ICBM - Institut für Chemie und Biologie des Meeres, Schleusenstraße 1, D-26382 Wilhelmshaven

Documentation of the TMAP Parameter "Pollutants in seabird eggs" in The Netherlands in 2014

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).

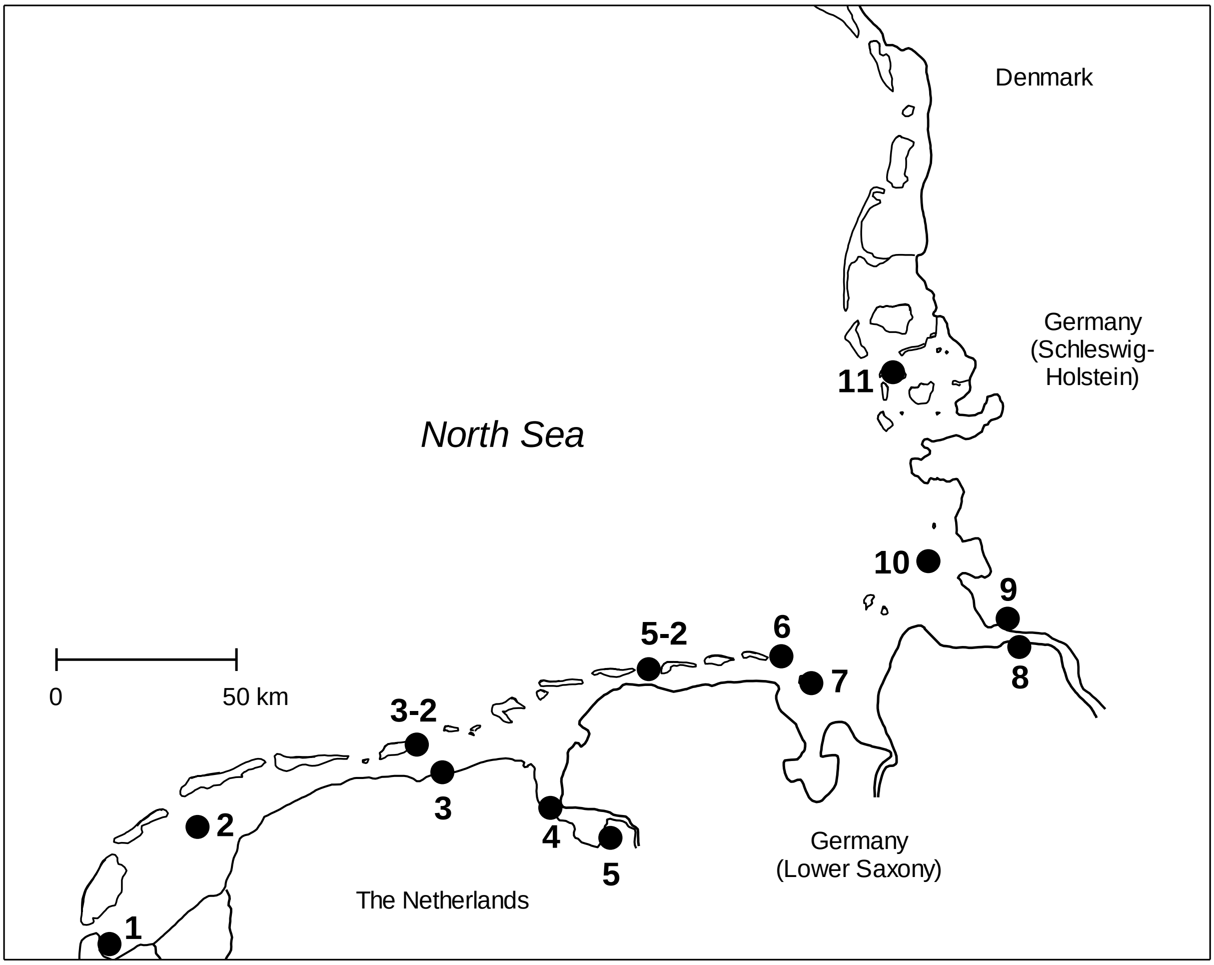

Fig. 1.1: Sampling sites of Oystercatcher and/or Common Tern eggs in the trilateral Wadden Sea. The Netherlands: 1 Balgzand, 2 Griend, 3 Julianapolder, 3-2 Schiermonnikoog, 4 Delfzijl; Germany, Lower Saxony: 5 Dollart, 5-2 Baltrum, 6 Minsener Oog, 7 Mellum (6 and 7 = Jade), 8 Hullen, 9 Neufelderkoog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

Table 1.1: Number of Oystercatcher and Common Tern eggs sampled per site in 2014

	Species	
Site	Oystercatcher	Common Tern
Balgzand	10	10
Griend	10	10
Julianapolder	10	-
Schiermonnikoog	-	10
Delfzijl	10	10

2. Chemical analytics

The samples were analyzed as shortly described by OSPAR (1997), Sommer et al. (1997) and Becker et al. (2001). You can get a detailed description of methods on request.

3. Documentation of data, description of the EXCEL-file and of the variables

The data from The Netherlands in 2014 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:

<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 2010 – 2014, Spearman rank correlations were calculated (two-tailed) for the years 2010 - 2014. To identify potential differences in pollutant concentrations between 2013 and 2014, 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 2014

For the Oystercatcher, we identified the following areas with relatively high contamination. They are listed in order of mean contamination level, beginning with the highest (see Abb. 5.1.1; Tab. 8.1.1):

Mercury:	Trischen, Elbe, Griend
PCB:	Dollart, Trischen, Julianapolder
HCB:	Delfzijl, Dollart, Elbe
DDT:	Trischen, Elbe, Dollart
HCH:	Halligen, Trischen, Griend
Chlordanes:	Dollart, Trischen, Jade

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 in general the differences between the two species were in 2014 lower compared to the years before. For example the PCB conentrations reached equal values in some areas. 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, see Abb. 5.1.1; Tab. 8.1.1):

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

In the **Oystercatcher**, the geographical pattern of **Hg** concentrations in 2014 was largely similar to those of the years before (see last reports): Again **Hg** peaked at Trischen and more or less surrounding sites. A further peak was detected at Griend, which reached nearly similar values. We see also the same trend as the years before: Because of the rising concentrations in formerly lower contaminated areas the differences between the areas seemed to be lower. This development may result in an established level of less than 200 ng/g **Hg** in Oystercatcher eggs from all investigated areas of the Wadden Sea.

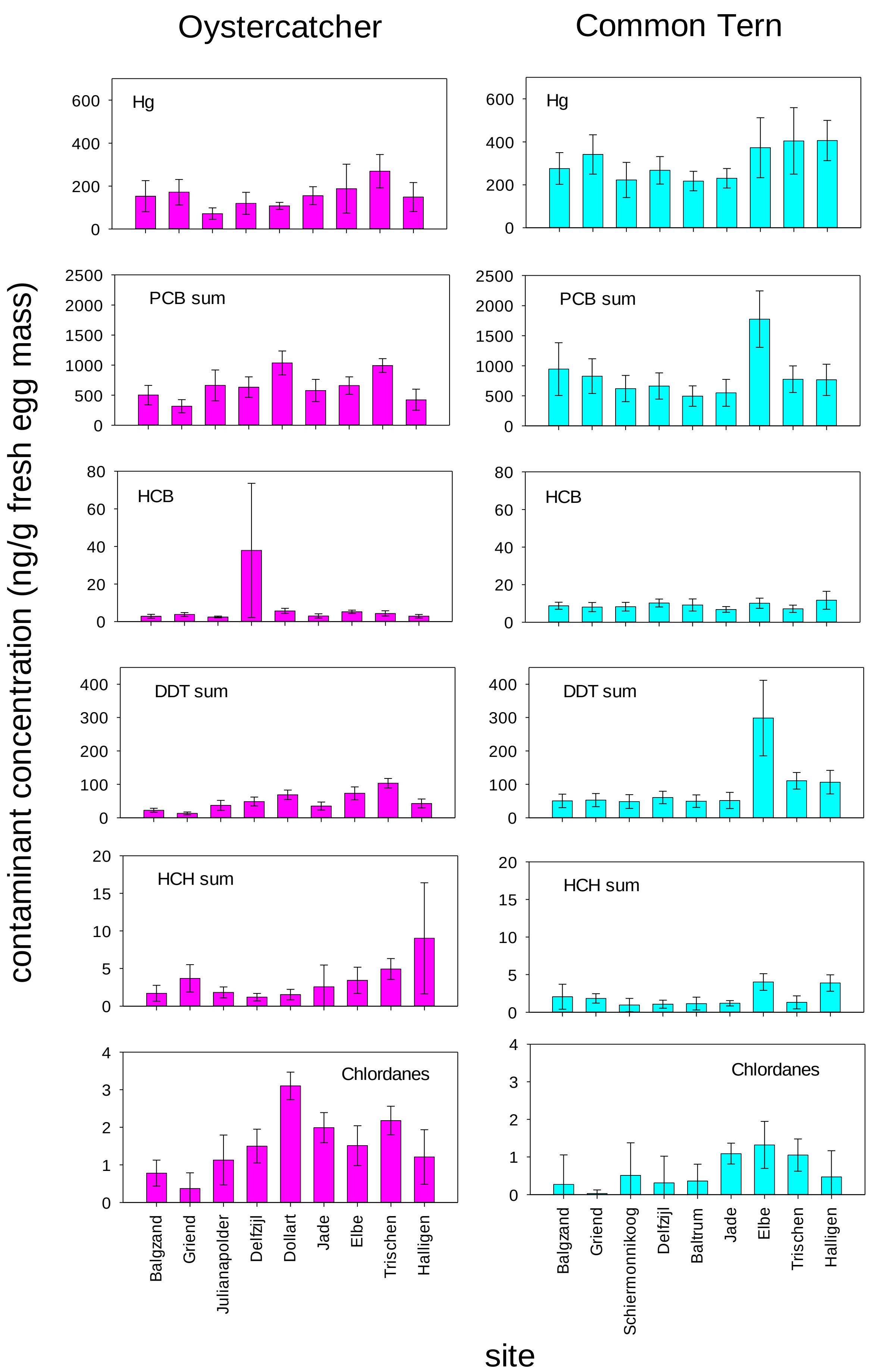

Fig. 5.1.1: Spatial patterns of pollutant concentrations in Oystercatcher and Common Tern eggs from the Wadden Sea in 2014 (means with standard deviations)

For **PCB** a prominent concentration peak was 2014 recognized at the Dollart. Different to 2013 we found in 2014 no peak at Trischen. Lower peaks of half amounts compared to the Dollart were found at Julianapolder, Elbe, Jade and Delfzijl. But on the other hand we saw 2014 the same trend as 2013 that the PCB concentrations equalise at the different locations of the Wadden Sea.

As in the years before the clearly highest concentration of **HCB** was measured in 2014 at Delfzijl where it was a little higher than in 2013 but in the same range. In average the HCB concentrations in oystercatcher eggs from Delfzijl were seven to twelve times higher compared to the other areas and four times higher compared to the Common Terns eggs. Two further, but much smaller peaks were recorded at the Dollart and river Elbe.

For **DDT** the highest concentrations in 2014 were found in Oystercatcher eggs from Trischen and the river Elbe but also concentration at the Dollart reached high levels.

For the second time we see in 2014 a strong peak of **HCH** concentrations in eggs from the Halligen, which was mainly caused by high **β-HCH** levels. As in 2013 we see in 2014 also a few eggs with a very high level, but different to the year before the **β-HCH** levels of all eggs were higher in 2014 compared to other areas. In the other areas the **HCH** levels were rather similar, except a second peak at Trischen.

For **Chlordanes** peak values have been detected in Oystercatcher eggs from Dollart and Elbe. The high levels in eggs from Balgzand and Griend recorded in 2013 did 2014 not occur**.**

Except the strong peak of **HCB** at Delfzijl and of **HCH** at Halligen, we found only small differences in the concentrations of all measured chemicals between the different sites. The increased concentrations in both the western and the eastern Wadden Sea have resulted in a stronger approximation of the values at a generally increased contamination level.

In **Common Tern eggs** the contamination patterns of **PCB** and **DDT** identified in 2014 were in general similar to those in the years before, showing peak values at the river Elbe and high levels at Trischen and Halligen, the areas which are influenced by the water of the Elbe. In the other areas the DDT concentrations in Common Tern eggs were 2014 rather similar showing a level of 50 ng/g fresh weigh. For PCB we see beside the Elbe a second concentration peak at Balgzand and Griend.

Similar to the results in the oystercatcher eggs the **Hg** concentrations in the Common Tern eggs were in 2014 in all areas rather equal, but with a clearly higher level of 300 ng/g fresh weigh.

The **HCB** concentration in Common Tern eggs were in 2014 similar at all sites with a level of 9,0 ng/g fresh weigh and tended to be higher than HCB concentrations in Oystercatcher eggs, except the very high levels in Oystercatcher eggs from Delfzijl.

The measured **HCH** levels in Common Tern eggs were between 1 and 4 ng/g fresh weight with small concentration peaks at the river Elbe and Halligen.

Concentrations peaks of **Chlordanes** recorded in 2014 at the river Elbe. The high levels in the western parts of the Wadden Sea as seen in 2013 could not be confirmed in 2014.

5.2 Annual variation in pollutant concentration in the period 2010-2014

Mean contamination values for the different substance groups in the period 2010-2014 are given in Figures 8.2.1-8.2.6 in the Appendix. A summarizing overview of short-term (2013-2014) and mid-term (2010-2014) temporal changes in the Dutch and German Wadden Sea are given in Tables 5.2.1 and 5.2.2.

Balgzand

Temporal Trends 2010-2014:

Oystercatcher	Significant **decrease** was detected in Hg.
Common Tern	Significant **increase** was detected in HCB, a significant **decrease** occurred in Hg and HCH.

In 2014 a significantly **lower** level of HCB and Chlordanes than in 2013 were found in Common Tern eggs. In Oystercatcher eggs concentration of Chlordanes was **lower** in 2014 compared to 2013.

Griend

Temporal Trends 2010-2014*:*

Oystercatcher	Significant **increase** was detected in HCB and a significant **decrease** in PCB.
Common Tern	Significant **increase** was identified in HCB and a significant **decrease** in Hg.

Between 2013 and 2014 Chlordane concentrations **decreased** in Oystercatcher eggs. In Common Tern eggs, the levels of Hg and HCH **increased** in that period whereas levels of HCB and Chlordanes **decreased**.

Julianapolder/Schiermonnikoog

Temporal Trends 2010-2014*:*

Oystercatcher	Significant **increase** in the concentration of HCB was identified at Julianapolder.
Common Tern	Significant **decreases** in the concentrations of Hg and HCH were detected at Schiermonnikoog.

In Oystercatcher eggs from 2014 sampled at Julianapolder, the level of Hg and Chlordanes were significantly **lower** than in 2013. In Common Tern eggs from 2014 sampled at Schiermonnikoog, the concentrations of all measured chemicals **did not change** significantly compared to 2013.

Delfzijl

Temporal Trends 2010-2014*:*

Oystercatcher	The concentration of Hg **decreased** significantly. HCB concentrations did not change significantly.
Common Tern	**No** significant **changes** in the concentrations of the measured chemicals occurred.

Between 2013 and 2014 HCH concentrations in Oystercatcher eggs **decreased**. In Common Tern eggs concentrations of Hg, HCB and Chlordanes were 2014 significantly **lower** compared to the year before.

Table 5.2.1: Overview over the development of selected pollutants in eggs of Oystercatcher and Common Tern in the Wadden Sea from 2010-2014, 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 2013-2014, according to Mann-Whitney-U-tests. -: significant decline, +: significant increase.

	Oystercatcher									Common Tern								
	Balgzand	Griend	Julianapolder	Delfzijl	Dollart	Jade	Hullen	Trischen	Halligen	Balgzand	Griend	Schiermonnikoog	Delfzijl	Baltrum	Jade	Neufelderkoog	Trischen	Halligen
Hg			-								+		-			-		
PCB Summe								+									-	
HCB					+		+		-	-	-		-	-	-	-	-	-
DDT Summe								+										+
HCH Summe				+							+					-	-	+
Chlordan-Nonachlor-Summe	-	-	-		+			+		-	-		-		+	+	+	

6. General Assessment

6.1 Spatial Trends

The concentrations of the mentioned substances in **Oystercatcher** eggs showed in 2014 only small geographical differences. Conspicuous were, as in the years before, the HCB concentrations at Delfzijl, which were up to seven times higher compared to other sites in the Wadden Sea. In Oystercatcher eggs highest levels of PCB were detected at the Dollart, highest levels of DDT at Trischen, whereas HCH reached highest levels at Halligen. Compared to 2013 the measured concentrations were slightly lower in case of Hg, HCH and Chlordanes, but tended to be higher in case of PCB, HCB and DDT.

In the **Common Tern**, clearly prominent concentration peaks of PCB, DDT, HCH and Chlordanes were found again at the Elbe estuary. Consequently, a continuous decrease of pollution was recorded with increasing distance from the Elbe estuary which is in accordance to the observations from previous years. So we found the second highest levels mostly at Trischen, as the area is influenced most by the waters of the river Elbe. But in case of HCB we saw a lesser influence of the river Elbe compared to the other contaminants: The concentration showed only small geographical differences and tended to align in Common Tern eggs at a level of ca. 9 ng/g fresh weight witch is clearly lower compared to 2013. Generally the concentrations in in Common Tern eggs tended to be a little lower in 2014 than in 2013. Different to 2013 there was no geographical differences of the Hg concentrations in Common Tern eggs. We see an established level of 300 ng/g Hg in all investigated areas of the Wadden Sea.

In general, the species-specific spatial contamination patterns in 2014 remained similar to those recorded in 2013 and the years before: The contamination pattern of the Common Tern again showed clear concentration peaks at the river Elbe. And that of the Oystercatcher again indicated a clear HCB peak at Delfzijl and for the first time a strong concentration peak of HCH at Halligen. 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.
This may also explain the high HCH levels in eggs from the Halligen, which was mainly caused by high β-HCH levels in the eggs. β-HCH implies a contamination with technical HCH which was used as an insecticide before the implementation of Lindane (concentrated γ-HCH). Apparently there are still remainders of these old insecticides.
Furthermore, for the benthic feeding Oystercatcher, contaminants bound to sediment particles which might have been transported previously, are probably more important than for the pelagic feeding Common Tern. In addition, the partly whole-year presence of the Oystercatcher in the Wadden Sea might have affected the contamination patterns recorded. In general, the data underline the importance of the large rivers Elbe and Ems for the influx of several contaminants into the Wadden Sea. For Hg, PCB, HCB and DDT, contamination levels tended to be higher in the Common Tern than those in the Oystercatcher (except for HCB at Delfzijl), reflecting the higher trophic level of the piscivorous Common Tern with an even more effective bioaccumulation of pollutants. However, for Chlordanes contamination was clearly higher in Oystercatcher than in Common Tern at most study sites.

The mentioned concentration peak of HCB in Oystercatcher eggs from Delfzijl could be seen since many years and may be caused by contaminated water and sediment in the Sea Harbour Channel in Delfzijl (Eggens & Bakker 2001). After a decrease in 2012 the concentrations in 2014 were again higher compared to 2013. 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).

6.2 Temporal trends

During the **five-year-period 2010-2014** we see both increasing as well as decreasing contamination levels at different study sites. In most cases there was no clear picture if the contamination level of the different measured substances rises of fall at one place, so the results were not easy to interpret.

In **Oystercatcher** eggs decreasing concentrations were detected in case of Hg at five of the nine sampled sites as well as in case of HCH at four and in case of PCB and HCB at two, respectively. In total we see 13 decreases and most of them were detected at Trischen (three).
Increases were seen in case of PCB and HCB at each three of the nine sampled sites as well as in case of DDT at two. In total we see nine increases and most of them were detected at Halligen (three).

The measured increase was in total only small. For example, PCB concentration in Oystercatcher eggs at Trischen and Halligen increased by a factor of two as well as DDT concentration at Halligen (see figures at 8.2). The mentioned decreases of Hg levels in Oystercatcher eggs were at all sites beneath a factor of two but continuously and with a very low variance in all years.

In the **Common Tern** eggs we detected also significant in- and decreases in the period during 2010-2014. We see an increase of Chlordanes and HCB at four of nine study sites. HCH increased at two, PCB and DDT increased at one site respectively. In total we found 12 significant increased substance levels in Common Tern eggs and to a greater extent as in Oystercatcher eggs, but lower compared with the pentad 2009 to 2013. Remarkable were the Hg concentrations, which decreased very uniformly in eight of the nine sampled sites. HCH decreased at four as well as the HCB and DDT concentrations at one site respectively. In total we found 14 significant decreased substance levels in Common Tern eggs.

When **comparing the year 2014 with 2013** we recorded equal contamination decreases and increases (6) 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. Most increases occurred at Trischen (3) and Dollart (2). Two points were remarkable: First the concentrations of Chlordanes decreased at three places in the western part but increased at Trischen as well as at Dollart; and second TEQs in the Oystercatcher eggs increased at Jade and Halligen but decreased at Trischen whereas the PCB-total increased.

In contrast in **Common Tern** eggs more contamination decreases (16) than increases (7) were detected (Tab. 5.2.2.): rather consistently the HCB concentrations decreased at eight of the nine study sites whereas Hg and HCH decreased at two sites. Most chemical groups decreased at Elbe, Trischen and Delfzijl (3 each). Most increases were due to rising concentrations of chlordanes at Elbe and Jade, but chlordanes also decreased at three places in the Wadden Sea.

Even with the data from 2014 the question if the contamination level of the environmental chemicals rose again or showed fluctuations around established levels in birds (cf. Becker & Dittmann 2009) could not finally be answered. In case of Hg a fluctuation around an established level may be supposed, but the level is different in both species.
On the long term scale there were conspicuous decreases in the concentrations of all environmental chemicals mainly in the middle of the 1990 (Becker et al. 2001, Mattig et al. 2014). On the other hand on the mid-term scale there were again increasing concentrations but on a lower level than before the 1990. Here we have to ask for the human activities or natural processes that are responsible for the increasing levels of environmental chemicals which are forbidden by law since many years. The data of this report indicate that increases occur mainly at the previously lower contaminated sites. The influx of the great rivers seems not to be responsible for these higher levels, as the data show generally increasing levels throughout the Wadden Sea.

6.3 Summarized Assessment

Summarizing, the results from 2014 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, in the Oystercatcher particularly high concentrations of HCB have been found at Delfzijl. In Oystercatcher eggs, the spatial contamination peaks were lesser than in the previous years. This was mainly caused by contamination increases in formerly comparatively low polluted areas.

The mid-term comparison indicates in both species and nearly at all sites a decrease in Hg contamination level, which showed no longer geographical patterns. Hg in Oystercatcher eggs seems to have an established level of less than 200 ng/g fresh weight in all areas of the Wadden Sea and in Common Tern egg of 300 ng/g fresh weight, respectively.

After the common increase of the HCB levels in the eggs of both species until last year, only an increase in Oystercatcher eggs at Delfzijl was remarkable. Highest HCB levels were found there, like many years before, somewhat higher than in 2013.

When comparing the year 2014 with the previous one, the contamination levels were nearly in the same value. The recorded increases of many contaminants in the last years may have resulted in higher levels, which were, except in case of Hg, clearly higher than annual fluctuations around established levels. Furthermore we see an undesired reversal of the former decreasing trends and might expect higher levels in the future. This is also of interest on 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).

7. Literature

Becker, P.H. & T. Dittmann (2010): “Contaminants in Bird Eggs” in the Wadden Sea: Trends and Perspectives. Proc. 12th Intern. Scientific Wadden Sea Symposium, Wilhelmshaven. Common Wadden Sea Secretariat, Wilhelmshaven, Germany.

Becker P.H. & T. Dittmann (2009): Contaminants in Bird Eggs. Thematic Report No. 5.2. In: Marencic, H. & Vlas, J. de (Eds.), 2009. Quality Status Report 2009. Wadden Sea Ecosystem No. 25. Common Wadden Sea Secretariat, Trilateral Monitoring and Assessment Group, Wilhelmshaven, Germany.

Becker, P.H., & J. Muñoz Cifuentes (2004): Contaminants in birds eggs: recent spatial and temporal trends. In: Wadden Sea Ecosystem No. 18, 5-25. Common Wadden Sea Secretariat, Wilhelmshaven.

Becker, P.H., J. Muñoz Cifuentes (2005): Contaminants in Birds Eggs. Chapter 4.5. In: Essink,K., Dettmann,C., Farke, H., Laursen, K., Lüerßen, G., Marencic, H., Wiersinga, W. (Eds.) Wadden Sea Quality Status Report 2004. Wadden Sea Ecosystem No. 19. Trilateral Monitoring and Assessment Group, Common Wadden Sea Secretariat, Wilhelmshaven, Germany: 123-128.

Becker, P.H., J. Muñoz Cifuentes, B. Behrends & K.R. Schmieder (2001): Contaminants in Bird Eggs in the Wadden Sea – Spatial and Temporal Trends 1991 – 2000. Wadden Sea Ecosystem 11. Common Wadden Sea Secretariat Wilhelmshaven: 68 pp.

Becker, P.H., S. Schuhmann & C. Koepff (1993): Hatching failure in Common Terns (*Sterna hirundo*) in relation to environmental chemicals. Environ. Pollut. 79: 207-213.

Dittmann, T., Becker, P.H., Bakker, J., Bignert, A., Nyberg, E., Pereira, M.G., Pijanowska, U., Shore, R., Stienen, E., Toft, G.O. & Marencic, H. (2012): Large-scale spatial pollution patterns around the North Sea indicated by costal bird eggs within an EcoQO programme. Environ. Sci. Pollut. Res. 19: 4060-4072.

Eggens M.L. & Bakker J.F. (2001): Toxicity of dredged material polluted with hexachlorbenzene (HCB) – is there a risk for organisms living in the Ems-Dollard Estuary? Wadden Sea Newsletter 24: 13-15.

Mattig FR, Pijanowska U, Becker PH (2014) Thirty-two years of Monitoring Pollutants with Seabirds in the Wadden Sea. Wader Study Group Bull 121 (2): 70

Muñoz Cifuentes, J. (2004): Seabirds at risk? Effects of environmental chemicals on reproductive success and mass growth of seabirds breeding at the Wadden Sea in the mid 1990s. Wadden Sea Ecosystem No. 18.

OSPAR, 1997. Oslo and Paris Conventions for the Prevention of Marine Pollution. Joint meeting of the Oslo and Paris Commissions, Brussels 2-5 September 1997. Summary record OSPAR 97/15/1

Sommer, U., Schmieder, K.R. & Becker, P.H. (1997): Untersuchung von Seevogeleiern auf chlorierte Pestizide, PCB's und Quecksilber. BIOforum 20 (3/97): 68-72.

Van den Berg, M., Birnbaum, L., Bosveld, A.T.C., Brunström, B., Cook, P., Feeley, M. Giesy, J.P., Hanberg, A., Hasegawa, R., Kennedy, S.W., Kubiak, T., Larsen, J.C., Rolaf van Leeuwen, F.X., Liem, A.K.D., Nolt, C., Peterson, R.E., Poellinger, L., Safe, S., Schrenk, D., Tillit, D., Tysklind, M., Younes, M., Waern, F. and Zacharewski, T., 1998. Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ. Health Perspect. 106(12): 775-792.

Verein Deutscher Ingenieure (VDI) (2009): VDI Richtlinien – Biological procedures to determine effects of air pollutants (bioindication). Biomonitoring with bird eggs as accumulative and reactive indicators. VDI 4230, Part 3. Verein Deutscher Ingenieure, Düsseldorf.

This report was compiled by Frank R. Mattig, Ursula Pijanowska and Peter Schupp.

Wilhelmshaven, 24 February 2015

____

(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 2014

Table 8.1.1: Concentrations of chemicals in Oystercatcher and Common Tern eggs sampled in The Netherlands in 2014. 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	153,4 ± 72,4	171,7 ± 59,2	72,1 ± 26,7	119,6 ± 51,4
6 PCB (law)	256,2 ± 86,5	157,9 ± 56,7	336,0 ± 131,3	330,3 ± 95,4
PCB sum	502,2 ± 161,9	318,3 ± 108,9	663,2 ± 256,7	634,7 ± 170,1
HCB	2,9 ± 1,0	3,8 ± 1,0	2,5 ± 0,4	37,9 ± 35,7
ppDDE	21,6 ± 5,2	12,7 ± 4,1	35,1 ± 14,9	45,9 ± 13,0
ppDDT	0,0 ± 0,0	0,0 ± 0,0	0,4 ± 0,9	0,5 ± 1,5
ppDDD	0,9 ± 1,0	0,4 ± 0,5	1,8 ± 0,7	2,4 ± 0,2
DDT sum	22,4 ± 5,8	13,1 ± 4,1	37,3 ± 14,8	48,8 ± 13,0
alpha-HCH	0,0 ± 0,0	0,0 ± 0,0	0,0 ± 0,0	0,0 ± 0,0
beta-HCH	1,7 ± 1,1	3,6 ± 1,8	1,6 ± 0,6	1,2 ± 0,5
gamma-HCH	0,0 ± 0,1	0,1 ± 0,2	0,2 ± 0,3	0,0 ± 0,0
HCH sum	1,7 ± 1,1	3,7 ± 1,8	1,8 ± 0,7	1,2 ± 0,5
Chlordane sum	0,8 ± 0,3	0,4 ± 0,4	1,1 ± 0,7	1,5 ± 0,4

	Balgzand	Griend	Schiermonnikoog	Delfzijl
Common Tern	**(N=10)**	**(N=10)**	**(N=10)**	**(N=10)**
Hg	276,0 ± 73,7	341,5 ± 91,7	222,6 ± 81,8	267,7 ± 64,1
6 PCB (law)	478,6 ± 236,2	414,0 ± 154,9	303,5 ± 104,6	326,0 ± 112,1
PCB sum	944,8 ± 438,1	827,3 ± 289,1	621,8 ± 218,4	663,3 ± 218,1
HCB	8,8 ± 1,8	8,1 ± 2,4	8,3 ± 2,3	10,3 ± 2,1
ppDDE	49,1 ± 19,6	50,9 ± 19,6	46,5 ± 19,8	58,3 ± 18,5
ppDDT	0,0 ± 0,0	0,0 ± 0,0	0,0 ± 0,0	0,2 ± 0,7
ppDDD	1,4 ± 1,1	2,1 ± 0,2	2,1 ± 1,2	2,4 ± 0,3
DDT sum	50,4 ± 20,3	53,0 ± 19,6	48,6 ± 20,6	60,9 ± 18,7
alpha-HCH	0,0 ± 0,0	0,0 ± 0,0	0,0 ± 0,0	0,0 ± 0,0
beta-HCH	2,1 ± 1,7	1,8 ± 0,5	0,9 ± 0,9	1,0 ± 0,5
gamma-HCH	0,0 ± 0,0	0,1 ± 0,2	0,0 ± 0,1	0,0 ± 0,1
HCH sum	2,1 ± 1,7	1,8 ± 0,6	1,0 ± 0,9	1,1 ± 0,5
Chlordane sum	0,3 ± 0,8	0,0 ± 0,1	0,5 ± 0,9	0,3 ± 0,7

8.2 Temporal trends of pollutant concentrations at different sites during 2010-2014

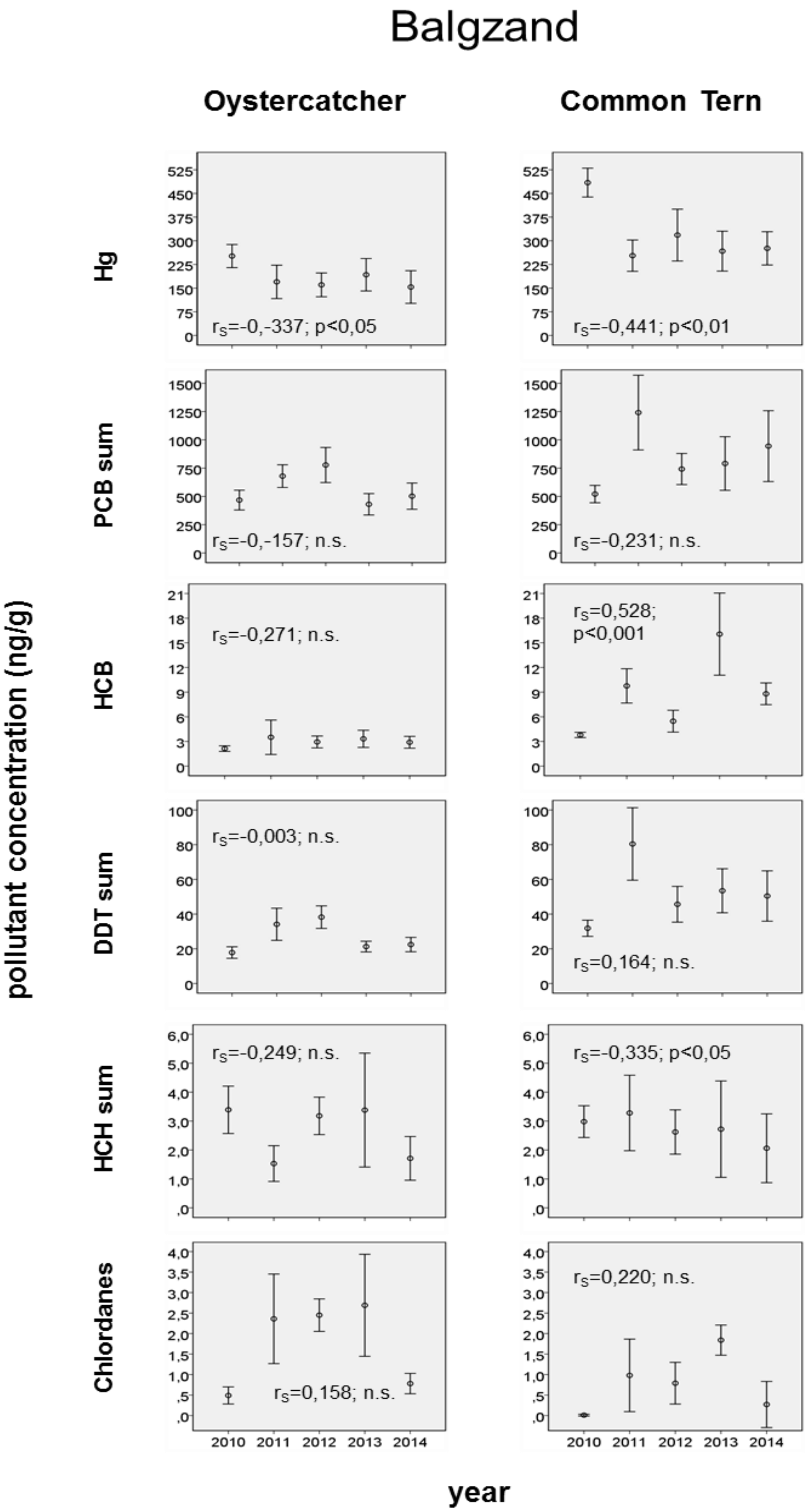

Fig. 8.2.1: Temporal development of pollutant concentrations in Oystercatcher and Common Tern eggs from Balgzand, NL, in the period 2010-2014. Arithmetic means are given with the 95% confidence interval.

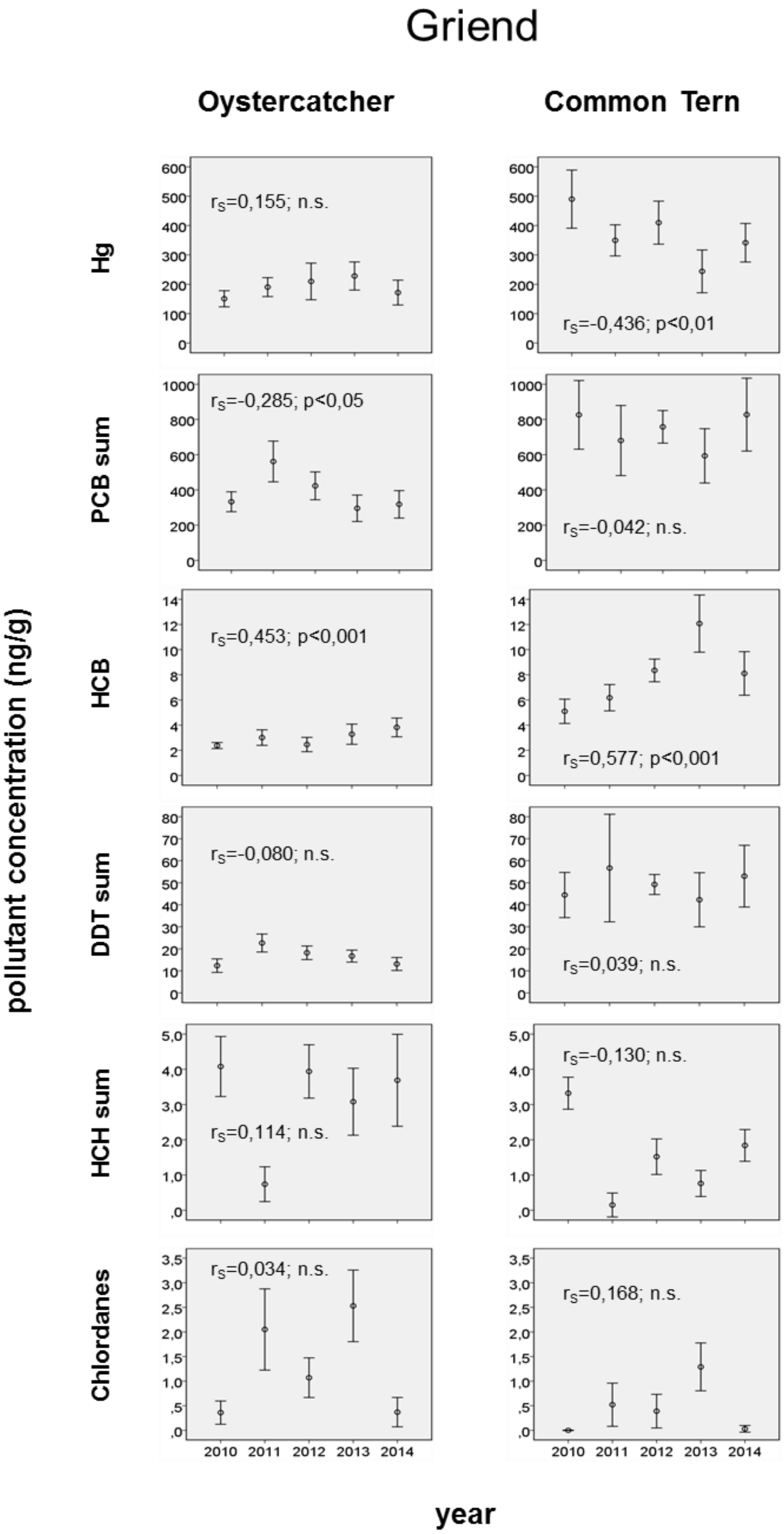

Fig. 8.2.2: Temporal development of pollutant concentrations in Oystercatcher and Common Tern eggs from Griend, NL, in the period 2010-2014. Arithmetic means are given with the 95% confidence interval.

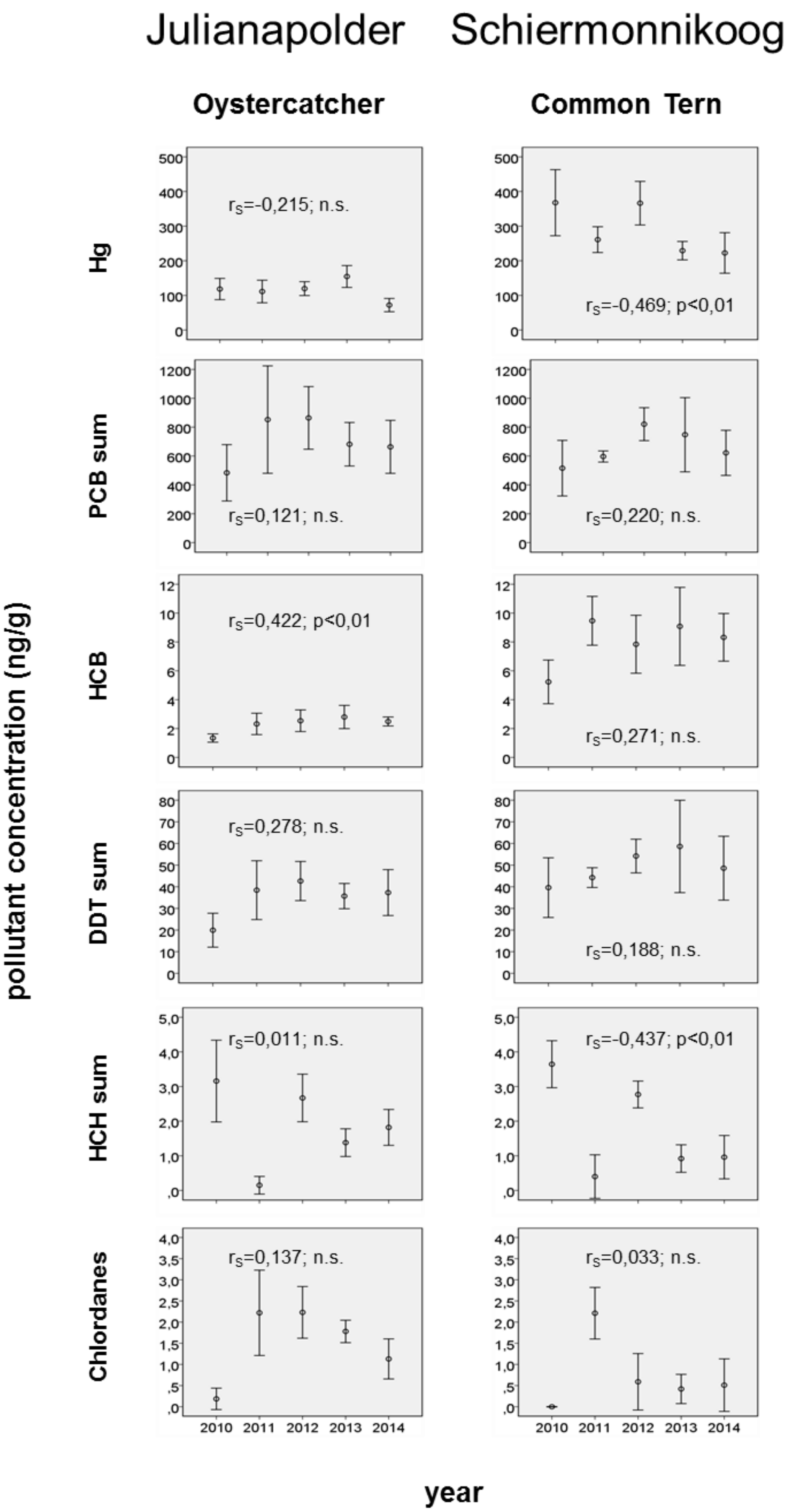

Fig. 8.2.3: Temporal development of pollutant concentrations in Oystercatcher eggs from Julianapolder and in Common Tern eggs from Schiermonnikoog, NL, in the period 2010-2014. Arithmetic means are given with the 95% confidence interval.

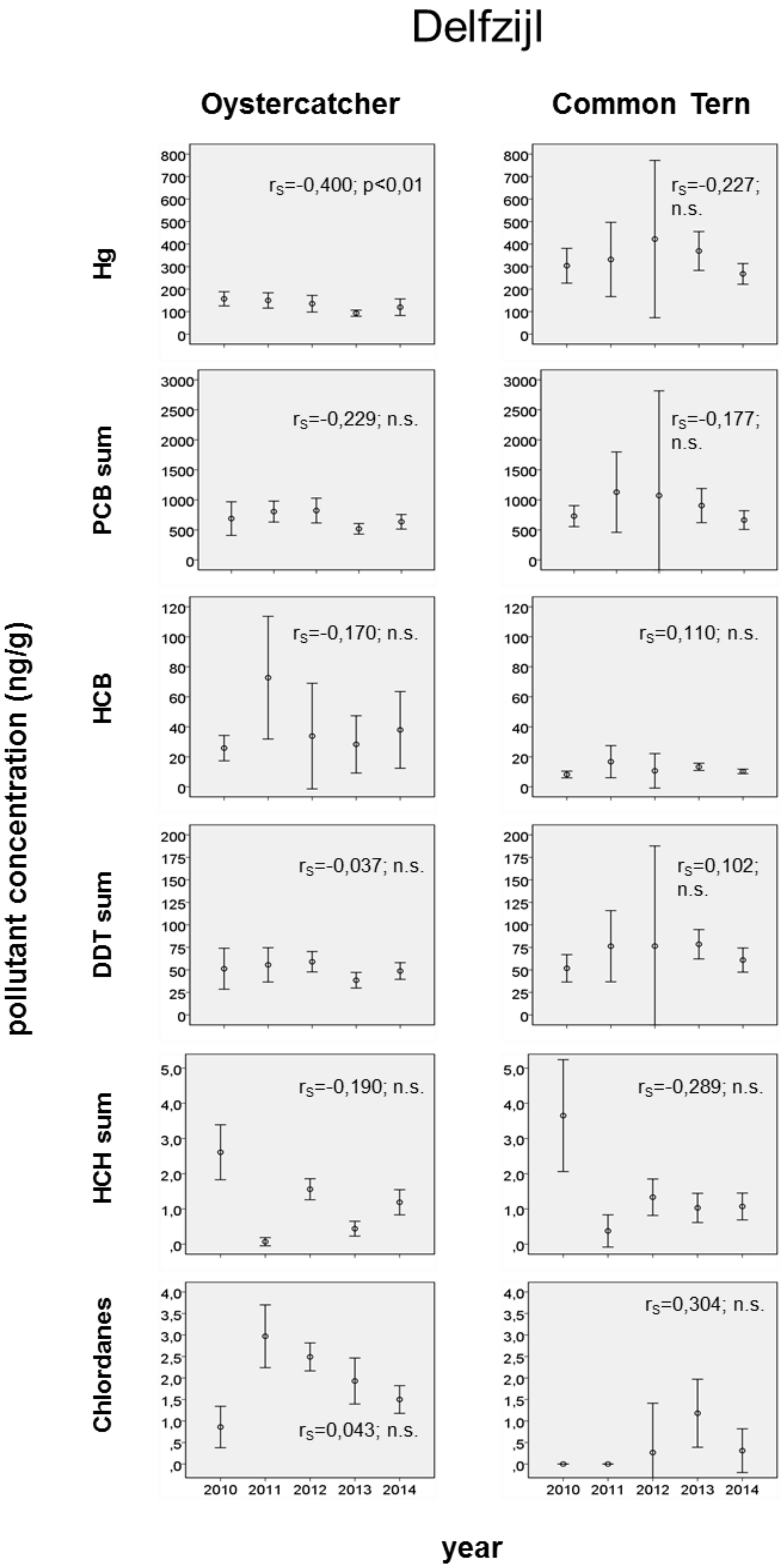

Fig. 8.2.4: Temporal development of pollutant concentrations in Oystercatcher and Common Tern eggs from Delfzijl, NL, in the period 2010-2014. Arithmetic means are given with the 95% confidence interval.