tended to equalize at the different locations of the Wadden Sea, in 2019 the concentration peak at the river Elbe was clearly visible and reached two to three times higher values. In 2019 the average PCB level was 572,1 +/- 320,5 ng/g wet weight (range 2019: 119,7 – 1.762,6 ng/g wet weight) and therefore higher compared to 2018 with an average PCB level of 525,1 +/- 273,2 ng/g wet weight (range: 129,3 – 1.683,9 ng/g wet weight), 2017 (average: 460,2 +/- 227,3 ng wet weight; range: 154,8 – 1.309,8 ng/g wet weight) and 2015 (average: 560,6 +/- 242,5 ng/g; range: 203,9 – 1.205,0 ng/g wet weight) but lower compared to 2016 (average: 578,7 +/- 238,4 ng/g wet weight, range: 159,3 – 1.330,0 ng/g wet weight).

As in the years before in 2019 the clearly highest concentrations of **HCB** in Oystercatcher eggs were measured at Delfzijl. But the prominent concentration peak there was again clearly visible contrary to 2018. 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 2019 the average HCB level in the whole Wadden Sea in Oystercatcher eggs was 3,1 +/- 3,8 ng/g wet weight (range 2019: 0,9 – 24,9 ng/g wet weight) and so a little lower compared to 2018 (average: 4,1 +/- 2,4 ng/g wet weight; range: 1,2 – 14,9 ng/g wet weight) 2017 (average: 3,4 +/- 4,4 ng/g wet weight; range: 0,7 – 26,5 ng/g wet weight) and 2016 (average: 3,5 +/- 3,0 ng/g wet weight; range: 0,7 – 15,1 ng/g wet weight).

For **DDT** the highest concentrations in 2019 were found in Oystercatcher eggs from the river Elbe and from Trischen. 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 2019 of 23,7 +/- 16,4 ng/g wet weight (range 2019: 6,9 – 104,3 ng/g wet weight) was lower compared to 2018 (average: 32,1 +/- 21,9 ng/g wet weight; range: 7,1 – 91,2 ng/g), 2017 (average: 27,4 +/- 16,5 ng/g wet weight; range: 6,6 – 78,8 ng/g wet weight) and 2016 (52,6 +/- 112,8 ng/g wet weight, range: 10,5 – 935,7 ng/g wet weight).

In 2019 the **HCH** concentrations showed concentration peaks at Griend and at the river Elbe. Average levels reached clearly lower values (2019 average: 1,1 +/- 1,3 ng/g wet weight, range: 0,0 – 5,5 ng/g wet weight) compared to 2018 (average: 3,2 +/- 3,7 ng/g wet weight, range: 0,0 – 25,1 ng/g wet weight) 2017 (average: 2,3 +/- 3,3 ng/g wet weight; range: 0,0 – 14,4 ng/g wet weight) and 2016 (average: 2,3 +/- 3,3 ng/g wet weight, range: 0,0 – 16,1 ng/g wet weight). In 2019 the HCH concentrations in oystercatcher eggs showed no extreme values in their geographical pattern but were rather similar to the years before.

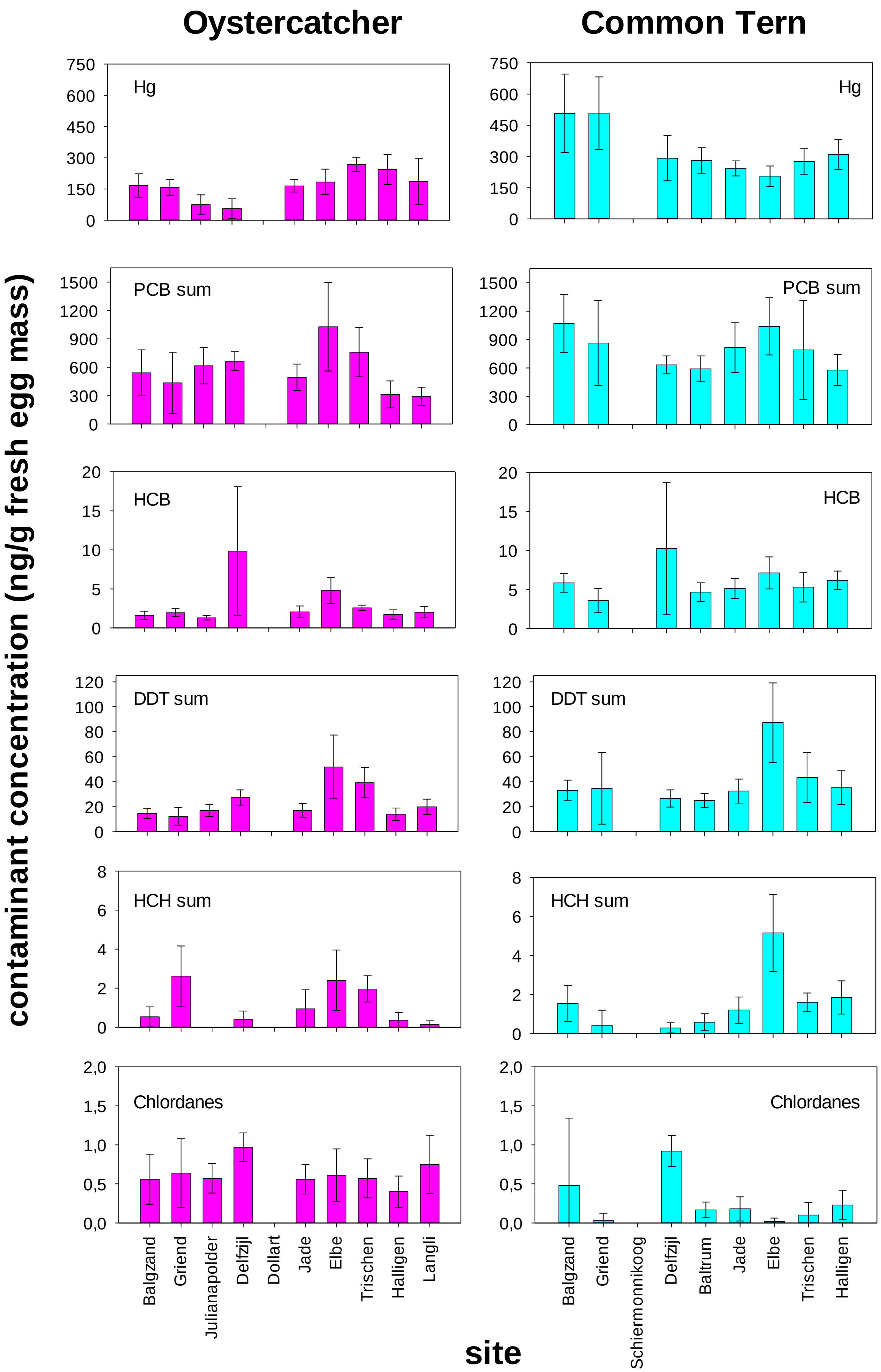


Fig. 5.1.1: Spatial patterns of pollutant concentrations in Oystercatcher and Common Tern eggs from the Wadden Sea in 2019 (means with standard deviations)

For **Chlordanes** high values in 2019 have been detected in Oystercatcher eggs from Delfzijl. But levels reached higher values in all western areas. And in general, levels of Chlordanes were clearly higher in Oystercatcher eggs compared to those from Common Tern eggs. The average Chlordane levels in 2019 in Oystercatcher eggs were 0,6 +/- 0,3 ng/g wet weight (range 2019: 0,0 – 1,8 ng/g wet weight) and therefore higher compared to average Chlordane levels in 2018 (average: 0,2 +/- 0,3 ng/g wet weight; range: 0,0 – 1,1 ng/g wet weight) but lower compared to 2017 (average: 1,1 +/- 0,6 ng/g wet weight; range: 0,2 – 2,5 ng/g wet weight).

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 2019 again, the main contamination area of **PCB**, **DDT** 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 first time lowest levels at the Elbe and peaks in the eastern parts at Balgzand and Griend. These two locations show also high amounts of PCB in Common Tern eggs as well as Delfzijl high amounts of HCB.

In 2019 the **Hg** concentrations in the Common Tern eggs showed rather equal levels, with peaks at Balgzand and Griend. The average level in 2019 of all areas was 328,4 +/- 150,9 ng/g wet weight (rang 2019: 130,6 – 871,4 ng/g) and reached lower values than in 2018 (average: 341,5 +/- 110,9 ng/g wet weight; rang: 171,8 - 644,4 ng/g wet weight) but higher values than in 2017 (average: 310,2 +/- 98,6 ng/g wet weight; rang: 150,0 - 685,2 ng/g wet weight) or in 2016 (average: 295,1 +/- 105,8 ng/g wet weight, range 138,1 – 643,3 ng/g wet weight).

For **PCB** we see in 2019 again at all areas rather similar concentrations in Common Tern eggs with an average level of 800,3 +/- 350,3 ng/g wet weight (range 2019: 231,1 – 1.404,6 ng/g). So levels were higher than 2018 (average: 684,7 +/- 287,4 ng/g wet weight; range: 231,1 – 1.404,6 ng/g), 2017 (average: 613,1 +/- 213,7 ng/g wet weight; range: 274,1 – 2.173,3 ng/g wet weight) and 2016 (average: 722,9 +/- 324,8 ng/g wet weight, range: 274,1 – 2.173,3 ng/g wet weight). Small peaks occurred at Elbe and surrounding areas as well as at Balgzand and Griend.

In 2019 the **HCB** concentrations in Common Tern eggs had an average level of 6,1 +/- 3,7 ng/g fresh weight (range 2019: 1,8 – 25,2 ng/g wet weight) and were lower than values in 2018 (average: 7,8 +/- 3,1 ng/g fresh weight; range: 2,5 – 14,9 ng/g wet weight) and 2017 (average: 6,2 +/- 2,7 ng/g fresh weight; range: 2,8 – 15,5 ng/g wet weight) but higher compared to 2016 (average: 5,9 +/- 3,9 ng/g fresh weight, range: 0,6 – 21,5 ng/g wet weight). In 2018 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 Delfzijl.

In 2019, **DDT** concentrations in Common Tern eggs were more or less in a similar range, showing an average level of 39,9 +/- 25,8 ng/g wet weight (range 2019: 12,5 - 156,3 ng/g wet weight) and a clear peak at the river Elbe. Average levels were beyond these of 2018 (average: 50,4 +/- 27,8 ng/g wet weight; range: 10,5 – 120,9 ng/g wet weight) 2017 (average: 46,9 +/- 25,6 ng/g wet weight; range: 16,3 – 130,5 ng/g wet weight) and 2016 (average: 58,6 +/- 43,8 ng/g wet weight, range: 17,9 – 231,4 ng/g wet weight).

The measured **HCH** levels in Common Tern eggs in 2019 ranged between 0,00 and 8,50 ng/g wet weight with an average of 1,59 +/- 1,72 ng/g and a peak at the Elbe. Levels were clearly higher compared to 2018 (average: 0,73 +/- 0,71 ng/g; range: 0,00 and 2,8 ng/g wet weight) and 2016 (average: 1,3 +/- 1,2 wet weight; range: 0,0 – 5,3 ng/g wet weight) but lower than in 2017 (average: 2,6 +/- 2,6 wet weight; range: 0,0 – 12,4 ng/g wet weight).

Concentrations of **Chlordanes** recorded in 2019 in Common Tern eggs were rather low in all areas with an average of 0,3 +/- 0,4 ng/g wet weight (range 2019: 0,0 – 4,8 ng/g wet weight). Values in 2019 were clearly above those of 2018 (average: 0,08 +/- 0,56 ng/g wet weight; range: 0,0 – 4,8 ng/g wet weight) but clearly beyond those of 2017 (average: 0,6 +/- 0,6 ng/g wet weight; range 0,0 – 4,4 ng/g wet weight) and of the same value of 2016 (average 0,3 +/- 0,3 ng/g wet weight; range 0,0 – 2,8 ng/g wet weight).

## 5.2 Annual variation in pollutant concentrations in the period 2015-2019

Mean contamination values for the different substance groups in the period 2015-2019 are given in Figures 8.2.1-8.2.6 in the Appendix. A summarizing overview of short-term (2018-2019) and mid-term (2015-2019) 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* 2015-2019:

| | |
|---|---|
| Oystercatcher | In the period between 2015 and 2019 a significant **decrease** was detected in DDT, HCH and Chlordanes concentration levels. |
| Common Tern | A Significant **increase** occurred in Hg and PCB levels. |

In Oystercatcher eggs sampled in 2019 the concentrations of HCB, DDT and HCH were significantly **lower** compared to 2018. In 2019 in Common Tern eggs levels of PCB, HCB, HCH and Chlordanes were significantly **higher** in comparison to 2018.

### Griend

*Temporal Trends* 2015-2019*:*

| | |
|---|---|
| Oystercatcher | Significant **decrease** was detected in HCB, DDT, HCH and Chlordanes. |
| Common Tern | Significant **decrease** was identified in levels of HCH and Chlordanes. |

Between 2018 and 2019, HCB concentrations **decreased** significantly in Oystercatcher eggs whereas levels of Chlordane **increased**. In Common Tern eggs levels of HCB **decreased** in that period whereas levels of Hg **increased**.

### Julianapolder/Schiermonnikoog

*Temporal Trends* 2015-2019*:*

| | |
|---|---|
| Oystercatcher | Significant **decreases** in the concentrations of DDT, HCH and Chlordanes were identified at Julianapolder. |
| Common Tern | Significant **decreases** in the concentrations of Hg, PCB, HCB and DDT were detected at Schiermonnikoog (only 2015 to 2017). |

In Oystercatcher eggs from 2019 sampled at Julianapolder, the concentrations of HCB, DDT and HCH **decreased** significantly compared to 2018, whereas concentrations of Chlordanes **increased**.
In 2018 and 2019 no Common Tern eggs could be sampled, so no comparisons 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 2015-2019, 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 2018-2019, 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 | | + | + | + | / | + | + | + | + | + | | / | + | + | + | | | + |

## <u>Delfzijl</u>

*<u>Temporal Trends</u>* <u>2015-2019</u>*<u>:</u>*

Oystercatcher — In the period between 2015 and 2019 significant **decreases** in the concentrations of Hg, HCH and Chlordanes occurred, whereas concentrations of PCB **increased**.

Common Tern — The concentrations of Hg, DDT and HCH **decreased** significantly, whereas concentrations of HCB **increased**.

Between 2018 and 2019 concentrations of Chlordanes in Oystercatcher eggs **increased** significantly, whereas concentrations of Hg and DDT **decreased**. In Common Tern eggs the concentrations of DDT were significantly **lower** in 2019 compared to the year before, whereas concentrations of Chlordanes were **higher**.

# 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 2019 again, the concentrations of the mentioned substances in **Oystercatcher** eggs showed only small geographical differences. But after vanishing last year the conspicuous HCB peak at Delfzijl was again clearly visible 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 2018 the measured concentrations in Oystercatcher eggs were lower in 2019 in case of Hg, HCB, DDT and HCH whereas concentrations of PCB tended to be higher.

In the **Common Tern** concentration peaks of 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 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 2018 but reached with ca. 330 ng/g wet weight again a high level. Also the PCB concentrations reached higher levels in 2019 compared to 2018. In case of HCB, DDT and Chlordanes the concentrations in Common Tern eggs tended to be lower in 2019 than in 2018 whereas concentrations of HCH tended to be higher.

In general, the species-specific spatial contamination patterns in 2019 remained similar to those recorded in 2018 and the years before: The contamination pattern of the Common Tern again showed concentration peaks at the river Elbe, but in 2019 not in case of Hg. On the other hand the contamination pattern of the Oystercatcher was in 2019 nearly similar to the Common Tern but showing different geographical peaks for Hg and HCH. 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 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 2019 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 2015-2019**, 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 Elbe Hg concentrations increased significantly in Oystercatcher eggs between 2015 and 2019, whereas Hg concentrations in Common Tern eggs decreased significantly at the same place in the same period.

In **Oystercatcher** eggs increasing concentrations were detected in case of Hg at two of the nine sampled sites as well as decreasing concentrations at two sites in the years between 2015 and 2019. In case of PCB increasing concentration were detected at one site as well as decreasing at one other. The DDT concentrations decreased significantly at eight of the nine studied sites in the years between 2015 and 2019 as well as the HCH at six and the Chlordane concentrations at seven sites, respectively. In case of HCB decreases were seen at two of the nine sampled sites as well as increases at one. In total we saw only four increases in Oystercatcher eggs in the five years, but 26 decreases and most of them were detected at the Dollart and Griend (four), as well as by Balgzand, Julianapolder, Delfzijl, Jade and Elbe (in each case three).

In the **Common Tern** eggs we detected more significant de- than increases in the period during 2015-2019 too. We saw a decrease of DDT concentrations at six and in case of Chlordanes at five of nine study sites. Hg and HCH decreased at four as well as the PCB and HCB concentrations at two of the nine sampled sites. In total we found four increased and 23 significant decreased substance levels in Common Tern eggs in the five-year-period, and most of them were detected at the Elbe (six sites) and Schirmonnikoog (four sites) as well as at Delfzijl and Trischen (three each). But Schirmonnikoog comprised only data from the period during 2015-2017, so they are not similar. Most of the increases were found in Common Tern eggs from Balgzand (Hg and PCB). 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 all sites during the five year period (Oystercatcher: nine sites; Common Tern: nine sites).

Because of lacking breeding success in **Oystercatchers** at Dollart in 2019 there were only eight sites to compare for this species between the last two years. When **comparing the year 2019 with 2018** we recorded more contamination decreases (16) than increases (7) 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 to the HCB and HCH concentrations at five of the eight investigated locations and to the DDT concentrations at four respectively. They occurred at Balgzand, Julianapolder as well as at Trischen (three decreases each).

Remarkable were the Chlordane concentrations in the Oystercatcher eggs, which increased rather uniformly at seven of the eight investigated sites between 2018 and 2019 as well as the TEQs which increased at one, respectively.

Because of the destroyed **Common Tern** nests at Schirmonnikoog due to a spring-tide in 2019 there were only eight sites to compare for this species between the last two years. Nevertheless clearly more contamination increases (13) than decreases (9) 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. Similar to the Oystercatcher the Chlordane concentrations increased rather uniformly in Common Tern eggs at five of the investigated sites between 2018 and 2019 as well as the TEQs at four. Decreases occurred in the HCB concentrations at four sites, but they increased also at one site. DDT decreased at two sites as well as Hg at three sites, but last one increased also at one site. In case of PCB two increases occurred. Most chemical groups increased between 2018 and 2019 at Balgzand (four) as well as at Elbe and Halligen (two), whereas most decreases were found at the Baltrum and also at Halligen (two).

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 2019 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 and Griend 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 2019.

When comparing the year 2019 with the previous one, both species showed a little lower Hg burden in their eggs, whereas concentrations in Oystercatcher eggs tended to be higher. In contrast the HCB concentrations were again higher, after a steady increase in the previous years until 2014 (Becker et al 2001, Mattig et al. 2014) followed by a slowly decrease (TMAP 2018).

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 2019 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 2019 at all investigated areas, whereas the HCH limit values (2 ng/g) only exceeded at the Elbe. For the Oystercatcher eggs the limit values of HCH (2 ng/g) were undercut at all investigated sites except at Trischen, Elbe and Griend. Limit values of Hg (100 ng/g) were undercut only at two places (Julianapolder and Delfzijl). However, results of 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.

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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 2019

Table 8.1.1: Concentrations of chemicals in Oystercatcher and Common Tern eggs sampled in The Netherlands in 2019. 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 | 167,0 | ± | 56,2 | 157,4 | ± | 39,2 | 75,3 | ± | 46,7 | 56,1 | ± | 46,9 |
| 6 PCB (law) | 248,3 | ± | 113,6 | 198,1 | ± | 148,7 | 282,2 | ± | 87,4 | 307,6 | ± | 44,8 |
| PCB sum | 541,9 | ± | 243,1 | 436,5 | ± | 323,1 | 616,7 | ± | 191,1 | 664,1 | ± | 100,2 |
| HCB | 1,6 | ± | 0,5 | 2,0 | ± | 0,5 | 1,3 | ± | 0,3 | 9,8 | ± | 8,3 |
| ppDDE | 14,6 | ± | 4,1 | 12,2 | ± | 7,2 | 16,9 | ± | 4,8 | 27,2 | ± | 6,0 |
| ppDDT | 0,0 | ± | 0,0 | 0,1 | ± | 0,1 | 0,0 | ± | 0,0 | 0,0 | ± | 0,0 |
| ppDDD | 0,0 | ± | 0,0 | 0,0 | ± | 0,0 | 0,0 | ± | 0,0 | 0,1 | ± | 0,1 |
| DDT sum | 14,6 | ± | 4,1 | 12,3 | ± | 7,2 | 16,9 | ± | 4,8 | 27,3 | ± | 6,1 |
| alpha-HCH | 0,0 | ± | 0,0 | 0,0 | ± | 0,0 | 0,0 | ± | 0,0 | 0,0 | ± | 0,1 |
| beta-HCH | 0,5 | ± | 0,5 | 2,6 | ± | 1,5 | 0,0 | ± | 0,0 | 0,4 | ± | 0,4 |
| gamma-HCH | 0,0 | ± | 0,0 | 0,0 | ± | 0,0 | 0,0 | ± | 0,0 | 0,0 | ± | 0,0 |
| HCH sum | 0,5 | ± | 0,5 | 2,6 | ± | 1,5 | 0,0 | ± | 0,0 | 0,4 | ± | 0,4 |
| Chlordane sum | 0,6 | ± | 0,3 | 0,6 | ± | 0,4 | 0,6 | ± | 0,2 | 1,0 | ± | 0,2 |

| | Balgzand | | | Griend | | | Schiermonnikoog | | | Delfzijl | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Common Tern** | **(N=10)** | | | **(N=10)** | | | **(N=0)** | | | **(N=10)** | | |
| Hg | 507,3 | ± | 188,7 | 508,2 | ± | 174,1 | - | ± | - | 291,9 | ± | 108,5 |
| 6 PCB (law) | 478,8 | ± | 145,0 | 395,1 | ± | 217,6 | - | ± | - | 291,2 | ± | 42,7 |
| PCB sum | 1.070,4 | ± | 306,1 | 863,8 | ± | 449,4 | - | ± | - | 632,4 | ± | 95,0 |
| HCB | 5,9 | ± | 1,2 | 3,6 | ± | 1,6 | - | ± | - | 10,3 | ± | 8,4 |
| ppDDE | 32,7 | ± | 8,1 | 34,2 | ± | 28,7 | - | ± | - | 26,5 | ± | 6,8 |
| ppDDT | 0,0 | ± | 0,0 | 0,1 | ± | 0,1 | - | ± | - | 0,0 | ± | 0,0 |
| ppDDD | 0,3 | ± | 0,4 | 0,5 | ± | 0,4 | - | ± | - | 0,1 | ± | 0,1 |
| DDT sum | 33,0 | ± | 8,3 | 34,7 | ± | 28,7 | - | ± | - | 26,5 | ± | 6,9 |
| alpha-HCH | 0,0 | ± | 0,0 | 0,0 | ± | 0,0 | - | ± | - | 0,0 | ± | 0,0 |
| beta-HCH | 1,5 | ± | 0,9 | 0,4 | ± | 0,8 | - | ± | - | 0,3 | ± | 0,3 |
| gamma-HCH | 0,0 | ± | 0,0 | 0,0 | ± | 0,0 | - | ± | - | 0,0 | ± | 0,0 |
| HCH sum | 1,5 | ± | 0,9 | 0,4 | ± | 0,8 | - | ± | - | 0,3 | ± | 0,3 |
| Chlordane sum | 0,5 | ± | 0,9 | 0,0 | ± | 0,1 | - | ± | - | 0,9 | ± | 0,2 |

## 8.2 Temporal trends of pollutant concentrations at different sites during 2015-2019

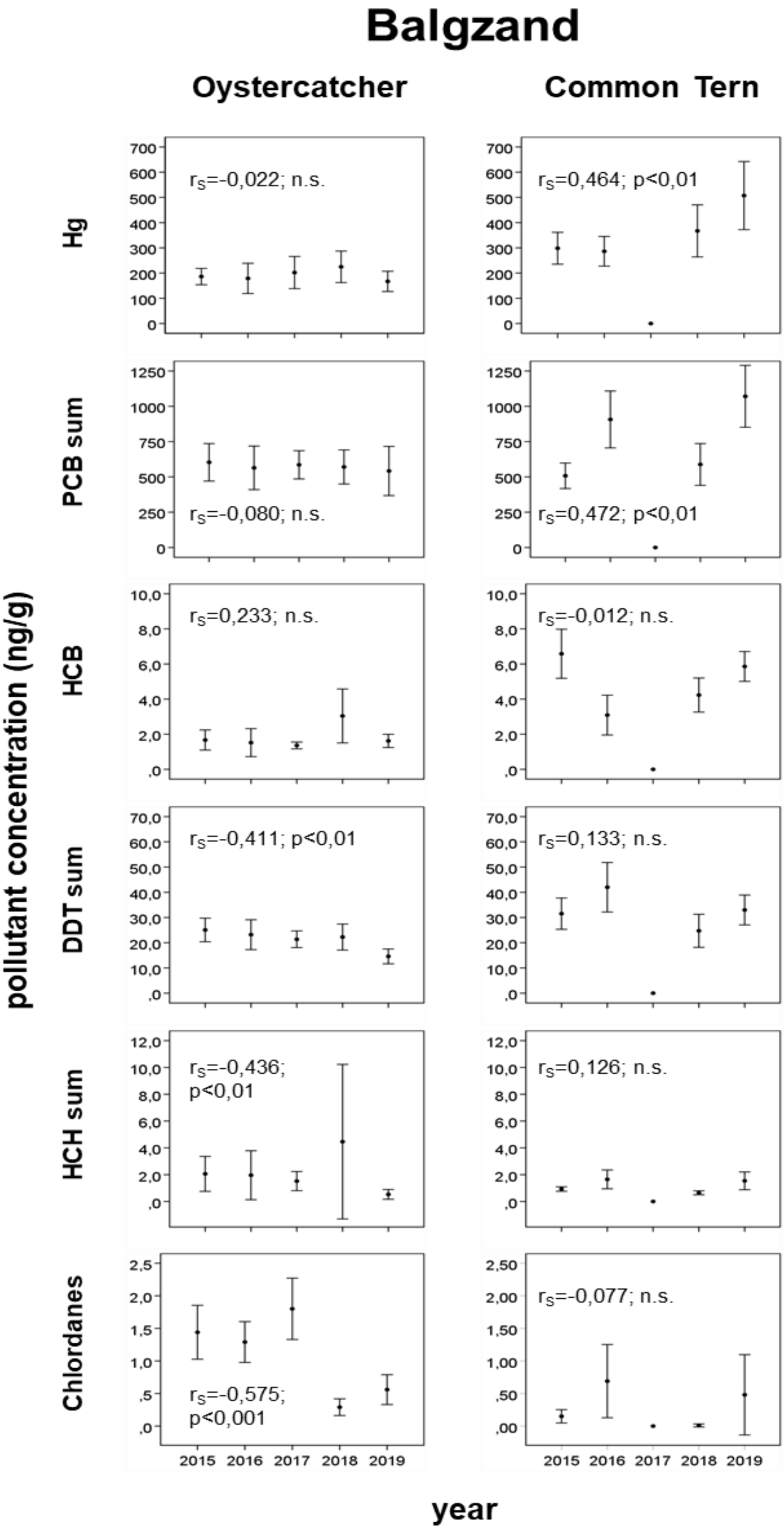


Fig. 8.2.1: Temporal development of pollutant concentrations in Oystercatcher and Common Tern eggs from Balgzand, NL, in the period 2015-2019. Arithmetic means are given with the 95% confidence interval.

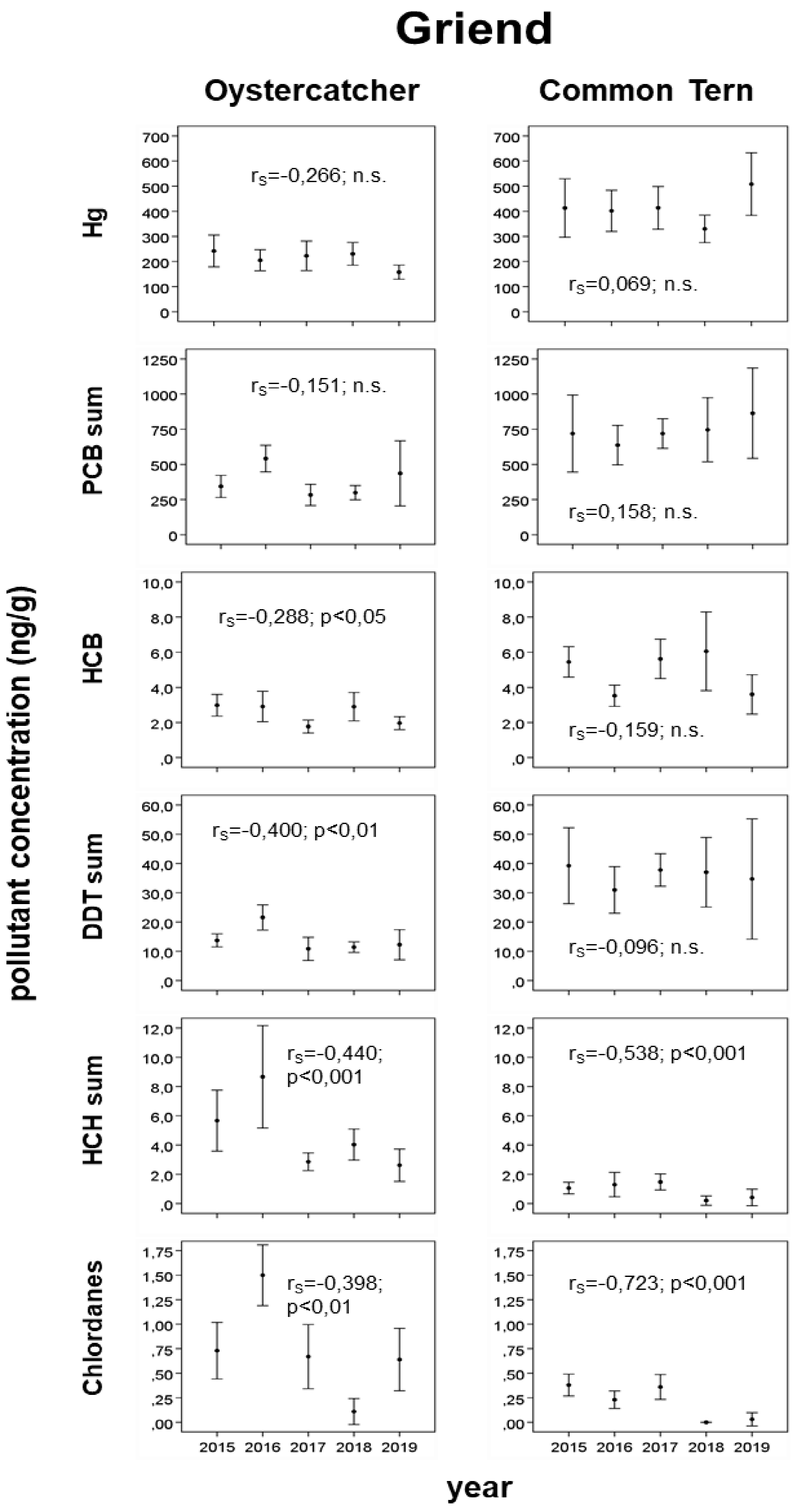


Fig. 8.2.2: Temporal development of pollutant concentrations in Oystercatcher and Common Tern eggs from Griend, NL, in the period 2015-2019. Arithmetic means are given with the 95% confidence interval.

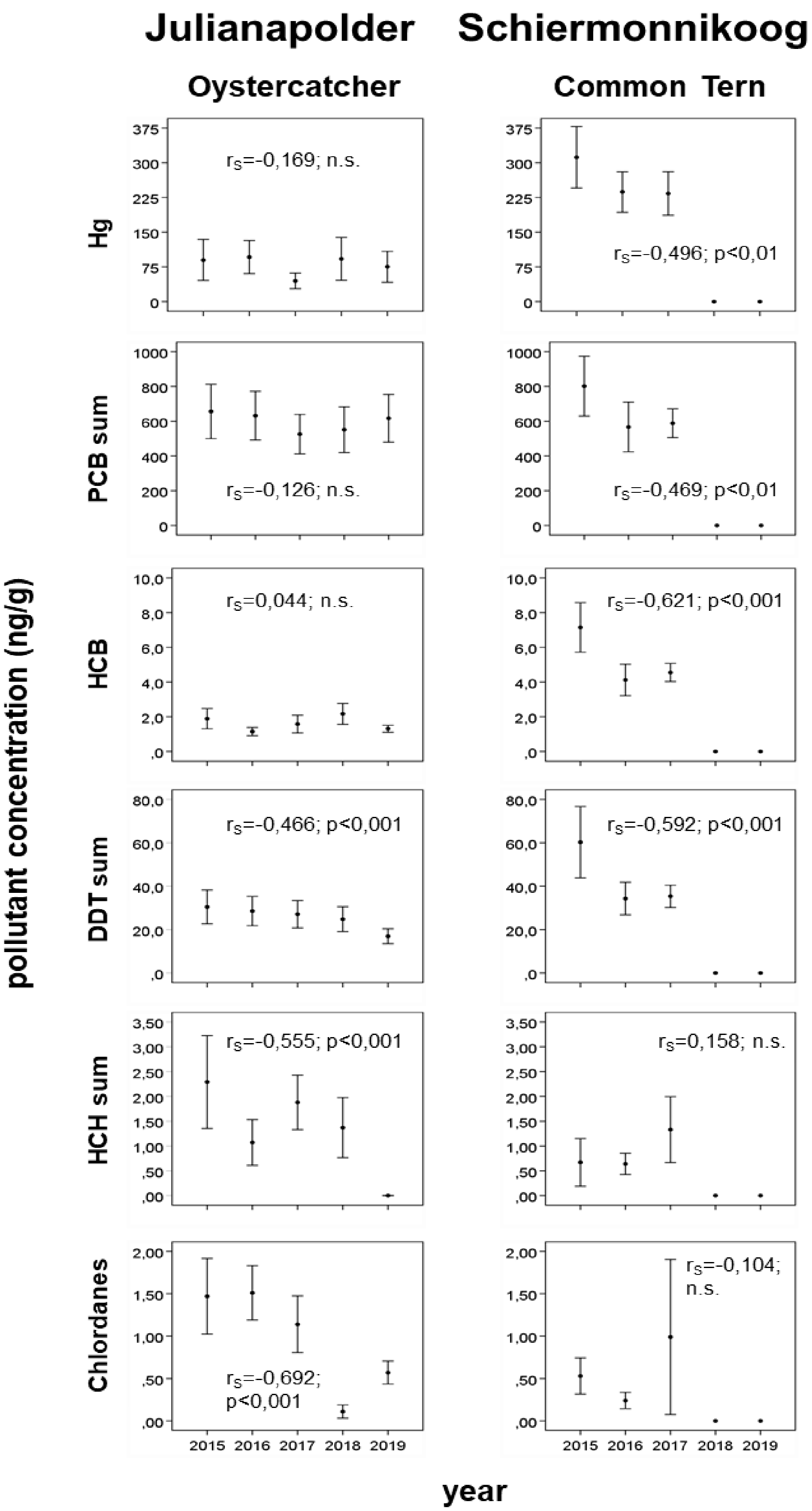


Fig. 8.2.3: Temporal development of pollutant concentrations in Oystercatcher eggs from Julianapolder and in Common Tern eggs from Schiermonnikoog, NL, in the period 2015-2019. Arithmetic means are given with the 95% confidence interval.

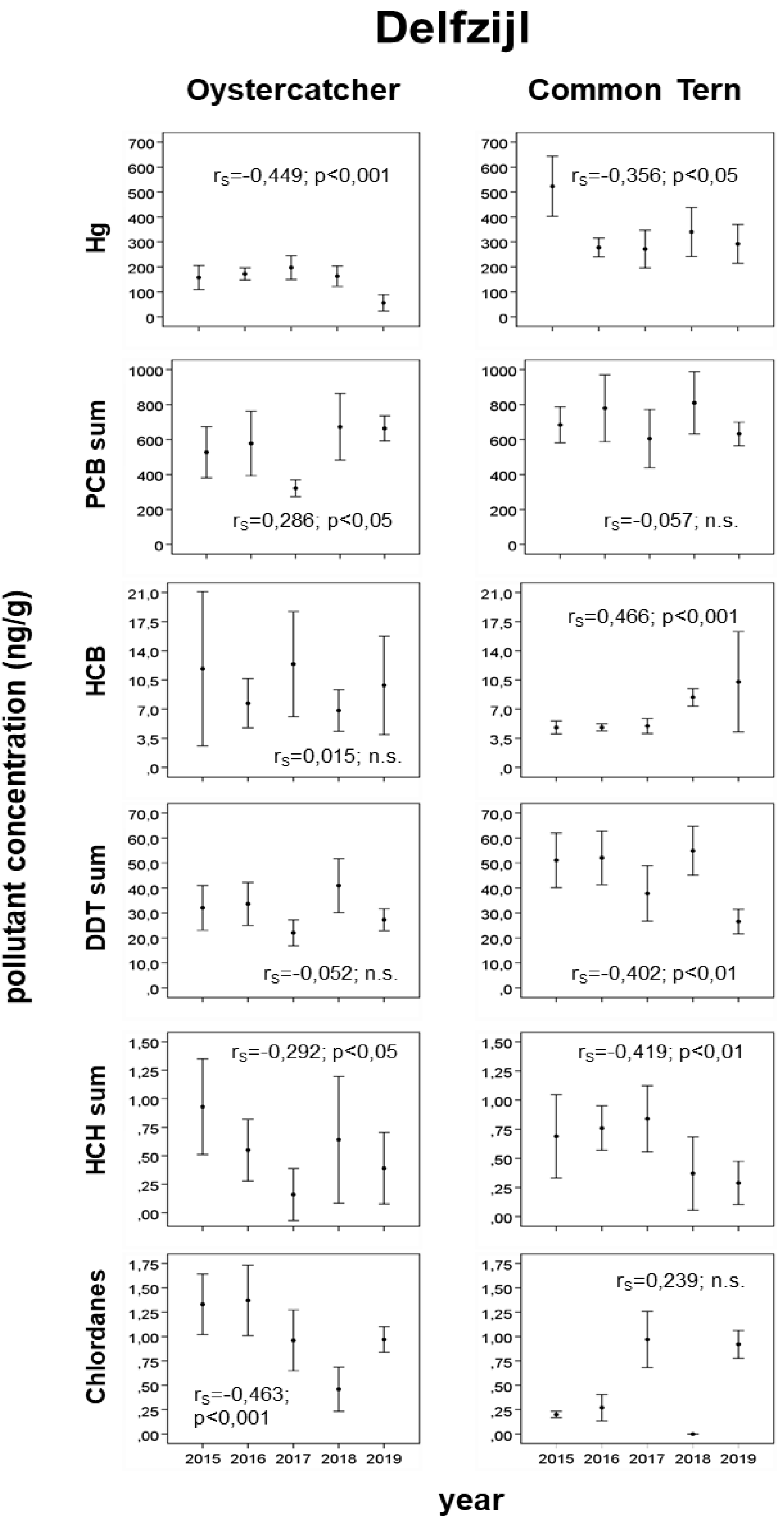


Fig. 8.2.4: Temporal development of pollutant concentrations in Oystercatcher and Common Tern eggs from Delfzijl, NL, in the period 2015-2019. Arithmetic means are given with the 95% confidence interval.