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# Documentation of the TMAP Parameter "Pollutants in seabird eggs" in The Netherlands in 2010

## 1. Egg sampling

### 1.1 Sampling sites in the Wadden Sea in 2010

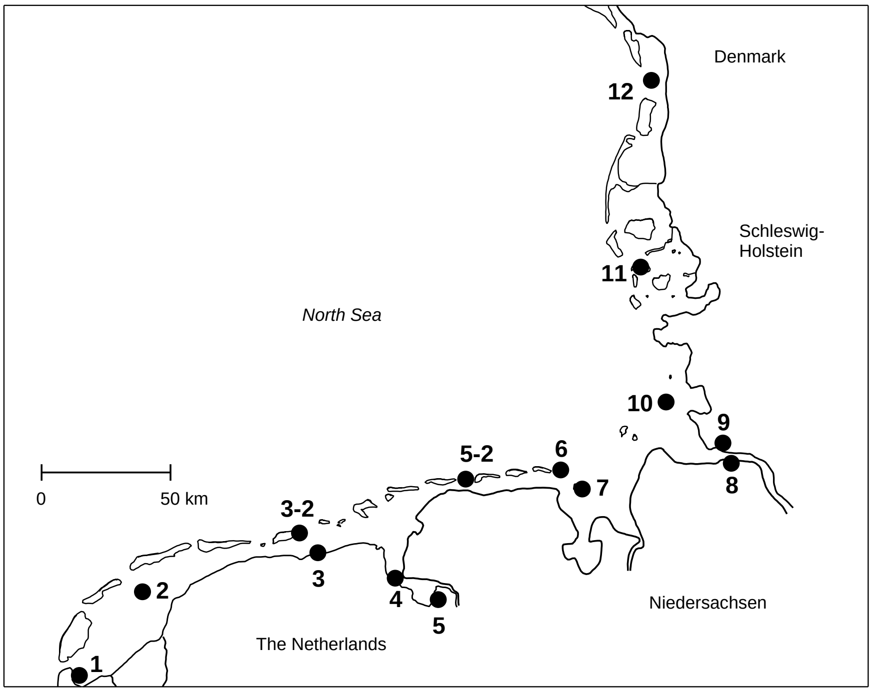


Fig. 1.1: TMAP parameter „Contaminants in bird eggs“: Sampling sites of Oystercatcher and/or Common Tern eggs in the trilateral Wadden Sea. The Netherlands: 1 Balgzand, 2 Griend, 3 Julianapolder, 3-2 Schiermonnikoog, 4 Delfzijl; Germany, Lower Saxon: 5 Dollart, 5-2 Baltrum, 6 Minsener Oog, 7 Mellum (6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

### 1.2 The following egg samples were collected in The Netherlands in 2010:

| | Species | |
|---|---|---|
| Site | Oystercatcher | Common Tern |
| Balgzand | 10 | 10 |
| Griend | 10 | 9 |
| Julianapolder | 7 | - |
| Schiermonnikoog | - | 9 |
| Delfzijl | 10 | 6 |

### 1.3 Sampling: See OSPAR (1997), Becker et al. (2001) and VDI (2009) for methods

## 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 2010 are documented in an EXCEL-file (already sent on disk). 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 present 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) |
| TEQs | Sum of concentrations of 10 of 12 dioxin-like PCBs PCB126, PCB169, PCB105, PCB114, PCB118, PCB123, PCB156, PCB157, PCB167, PCB189), each multiplied with a specific toxicity equivalence factor (TEF) depending on the toxicity of the substance in relationship to the most toxic substance “dioxin” (2,3,7,8-TCDD) for which TEF is defined as 1 (Van den Berg et al. 1998) |
| 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 |

***HEAVY METALS:***

Hg (mercury)

All concentrations are given in $ng \cdot g^{-1}$ fresh weight of the eggs, the TEQs in $pg \cdot g^{-1}$ fresh weight of the eggs.

**Statistics:**

For analysing temporal trends Spearman rank correlations were calculated (two-tailed) for the years 2006 - 2010. To identify potential differences in pollutant concentrations between 2009 and 2010, 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 Annual variation in pollutant concentrations in the period 2006-2010

In most areas concentrations decreased over the five year period or changed insignificantly. Here, we address only significant increases over the five year period or between 2009 and 2010 (Table 8.3.1, Fig. 8.3.1 – 8.3.6).

### Balgzand

*Oystercatcher*: HCH-concentrations have been increasing over the five year period.
In *Common Tern* eggs, concentrations of Hg, PCB and HCH were **higher** in 2010 compared to 2009.

### Griend

*Common Tern*: Between 2009 and 2010, Hg PCB, HCB and HCH concentrations **increased** in Common Tern eggs.

### Julianapolder/Schiermonnikoog

In *Common Tern* eggs from 2010, the concentrations of Hg, HCB and HCH were significantly **higher** than in 2009.

### Delfzijl

In 2010, significantly **higher** levels of HCH than in 2009 were found in *Oystercatcher* eggs. Between 2009 and 2010, levels of HCB and HCH **increased** in *Common Tern* eggs.

## 5.2 Spatial patterns of selected contaminants in the Wadden Sea in 2010

In the following areas a comparatively high contamination with certain pollutants could be found in **Oystercatcher** eggs (in the order of mean contamination level, beginning with the highest):

| | |
|---|---|
| Mercury: | Trischen, Halligen, Balgzand, Mandø |
| PCB: | Elbe, Dollart, Delfzijl |
| HCB: | Delfzijl, Elbe |
| DDT: | Elbe, Trischen, Delfzijl, Dollart |
| HCH: | Jade, Trischen, Halligen, Elbe |
| Chlordanes: | Dollart, Delfzijl |

Like in previous years, concentrations of most pollutants were higher in the **Common Tern** than in the Ostercatcher. In the following areas relatively high contaminations of Common Tern eggs were detected (given in the order of contamination level, beginning with the highest average level):

| | |
|---|---|
| Mercury: | Elbe, Trischen, Halligen, Balgzand, Griend, Delfzijl |
| PCB: | Elbe, Trischen, Griend, Delfzijl |
| HCB: | Elbe |
| DDT: | Elbe, Trischen |
| HCH: | Elbe, Trischen |
| Chlordanes: | Trischen |

In the **Oystercatcher** the spatial pattern of pollutant concentrations in 2010 was still relatively similar to that of the previous two years (cf. last report, Becker & Dittmann 2009) in Hg, PCB, HCB and HCH: Peak levels of Hg were found in the vicinity of the Halligen and Trischen and comparatively low values were measured in Julianapolder, Delfzijl and Mandø. In PCB comparatively high levels were once again found at the Elbe and Dollart, as well as in Trischen and Delfzijl. Peak values of HCB were recorded in Delfzijl, which surpassed the values from 2009, while concentrations at the Elbe were lower than in the previous year. Highest mean concentrations of HCH were found at the Jade and Trischen. In 2010, increased values of DDT were found at the Dollart and Delfzijl, as well as at the Elbe and Trischen. The spatial pattern of chlordanes in 2010 was similar to that of the previous year, with highest concentrations at the Dollart and in Delfzijl.

The geographical pattern of contaminants found in eggs of the **Common Tern** was very similar to that found in 2009: By far the highest concentration of Hg, PCB, HCB, DDT and HCH were yet again found at the Elbe, with more or less abruptly declining concentrations to be found to the North and West. Contrary to the other contaminants, mercury levels were higher at almost all locations or even doubled (see Table 8.3.2). Chlordane reached only one extreme value in Trischen.

## 5.3 Temporal trends and spatial patterns in TEQs

Singular elevated values of TEQs in Oystercatchers and Common Terns, as were found in 2009 (see Fig. 8.4.1), could not be seen in 2010. Differences in spatial distribution were minor, even in the Common Tern that showed double TEQ values at the Elbe, as compared to other locations.

# 6. General Assessment

The spatial patterns of pollutants in the year 2010 were very similar to the previous year. In the Common Tern, concentrations in all tested substance groups were by far the highest at the Elbe. Similar to previous years, contamination levels sunk continuously in relation to distance towards the North and West of the Elbe estuary.

In the Oystercatcher elevated levels in concentrations of multiple substance groups were found not only at the Elbe or Trischen, but also in the Western part of the Wadden Sea. These substance groups comprised of the industrial chemicals PCB and HCB, as well as insecticides DDT and chlordane that were measured in highest concentration at the Dollart and in similarly high concentrations as at the Elbe and Trischen. Mercury and PCB levels were also elevated in the area of Balgzand (mercury was also elevated in the Common Tern), which indicates influx from Rhein and Schelde, which arrives at the Western Wadden Sea through sea currents.

While showing a similar spatial pattern, mercury concentrations in Common Tern eggs were found to have doubled in 2010, as compared to 2009. This was not found in Oystercatcher eggs. Reasons for this development are unknown. The strongest increases were found in the Western Wadden Sea (and also in a Belgian colony, unpublished data 2010) and affected mainly the migratory Common Tern. This could indicate that the source of the mercury contamination was outside the Wadden Sea. The eruption of the Icelandic volcano Eyafjallajökull caused an ash cloud that was spread to the Wadden Sea by northwesterly winds between April 14$^{th}$ and April 25$^{th}$. However, experts consider the contamination with mercury by volcanic ash to be very low and therefore this can be disregarded as a cause for the significantly increased concentrations in Common Tern eggs throughout the Wadden Sea.

Like in previous years, the data highlight the importance of the large rivers Elbe and Ems and possibly Rhein (Balgzand) for the influx of various environmental pollutants into the Wadden Sea. Concentrations of contaminants in the eggs of Common Terns were generally higher than in eggs of Oystercatchers, which is due to terns being piscivorous and thereby on a higher trophic level, which causes stronger accumulation of pollutants.

Despite some increases between 2009 and 2010, the concentrations of many contaminants decreased over the five year period 2006 to 2010 in several areas. In the Oystercatcher three significant increases were accompanied by 22 significant decreases, in the Common Tern two significant increases and 20 significant decreases were found. The notably elevated concentrations of TEQs in the central Wadden Sea from 2008 (see last year's report) have also strongly decreased. In general the condition for coastal birds in the Wadden Sea has considerably improved over the last five years.

However, in 2010 elevated concentrations were found in several areas compared to 2009, which shows that the Wadden Sea is still subject to chemical contamination. In the Common Tern the levels of 2010 were significantly lower than in 2009 in only two cases, but significantly higher in 26 cases. In the Oystercatchers values were lower in four cases, but higher in eleven cases. Especially striking were the elevated mercury concentrations in the Common Tern in almost all areas (see above), as well as HCH concentrations that have been rising in Trischen, Schiermonigkoog and Julianpolder since 2008. It is remarkable that HCB concentrations have risen so strongly at the Dollart since 2007 that they are measurable in Germany as well, despite intensive restrictions of HCB sources at industrial sites in Delfzijl in the early 2000s (Becker & Dittmann 2009).

In conclusion, once again recent results show noticeable differences between the geographical distribution of contamination in the two study species, due to continuing fluvial influx of pollutants. While the river Elbe continues to be the most important source of pollution for Common Terns, the Dollart has emerged as an additional major source of contamination for the Oystercatcher, probably through influx from industry situated along the Ems. Although long-term trends of contamination levels in coastal birds were mostly decreasing, recent increases in some pollutants demand a continuing monitoring with high spatial and temporal resolution.

# 7. Literature

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# 8. Enclosures

8.1 Concentrations of selected contaminants in eggs of Oystercatcher and Common Tern at different sites of the Dutch Wadden Sea 2010
8.2 Spatial patterns in pollutant concentration in eggs of Oystercatcher and Common Tern in the Dutch, German and Danish Wadden Sea in 2010
8.3 Temporal trends of pollutant concentrations at different sites during 2006-2010
8.4 Temporal and spatial trends in TEQ concentrations

# 9. This report was compiled by Peter H. Becker, Katharina Weißenfels and Ursula Pijanowska.

Wilhelmshaven, 31 January 2011

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(Prof. Dr. Peter H. Becker)

## 8.1 Concentrations of selected contaminants in eggs of Oystercatcher and Common Tern at different sites of the Dutch Wadden Sea 2010

Table 8.1.: Concentrations of chemicals in Oystercatcher and Common Tern eggs sampled in The Netherlands in 2010. Mean concentrations in ng · g $^{-1}$ ( fresh mass of egg content), standard deviations and number of samples are presented.

| Oystercatcher | Balgzand (N=10) | Griend (N=10) | Julianapolder (N=7) | Delfzijl (N=10) |
|---|---|---|---|---|
| Hg | 251,5 ± 51,2 | 150,7 ± 38,3 | 118,4 ± 33,2 | 156,9 ± 44,0 |
| 6 PCB (law) | 240,8 ± 60,3 | 185,4 ± 42,9 | 252,4 ± 108,2 | 356,8 ± 199,2 |
| PCB sum | 467,6 ± 122,0 | 332,9 ± 79,1 | 483,7 ± 211,2 | 688,3 ± 391,6 |
| HCB | 2,1 ± 0,5 | 2,4 ± 0,3 | 1,3 ± 0,3 | 25,8 ± 11,8 |
| ppDDE | 17,7 ± 4,6 | 12,3 ± 4,3 | 19,9 ± 8,4 | 50,9 ± 31,5 |
| ppDDT | 0,0 ± 0,0 | 0,0 ± 0,0 | 0,0 ± 0,0 | 0,1 ± 0,2 |
| ppDDD | 0,1 ± 0,0 | 0,0 ± 0,0 | 0,0 ± 0,0 | 0,2 ± 0,2 |
| DDT sum | 17,8 ± 4,6 | 12,4 ± 4,3 | 19,9 ± 8,5 | 51,3 ± 31,8 |
| alpha-HCH | 2,2 ± 0,9 | 2,9 ± 0,4 | 2,4 ± 0,3 | 1,8 ± 0,9 |
| beta-HCH | 1,2 ± 1,0 | 1,2 ± 1,1 | 0,7 ± 1,3 | 0,8 ± 0,6 |
| gamma-HCH | 0,0 ± 0,0 | 0,0 ± 0,1 | 0,0 ± 0,0 | 0,0 ± 0,0 |
| HCH sum | 3,4 ± 1,1 | 4,1 ± 1,2 | 3,2 ± 1,3 | 2,6 ± 1,1 |
| Chlordane sum | 0,5 ± 0,3 | 0,4 ± 0,3 | 0,2 ± 0,3 | 0,9 ± 0,7 |

| Common Tern | Balgzand (N=10) | Griend (N=9) | Schiermonnikoog (N=9) | Delfzijl (N=6) |
|---|---|---|---|---|
| Hg | 484,3 ± 64,0 | 489,9 ± 128,9 | 367,706 ± 124,1256 | 303,891 ± 73,607 |
| 6 PCB (law) | 271,4 ± 55,8 | 429,6 ± 130,9 | 260,6 ± 120,2 | 353,8 ± 79,9 |
| PCB sum | 520,8 ± 107,3 | 826,0 ± 253,5 | 515,7 ± 250,5 | 729,1 ± 166,3 |
| HCB | 3,8 ± 0,4 | 5,1 ± 1,3 | 5,2 ± 2,0 | 8,2 ± 2,1 |
| ppDDE | 31,7 ± 6,5 | 44,1 ± 13,1 | 39,3 ± 17,7 | 51,1 ± 14,3 |
| ppDDT | 0,0 ± 0,0 | 0,1 ± 0,3 | 0,0 ± 0,0 | 0,1 ± 0,2 |
| ppDDD | 0,2 ± 0,1 | 0,3 ± 0,2 | 0,3 ± 0,2 | 0,5 ± 0,6 |
| DDT sum | 31,8 ± 6,5 | 44,4 ± 13,3 | 39,6 ± 17,9 | 51,7 ± 14,5 |
| alpha-HCH | 2,2 ± 0,4 | 3,3 ± 0,6 | 3,3 ± 0,3 | 3,5 ± 1,6 |
| beta-HCH | 0,7 ± 0,8 | 0,0 ± 0,0 | 0,3 ± 0,7 | 0,2 ± 0,3 |
| gamma-HCH | 0,0 ± 0,0 | 0,0 ± 0,0 | 0,0 ± 0,1 | 0,0 ± 0,0 |
| HCH sum | 3,0 ± 0,8 | 3,3 ± 0,6 | 3,6 ± 0,9 | 3,7 ± 1,5 |
| Chlordane sum | 0,0 ± 0,0 | 0,0 ± 0,0 | 0,0 ± 0,0 | 0,0 ± 0,0 |

## 8.2 Spatial patterns of pollutant concentration in the Wadden Sea in 2010

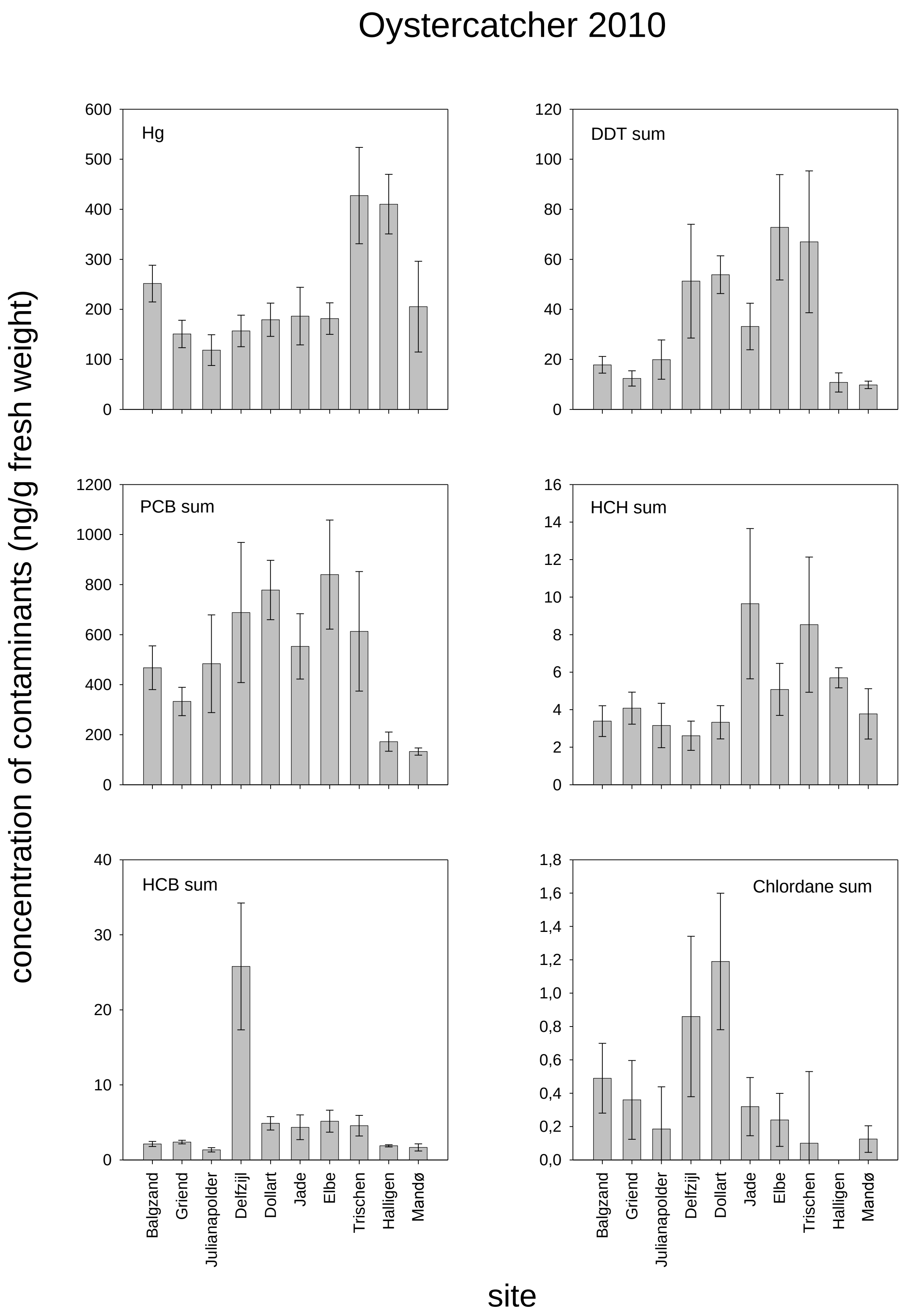


Fig. 8.2.1: Spatial patterns of pollutant concentrations in Oystercatcher eggs from the Wadden Sea in 2010

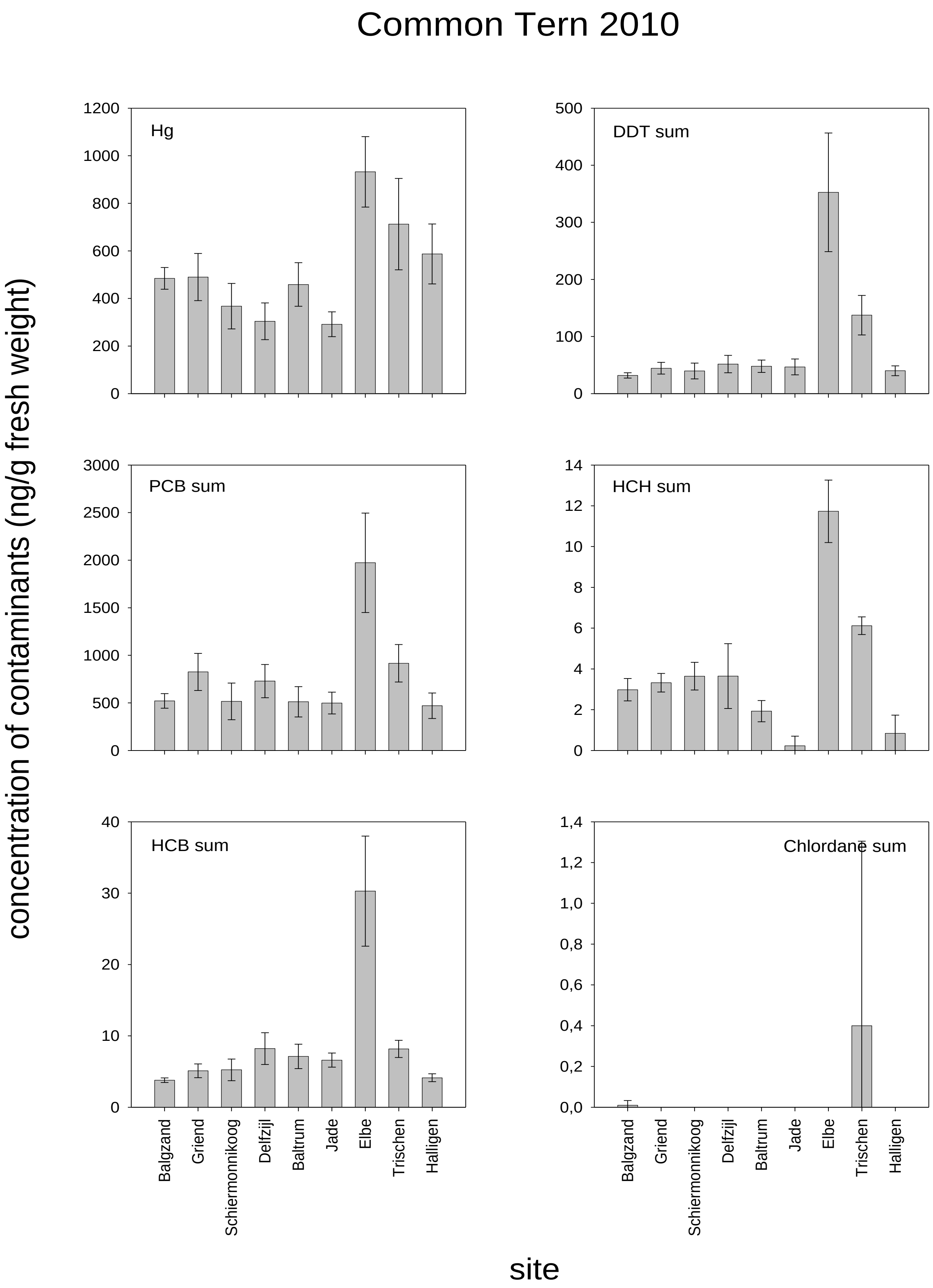


Fig. 8.2.2: Spatial patterns of pollutant concentrations in Common Tern eggs from the Wadden Sea in 2010

## 8.3 Temporal trends of pollutant concentrations at different sites during 2006-2010

Table 8.3.1: Overview over the development of selected pollutants in eggs of Oystercatcher and Common Tern in the Wadden Sea between 2006-2010, according to Spearman rank correlations. -: significant decline, +: significant increase.

| | Oystercatcher | | | | | | | | | | Common Tern | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Balgzand | Griend | Julianapolder | Delfzijl | Dollart | Jade | Hullen | Trischen | Halligen | Langli/ Mandø | Balgzand | Griend | Schiermonnikoog | Delfzijl | Baltrum | Jade | Neufelderkoog | Trischen | Halligen |
| Hg | | - | | | + | | - | | | | | | | - | | | | | + |
| PCB sum | | | - | | - | | | | - | - | - | - | - | | - | | | | |
| HCB | | | - | | | | - | | | - | - | | | | | + | - | | - |
| DDT sume | | - | - | - | | | | | - | - | - | - | - | - | | | - | | |
| HCH sum | + | | | | | + | | - | | | | | | | | - | - | | |
| Chlordan Nonachlor sum | - | - | - | | - | - | | - | - | - | - | - | - | | - | - | - | | - |

Table 8.3.2: Overview over the development of selected pollutants in eggs of Oystercatcher and Common Tern in the Wadden Sea between 2009-2010, according to Mann-Whitney-U-tests.
-: significant decline, +: significant increase. In the case of Oystercatchers, trends for Mandø and Trischen are given in brackets because the sample sizes of 4 and 3 eggs were too small to conduct pairwise tests.

| | Oystercatcher | | | | | | | | | | Common Tern | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Balgzand | Griend | Julianapolder | Delfzijl | Dollart | Jade | Hullen | Trischen | Halligen | Langli/ Mandø | Balgzand | Griend | Schiermonnikoog | Delfzijl | Baltrum | Jade | Neufelderkoog | Trischen | Halligen |
| Hg | | | | | | | | (+) | + | | + | + | + | | + | | + | + | + |
| PCB sum | | | | | + | | | | | (-) | + | + | | | | | + | + | |
| HCB | | | - | | | | | (+) | + | (+) | - | + | + | + | + | | + | + | |
| DDT sum | - | | - | | + | | | | + | (-) | | | - | | + | | + | + | |
| HCH sum | | | | + | + | + | | | + | (+) | + | + | + | + | + | | + | + | |
| Chlordan Nonachlor sum | | | | - | | | | | | | | | | | | | | | |

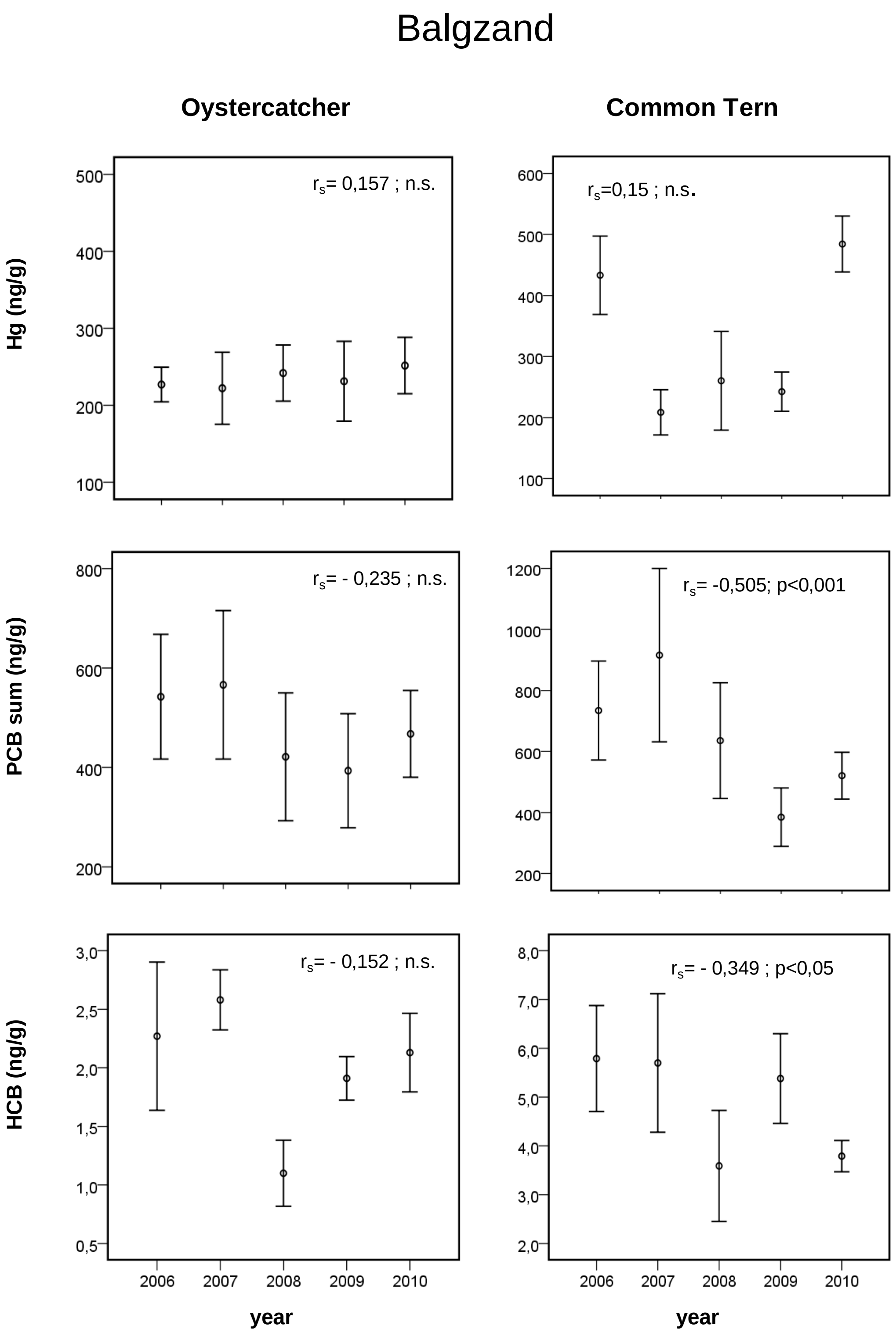


Fig. 8.3.1: Temporal development of pollutant concentrations in Oystercatcher and Common Tern eggs from Balgzand, NL, in the period 2006-2010. Arithmetic means are given with the 95% confidence interval.

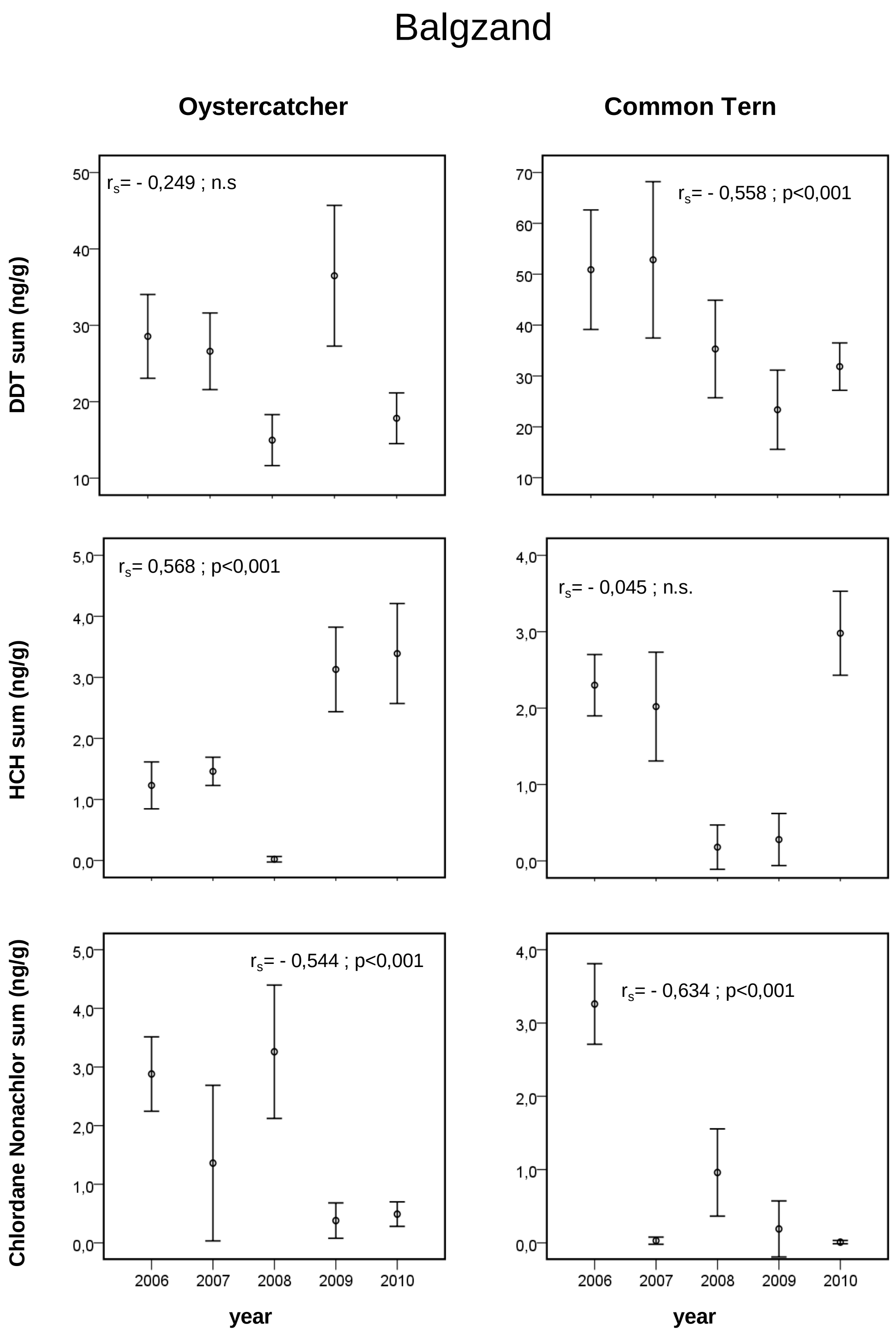


Fig. 8.3.1 (continued): Temporal development of pollutant concentrations in Oystercatcher and Common Tern eggs from Balgzand, NL, in the period 2006-2010. Arithmetic means are given with the 95% confidence interval.

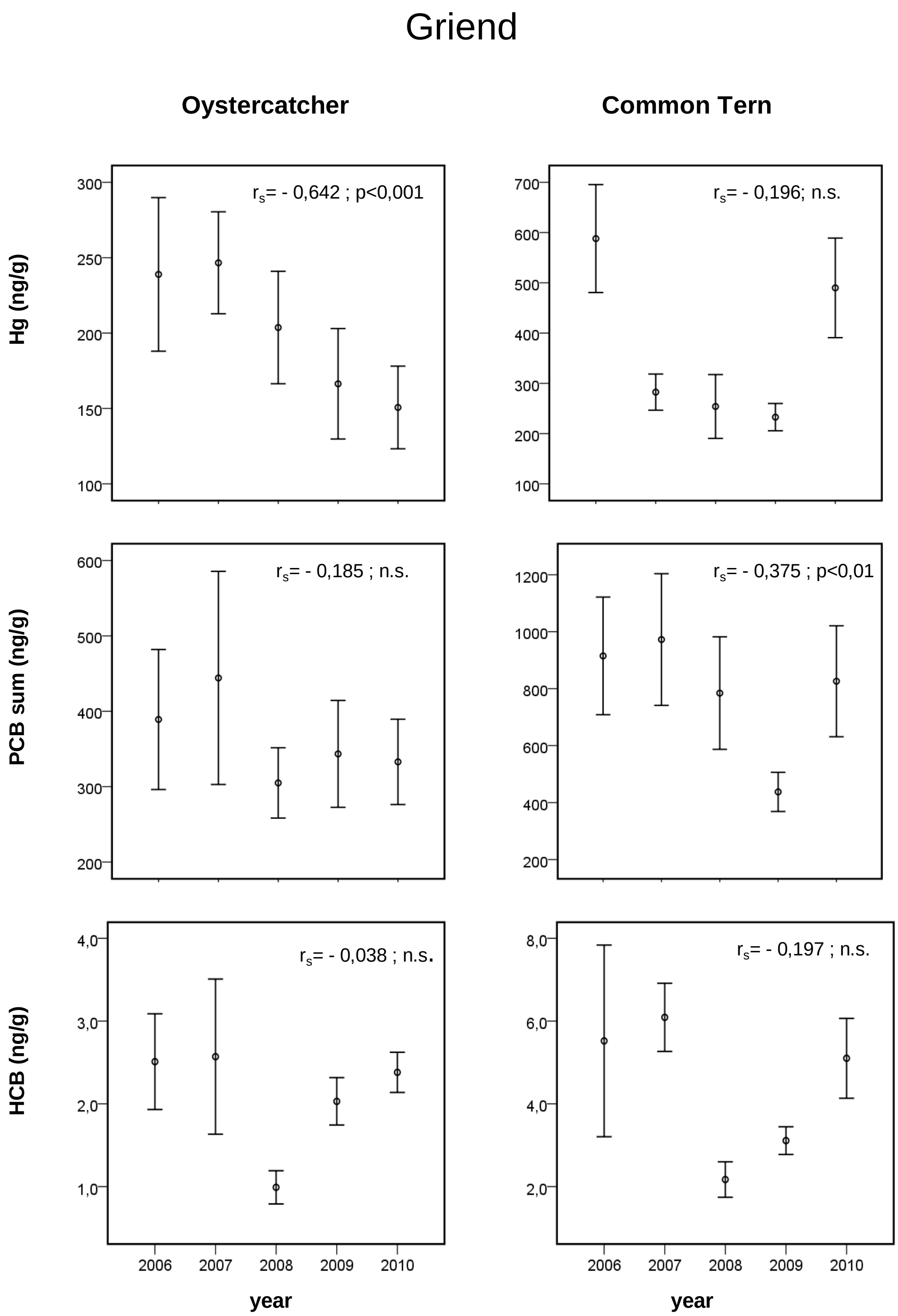


Fig. 8.3.2: Temporal development of pollutant concentrations in Oystercatcher and Common Tern eggs from Griend, NL, in the period 2006-2010. Arithmetic means are given with the 95% confidence interval.

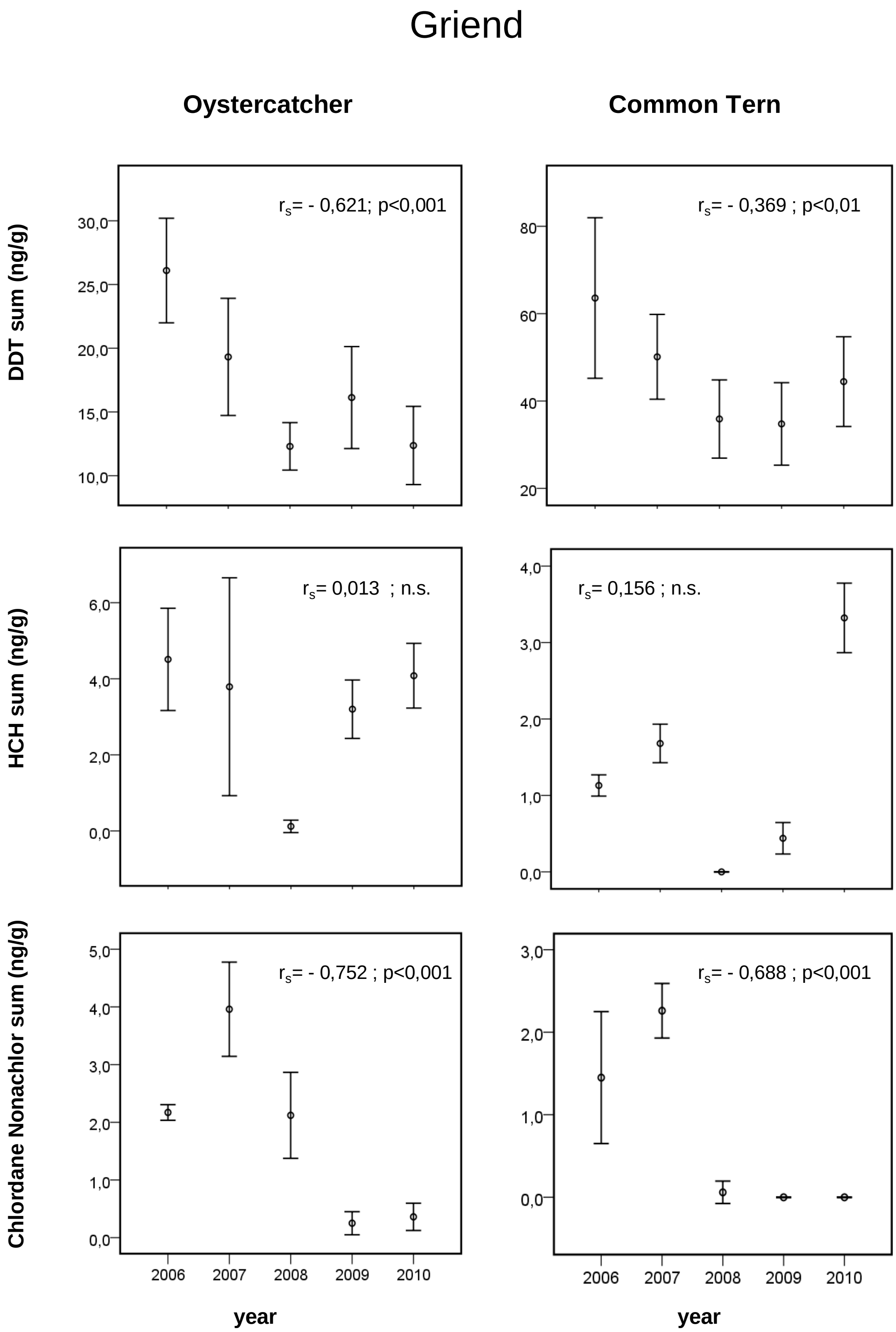


Fig. 8.3.2 (continued): Temporal development of pollutant concentrations in Oystercatcher and Common Tern eggs from Griend, NL, in the period 2006-2010. Arithmetic means are given with the 95% confidence interval.

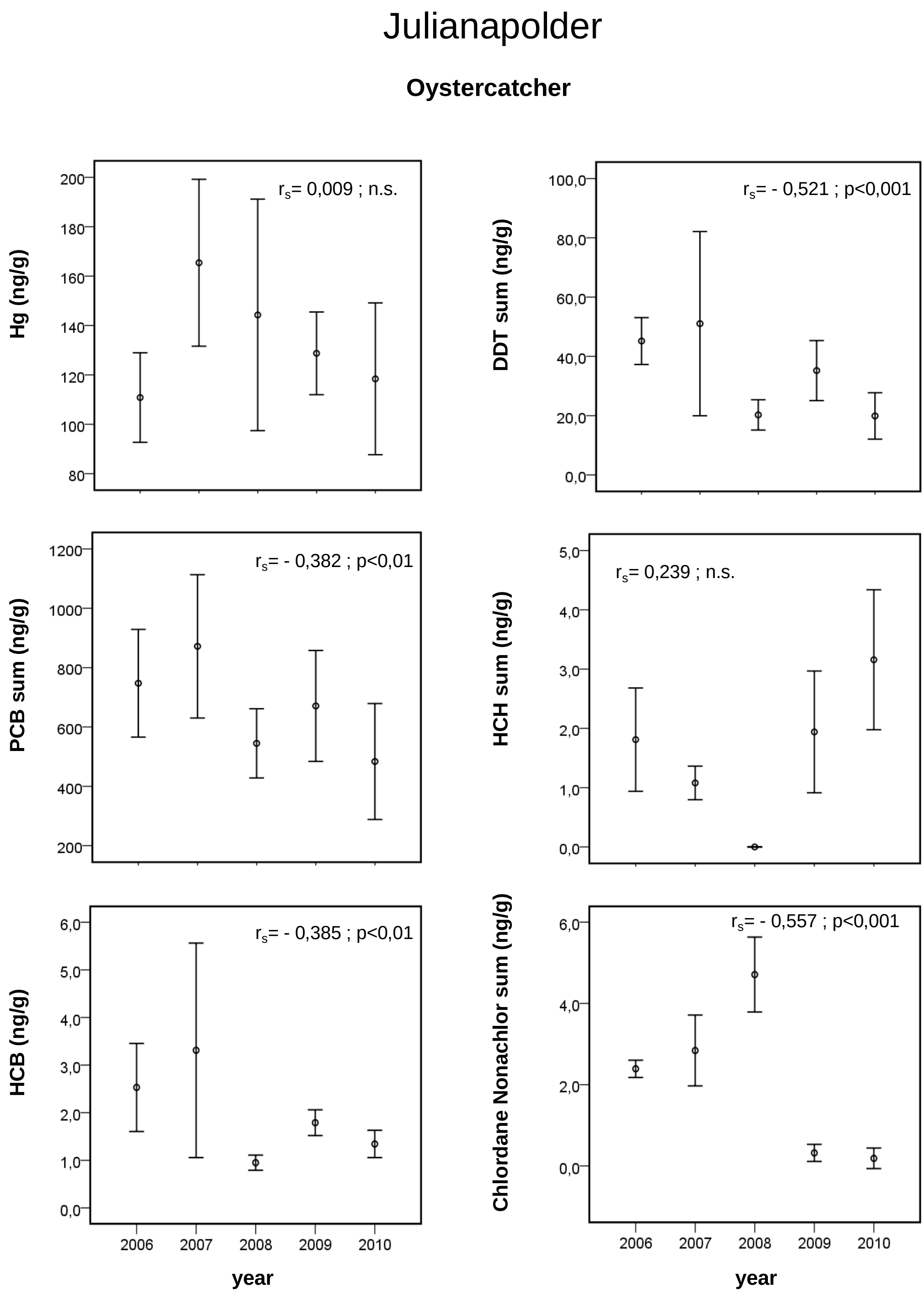


Fig. 8.3.3: Temporal development of pollutant concentrations in Oystercatcher eggs from Julianapolder, NL, in the period 2006-2010. Arithmetic means are given with the 95% confidence interval.

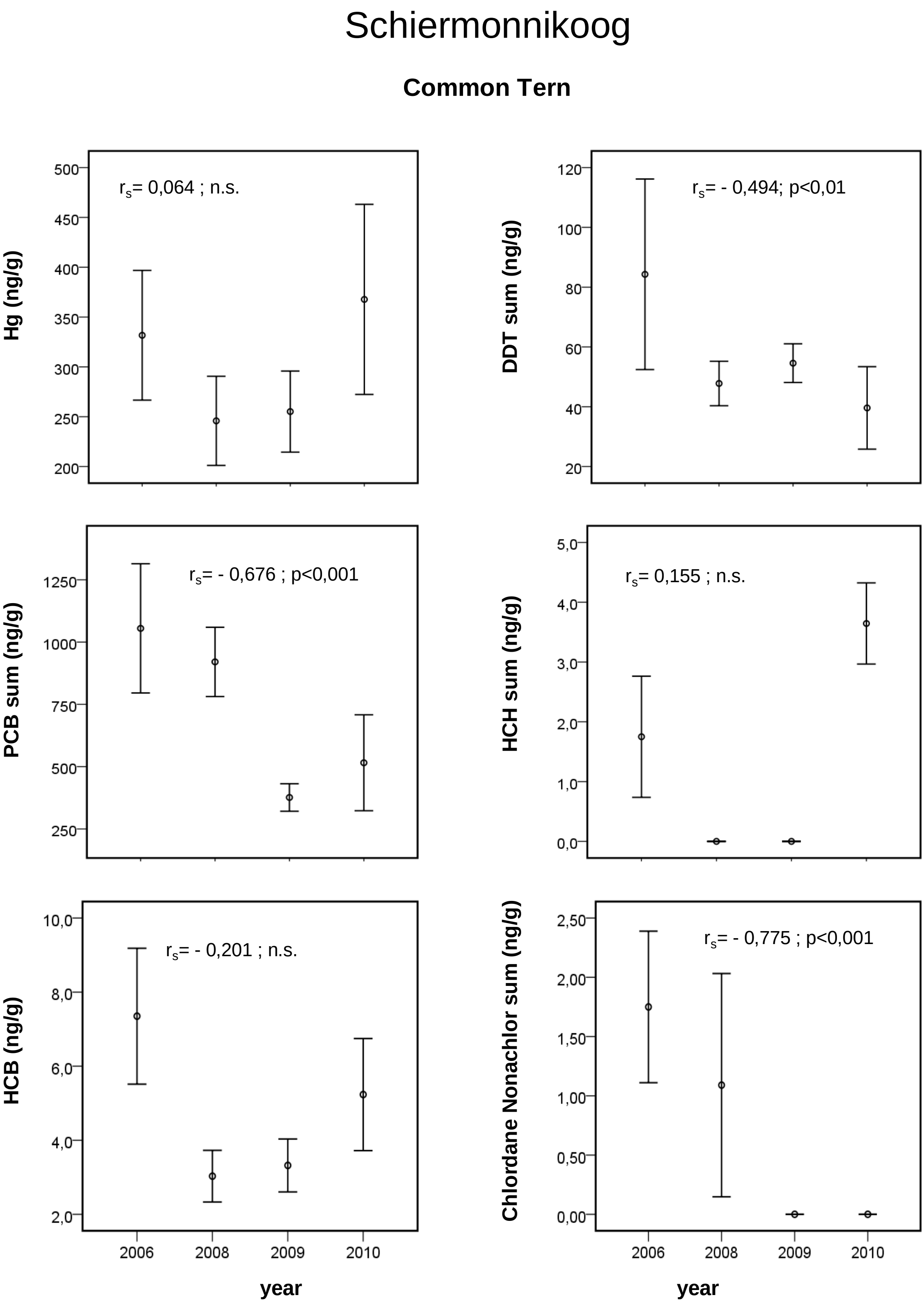


Fig. 8.3.4: Temporal development of pollutant concentrations in Common Tern eggs from Schiermonnikoog, NL, in the period 2006-2010. Arithmetic means are given with the 95% confidence interval.

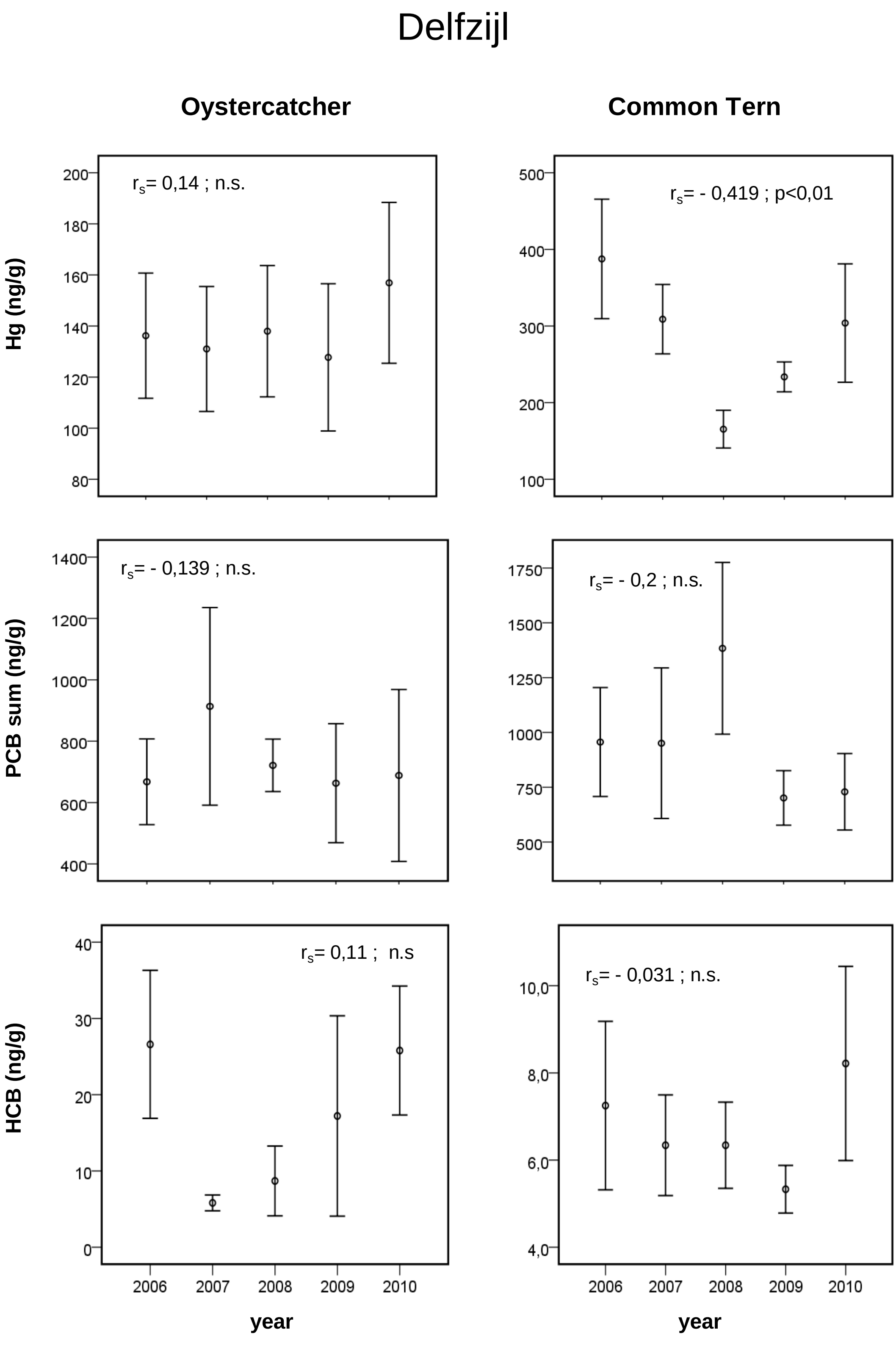


Fig. 8.3.5: Temporal development of pollutant concentrations in Oystercatcher and Common Tern eggs from Delfzijl, NL, in the period 2006-2010. Arithmetic means are given with the 95% confidence interval.

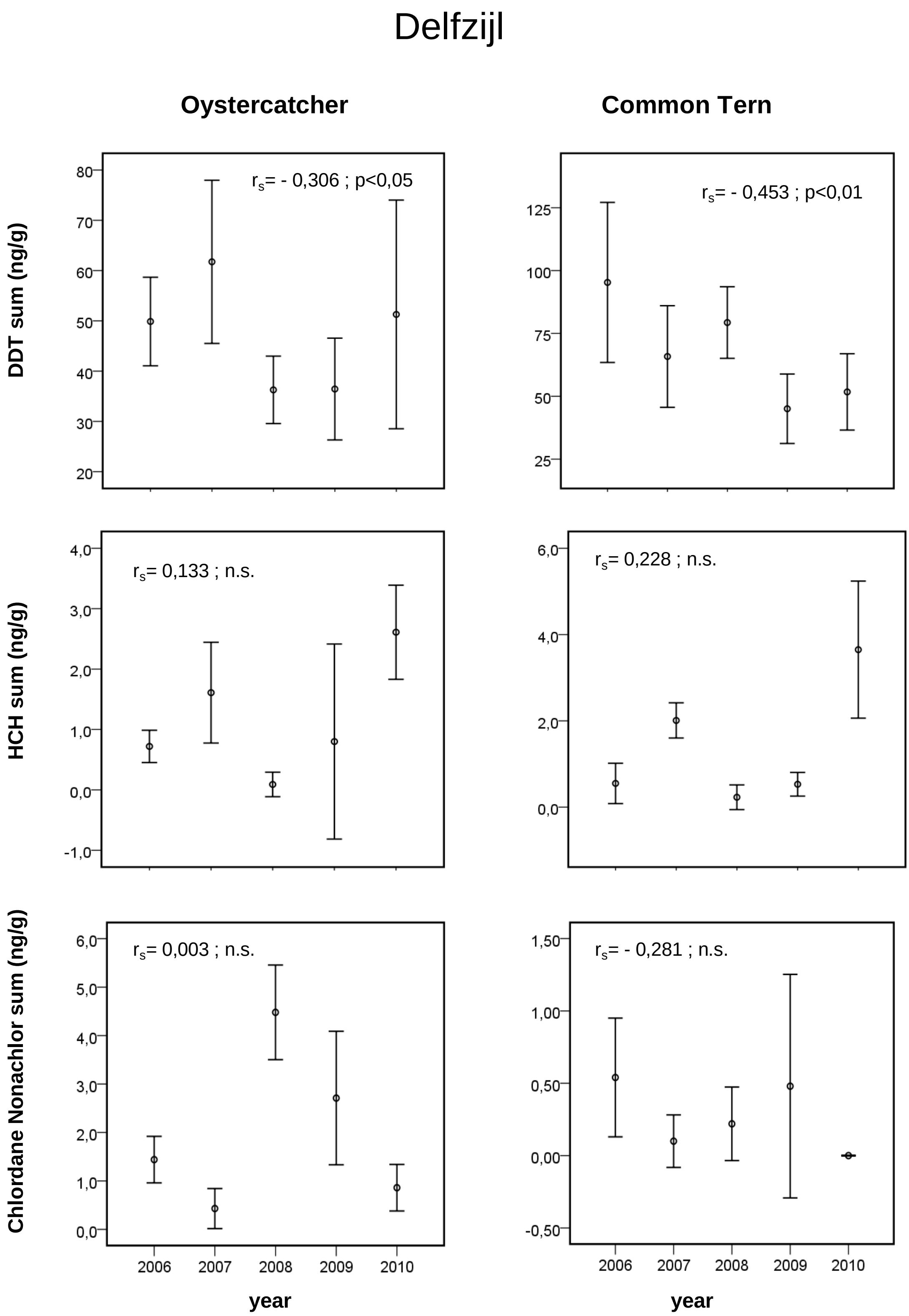


Fig. 8.3.5 (continued): Temporal development of pollutant concentrations in Oystercatcher and Common Tern eggs from Delfzijl, NL, in the period 2006-2010. Arithmetic means are given with the 95% confidence interval.

## 8.4 Temporal and spatial trends in TEQ concentrations

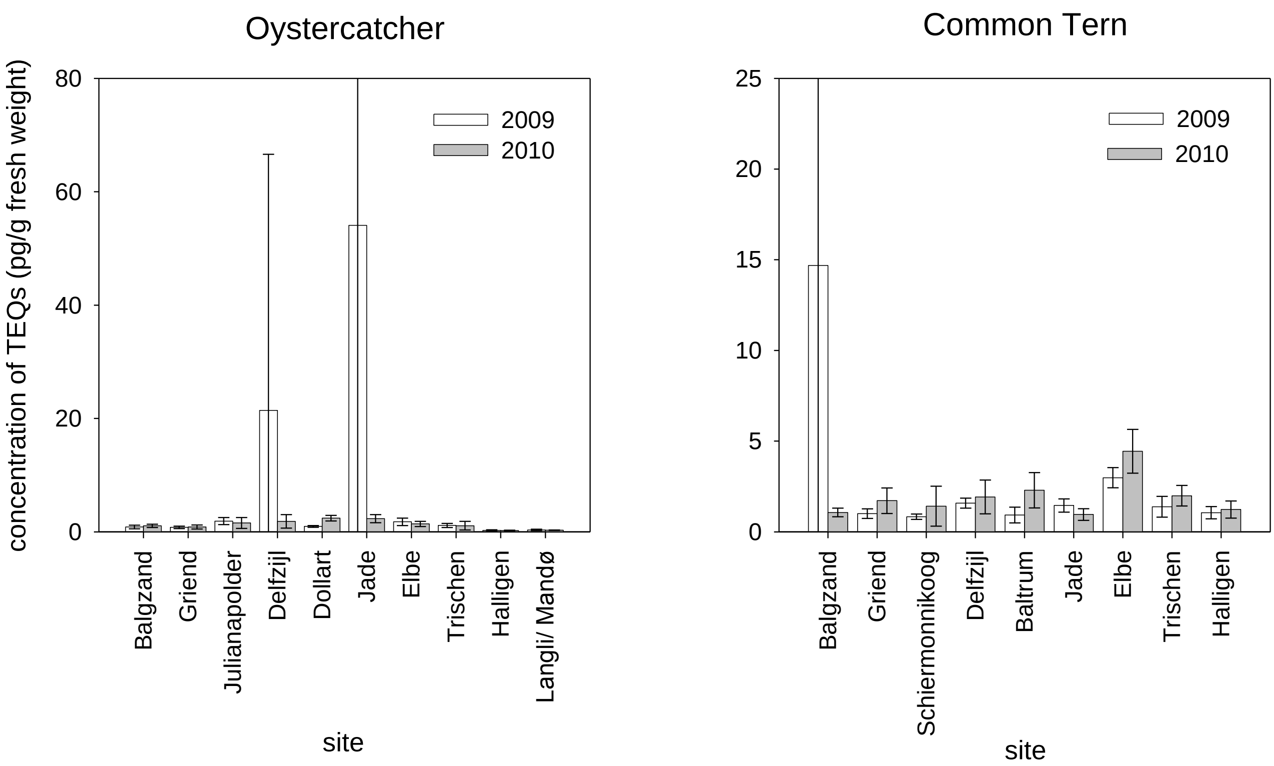


Fig. 8.4 : Concentration of TEQs in Oystercatcher and Common Tern eggs in the Wadden Sea in 2009 and 2010