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Abstract

This report presents data from the last year of a 5-year period of the Urban Fjord programme. The programme started in 2013 and has since been altered/advanced. In 2025 the programme covers sampling and analyses of sediment, polychaetes, krill, shrimps, blue mussels, herring, cod, eider, and herring gull from the Inner Oslofjord. A total of ~230 single compounds/isomers were analysed, and frequent detection was found of specific PFAS compounds (e.g. PFOS) in most matrices, certain QACs in several matrices (ATAC-C22 in all matrices), specific benzothiazoles in eider blood, LCCPs in certain matrices, certain siloxanes in most matrices, metals in all matrices and PCBs in all matrices. Biomagnification was observed for 24 PCB congeners, LCCPs and D4 (siloxane; lipid wt. basis). Furthermore, biomagnification was observed for PFOSA, ATAC-C20 and ATAC-C22, as well as for the metals As and Hg (wet wt. basis).

Keywords: Contaminants, Urban Areas, Bioaccumulation, Inputs
Emneord: Miljøgifter, Urbane områder, Bioakkumulering, Tilførsler

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Preface

This report presents data from the last year of a 5-year period of the Urban Fjord programme. The programme started in 2013 and has since been advanced. The content differs between years, and the 2025 programme covers sampling and analyses of sediment, polychaetes, krill, shrimps, blue mussels, herring, cod, eider and herring gull from the Inner Oslofjord.

This year's campaign was carried out by NIVA, with a large number of chemical analyses performed by the Norwegian Institute for Air Research, NILU. Bird samples (eider and herring gull) were sampled by Morten Helberg at Birdlife Norge.

Besides the authors of this report, several persons are acknowledged for their contribution in sample collection, sample preparation, data treatment and analysis: Ingar Johansen, Gunhild Borgersen, Pawel Rostowski, Mikael Harju, Hilde Uggerud, Marit Vadset, Inger-Christin Steen, Anders Borgen, Carsten Lome, Dag Hjermann.

This report represents an extended summary of the Urban Fjord 2025 campaign and has been quality assured by senior scientist Morten Jartun and research manager Malcolm Reid.

Oslo, June 2026

Summary

The 2025 “Urban fjord” programme covers sampling and analyses of sediment, polychaetes, krill, shrimps, blue mussels, herring, cod, eider and herring gull from the Inner Oslofjord. A total of ~230 single compounds/isomers were analysed, and frequent detection was found of:

- Specific PFAS compounds (e.g. PFOS) in most matrices
- Certain QACs in several matrices (ATAC-C22 in all matrices)
- Specific benzothiazoles in eider blood
- LCCPs in certain matrices
- Certain siloxanes in most matrices
- Metals in all matrices
- PCBs in all matrices

Concentrations of PFAS were highest in cod (liver) and birds (eggs in particular). PFOS (including brPFOS) was a dominating PFAS. PFOSA constituted the highest proportion of the sum-PFAS concentration in cod, as well as in blue mussel, shrimp, and herring. UV-compounds were only analysed in sediment and birds. In herring gull and eider, UV-compounds were only detected in eggs and UV-327 was found in both species, as well as in sediment. UV-328 was a major UV-compound in sediment and herring gull eggs. Octocrylene was also an important UV-compound in sediment. The highest concentrations of quaternary ammonium compounds (QACs) were observed in sediment and polychaetes and DADMAC-C16 and DADMAC-C18 were dominating. In all other samples (biota), ATAC-C22 were dominating. Benzothiazoles were only analysed in sediment and birds. Benzothiazole (BT) was found in both blood and eggs of both bird species. Conspicuous amounts were found in blood of eider, with MBT displaying the highest concentration, and with OHBT also detected. The highest concentrations of dechloranes were found in sediment, cod liver and eggs of herring gull and eider, and dechlorane plus *syn* and *anti* were important constituents of sum-dechloranes. In cod liver, dechlorane 602 and dechlorane 603 constituted the highest proportions of the sum-dechloranes concentration. High proportions of dechlorane 602 were also observed in eggs of herring gull and eider. All classes of chlorinated paraffins (SCCPs, MCCPs and LCCPs) were found in sediment, with LCCPs showing the highest concentration. Among the biota samples, the highest concentrations of chlorinated paraffins were observed in cod liver and eggs of herring gull. LCCPs constituted the highest proportion of the sum-chlorinated paraffins concentrations. Phthalates were only analysed in sediment and DEHP and DINP constituted the highest proportions of the sum-phthalates concentration. OPFRs were only analysed in sediments and TCPP constituted the highest proportion of the sum-OPFRs concentration. Phenolic compounds were only analysed in sediment and bile of cod and 4,4-bisphenol A displayed the highest concentration in both matrices. Siloxanes were detected in all matrices and D5 was a major constituent of the sum-siloxanes concentrations. M3T(Ph) was a major constituent of sum-siloxanes in blood of herring gull and eider. Long (linear) siloxanes (L7 and L8) constituted ~20% of the sum-siloxanes concentration in sediment. Musks were only analysed in sediment, and Galaxolide and Tonalide (AHMT) were both detected.

Biomagnification (quantified by Trophic Magnification Factors, TMF) was observed for 24 PCB congeners, LCCPs and D4 (lipid wt. basis). Furthermore, biomagnification was observed for PFOSA, ATAC-C20 and ATAC-C22, as well as for the metals As and Hg (wet wt. basis). Certain PCBs have been shown to biomagnify in the Inner Oslofjord food web every year (since 2013) of the monitoring. Also, Hg and As have been shown to biomagnify most years. Biomagnification of PFOSA was also observed

2016-2018, while ATAC-C20 and -C22 were shown to biomagnify (only wet wt basis) in 2017, 2019 and 2023.

Sammendrag

"Urban fjord"-programmet for 2025 har dekket prøvetaking og analyse av sediment, flerbørstemark, krill, reker, blåskjell, sild, torsk, ærfugl og gråmåke fra Indre Oslofjord. Totalt ble ~230 enkeltforbindelser/isomerer bestemt og hyppig deteksjon ble funnet av:

- Spesifikke PFAS-forbindelser (som PFOS) i de fleste prøvetyper
- Visse QAC-forbindelser i flere prøvetyper (ATAC-C22 i alle)
- Spesifikke benzotiazoler i blod av ærfugl
- LCCP i visse prøvetyper
- Visse siloksaner i de fleste prøvetyper
- Metaller i alle prøvetyper
- PCB-forbindelser i alle prøvetyper

Konsentrasjoner av PFAS var høyest i torsk (lever) og fugl (særlig egg). PFOS (inkludert brPFOS) var her en dominerende PFAS-forbindelse. PFOSA utgjorde den høyeste andelen av sum-PFAS-konsentrasjonen i torsk, samt i blåskjell, reke og sild. UV-stoffer ble kun analysert i sediment og prøver av fugl. I gråmåke og ærfugl ble UV-stoffer kun detektert i egg og UV-327 ble funnet i begge arter, samt i sediment. UV-328 var et dominerende UV-stoff i sediment og egg av gråmåke. Oktokrylen var også et viktig UV-stoff i sediment. De høyeste konsentrasjonene av kvaternære ammoniumforbindelser ble observert i sediment og flerbørstemark, og DADMAC-C16 og DADMAC-C18 var dominerende. I alle de øvrige prøvetypene (biota) var ATAC-C22 dominerende. Benzotiazoler ble kun analysert i sediment og fugl. Benzotiazol (BT) ble funnet i både blod og egg fra begge arter. Iøyenfallende konsentrasjoner ble observert i blod fra ærfugl, med høyest konsentrasjon av MBT, men også OHBT var detektert. De høyeste konsentrasjonene av dekloraner ble funnet i sediment, lever av torsk, og egg av gråmåke og ærfugl, og dekloran pluss *syn* og *anti* utgjorde høye andeler av summen av dekloraner. I lever av torsk utgjorde dekloran 602 og dekloran 603 de høyeste andelene av sum-dekloran-konsentrasjonen. Høye andeler av dekloran 602 ble også observert i egg av gråmåke og ærfugl. Alle klasser av klorparafiner (SCCP, MCCP og LCCP) ble funnet i sediment, med høyest konsentrasjon av LCCP. Blant biota-prøvene ble de høyeste konsentrasjonene av klorparafiner funnet i lever av torsk og egg av gråmåke. LCCP utgjorde de høyeste andelene av sum-klorparafiner-konsentrasjonene. Ftalater ble kun analysert i sediment, og DEHP og DINP utgjorde de høyeste andelene av sum-ftalat-konsentrasjonen. Fosfororganiske flammehemmere (OPFR) ble kun analysert i sediment og TCPP utgjorde den høyeste andelen av sum-OPFR-konsentrasjonen. Fenoliske forbindelser ble kun analysert i sediment og galle fra torsk, og 4,4-bisfenol A viste høyest konsentrasjon i begge prøvetyper. Siloksaner ble detektert i alle prøvetyper og D5 utgjorde høye andeler av sum-siloksan-konsentrasjonene. M3T(Ph) var en dominerende forbindelse i blod fra gråmåke og ærfugl. Lange (lineære) siloksaner (L7 of L8) utgjorde ~20% av sum-siloksan-konsentrasjonen i sediment. Muskforbindelser ble kun analysert i sediment, og Galaxolide og Tonalide (AHMT) ble begge detektert.

Biomagnifisering (kvantifisert vha. trofiske magnifiseringsfaktorer, TMF) ble observert for 24 PCB-kongenere, LCCP og D4 (lipidvektsbasis). Videre ble biomagnifisering observert for PFOSA, ATAC-C20 og ATAC-C22, samt for metallene As og Hg (våtvektsbasis). Flere PCB-kongenere har vist biomagnifisering i næringsnettet i Indre Oslofjord i alle årene av overvåkingen (siden 2013). Også biomagnifisering av Hg og As er vist de fleste årene. Biomagnifisering av PFOSA ble observert i 2016-2018, mens ATAC-C20 og C-22 viste biomagnifisering (kun på våtvektsbasis) i 2017, 2019 og 2023.

1 Introduction

"Environmental contaminants in an urban fjord" is a programme designed to monitor discharges of anthropogenic chemicals in a densely populated area and to study how this contaminant input affects a fjord system. The programme addresses inputs of pollutants from potential sources, measurements of contaminant concentrations in different marine species, assessment of bioaccumulation patterns within a food web and estimation of effect risks in organisms.

This report presents data from the last year of a 5-year period of the Urban Fjord programme. The programme started in 2013 and has since been altered/advanced, and the content differs between years. The 2025 programme covers sampling and analyses of sediment, polychaetes, krill, shrimps, blue mussels, herring, cod, eider and herring gull from the Inner Oslofjord.

This year's campaign was carried out by NIVA, with a large number of chemical analyses performed by the Norwegian Institute for Air Research, NILU.

This report contains reused text from the previous reports from the "Urban fjord" programme, used in accordance with NIVA's guidelines for text reuse (e.g. Ruus et al. 2025 and Ruus et al. 2023).

2 Extended summary of Urban Fjord 2025

2.1 Samples and localities

An overview of the samples collected in the Urban Fjord programme 2025 is presented in Table 1. Localities for sample collection are shown in Figure 1.

Table 1. Overview of samples collected for the "Urban Fjord" programme 2025.

Species/Sample	Matrix	Locality	Station code	No. for analysis
Sediment	Whole sediment	Bekkelaget Alna River outlet Ildjernet	Bq41 AL1 Cm21	3
Blue mussel	Pooled samples, soft body	Steilene	IO Blåskjell	3 pooled samples
Polychaetes	Pooled samples, whole individuals	Bekkelaget Alna River outlet Ildjernet	Bq41 AL1 Cm21	3 pooled samples[1]
Zooplankton (krill)	Pooled samples, whole individuals	Midtmeie	IO	3 pooled samples
Shrimp	Pooled samples, soft tissue tails	Midtmeie	IO	3 pooled samples
Herring	Muscle	Midtmeie	IO	3 pooled samples[2]
Cod	Muscle, liver, bile	Midtmeie	IO	3 pooled samples[2]
Herring gull (blood)	Blood	Søndre skjælholmen	Skjælholmene	3
Herring gull (egg)	Egg	Søndre skjælholmen	Skjælholmene	3
Eider (blood)	Blood	Søndre skjælholmen Husbergøya	Skjælholmene Husbergøya	3
Eider (egg)	Egg	Søndre skjælholmen Husbergøya	Skjælholmene Husbergøya	3

[1] For species constituting polychaete samples, see Table 2

[2] Each of 5 specimens (biometric data are given in Appendix, Chapter 4)

Table 2. Species constituting polychaete samples (grams of each species).

	Bekkelaget Bq41	Alna River outlet Al1	Ildjernet Cm21
Glycera	60	12*	12
Polyphysia crassa	9	30	151
Lumbrineridae	12	15	13
Terebellidae	13	52	15
Aphrodita aculeata	24	35	46
Misc.	4	4	8
Goniada maculata	11		4
Nephtys sp.		5	
Total (grams)	**133**	**148**	**249**

* Weight includes *Goniada maculata*.

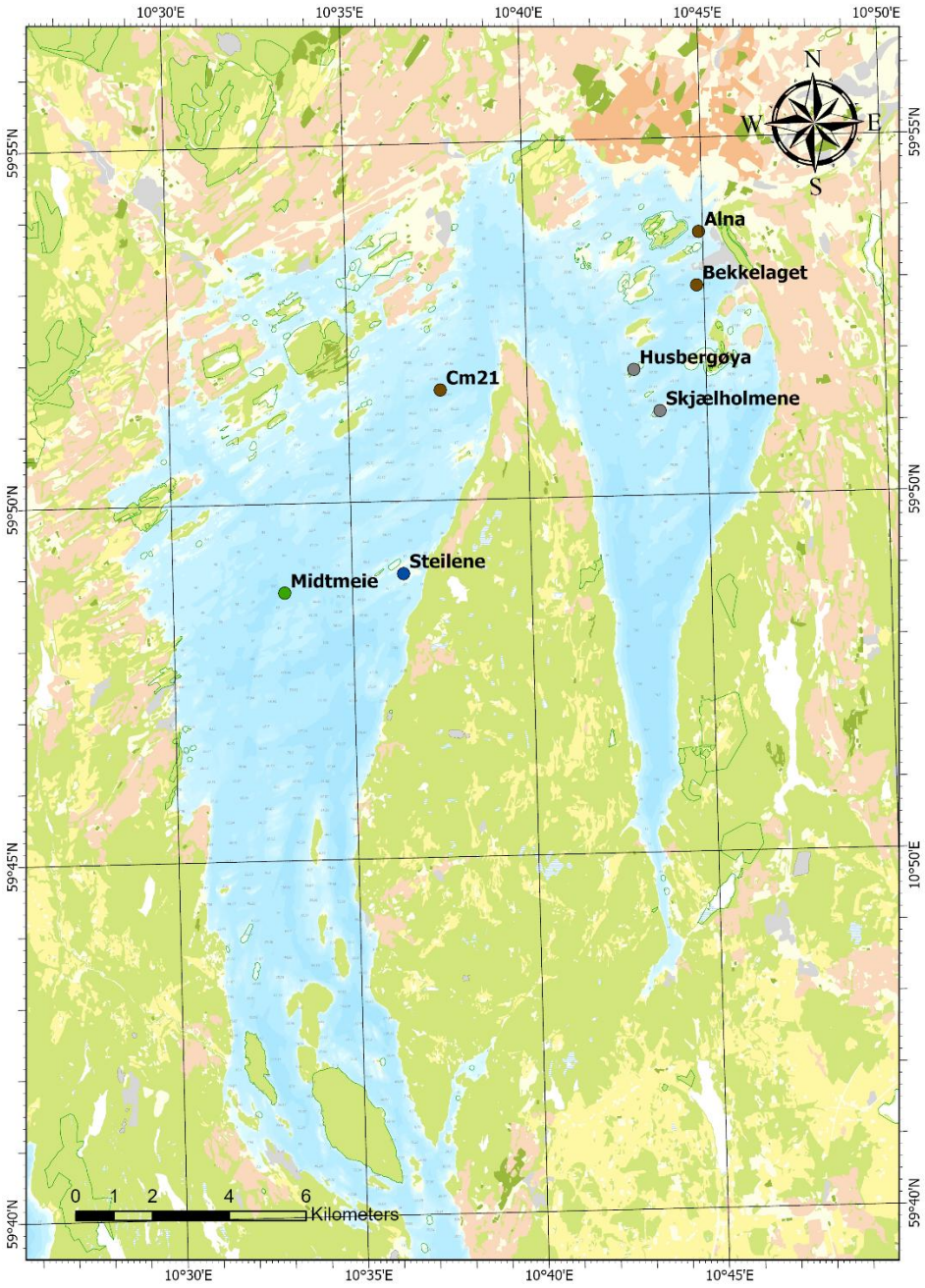


Figure 1. Map depicting stations for collection of sediment (brown), polychaetes (brown), blue mussel (blue), krill (green), shrimp (green), herring (green), cod (green), herring gull (grey; only Skjælholmene) and eider (grey) in the Inner Oslofjord.

2.2 Chemical analysis

Details of the chemical analytical methods are presented in Chapter 3. Table 3 shows an overview of the chemical analyses performed in the different samples, while Table 7 (in Appendix, Chapter 4) shows the specific analytes in the programme.

2.3 Assessment of biomagnification

The chemical analyses in this study were performed on pooled samples. However, analyses of stable isotopes ($\delta^{13}C$ and $\delta^{15}N$) were performed on individual muscle samples (n=15) of cod and herring; see Appendix, Chapter 4). In the biomagnification assessment, the mean $\delta^{15}N$ values of the individuals constituting the pooled samples of herring and cod were applied.

Biomagnification was assessed in the food web consisting of polychaeta, blue mussel, krill, shrimp, Herring (muscle) and cod (liver or muscle). The $\delta^{13}C$ signature shows that herring gull is not a representative member of the Inner Oslofjord (see Appendix and previous reports; e.g. Grung et al. 2021). Furthermore, using the same food web as previously, in the calculations, is advantageous for comparative purposes.

When exploring correlations between contaminant concentrations and trophic position, concentrations of the following contaminants were expressed on a wet weight basis: Metals, PFASs and QACs. The concentrations of the following contaminants were expressed on a lipid weight basis: PCBs and other organochlorine compounds, chlorinated paraffins, siloxanes and dechloranes. Other contaminants were not analysed in sufficient number of matrices for biomagnification assessment. Cod was represented by the concentrations in liver or muscle.

Biomagnification potential was evaluated by comparing contaminant concentrations with trophic position, calculated from $\delta^{15}N$ levels (assuming an enrichment, $\Delta^{15}N$, of 3.4 between each integer trophic level, and that the average δ15N of blue mussel represents trophic level 2). Trophic Magnification Factors (TMFs) were calculated from statistically significant relationships:

$$Log_{10}[\text{Contaminant}] = a + b(\text{Trophic position})$$

as $TMF = 10^{b}$.

Table 3. Overview: Analyses in different matrices in 2025.

	Sediment	Polychaeta	Blue mussel	Krill	Shrimp	Herring	Cod [1]	Herring gull [2]	Eider [2]
Metals	X	X	X	X	X	X	X	X	X
Siloxanes	X	X	X	X	X	X	X	X	X
PCBs (and organochlorines)	X	X	X	X	X	X	X	X	X
OPFRs	X								
Phenolic comp.	X						X		
PFAS	X	X	X	X	X	X	X	X	X
UV-chemicals	X							X	X
Dechloranes	X	X	X	X	X	X	X	X	X
QAC	X	X	X	X	X	X	X	X	X
Musk	X								
Benzothiazoles	X							X	X
Phthalates	X								
Chlorinated paraffins	X	X	X	X	X	X	X	X	X
Stable isotopes of C and N		X	X	X	X	X	X	X	X

[1] Liver and muscle (stable isotopes only in muscle). Phenolic compounds in bile.

[2] Blood and eggs.

2.4 Results and discussion

In this chapter, key findings are presented. All results are presented in electronic Appendices.

2.4.1. Stable isotopes

The results regarding the stable isotopes of C and N are given in the Appendix (Chapter 4).

2.4.2. Detection frequencies of contaminants

A total of ~230 single compounds/isomers were determined in this study. Figure 2 gives the detection frequency of the various compounds in the different samples. The figure shows frequent detection of specific PFAS compounds (e.g. PFOS) in most matrices, certain QACs in several matrices (ATAC-C22 in all matrices), specific benzothiazoles in eider blood, LCCPs in certain matrices, certain siloxanes in most matrices, metals in all matrices and PCBs in all matrices.

See Chapter 3.2.1 for an indication of analyses/analytes with the lowest/highest uncertainties.

A.

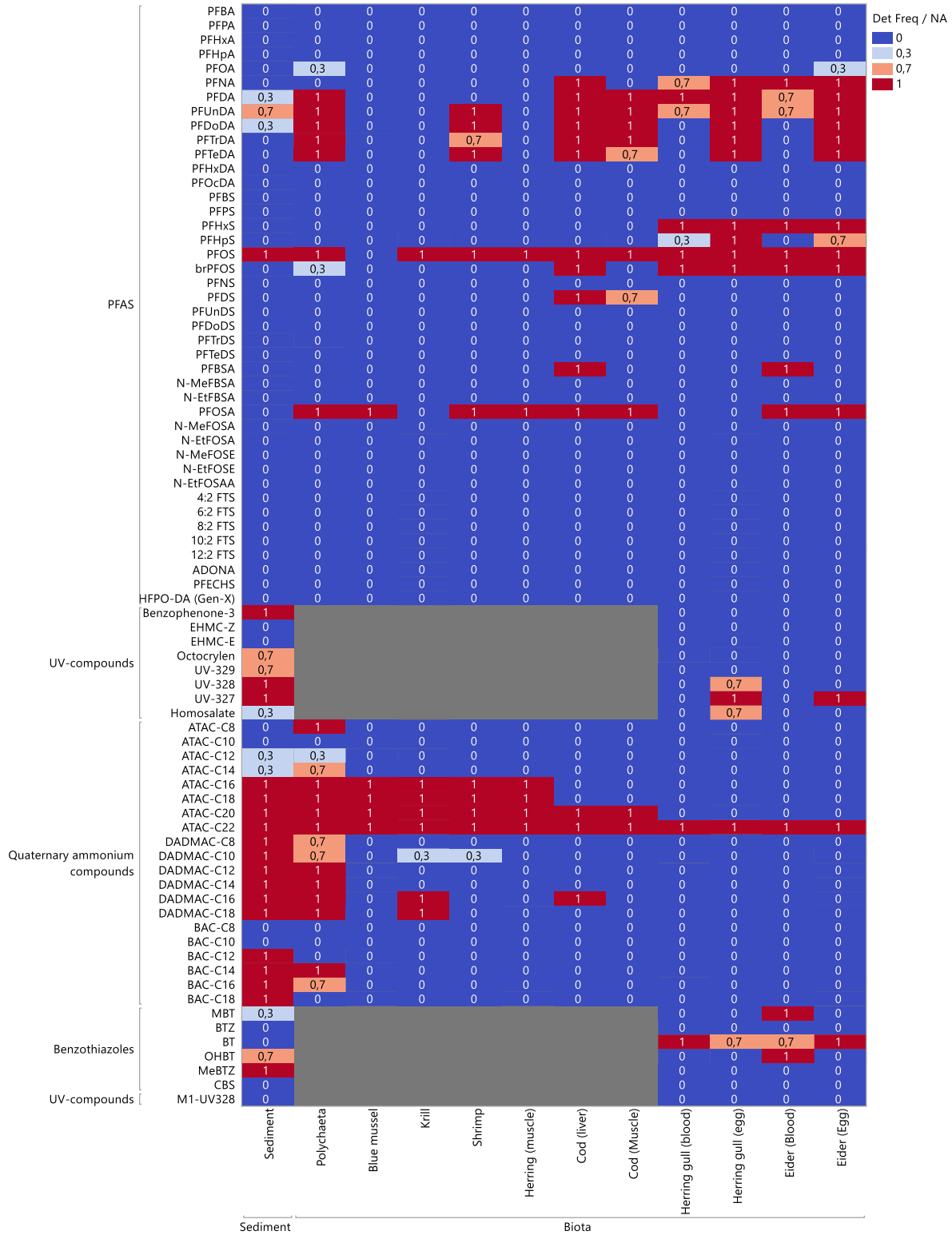
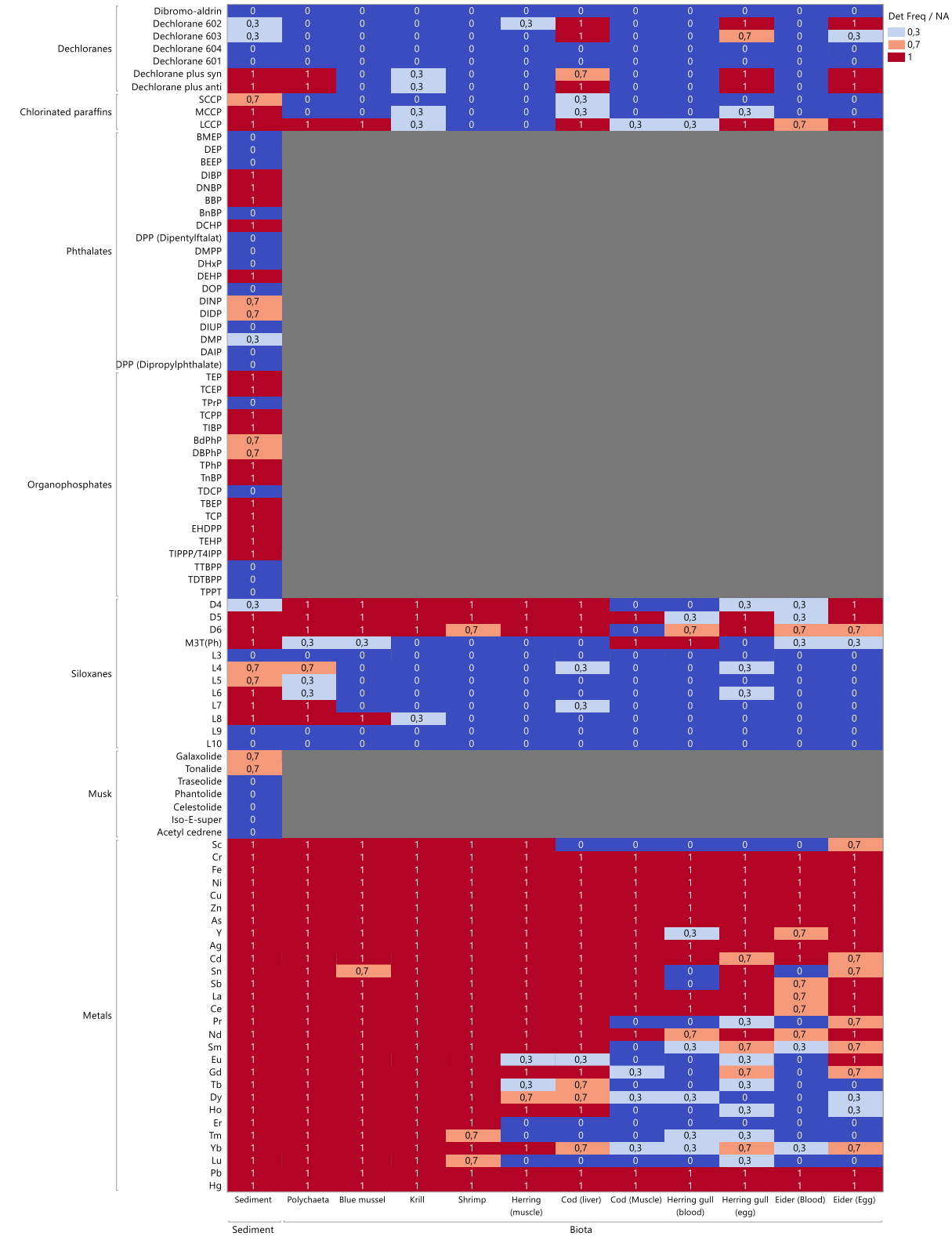
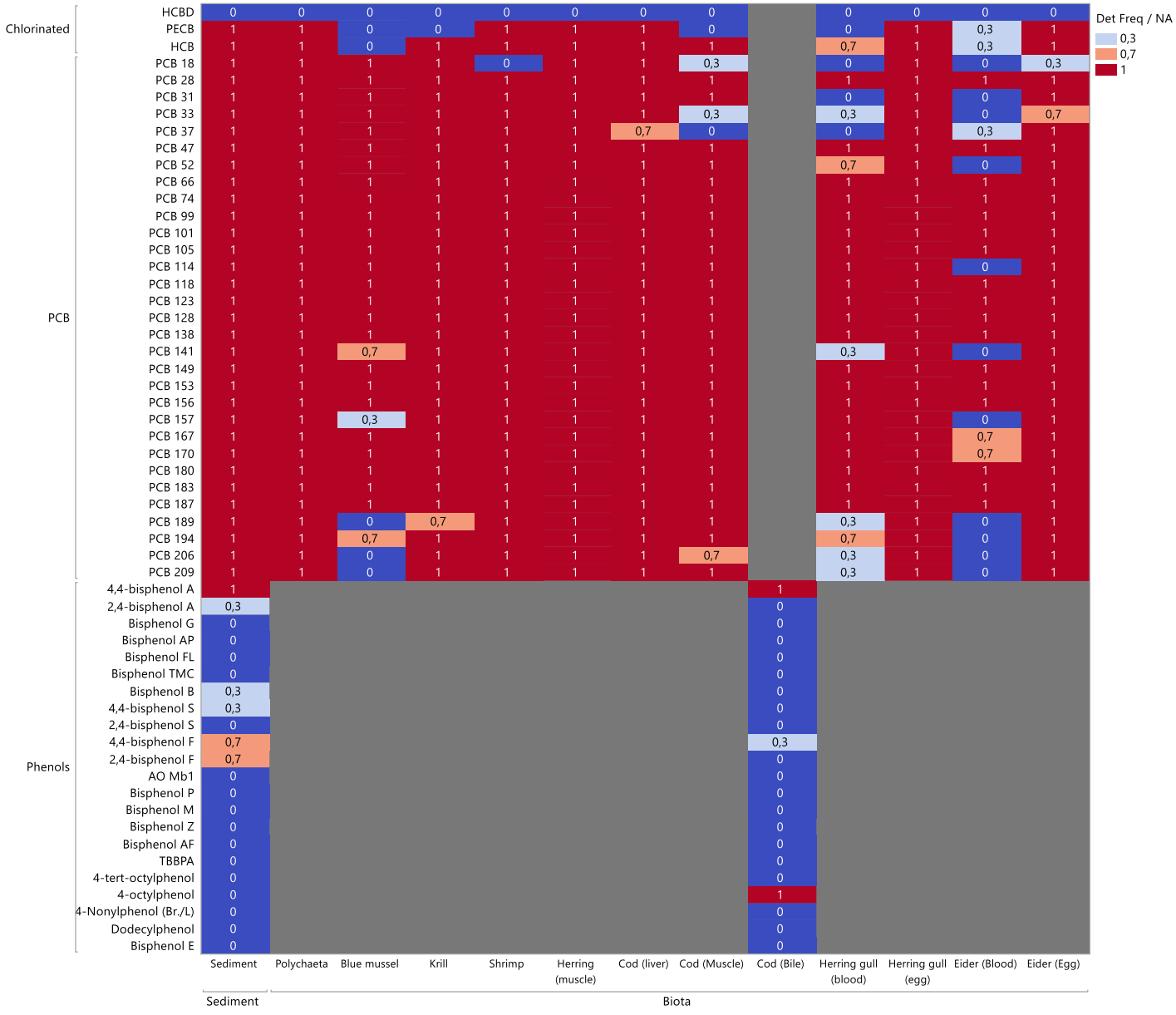


Figure 2. Detection frequency (as fraction; %/100) of all compounds in the different species/matrices in this study. A: PFAS, UV-compounds, quaternary ammonium compounds, and benzothiazoles; B: Chlorinated compounds, phthalates, OPFRs, siloxanes, musks and metals; C: More chlorinated compounds and phenolic compounds.

B.


Det Freq / NA
0,3
0,7
1
Dechloranes
Dibromo-aldrin 0 0 0 0 0 0 0 0 0 0 0 0
Dechlorane 602 0,3 0 0 0 0 0,3 1 0 0 1 0 1
Dechlorane 603 0,3 0 0 0 0 0 1 0 0 0,7 0 0,3
Dechlorane 604 0 0 0 0 0 0 0 0 0 0 0 0
Dechlorane 601 0 0 0 0 0 0 0 0 0 0 0 0
Dechlorane plus syn 1 1 0 0,3 0 0 0,7 0 0 1 0 1
Dechlorane plus anti 1 1 0 0,3 0 0 1 0 0 1 0 1
Chlorinated paraffins
SCCP 0,7 0 0 0 0 0 0,3 0 0 0 0 0
MCCP 1 0 0 0,3 0 0 0,3 0 0 0,3 0 0
LCCP 1 1 1 0,3 0 0 1 0,3 0,3 1 0,7 1
Phthalates
BMEP 0
DEP 0
BEEP 0
DIBP 1
DNBP 1
BBP 1
BnBP 0
DCHP 1
DPP (Dipentylftalat) 0
DMPP 0
DHxP 0
DEHP 1
DOP 0
DINP 0,7
DIDP 0,7
DIUP 0
DMP 0,3
DAIP 0
DPP (Dipropylphthalate) 0
Organophosphates
TEP 1
TCEP 1
TPrP 0
TCPP 1
TIBP 1
BdPhP 0,7
DBPhP 0,7
TPhP 1
TnBP 1
TDCP 0
TBEP 1
TCP 1
EHDPP 1
TEHP 1
TIPPP/T4IPP 1
TTBPP 0
TDTBPP 0
TPPT 0
Siloxanes
D4 0,3 1 1 1 1 1 1 0 0 0,3 0,3 1
D5 1 1 1 1 1 1 1 1 0,3 1 0,3 1
D6 1 1 1 1 0,7 1 1 0 0,7 1 0,7 0,7
M3T(Ph) 1 0,3 0,3 0 0 0 0 1 1 0 0,3 0,3
L3 0 0 0 0 0 0 0 0 0 0 0 0
L4 0,7 0,7 0 0 0 0 0,3 0 0 0,3 0 0
L5 0,7 0,3 0 0 0 0 0 0 0 0 0 0
L6 1 0,3 0 0 0 0 0 0 0 0,3 0 0
L7 1 1 0 0 0 0 0,3 0 0 0 0 0
L8 1 1 1 0,3 0 0 0 0 0 0 0 0
L9 0 0 0 0 0 0 0 0 0 0 0 0
L10 0 0 0 0 0 0 0 0 0 0 0 0
Musk
Galaxolide 0,7
Tonalide 0,7
Traseolide 0
Phantolide 0
Celestolide 0
Iso-E-super 0
Acetyl cedrene 0
Metals
Sc 1 1 1 1 1 1 0 0 0 0 0 0,7
Cr 1 1 1 1 1 1 1 1 1 1 1 1
Fe 1 1 1 1 1 1 1 1 1 1 1 1
Ni 1 1 1 1 1 1 1 1 1 1 1 1
Cu 1 1 1 1 1 1 1 1 1 1 1 1
Zn 1 1 1 1 1 1 1 1 1 1 1 1
As 1 1 1 1 1 1 1 1 1 1 1 1
Y 1 1 1 1 1 1 1 1 0,3 1 0,7 1
Ag 1 1 1 1 1 1 1 1 1 1 1 1
Cd 1 1 1 1 1 1 1 1 1 0,7 1 0,7
Sn 1 1 0,7 1 1 1 1 1 0 1 0 0,7
Sb 1 1 1 1 1 1 1 1 0 1 0,7 1
La 1 1 1 1 1 1 1 1 1 1 0,7 1
Ce 1 1 1 1 1 1 1 1 1 1 0,7 1
Pr 1 1 1 1 1 1 1 0 0 0,3 0 0,7
Nd 1 1 1 1 1 1 1 1 0,7 1 0,7 1
Sm 1 1 1 1 1 1 1 0 0,3 0,7 0,3 0,7
Eu 1 1 1 1 1 0,3 0,3 0 0 0,3 0 1
Gd 1 1 1 1 1 1 1 0,3 0 0,7 0 0,7
Tb 1 1 1 1 1 0,3 0,7 0 0 0,3 0 0
Dy 1 1 1 1 1 0,7 0,7 0,3 0,3 0 0 0,3
Ho 1 1 1 1 1 1 1 0 0 0,3 0 0,3
Er 1 1 1 1 1 0 0 0 0 0 0 0
Tm 1 1 1 1 0,7 0 0 0 0,3 0,3 0 0
Yb 1 1 1 1 1 0,7 0,3 0,3 0,7 0,3 0,7
Lu 1 1 1 1 0,7 0 0 0 0 0,3 0 0
Pb 1 1 1 1 1 1 1 1 1 1 1 1
Hg 1 1 1 1 1 1 1 1 1 1 1 1
Sediment
Polychaeta
Blue mussel
Krill
Shrimp
Herring (muscle)
Cod (liver)
Cod (Muscle)
Herring gull (blood)
Herring gull (egg)
Eider (Blood)
Eider (Egg)
Sediment
Biota

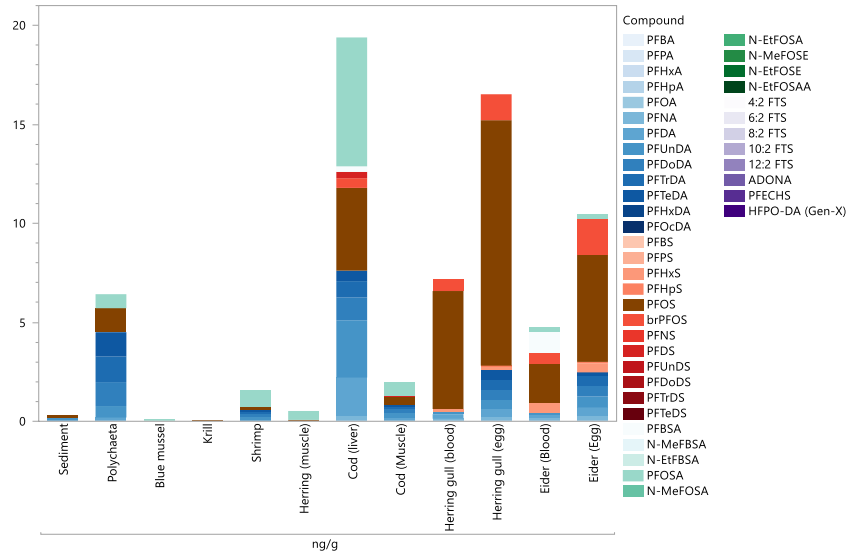
C.


Chlorinated
PCB
Phenols
HCBD
PECB
HCB
PCB 18
PCB 28
PCB 31
PCB 33
PCB 37
PCB 47
PCB 52
PCB 66
PCB 74
PCB 99
PCB 101
PCB 105
PCB 114
PCB 118
PCB 123
PCB 128
PCB 138
PCB 141
PCB 149
PCB 153
PCB 156
PCB 157
PCB 167
PCB 170
PCB 180
PCB 183
PCB 187
PCB 189
PCB 194
PCB 206
PCB 209
4,4-bisphenol A
2,4-bisphenol A
Bisphenol G
Bisphenol AP
Bisphenol FL
Bisphenol TMC
Bisphenol B
4,4-bisphenol S
2,4-bisphenol S
4,4-bisphenol F
2,4-bisphenol F
AO Mb1
Bisphenol P
Bisphenol M
Bisphenol Z
Bisphenol AF
TBBPA
4-tert-octylphenol
4-octylphenol
4-Nonylphenol (Br./L)
Dodecylphenol
Bisphenol E
Det Freq / NA
0,3
0,7
1
Sediment
Polychaeta
Blue mussel
Krill
Shrimp
Herring (muscle)
Cod (liver)
Cod (Muscle)
Cod (Bile)
Herring gull (blood)
Herring gull (egg)
Eider (Blood)
Eider (Egg)
Sediment
Biota

2.4.3. PFAS

Concentrations of PFAS were highest in cod (liver) and birds (eggs in particular; Figure 3). PFOS (including brPFOS) was a dominating PFAS. PFOSA constituted the highest proportion of the sum-PFAS concentration in cod, as well as in blue mussel, shrimp, and herring.

A.



B.

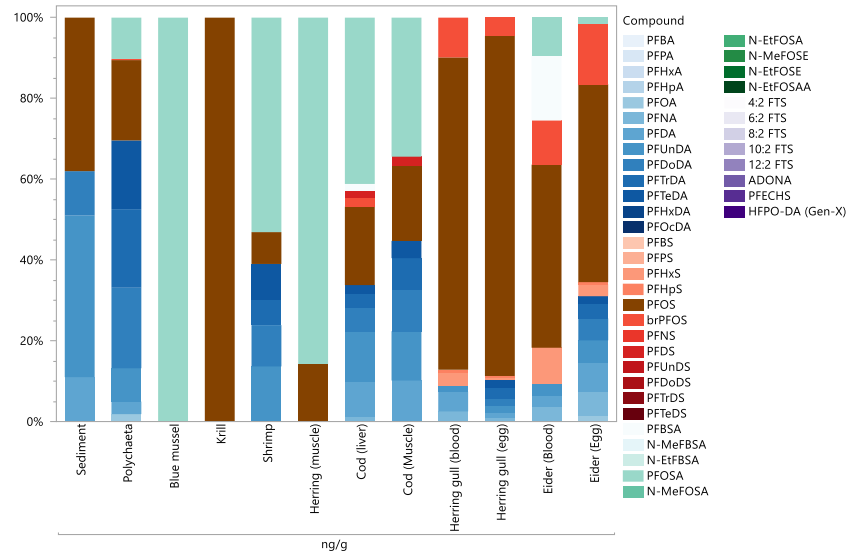
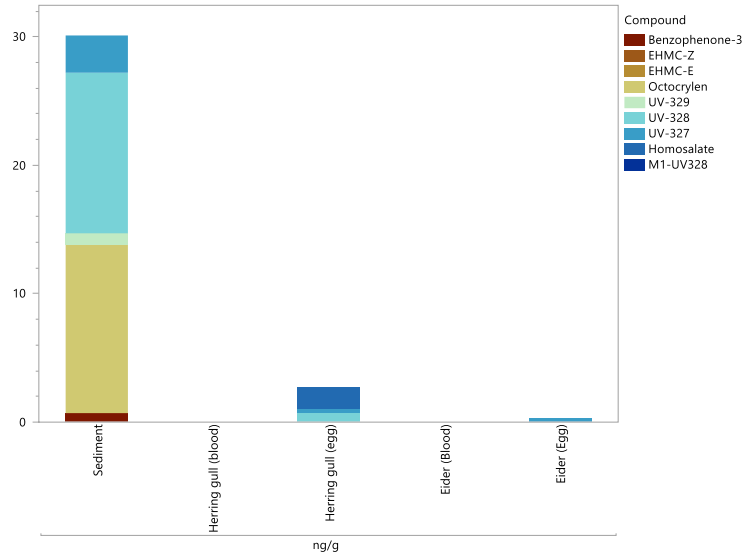


Figure 3. Concentrations (median; ng/g wet wt. in biota, ng/g dry wt. in sediment) of PFAS compounds in all matrices (A) and their contribution (%) to the sum-PFAS concentration (B). Non-detected compounds are assigned a value of zero (0). TFA, PFPrA, PMeS, PFEtS and PFPrS were not determined.

2.4.4. UV-compounds

UV-compounds were analysed in sediment and birds. In herring gull and eider, UV-compounds were only detected in eggs and UV-327 was found in both species, as well as in sediment (Figure 4). UV-328 was a major UV-compound in sediment and herring gull eggs. Octocrylene was also an important UV-compound in sediment.

A.



B.

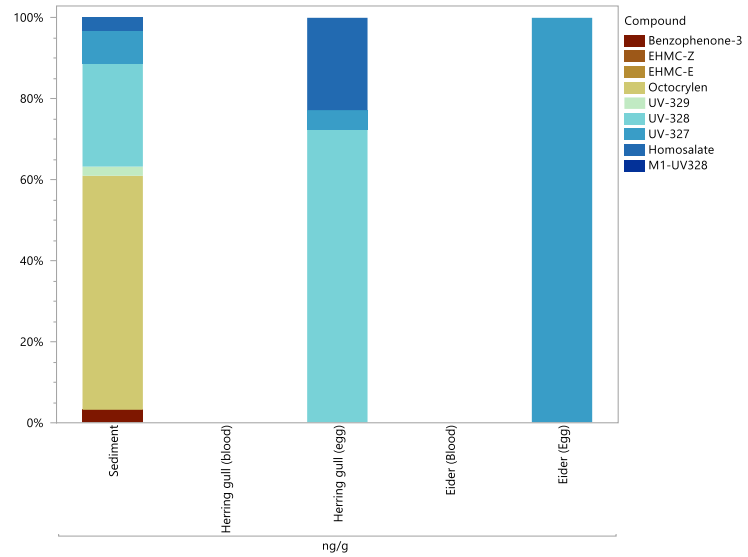
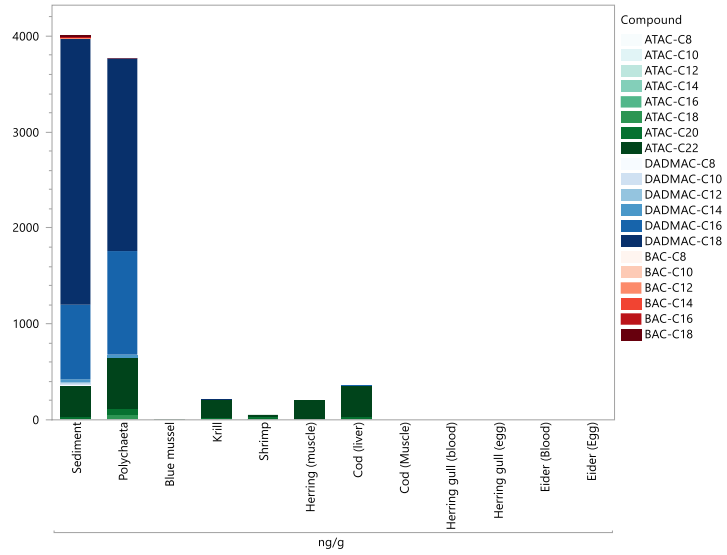


Figure 4. Concentrations (median; ng/g wet wt. in biota, ng/g dry wt. in sediment) of UV-compounds in sediment, herring gull (blood and egg) and eider (blood and egg) (A) and their contribution (%) to the sum-UV-compounds concentration (B). Non-detected compounds are assigned a value of zero (0).

2.4.5. Quaternary ammonium compounds

The highest concentrations of quaternary ammonium compounds (QACs) were observed in sediment and polychaetes and the dialkyldimethyl ammonium compounds DADMAC-C16 and DADMAC-C18 were most dominating. In all other samples (biota), the alkyltrimethyl ammonium compound ATAC-C22 constituted the highest proportion of the sum-QAC concentrations (Figure 5).

A.



B.

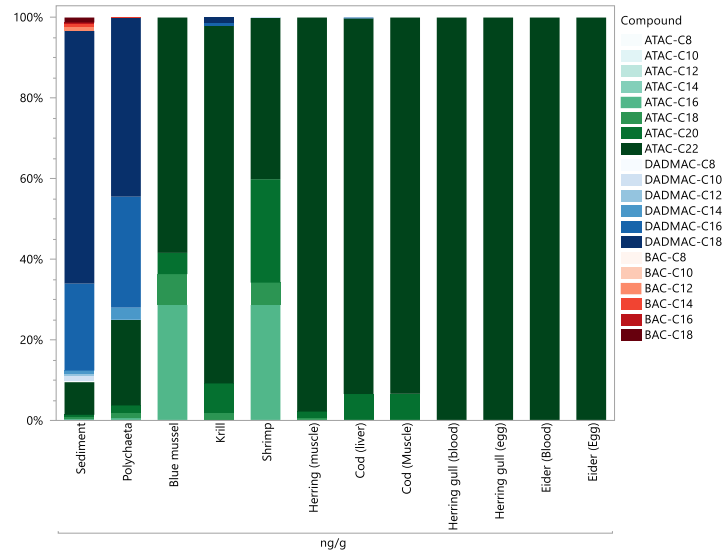


Figure 5. Concentrations (median; ng/g wet wt. in biota, ng/g dry wt. in sediment) of quaternary ammonium compounds in all matrices (A) and their contribution (%) to the sum- QAC concentration (B). Non-detected compounds are assigned a value of zero (0).

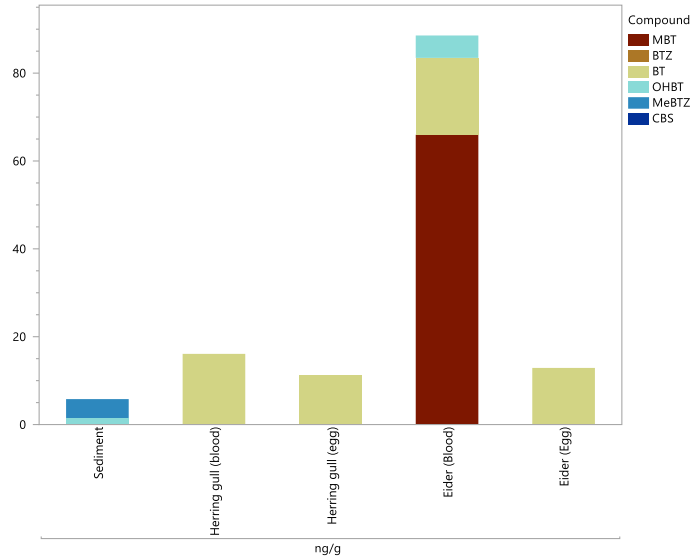
2.4.6. Benzothiazoles

Benzothiazoles were analysed and detected in sediment and birds. Benzothiazole (BT) was found in both blood and eggs of both bird species. Conspicuous amounts were found in blood of eider, with mercaptobenzothiazole (MBT) displaying the highest concentrations (63, 66 and 101 ng/g wet wt.), and with 2(3H)-Benzothiazolone (OHBT) also detected (4.8, 5.1 and 9.1 ng/g wet wt.; Figure 6). Ask et al. (2025) detected benzothiazoles in blood of eider from the Baltic and this was, to their knowledge, the first report of OHBT in birds. They found an OHBT-concentration of 1.57 ng/g (wet wt.; early breeders, early incubation) and an MBT-concentration of 3.15 ng/g (wet wt.; late breeders, late incubation). MBT is used primarily as a vulcanization accelerator and preservative in the manufacturing of rubber, such as tyre production. It is shown that Inner Oslofjord sediments contain high amounts of tyre wear particles (TWP; Alling et al. 2025).

2.4.7. Organochlorines and PCBs

PCBs were detected in all matrices analysed. Highest concentrations were found in the lipid rich matrices cod liver and bird eggs, which could also be observed for PeCB and HCB (see electronic Appendix).

A.



B.

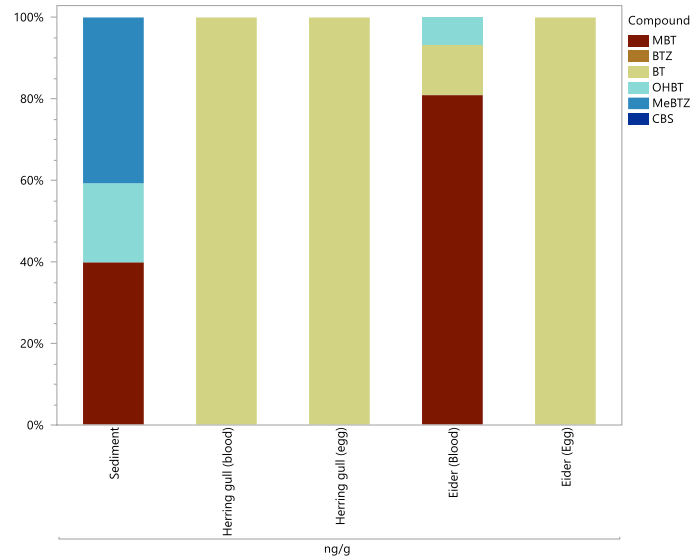
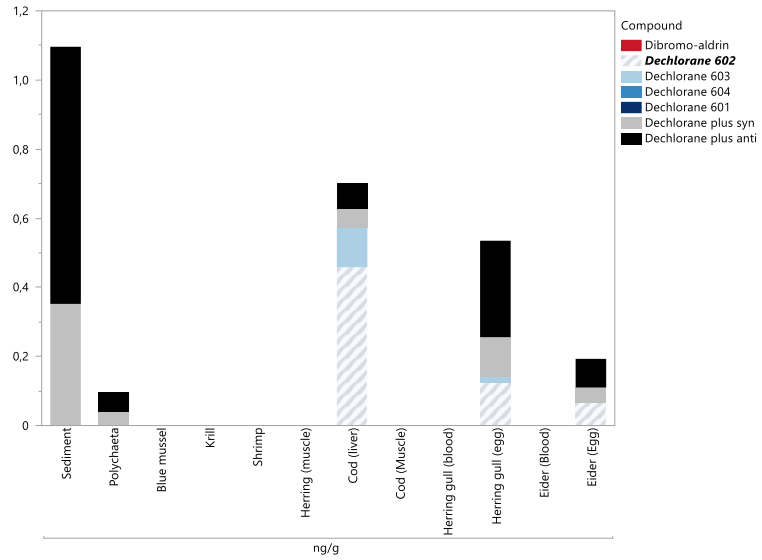


Figure 6. Concentrations (median; ng/g wet wt. in biota, ng/g dry wt. in sediment) of benzothiazoles in sediment, herring gull (blood and egg) and eider (blood and egg) (A) and their contribution (%) to the sum-benzothiazoles concentration (B). Non-detected compounds are assigned a value of zero (0).

2.4.8. Dechloranes

The highest concentrations of dechloranes were observed in sediment, cod liver and eggs of herring gull and eider, and dechlorane plus *syn* and *anti* were important constituents of sum-dechloranes (Figure 7). In cod liver, dechlorane 602 and dechlorane 603 constituted the highest proportions of the sum-dechloranes concentration. High proportions of dechlorane 602 were also observed in eggs of herring gull and eider.

A.



B.

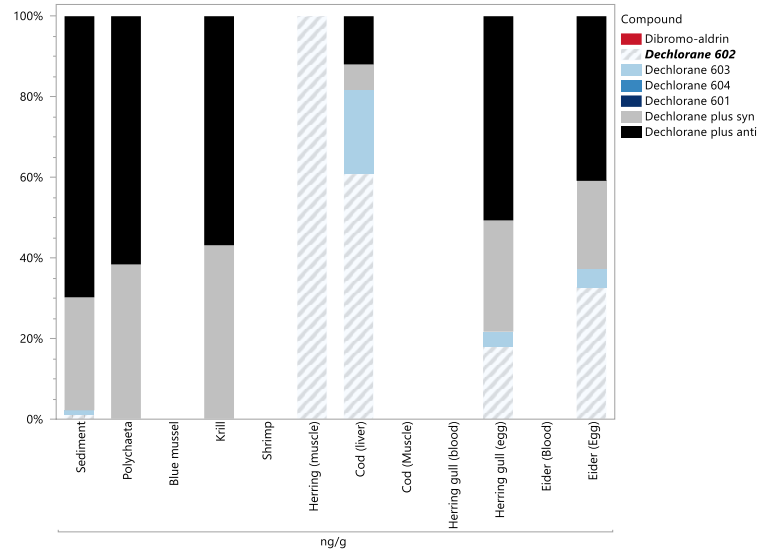
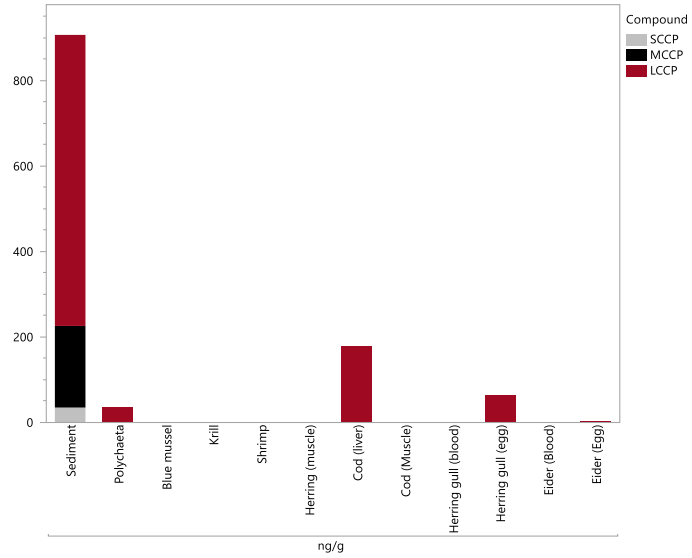


Figure 7. Concentrations (median; ng/g wet wt. in biota, ng/g dry wt. in sediment) of dechloranes in all matrices (A) and their contribution (%) to the sum-dechloranes concentration (B). Non-detected compounds are assigned a value of zero (0).

2.4.9. Chlorinated paraffins

SCCPs, MCCPs and LCCPs were found in sediment, with LCCPs showing the highest concentrations (Figure 8). Among the biota samples, the highest concentrations of chlorinated paraffins were observed in cod liver and eggs of herring gull. In these matrices also, LCCPs constituted the highest proportions of the sum-chlorinated paraffins concentrations. As previously mentioned (Ruus et al 2025), high proportions of LCCPs have earlier been found in birds and other biota samples (Yuan et al. 2019, Yuan et al. 2021, Yuan et al. 2022).

A.



B.

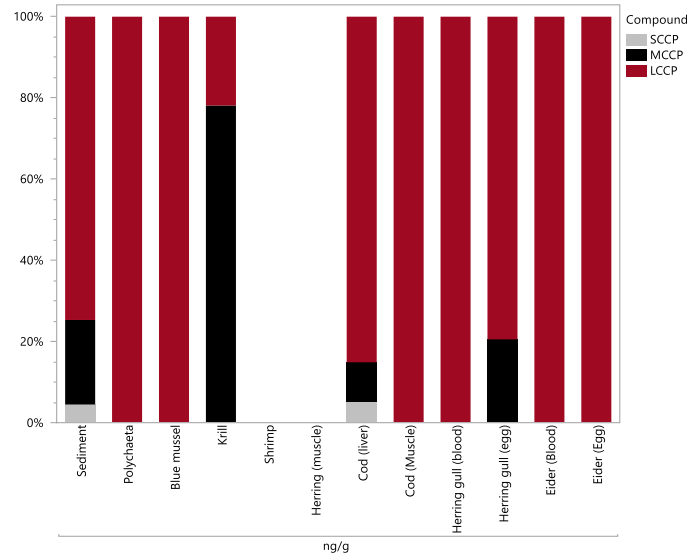
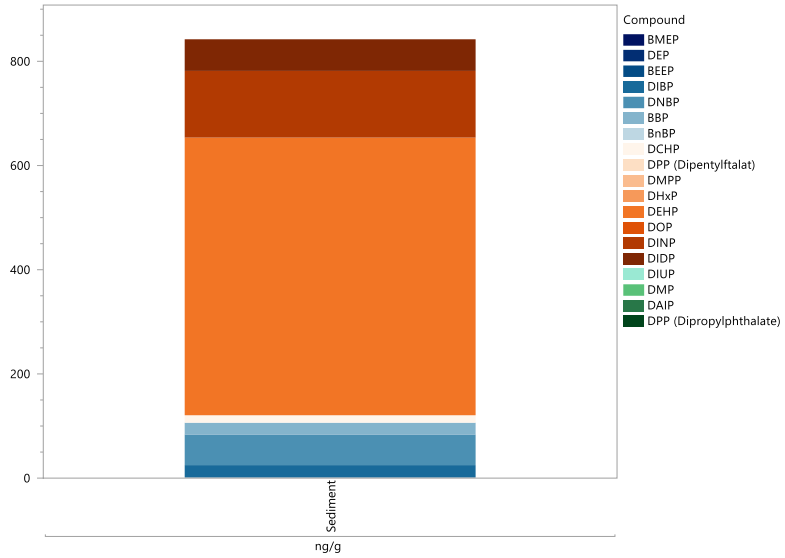


Figure 8. Concentrations (median; ng/g wet wt. in biota, ng/g dry wt. in sediment) of chlorinated paraffins in all matrices (A) and their contribution (%) to the sum-chlorinated paraffins concentration (B). Non-detected compounds are assigned a value of zero (0).

2.4.10. Phthalates

Phthalates were detected in sediments (the only matrix where they were analysed; Figure 9). DEHP and DINP constituted the highest proportions of the sum-phthalates concentrations.

A.



B.

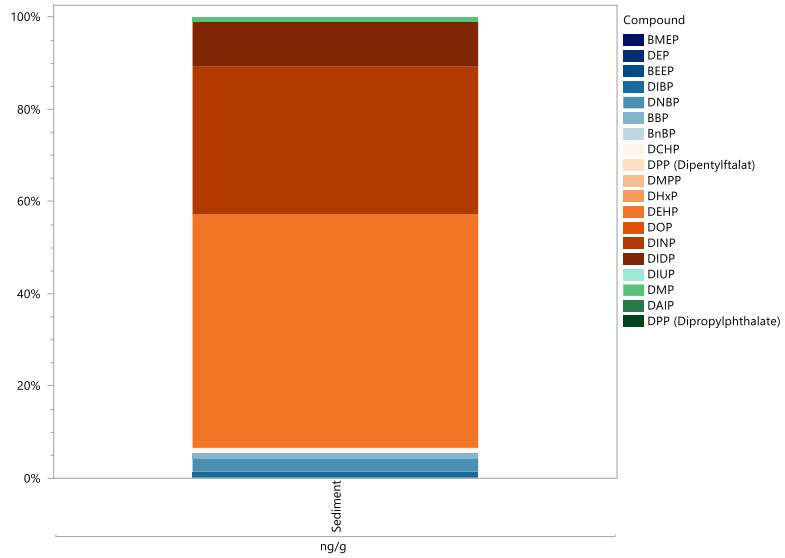
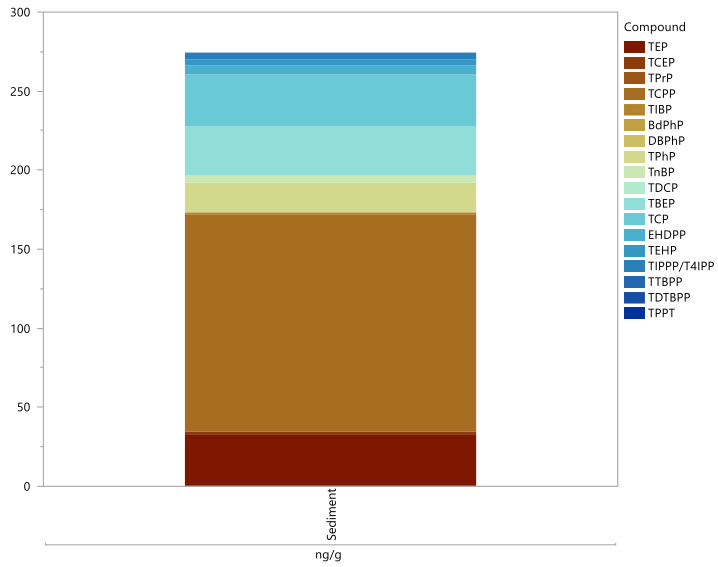


Figure 9. Concentrations (median; ng/g dry wt.) of phthalates in sediment (A) and their contribution (%) to the sum-phthalates concentration (B). Non-detected compounds are assigned a value of zero (0).

2.4.11. OPFRs

OPFRs were detected in sediments (the only matrix where they were analysed; Figure 10). TCPP constituted the highest proportion of the sum-OPFRs concentration.

A.



B.

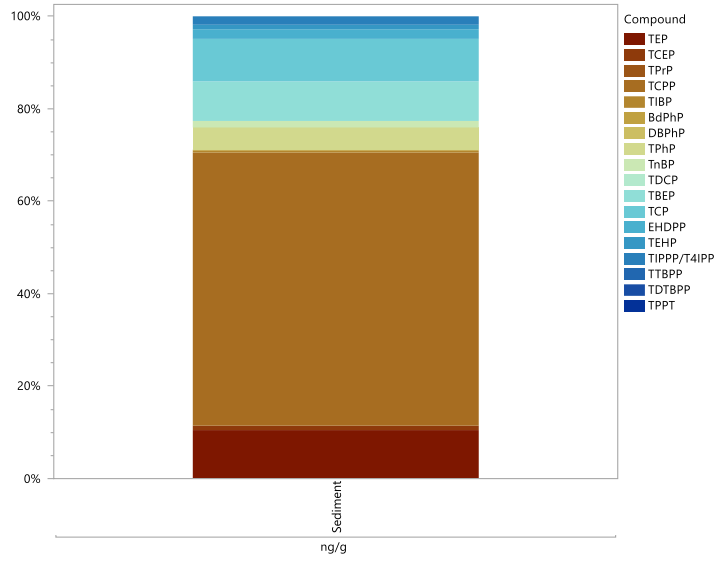
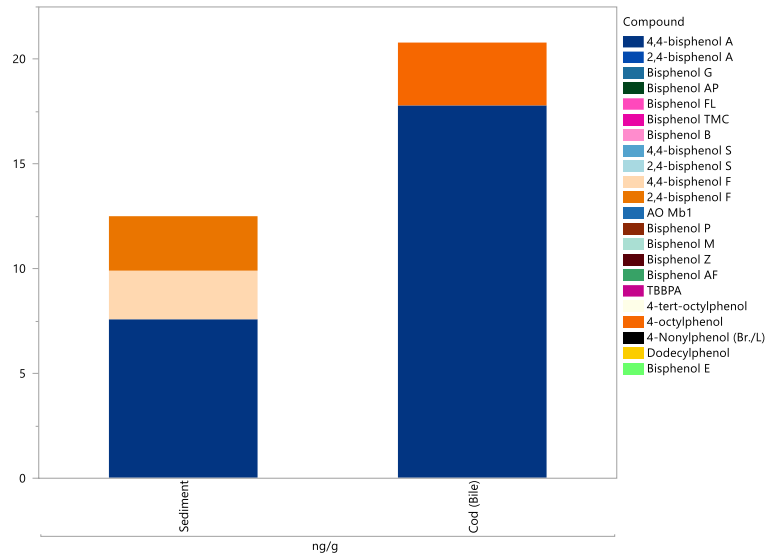


Figure 10. Concentrations (median; ng/g dry wt.) of OPFRs in sediment (A) and their contribution (%) to the sum-OPFRs concentration (B). Non-detected compounds are assigned a value of zero (0).

2.4.12. Phenolic compounds

Phenolic compounds were detected in sediments and bile of cod (the two matrices where they were analysed; Figure 11). 4,4-bisphenol A displayed the highest concentration in both matrices.

A.



B.

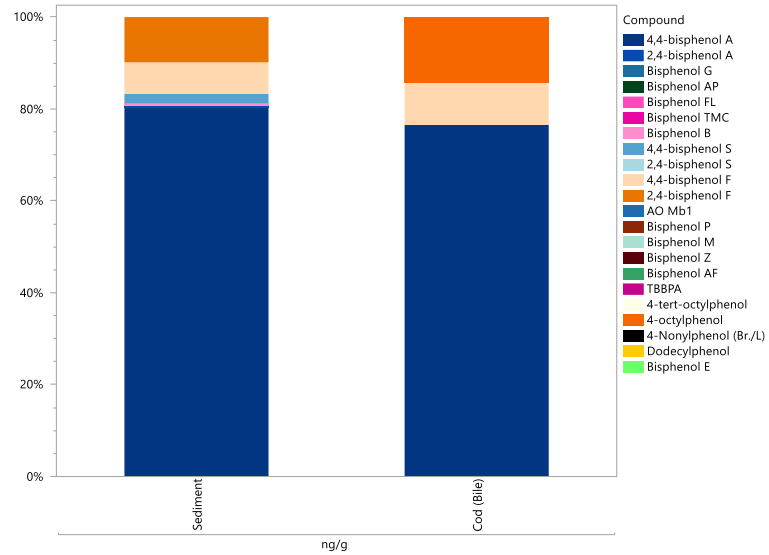


Figure 11. Concentrations (median; ng/g wet wt. in biota, ng/g dry wt. in sediment) of phenolic compounds in sediment and bile of cod (A) and their contribution (%) to the sum-phenolic compounds concentration (B). Non-detected compounds are assigned a value of zero (0).

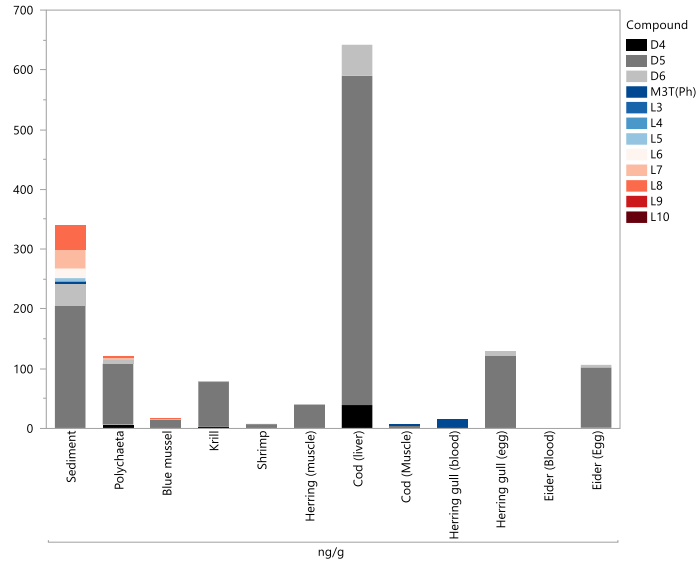
2.4.13. Siloxanes

Siloxanes were detected in all matrices (Figure 12) and the highest concentrations were observed in cod liver. D5 was a major constituent of the sum-siloxanes concentrations. M3T(Ph) was a major constituent of sum-siloxanes in blood of herring gull and eider. Long (linear) siloxanes (L7 and L8) constituted ~20% of the sum-siloxanes concentration in sediments. As previously mentioned (Ruus et al. 2025), Wang et al. (2021) studied the occurrence and distribution of cyclic and linear siloxanes in a South Korean river, with a focus on crucian carp (*Carassius carassius*). While a high bioaccumulative property of D5 was suggested, no bioaccumulation potentials were observed for linear siloxanes (L3-L17).

2.4.14. Musks

Musks were only analysed in sediment. Galaxolide and Tonalide (AHMT) were both detected in two of three samples (Figure 2) and Galaxolide appeared in the highest concentrations.

A.



B.

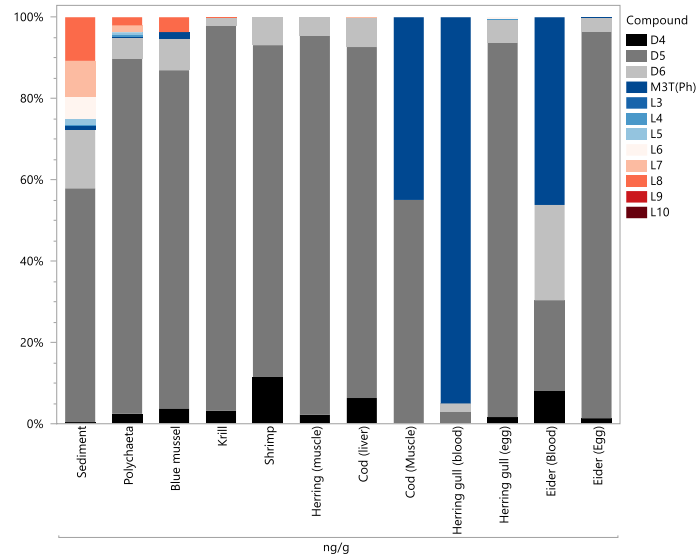


Figure 12. Concentrations (median; ng/g wet wt. in biota, ng/g dry wt. in sediment) of siloxanes in all matrices (A) and their contribution (%) to the sum-siloxanes concentration (B). Non-detected compounds are assigned a value of zero (0).

2.4.15. Metals

Iron (Fe) is the dominating metal in sediment and in haemoglobin rich matrices, such as blood of herring gull and eider (see electronic Appendix). In these matrices, concentrations are much higher than for the other metals, thus iron is omitted from graphical display in Figure 13. The essential metals zinc (Zn) and copper (Cu) also constituted high proportions of the sum of metals in all matrices. As previously (Ruus et al. 2025), arsenic (As) constituted conspicuous proportions of sum-metals in several matrices. It is known that a significant proportion of arsenic in marine organisms is organic As species (such as arsenobetaine), which are much less toxic than inorganic As (Amlund 2005).

Rare earth metals (Sc, Y and lanthanides) were found mainly in sediment (Figure 13). As previously pointed out (Ruus et al. 2023), the homogenizing effects of sedimentary processes should result in nearly constant distributions of rear earth elements (REE) in sedimentary rocks, and the pattern should reflect upper continental crust abundances (Taylor and McLennan, 1985). Furthermore, The REE distribution in modern sedimentary environments is similar to that of the post-Archean shales (such as the Post Archean Australian Shale, PAAS; Taylor and McLennan, 1985).

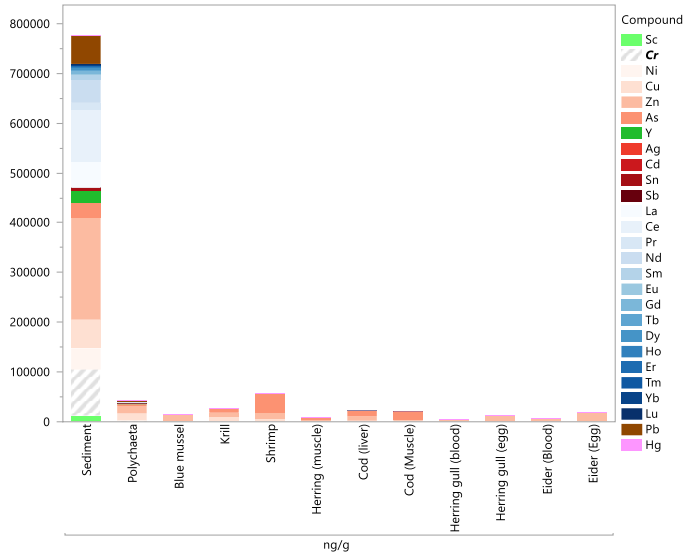
In sediments from station Cm21, post Archean Australian Shale (PAAS)-normalized ratios (Taylor and McLennan, 1985) of light rear earth elements (LREE), middle REE (MREE) and heavy REE (HREE) were (on average) 1.41, 1.43 and 0.92, while “continental crust”-normalized ratios (from McLennan, 2001) of LREE, MREE and HREE were (on average) 1.77, 1.77 and 1.16 (Figure 14).

In sediments from station Bq41, post Archean Australian Shale (PAAS)-normalized ratios (Taylor and McLennan, 1985) of LREE, MREE and HREE were (on average) 1.35, 1.40 and 0.87, while “continental crust”-normalized ratios (from McLennan, 2001) of LREE, MREE and HREE were (on average) 1.69, 1.73 and 1.11 (Figure 14).

In sediments from station Al1, post Archean Australian Shale (PAAS)-normalized ratios (Taylor and McLennan, 1985) of LREE, MREE and HREE were (on average) 1.43, 1.47 and 0.92, while “continental crust”-normalized ratios (from McLennan, 2001) of LREE, MREE and HREE were (on average) 1.78, 1.82 and 1.16 (Figure 14).

As such, enrichment is shown, most in MREE, with gadolinium (Gd) showing high ratios, suggesting anthropogenic influence (Olmez et al. 1991; Migaszewski and Galuszka, 2015). As previously mentioned (Ruus et al. 2023), Gd complexes have e.g. been used as contrast agents in magnetic resonance imaging (MRI; Migaszewski and Galuszka, 2015).

A.



B.

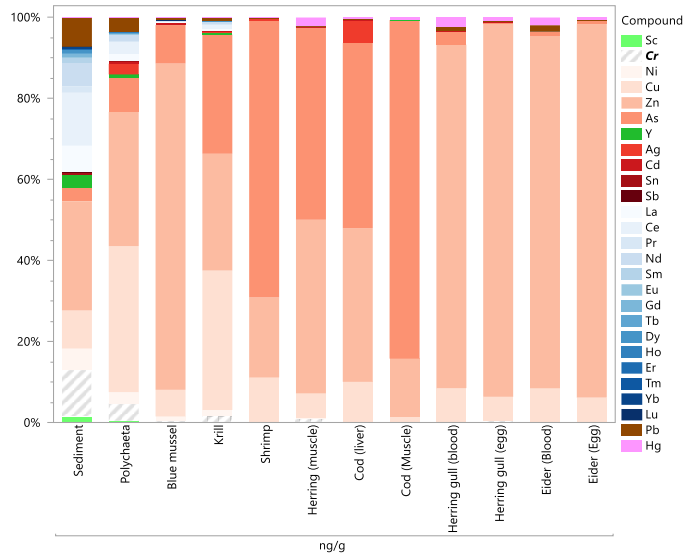


Figure 13. Concentrations (median; ng/g wet wt. in biota, ng/g dry wt. in sediment) of metals in all matrices (A) and their contribution (%) to the sum-metals concentration (B). Non-detected compounds are assigned a value of zero (0). Note that iron (Fe) has been omitted from the figure because of much higher concentrations than the other metals.

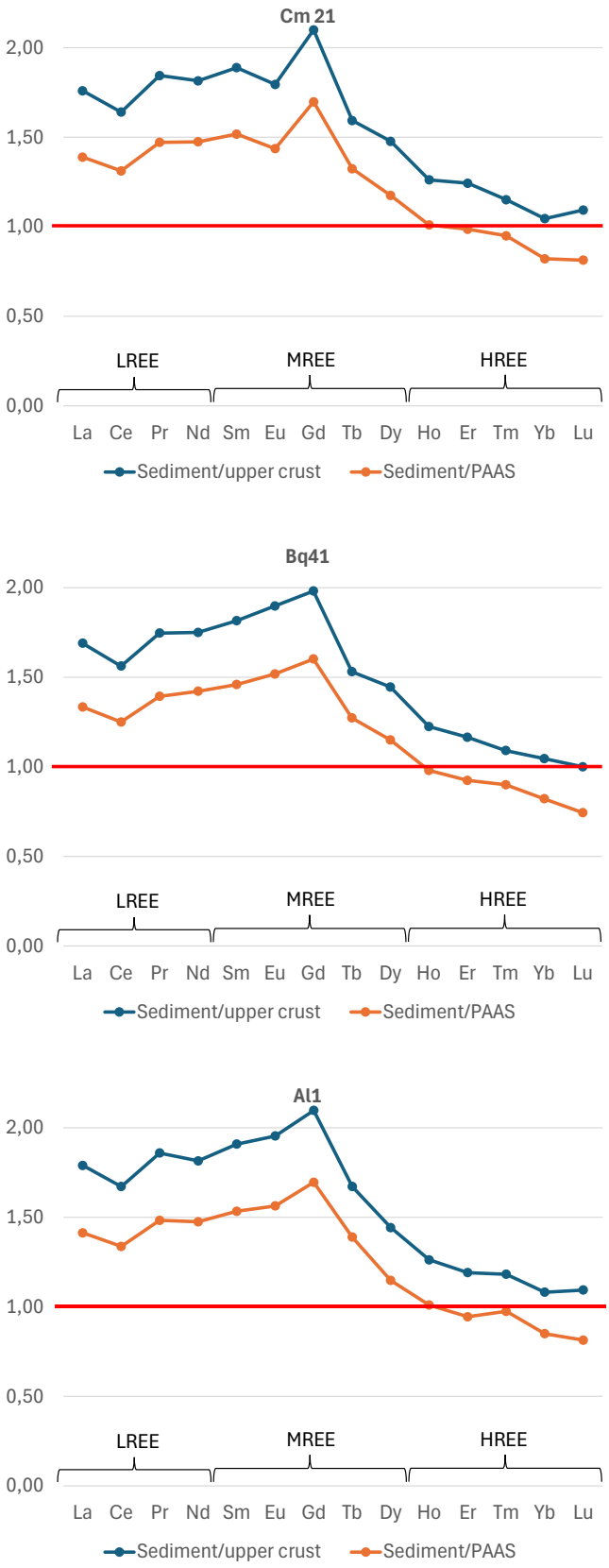


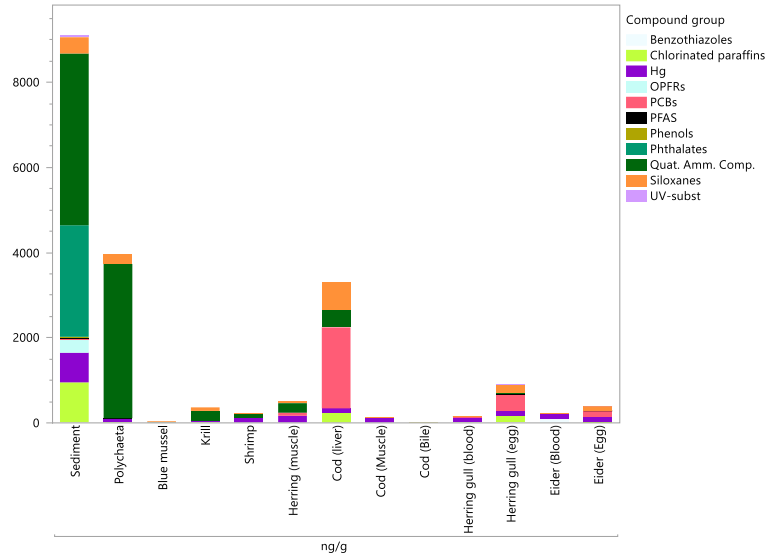
Figure 14. Ratio of lanthanide content in Inner Oslofjord sediments (top: Cm21; middle: Bq41; bottom: Al1) to lanthanide content in Post Archean Australian Shale (PAAS; Taylor and McLennan; 1985) and continental crust (McLennan, 2001).

2.4.16. Comparisons of the different contaminant groups

Figure 15 shows concentrations of selected compounds/compound groups in all matrices, and their contribution (in %) to the sum concentration of all these compounds/compound groups. In terms of sources and sinks of contaminants in the Oslo Urban fjord system, it is of interest to give a general impression of the dominating contaminants/groups of contaminants in the different matrices analysed.

Phthalates and QACs were dominating contaminants in sediment, followed by chlorinated paraffins, Hg and siloxanes. Hg constituted high proportions of the sum of all selected contaminants in most matrices, and especially in fish muscle (herring and cod), shrimp and blood of herring gull and eider. Siloxanes and QACs also constituted large proportions of the sum of all selected contaminants in biota. PCBs constituted large proportions of the sum of all selected contaminants especially in lipid rich tissues, such as cod liver and bird eggs. Chlorinated paraffins also constituted notable proportions of the sum of all selected contaminants in several of the matrices. PFAS constituted larger proportions of the sum of all selected contaminants in blood and eggs of herring gull and eider, than in any of the other matrices. Interestingly, benzothiazoles were among the compound groups constituting the largest proportions of the sum of all selected contaminants in blood of herring gull and especially Eider (see also Chapter 2.4.6).

A.



B.

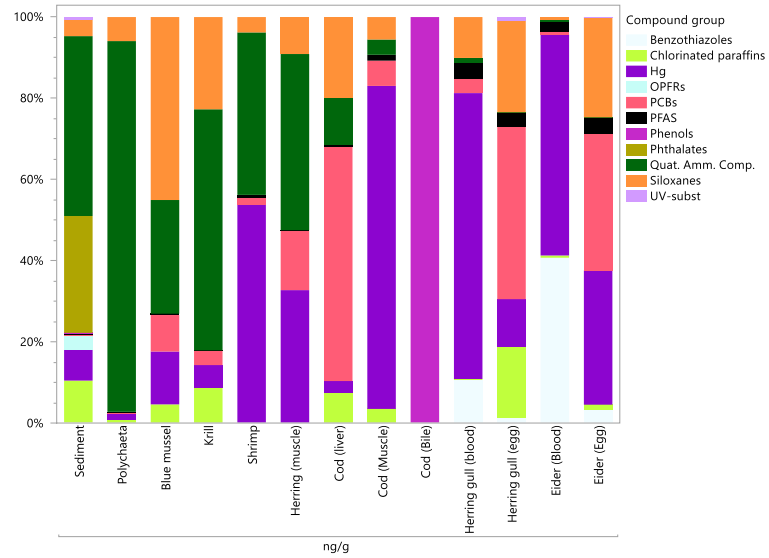


Figure 15. Concentrations (means; ng/g wet wt. in biota, ng/g dry wt. in sediment) of selected compounds/compound groups in all matrices (A) and their contribution (%) to the sum concentration of all these compounds/compound groups (B). Non-detected compounds are assigned a value of zero (0). Note: OPFRs, phthalates and musks were only analysed in sediment; Phenolic compounds were only analysed in sediment and cod bile; Benzothiazoles and UV-compounds were only analysed in sediment and birds (blood and egg of herring gull and eider). No other compounds than phenols were analysed in cod bile.

2.4.17. Relation to Environmental Quality Standards (EQS)

In Table 4 and Table 5, concentrations are compared to environmental quality standards (EQS). Concentrations are means and according to Miljødirektoratet (2026, May 13th), ½ LoQ is applied when one or more (but not all) values are below LoQ. For sums of analogues, non-detected analogues are assigned a value of zero (0).

Table 4. Concentrations of contaminants (mean; mg/kg dry wt.) in sediment from the inner Oslofjord (mean, n=3), and the respective Norwegian quality standards (EQS; Miljødirektoratet 2026, May 13th). Red numbers indicate concentrations exceeding the quality standard.

River basin specific compounds	EQS (mg/kg dry wt.)	Sediment conc. (mg/kg dry wt.)
Bisphenol A *	0.0011	0.0227
Dodecylphenol	0.0044	<0.0002
Decamethylcyclopentasiloxane (D5)	0.044	0.220
Medium chained chlorinated paraffins (MCCPs)	4.6	0.20
Copper (Cu)	84	75
PCB7	0.0041	0.0200
PFOA	0.071	<0.0002
Zinc (Zn)	139	215
TBBPA	0.11	<0.002
Arsenic (As)	18	26
Chromium (Cr)	620	91.3
TCEP	0.072	0.003
Triclosan	0.009	n.a.
EU priority substances		
Cadmium (Cd)	2.5	0.28
Lead (Pb)	150	57
Nickel (Ni)	42	42.5
Mercury (Hg)	0.52	0.70
Brominated diphenyl ethers *	0.062	n.a.
Hexachlorobenzene	0.017	0.0003
C10-13 chloroalkanes **	0.8	0.05
Pentachlorobenzene	0.4	0.0004
Nonylphenol (4-)	0.016	<0.045 ***
Octylphenol (4-tert-)	0.0003	<0.0013 ***
PFOS *	0.00023	0.00013
DEHP	10	1.33

* Bisphenol A is sum of 4,4´- and 2,4´-; BDEs are Sum of BDE-28, -47, -99, -100, -153 and -154; PFOS is sum of PFOS and brPFOS.

** Short chained chlorinated paraffins (SCCPs)

*** Too high limit of detection to evaluate. However, single congeners exceeded EQS, if red.

Table 5. Concentrations of contaminants (mean; µg/kg wet wt.) in blue mussel, herring (muscle) and cod (muscle and liver) from the Inner Oslofjord, and the respective Norwegian quality standards for biota (Miljødirektoratet 2026, May 13th). Red numbers indicate concentrations exceeding the quality standard.

River basin specific compounds	EQS (µg/kg)	Blue mussel conc. (µg/kg)	Herring conc. (µg/kg)	Cod muscle conc. (µg/kg)	Cod liver conc. (µg/kg)
Decamethylcyclopentasiloxane (D5)	15000	14.4	43.2	4.1	568
Medium chained chlorinated paraffins (MCCPs)	170	<25	<25	<25	40.3
PCB7	0.6	2.0	42.8	5.3	1243
PFOA	91	<0.2	<0.2	<0.2	<0.2
TCEP	7300	n.a.	n.a.	n.a.	n.a.
Triclosan	15000	n.a.	n.a.	n.a.	n.a.
EU priority substances					
Mercury (Hg)	20	5	167	107	97
Brominated diphenyl ethers *	0.0085	n.a.	n.a.	n.a.	n.a.
Hexachlorobenzene	10	<0.03	0.33	0.04	3.95
C10-13 chloroalkanes **	6000	<16	<16	<21	23
Pentachlorobenzene	50	<0.01	0.060	<0.01	0.502
Nonylphenol (4-)	3000	n.a.	n.a.	n.a.	n.a.
Octylphenol (4-tert-)	0.004	n.a.	n.a.	n.a.	n.a.
PFOS *	9.1	<0.1	0.07	0.36	4.66
DEHP	2900	n.a.	n.a.	n.a.	n.a.

* BDEs are Sum of BDE-28, -47, -99, -100, -153 and -154; PFOS is sum of PFOS and brPFOS.

** Short chained chlorinated paraffins (SCCPs)

*** Too high limit of detection to evaluate. However, single congeners exceeded EQS, if red.

2.4.18. Biomagnification of environmental contaminants in the Inner Oslofjord food web

Biomagnification (expressed by trophic magnification factors; TMFs) was evaluated in the selected inner Oslofjord food web. Statistically significant biomagnification was observed for 24 PCB congeners (lipid wt. basis), both when cod was represented by liver sample and muscle sample. Figure 16 depicts the significant regression for PCB-180 when cod is represented by liver sample. Furthermore, LCCPs and D4 showed statistically significant biomagnification (lipid wt. basis; both when cod was represented by liver sample and muscle sample), however LCCPs were only detected in blue mussel, polychaetes, krill (one sample) and cod, while D4 was not detected in cod muscle. Figure 17 and Figure 18 depict the significant regressions for LCCPs and D4, respectively, when cod is represented by liver sample.

PFOSA displayed significant biomagnification (wet wt. basis), both when cod was represented by liver sample and muscle sample. The TMF was highest when cod was represented by liver sample (Figure 19). ATAC-C20 (Figure 20) and ATAC-C22 also displayed significant biomagnification (wet wt. basis), when cod was represented by liver sample. Furthermore, As and Hg showed statistically significant biomagnification (wet wt. basis; both when cod was represented by liver sample and muscle sample). Figure 21 and Figure 22 depict the significant regressions for As and Hg, respectively, when cod is represented by muscle sample.

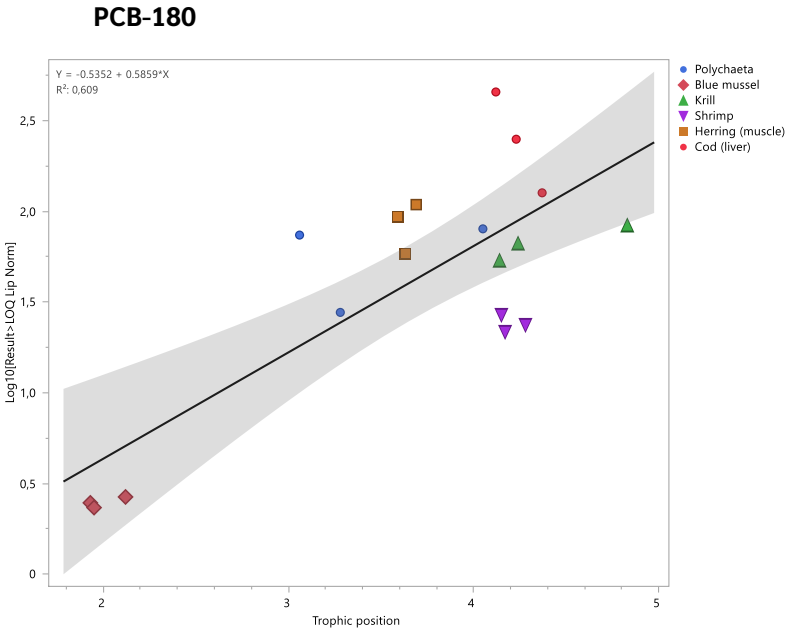


Figure 16. Trophic position against concentrations (ng/g lipid wt.; log_{10}-transformed) of PCB-180 in the studied Inner Oslofjord food web. The confidence region (95%) of the fitted line is indicated with grey shading. TMF=3.85; p=0.0001. Cod is represented by liver sample.

LCCPs

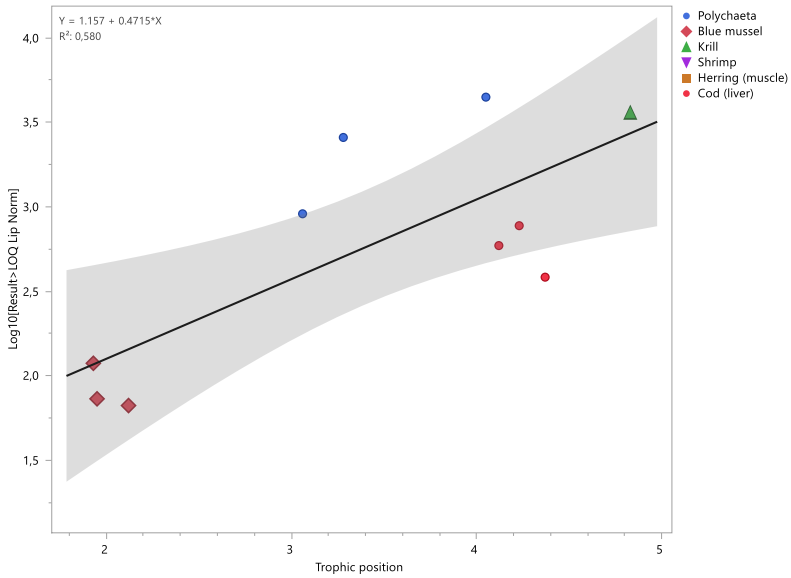


Figure 17. Trophic position against concentrations (ng/g lipid wt.; log_{10}-transformed) of LCCPs in the studied Inner Oslofjord food web. The confidence region (95%) of the fitted line is indicated with grey shading. TMF=2.96; p=0.0105. LCCPs were not detected in shrimp or herring. Cod is represented by liver sample.

D4

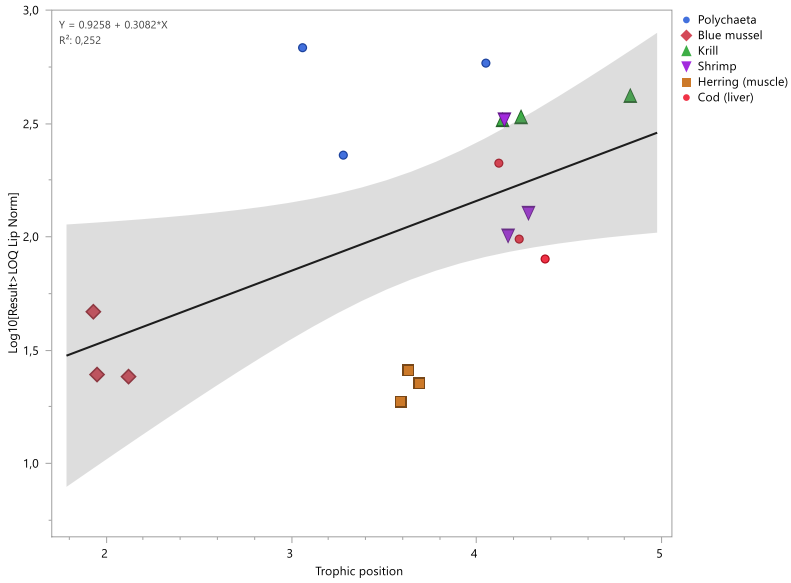


Figure 18. Trophic position against concentrations (ng/g lipid wt.; log_{10}-transformed) of D4 in the studied Inner Oslofjord food web. The confidence region (95%) of the fitted line is indicated with grey shading. TMF=2.03; p=0.0339. Cod is represented by liver sample.

PFOSA

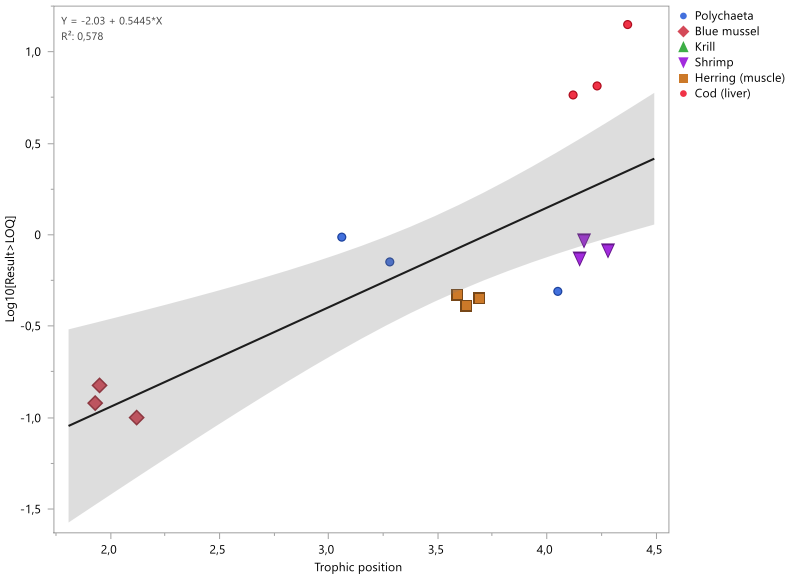


Figure 19. Trophic position against concentrations (ng/g wet wt.; log_{10}-transformed) of PFOSA in the studied Inner Oslofjord food web. The confidence region (95%) of the fitted line is indicated with grey shading. TMF=3.50; p=0.001. PFOSA was not detected in krill. Cod is represented by liver sample.

ATAC-C20

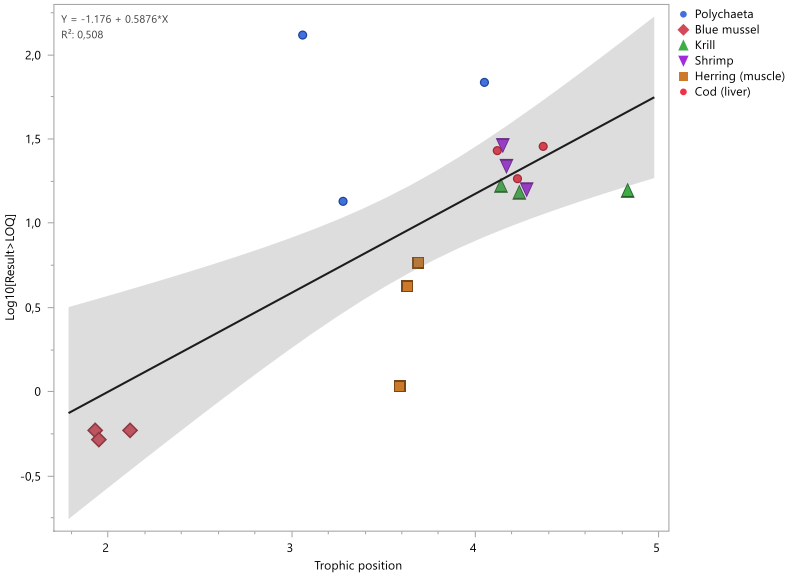


Figure 20. Trophic position against concentrations (ng/g wet wt.; log_{10}-transformed) of ATAC-C20 in the studied Inner Oslofjord food web. The confidence region (95%) of the fitted line is indicated with grey shading. TMF=3.87; p=0.0009. Cod is represented by liver sample.

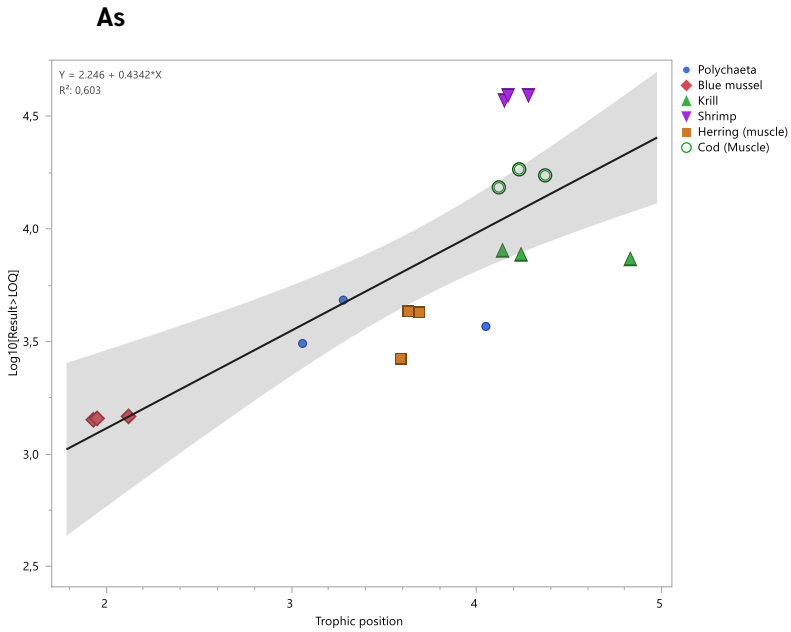


Figure 21. Trophic position against concentrations (ng/g wet wt.; log_{10}-transformed) of As in the studied Inner Oslofjord food web. The confidence region (95%) of the fitted line is indicated with grey shading. TMF=2.54; p=0.0003. Cod is represented by muscle sample.

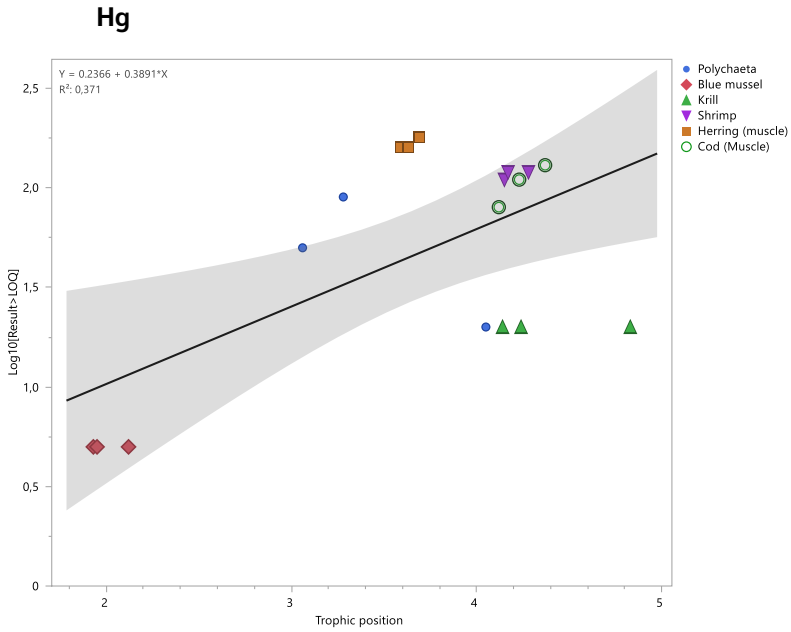


Figure 22. Trophic position against concentrations (ng/g wet wt.; log_{10}-transformed) of Hg in the studied Inner Oslofjord food web. The confidence region (95%) of the fitted line is indicated with grey shading. TMF=2.37; p=0.0097. Cod is represented by muscle sample.

3 Material and Methods Appendix

3.1 Sampling and matrices

3.1.1. Sediment

Sediment was collected at station Bekkelaget (Bq41), Alna River outlet (Al1) and Ildjernet (Cm21; Figure 1) by means of a van Veen grab (0.15 m^2) from Research Vessel Trygve Braarud on June 11th, 2025. Four grabs of the top layer (0-2 cm in grab samples with undisturbed surface) were prepared for one sample.

3.1.2. Polychaeta

Polychaetes were collected at stations Bq41, Al1 and Cm21 (Figure 1) using a van Veen grab (0.15 m^2) from RV Trygve Braarud. Polychaetes were collected at the same time as the sediments. The samples consisted of the species listed in Table 2.

3.1.3. Krill

Krill (*Euphausiacea*) were collected at Midtmeie, southwest of Steilene (Figure 1) August 12th, 2025, as representatives of the zooplankton. A fry trawl was operated from RV Trygve Braarud for this purpose. Material for three pooled samples was collected.

3.1.4. Shrimp

Shrimp (*Pandalus borealis*) were caught with benthic trawl from RV Trygve Braarud, in the same area as zooplankton (krill); Midtmeie, southwest of Steilene (Figure 1), August 11th, 2025.

3.1.5. Blue mussel

Mussels (*Mytilus edulis*) were collected at Steilene (Figure 1), on August 4th, 2025, by standard procedures (handpicked, using rake, or snorkelling; as done in the project "Contaminants in coastal waters", MILKYS; Schøyen et al. 2025). The method for collecting and preparing blue mussels was based on the National Standard for mussel collection (NS 9434:2017).

3.1.6. Herring

Herring (*Clupea harengus*) were caught with trawl from RV Trygve Braarud at Midtmeie, southwest of Steilene (Figure 1) on August 11th, 2025. Biometric data for the fish are given in Appendix (Chapter 4). 15 specimens were pooled into 3 pooled samples (5 individuals in each) for chemical analyses. Stable isotopes of carbon and nitrogen were performed on individual muscle samples (n=15).

3.1.7. Cod

Cod (*Gadus morhua*) were also caught with trawl from RV Trygve Braarud at Midtmeie, southwest of Steilene (Figure 1), on August 11th, 2025. Biometric data for the fish are given in Appendix (Chapter 4). 15 specimens were pooled into 3 pooled samples (5 individuals in each) for chemical analyses. Stable isotopes of carbon and nitrogen were performed on individual muscle samples (n=15).

3.1.8. Eider

Eider (*Somateria mollissima*) blood samples (from adult individuals trapped at nest) and eggs (3 of each) were sampled at Søndre Skjælholmen and Husbergøya (Figure 1), May 13th to 14th, 2025. Biometric data for the birds are given in Appendix, Chapter 4. Adult birds were trapped by walk-in

trap placed at the nest. Blood samples (~5 ml) were taken from a vein under the wing. Preferably, adult female and egg were sampled from the same nest.

3.1.9. Herring gull

Herring gull (*Larus argentatus*) blood samples (from adult individuals trapped at nest) and eggs (3 of each) were sampled at Søndre Skjælholmen (Figure 1), June 3rd, 2025. Biometric data for the birds are given in Appendix, Chapter 4. Adult birds were trapped by walk-in trap placed at the nest. Blood samples (~5 ml) were taken from a vein under the wing. Preferably, adult female and egg were sampled from the same nest.

3.2 Analytical procedures

3.2.1. QA/QC

In Table 6 there is a short method description, including LoQ and an assessment and categorization of the uncertainty for every individual compound analysed. The uncertainty is divided in three groups from 1-3.

Group 1 includes the compounds with the highest certainty. For the compounds in this group the method is well established, not only at NIVA/NILU, but also internationally. That means the quality of this analysis has been proven with intercalibration studies and quality parameters are good. Most of these analyses are accredited according to ISO 17025.

Group 2 includes the compounds with medium certainty. The internal control parameters in the lab are good, the method is fit for purpose, but the quality cannot, or have not, been proven within intercalibration studies. This group also includes parameters that have been tested in intercalibration studies, but the results within the studies show that the uncertainty of this analysis still is high (typically more than 50%).

Group 3 includes the compounds with the highest uncertainty. This could be due to not satisfying recovery data, method not fit for purpose, high variability in blanks, or other.

Table 6. Method information

Uncertainty categories:

1. Results from analysis of control samples (spikes and blanks etc) are accurate and precise. The laboratory has participated in and has passed ring-tests and proficiency tests for this analysis. Results are considered to be very reliable.

2. Results from analysis of control samples (spikes and blanks etc) are accurate and precise. The laboratory has not participated in proficiency tests for this analysis, or ring-tests included too few participants to be reliable. Results are considered to be reliable.

3. Results from analysis of control samples (spikes and blanks etc) are variable and precision is not acceptable. Results of these analyses are considered to be least reliable.

UV-compounds

Parameter group	Name parameter	CAS Number	Blank subtraction and determination of LOQ	LOQ range ng/g	Method	Uncertainty category
UV compounds	Benzophenone-3	131-57-7	Minimum three blanks per batch. Blank-subtraction and LOQ based on average signal of blanks +10*std. Octocrylene and homosalate have the highest levels in blanks.	0.1-0.5	Internal Standard (IS) added. Samples then extracted twice, followed by clean-up via GPC and/or PSA. GC-MS/MS detection	2
	Ethylhexylmethoxycinnamate (EHMZ-Z)	177352-99-7		0.2-1.6		2
	Ethylhexylmethoxycinnamate (EHMZ-E)	5466-77-3		4-20		2
	Octocrylene	6197-30-4		5-30		2
	UV-327	3864-99-1		0.1-1.5		2
	UV-328	25973-55-1		0.5		2
	UV-329	3147-75-9		0.5-1.5		2
	Homosalate	118-56-9		1.5-15		2

Comment to UV-compounds: Highest LoQ in bird blood due to limited sample volume.

Table 6 cont. Method information. PFAS

Parameter group	Name parameter	CAS Number	Blank subtraction and determination of LOQ	LOQ range, ng/g	Method	Uncertainty category
PFAS	***PFSA***					
	PFBA	375-22-4	One blank per batch. LOQ based on 10 x signal-to-noise	0.3	Internal standard is added, and solid samples are extracted twice. Water samples are concentrated on an SPE column. LC-QTOF-MS detection	2
	PFPA	2706-90-3		0.2		2
	PFHxA	307-24-4		0.2		1
	PFHpA	375-85-9		0.2		2
	PFOA	335-67-1		0.2		1
	PFNA	375-95-1		0.1		1
	PFDA	335-76-2		0.1		1
	PFUnDA	2058-94-8		0.1		1
	PFDoDA	307-55-1		0.1		1
	PFTrDA	72629-94-8		0.1		1
	PFTeDA	376-06-7		0.1		1
	PFHxDA	67905-19-5		0.2		2
	PFOcDA	16517-11-6		0.2		2
	PFSA					
	PFBS	375-73-5	One blank per batch. LOQ based on 10 x signal-to-noise.	0.1	Internal standard is added, and solid samples are extracted twice. Water samples are concentrated on an SPE column. LC-QTOF-MS detection	1
	PFPS	2706-91-4		0.1		2
	PFHxS	355-46-4		0.05		1
	PFHpS	375-92-8		0.05		1
	PFOS	2795-39-3		0.05		1
	brPFOS	1763-23-1		0.05		2
	PFNS	474511-07-4		0.05		2
	PFDS	335-77-3		0.05		1
	PFUnDS	441296-91-9		0.1		2
	PFDoDS	79780-39-5		0.1		2
	PFTrDS	791563-89-8		0.1		2
	PFTeDS	1379460-39-5		0.2		3
	nPFAS					
	PFBSA	30334-69-1	One blank per batch. LOQ based on 10 x signal-to-noise.	0.2	Internal standard is added, and solid samples are extracted twice. Water samples are concentrated on an SPE column. LC-QTOF-MS detection	2
	N-MeFBSA	68298-12-4		0.2		2
	N-EtFBSA	40630-67-9		0.2		2
	PFOSA	754-91-6		0.1		1
	N-MeFOSA	31506-32-8		0.1		2
	N-EtFOSA	4151-50-2		0.1		2
	N-MeFOSE	24448-09-7		1.0		2
	N-EtFOSE	1691-99-2		1.0		2
	N-EtFOSAA	2991-50-6		0.1		2
	newPFAS					
	4:2 FTS	757124-72-4	One blank per batch. LOQ	0.1	Internal standard is added, and solid	2
	6:2 FTS	27619-97-2		0.1		2

Parameter group	Name parameter	CAS Number	Blank subtraction and determination of LOQ	LOQ range, ng/g	Method	Uncertainty category
	8:2 FTS	481071-78-7	based on 10 x signal-to-noise.	0.1	samples are extracted twice. Water samples are concentrated on an SPE column. LC-QTOF-MS detection	2
	10:2 FTS	120226-60-0		0.1		2
	12:2 FTS	149246-64-0		0.1		2
	ADONA	958445-44-8		0.1		2
	PFECHS	67584-42-3		0.1		2
	HFPO-DA (Gen-X)	13252-13-6		0.3		3

Comments to PFAS:

PFTeS; reference standard material was unavailable for this compound. The uncertainty category is therefore set to 3. However, knowledge from similar compounds provides confidence and we judge the results to be reliable.

brPFOS: The reference standard for branched PFOS is provided as a technical mixture. It is therefore difficult to get reliable results on spiked samples. It is possible that additional branched PFOS has not been reported, but the results here present the most significant.

HFPO-DA (Gen-X): The recovery of this compound can vary, so the concentration can be a bit uncertain. There might also be some false negative results.

Table 6 cont. Method information. Quaternary ammonium compounds.

Parameter group	Name parameter	CAS Number	Blank subtraction and determination of LOQ	LOQ range, ng/g	Method	Uncertainty category
Quaternary ammonium compounds	DADMAC-C8	3026-69-5	One blank per batch. LOQ based on 10 x signal-to-noise.	0.1	Internal Standard is added. Samples are then extracted twice LC-QTOF-MS detection	2
	DADMAC-C10	2390-68-3		0.1		2
	DADMAC-C12	3282-73-3		0.1		2
	DADMAC-C14	68105-02-2		0.1		2
	DADMAC-C16	70755-47-4		0.1		2
	DADMAC-C18	3700-67-2		0.1		2
	BAC-C8	959-55-7		0.1		2
	BAC-C10	965-32-2		0.1		2
	BAC-C12	139-07-1		0.1		2
	BAC-C14	139-08-2		0.1		2
	BAC-C16	122-18-9		0.5		2
	BAC-C18	122-19-0		0.8		2
	ATAC-C8	2083-68-3		0.1		2
	ATAC-C10	2082-84-0		0.1		2
	ATAC-C12	1119-94-4		0.1		2
	ATAC-C14	1119-97-7		0.1		2
	ATAC-C16	57-09-0		0.3		2
	ATAC-C18	1120-02-1		0.1		2
	ATAC-C20	15809-05-9		0.1		2
	ATAC-C22	17301-53-0		0.1		2

Table 6 cont. Method information. Benzothiazoles.

Parameter group	Name parameter	CAS Number	Blank subtraction and determination of LOQ	LOQ range, ng/g	Method	Uncertainty category
Benzothiazoles	Mercaptobenzothiazole (MBT)	149-30-4	One blank per batch. LOQ based on 10 x signal-to-noise as measured in each sample	1.0	Internal Standard (IS) added. Solid samples are then extracted twice. LC-MS/MS detection	2
	Benzotriazole (BTZ)	95-14-7		0.5		2
	Benzothiazole (BT)	95-16-9		10.0		2
	2(3H)-Benzothiazolone (OHBT)	934-34-9		1.0		2
	metyl-1H-benzotriazole (MeBTZ)	29385-43-1		1.0		2
	N-cyclohexylbenzothiazole-2-sulfenamide (CBS)	95-33-0		1.0		2
	M1-UV328	84268-36-0		1.0		2

Table 6 cont. Method information. Metals.

Parameter group	Compound	Cas no	Blank	LOD range (mg/kg)	LOQ range (mg/kg)	Method	Uncertainty category
Metals Sediment	Sc	7440-20-2	Method blanks following sample series. LOD/LOQ based on calculation of 3 and 10 stddev respectively	0.0001-0.0002	0.0005-0.001	In-house accredited method. Microwave assisted decomposition with HNO_3. Analysed by ICP-MS (Agilent 7700x).	2
	Cr	7440-47-3		0.0001-0.0005	0.001-0.002		1
	Fe	7439-89-6		0.002-0.01	0.02-0.1		1
	Ni	7440-02-0		0.0002-0.0005	0.001-0.002		1
	Cu	7440-50-8		0.0005-0.001	0.002-0.005		1
	Zn	7440-66-6		0.002-0.005	0.01-0.05		1
	As	7440-38-2		0.0001-0.0002	0.0005-0.001		1
	Y	7440-65-5		0.00005-0.0001	0.0002-0.0005		2*
	Ag	7440-22-4		0.0001-0.0002	0.0005-0.001		1*
	Cd	7440-43-9		0.0001-0.0002	0.0004-0.001		1
	Sn	7440-31-5		0.0005-0.001	0.002-0.005		2*
	Sb	7440-36-0		0.0001-0.0001	0.0005-0.001		1
	La	7439-91-0		0.00003-0.0001	0.0002-0.0005		2
	Ce	7440-45-1		0.00003-0.00010	0.0002-0.0005		2*
	Pr	7440-10-0		0.00001-0.0001	0.0002-0.0005		2
	Nd	7440-00-8		0.00004-0.0001	0.0002-0.0005		2*
	Sm	7440-19-9		0.00001-0.0001	0.0002-0.0005		2*
	Eu	7440-53-1		0.00005-0.0001	0.0002-0.0005		2*
	Gd	7440-54-2		0.00005-0.0001	0.0002-0.0005		2*
	Tb	7440-27-9		0.00001-0.0001	0.0002-0.0005		2*
	Dy	7429-91-6		0.00001-0.0001	0.0002-0.0005		2*
	Ho	7440-60-0		0.00001-0.0001	0.0002-0.0005		2*
	Er	7440-52-0		0.00001-0.0001	0.0002-0.0005		2*
	Tm	7440-30-4		0.00001-0.0001	0.0002-0.0005		2*
	Yb	7440-64-0		0.00001-0.0001	0.0002-0.0005		2*
	Lu	7439-94-3		0.00001-0.0001	0.0002-0.0005		2*

Parameter group	Compound	Cas no	Blank	LOD range (mg/kg)	LOQ range (mg/kg)	Method	Uncertainty category
	Pb	7439-92-1		0.0001-0.0003	0.0005-0.001		1
	Hg	7439-97-6		0.0002-0.0004	0.0007-0.001	In-house accredited method. Microwave assisted decomposition with HNO_3. Digestate stabilized with HCl. Analysed by ICP-MS (Agilent 7700x).	1

*Not accredited

Table 6 cont. Method information. Metals cont.

Parameter group	Compound	Cas no	Blank	LOD range (mg/kg)	LOQ range (mg/kg)	Method	Uncertainty category
Metals Biota	Sc	7440-20-2	Method blanks following sample series. LOD/LOQ based on calculation of 3 and 10 stddev respectively	0.0001-0.002	0.0005-0.001	In-house accredited method. Microwave assisted decomposition with HNO_3. Analysed by ICP-MS (Agilent 7700x).	2
	Cr	7440-47-3		0.002-0.004	0.007-0.009		1
	Fe	7439-89-6		0.002-0.01	0.02-0.1		1
	Ni	7440-02-0		0.004-0.006	0.01-0.03		1
	Cu	7440-50-8		0.0005-0.001	0.002-0.005		1
	Zn	7440-66-6		0.002-0.005	0.01-0.05		1
	As	7440-38-2		0.0007-0.0009	0.004-0.006		1
	Y	7440-65-5		0.00005-0.0001	0.0002-0.0005		2*
	Ag	7440-22-4		0.0004-0.0007	0.0005-0.001		1*
	Cd	7440-43-9		0.0001-0.0004	0.0005-0.001		1
	Sn	7440-31-5		0.0005-0.001	0.002-0.005		2*
	Sb	7440-36-0		0.0002-0.0004	0.0007-0.001		1
	La	7439-91-0		0.00003-0.0001	0.0002-0.0005		2
	Ce	7440-00-8		0.00003-0.00010	0.0002-0.0005		2*
	Pr	7440-10-0		0.00001-0.0001	0.0002-0.0005		2
	Nd	7440-00-8		0.00004-0.0001	0.0002-0.0005		2*
	Sm	7440-19-9		0.00001-0.0001	0.0002-0.0005		2*
	Eu	7440-53-1		0.00005-0.0001	0.0002-0.0005		2*
	Gd	7440-53-2		0.00005-0.0001	0.0002-0.0005		2*
	Tb	7440-27-9		0.00001-0.0001	0.0002-0.0005		2*
	Dy	7429-91-6		0.00001-0.0001	0.0002-0.0005		2*
	Ho	7440-60-0		0.00001-0.0001	0.0002-0.0005		2*
	Er	7440-52-0		0.00001-0.0001	0.0002-0.0005		2*
	Tm	7440-28-0		0.00001-0.0001	0.0002-0.0005		2*
	Yb	7440-64-0		0.00001-0.0001	0.0002-0.0005		2*
	Lu	7439-94-3		0.00001-0.0001	0.0002-0.0005		2*

Parameter group	Compound	Cas no	Blank	LOD range (mg/kg)	LOQ range (mg/kg)	Method	Uncertainty category
	Pb	7439-92-1		0.0003-0.0005	0.0008-0.002		1
	Hg	7439-97-6		0.0002-0.0004	0.0007-0.001	In-house accredited method. Microwave assisted decomposition with HNO_3. Digestate stabilized with HCl. Analysed by ICP-MS (Agilent 7700x).	1

*Not accredited

Table 6 cont. Method information. PCBs and organochlorines.

Parameter group	Name parameter	Cas no	Blank	LOD range ng/g	LOQ range ng/g	Method	Uncertainty category	Stable isotope labeled (SIL) analogue
PCB/HCB	PECB	608-93-5	Method blanks following sample series. LOD/LOQ based on calculation of 3 and 10 stddev respectively	0.01-0.2	0.02-0.5	In-house, accredited method for PCB, PeCB and HCB. Internal standard addition, extraction, GPC and/or H_2SO_4 cleanup followed by adsorption chromatography. GC/HRMS (autspec)	1	Y
	HCB	118-74-1		0.01-0.1	0.03-0.3		1	Y
	HCBD	87-68-3		0.1-0.3	0.3-1		3	N
	PCB 28	7012-37-5		0.005-0.02	0.01-0.05		1	Y
	PCB 52	35693-99-3		0.009-0.04	0.03-0.1		1	Y
	PCB 101	37680-73-2		0.01-0.04	0.03-0.1		1	Y
	PCB 118	31508-00-6		0.007-0.04	0.02-0.05		1	Y
	PCB 138	35065-28-2		0.01-0.04	0.03-0.1		1	Y
	PCB 153	35065-27-1		0.01-0.05	0.03-0.1		1	Y
	PCB 180	35065-29-3		0.01-0.02	0.04-0.05		1	Y

Table 6 cont. Method information. Dechloranes

Parameter group	Name compound	Cas no	Blank	LOD range ng/g	LOQ range ng/g	Method	Uncertainty category	Stable isotope labeled (SIL) analogue
Dechlorane	Dibromoaldrin	20389-65-5	Method blanks following sample series. LOD/LOQ based on calculation of 3 and 10 stddev respectively	0.1-0.7	0.3-1.7	In-house method. Internal standard addition, extraction, GPC cleanup followed by adsorption chromatography. GCGC-qToF 7200 in ECNI	2	N
	Dechlorane 602	31107-44-5		0.01-0.1	0.03-0.3		2	Y
	Dechlorane 603	13560-92-4		0.01-0.	0.03-2		2	N
	Dechlorane 604	34571-16-9		0.2-1.4	0.7-4.6		2	N
	Dechlorane 601	13560-90-2		0.02-0.1	0.07-0.3		2	N
	Dechlorane plus syn	135821-03-3		0.03-0.1	0.1-0.3		2	Y
	Dechlorane plus anti	135821-74-8		0.04-0.2	0.2-0.7		2	N

Table 6 cont. Method information. Chlorinated paraffins.

Parameter group	Name parameter	Cas no	Blank	LOD range ng/g	LOQ range ng/g	Method	Uncertainty category	Stable isotope labeled (SIL) analogue
CP	SCCP	85535-84-8	Method blanks following sample series. S, M and LCCP are corrected for blanks prior to deconvolution. Results are corrected for blanks. Blanks are subtracted on congener group level prior to deconvolution. LOD/LOQ based on calculation of 3 and 10 stddev respectively	15-30		In-house method. Internal standard addition, extraction, H_2SO_4 cleanup followed by adsorption chromatography. In some cases with high levels of sulfur and/or PCB an additional cleanup with florsil is needed. GC-qToF 7200 in ECNI	3	13C-hexachlorodecane
	MCCP	85535-85-9		23-49			3	
	LCCP	85535-86-0		0.4-3		In-house method. Internal standard addition, extraction, GPC and/or H_2SO_4 cleanup followed by adsorption chromatography. Agilent LC-qToF 6546	3	

Table 6 cont. Method information. Phthalates.

Parameter group	Compound	Cas no	Blank	LOD range (ng/g)	LOQ range (ng/g)	Method	Uncertainty category	Stable isotope labeled (SIL) analogue
Phthalate sediment	BMEP	117-82-8	Three blanks pr batch. Blank substraction for each batch based on the blank average. LOD and LOQ calculated from 3 x stdev and 10 x stdev. From blanks	<5	<15	2-5 g of sediment was dried overnight and 2 g of dry material and deuterated internal standard was added and was taken for extraction with acetone using vortex and sonication for 10min (done three times). Samples were evaporated and added water. Samples were cleaned up on SPE-HLB and evaporated and transferred to analytical glass. Recovery standard added and analysis on LC-HRMS.	2	N
	DEP	84-66-2		<5	<15		2	Y
	BEEP	605-54-9		<5	<15		2	N
	DIBP	84-69-5		<5	<15		2	Y
	DNBP	84-74-2		<5	<15		2	Y
	BBP	85-68-7		<5	<15		2	N
	BnBP	117-83-9		<5	<15		2	N
	DCHP	84-61-7		<1	<3		2	Y
	DPP (Dipentylphthalate)	131-18-0		<5	<15		2	N
	DMPP	84-63-9		<5	<15		2	N
	DHxP	84-75-3		<5	<15		2	Y
	DEHP	117-81-7		<5	<15		2	Y
	DOP	117-84-0		<5	<15		2	N
	DINP	28553-12-0		<30	<90		2	N
	DIDP	26761-40-0		<30	<90		2	N
	DIUP	85507-79-5		<30	<90		2	N
	DMP	131-11-3		<15	<45		2	N
	DAIP	131-17-9		<5	<15		2	N
	DPP (Dipropylphthalate)	131-16-8		<20	<60		2	N

Table 6 cont. Method information. OPFRs.

Parameter group	Name of parameter	Cas no	Blank	LOD range (ng/g)	LOQ range (ng/g)	Method	Uncertainty category	Stable isotope labeled (SIL) analogue
OPFR sediment	TEP	78-40-0	Three blanks per batch. Blank subtraction for each batch based on the blank average. LOD and LOQ calculated from 3 x stdev and 10 x stdev. From blanks	1-5	5-10	2-5 g of sediment was dried overnight and 2 g of dry material and deuterated internal standard was added and was taken for extraction with acetone using vortex and sonication for 10min (done three times). Samples were evaporated and added water. Samples were cleaned up on SPE-HLB and evaporated and transferred to analytical glass. Recovery standard added and analysis on LC-MSMS.	2	Y
	TCEP	115-96-8		<0.1	<0.3		2	Y
	TPrP	513-08-6		<0.1	<0.3		2	N
	TCPP	13674-84-5		0.5-2	2-5		2	Y
	TiBP	126-71-6		0.5-2	2-3		2	Y
	BdPhP	2752-95-6		<0.1	<0.3		2	N
	DBPhP	2528-36-1		<0.1	<0.3		2	N
	TPhP	115-86-6		0.2-1	1-2		2	Y
	TnBP	126-73-8		0.2-1	1-2		2	Y
	TDCP	13674-87-8		<0.1	<0.3		2	Y
	TBEP	78-51-3		<0.1	<0.3		2	N
	TCP	1330-78-5		0.5-2	2-3		2	N
	EHDPP	1241-94-7		0.5-2	2-3		2	N
	TEHP	78-42-2		0.5-2	2-3		2	Y
	TIPPP/T4IPP	26967-76-0		0.5-2	2-3		2	Y
	TTBPP	78-33-1		<1	<3		2	N
	TDTBPP	95906-11-9		<50	<150		2	N
	TPPT	957-82-0		<0.1	<0.3		2	N

Table 6 cont. Method information. Siloxanes.

Parameter group	Name parameter	Cas nr	Blank	LOQ range ng/g	Method	Uncertainty category	Stable isotope labeled (SIL) analogue
Siloxanes, biota/sediment	D4 - octamethylcyclotetrasiloxane	556-67-2	Three blanks per batch. Blank subtraction for each batch based on the blank average. LOQ calculated from 10 x stdev. From blanks	<2.833	To 1-2 g of sample, ^{13}C D4, D5 and D6 were added as internal standard, followed by addition of acetonitrile and hexane. Ultrasonic bath and shaking before centrifugation. No further cleanup. Recovery standard added to a sub sample before analysis on GC/MSD. As described in previous MILFERSK/Urban fjord reports. No standard was available for L9-L10, and we used a crude product to estimate the retention time and transitions.	2	Y
	D5 - decamethylcyclopentasiloxane	541-02-6		<1.388		2	Y
	D6 - dodecamethylcyclohexasiloxane	540-97-6		<0.167		2	Y
	M3T (Ph)	2116-84-9		<0.434		2	N
	L3 - octamethyltrisiloxane	107-51-7		<1		2	N
	L4 - decamethyltetrasiloxane	141-62-8		<0.38		2	N
	L5 - dodecamethylpentasiloxane	141-63-9		<2.42		2	N
	L6 - tetradecamethylhexasiloxane	107-52-8		<0.878		3	N
	L7 - hexadecamethylheptasiloxane	541-01-5		<0.352		3	N
	L8 - octadecamethyloctasiloxane	556-69-4		<0.388		3	N
	L9 – eicosamethylnonasiloxane *	2652-13-3		<1		3	N
	L10 – docosamethyldecasiloxane *	556-70-7		<1		3	N

* No standard available

Table 6 cont. Method information. Musks.

Parameter group	Name parameter	Cas nr	Blank	LOQ range ng/g	Method	Uncertainty category	Stable isotope labeled (SIL) analogue
Musk sediment/biota	Traseolide	68140-48-7	Sediment/Biota: One laboratory blank was prepared alongside each batch of ~6 samples. For all samples, LODs were calculated by 3xSD of the associated laboratory blanks. Where compounds were not present in the laboratory blanks, sample/calibration standard peaks with signal:noise ratios of ~3:1 were converted to a sample concentration using the average blank volume/mass.	<4.51	Sediment/Biota: 1 g sample was mixed with Na_2SO_4. extracted via sonication with 2x 10 mL of acetone:hexane (1:1). After concentration. the extract was cleaned-up with EZ-POP SPE and concentrated. For all samples. d11-Tonalide was added as the internal standard prior to extraction and ^{13}C-PCB-159 was added as the recovery standard immediately prior to analysis on a GC-MS/MS with EI ionisation.	3	N
	Phantolide	15323-35-0		<1.96		3	N
	Otne/Iso-E-super	54464-57-2		<4.88		3	N
	Acetyl cedrene	32388-55-9		<8.74		3	N
	Galaxolide	1222-05-5		<1.29		3	N
	AHMT/Tonalide	21145-77-7		<0.52		3	Y
	Celestolide	13171-00-1		<2.57		3	N

Table 6 cont. Method information. Phenolic compounds.

Parameter group	Name parameter	Cas nr	Blank	Method	LOD (ng/g)	LOQ (ng/g)	Uncertainty category	Stable isotope labelled (SIL) analogue
Bisphenols	4,4-bisphenol A	80-05-7	Method blanks following sample series. LOD/LOQ based on calculation of 3 and 10 stdev respectively (or instrument detection limit if this is higher)	In-house method. Internal standard addition, accelerated solvent extraction (ASE) or supramolecular solvent extraction (SUPRAS), solid phase extraction cleanup. LC/HRMS (Orbitrap)	1.3	4	3	Y
	2,4-bisphenol A	837-08-1			0.3	1	3	N
	bisphenol G	127-54-8			0.2	0,7	3	N
	4,4-Bisphenol S	80-09-1			0.5	1,7	3	Y
	2,4-bisphenol S	5397-34-2			0.2	0,7	3	Y
	4,4-bisphenol F	620-92-8			0.7	2.3	3	Y
	2,4-bisphenol F	2467-03-0			0.9	3	3	N
	Bisphenol P	2167-51-3			0.3	1	3	Y
	Bisphenol Z	843-55-0			0.1	0,3	3	Y
	TBBPA	79-94-7			2	7	3	Y
	Bisphenol TMC	129188-99-4			0,3	1	3	N
	Bisphenol FL	3236-71-3			0,3	1	3	N
	Bisphenol M	13595-25-0			0.2	0,7	3	N
	Bisphenol AF	1478-61-1			0.1	0,3	3	Y
	Bisphenol AP	1571-75-1			0.2	0,7	3	N
	Biosphenol E	2081-08-5			0.1	0,3	3	N
	Biosphenol B	77-40-7			0.1	0,3	3	Y
Alkylphenols	4-tert-octylphenol	140-66-9			1	3	3	Y
	Dodecylphenol (branched)	27193-86-8			0.2	0,7	3	N
	4-octylphenol	1806-26-4			0.2	0,7	3	N
	Nonylphenol (branched/linear)	84852-15-3, 104-40-5			14-100	46-330	3	N
Other phenolic compounds	MB1	118-82-1		In-house method. Internal standard addition, extraction. HRMS	5	17	3	N

4 Appendix

Three electronic appendices are also associated with this report:

1. Concentrations of all compounds/isomers in all matrices (n, mean, median, min, max, LoQ and number of detected are presented).
2. Median concentrations of all compounds/isomers in all matrices, compared (cross table). Two tables where (a.) medians are calculated with non-detected compounds assigned a value of zero (0) and (b.) medians are calculated from concentrations >LoQ only.
3. Additional figures: $\delta^{15}N$ vs length in cod and herring, as well as all concentrations in all samples presented in bar plots.

Table 7. Analytes and support parameters analysed/evaluated in this study.

Substances	Abbreviation	CAS
Metals		
Mercury	Hg	7439-97-6
Chromium	Cr	7440-47-3
Iron	Fe	7439-89-6
Nickel	Ni	7440-02-0
Copper	Cu	7440-50-8
Zinc	Zn	7440-66-6
Arsenic	As	7440-38-2
Yttrium	Y	7440-65-5
Silver	Ag	7440-22-4
Cadmium	Cd	7440-43-9
Antimony	Sb	7440-36-0
Tin	Sn	7440-31-5
Lead	Pb	7439-92-1
Scandium	Sc	7440-20-2
Lanthanum	La	7439-91-0
Cerium	Ce	7440-45-1
Praeseodymium	Pr	7440-10-0
Neodymium	Nd	7440-00-8
Samarium	Sm	7440-19-9
Europium	Eu	7440-53-1
Gadolinium	Gd	7440-54-2
Terbium	Tb	7440-27-9
Dysprosium	Dy	7429-91-6
Holmium	Ho	7440-60-0
Erbium	Er	7440-52-0
Thulium	Tm	7440-30-4
Ytterbium	Yb	7440-64-4
Lutetium	Lu	7439-94-3
Siloxanes		
2,2,4,4,6,6,8,8-Octamethyl-1,3,5,7,2,4,6,8-tetroxatetrasilocane	D4	556-67-2
2,2,4,4,6,6,8,8,10,10-Decamethyl-1,3,5,7,9,2,4,6,8,10-pentoxapentasilecane	D5	541-02-6
Dodecamethylcyclohexasiloxane	D6	540-97-6
tris(trimethylsiloxy)phenylsilane	M3T (Ph)	2116-84-9
Octamethyltrisiloxane (L3)	L3	107-51-7
Decamethyltetrasiloxane (L4)	L4	141-62-8
Dodecamethylpentasiloxane (L5)	L5	141-63-9
Tetradecamethylhexasiloxane (L6)	L6	107-52-8
Hexadecamethylheptasiloxane (L7)	L7	541-01-5

Octadecamethyloctasiloxane (L8)	L8	556-69-4
Eicosamethylnonasiloxane (L9)	L9	2652-13-3
Docosamethyldecasiloxane (L10)	L10	556-70-7
Polychlorinated biphenyls (PCB)		
2,2',5-Trichlorobiphenyl	PCB 18	37680-65-2
2,4,4'-Trichlorobiphenyl	PCB 28	7012-37-5
2,4',5-Trichlorobiphenyl	PCB 31	16606-02-3
2,3',4'-Trichlorobiphenyl	PCB 33	38444-86-9
3,4,4'-Trichlorobiphenyl	PCB 37	38444-90-5
2,2',4,4'-Tetrachlorobiphenyl	PCB 47	2437-79-8
2,2',5,5'-Tetrachlorobiphenyl	PCB 52	35693-99-3
2,3',4,4'-Tetrachlorobiphenyl	PCB 66	32598-10-0
2,4,4',5-Tetrachlorobiphenyl	PCB 74	32690-93-0
2,2',4,4',5-Pentachlorobiphenyl	PCB 99	38380-01-7
2,2',4,5,5'-Pentachlorobiphenyl	PCB 101	37680-73-2
2,3,3',4,4'-Pentachlorobiphenyl	PCB 105	32598-14-4
2,3,4,4',5-Pentachlorobiphenyl	PCB 114	74472-37-0
2,3',4,4',5-Pentachlorobiphenyl	PCB 118	31508-00-6
2,3',4,4',5'-Pentachlorobiphenyl	PCB 123	65510-44-3
2,2',3,3',4,4'-Hexachlorobiphenyl	PCB 128	38380-07-3
2,2',3,4,4',5'-Hexachlorobiphenyl	PCB 138	35065-28-2
2,2',3,4,5,5'-Hexachlorobiphenyl	PCB 141	52712-04-6
2,2',3,4',5',6-Hexachlorobiphenyl	PCB 149	38380-04-0
2,2',4,4',5,5'-Hexachlorobiphenyl	PCB 153	35065-27-1
2,3,3',4,4',5-Hexachlorobiphenyl	PCB 156	38380-08-4
2,3,3',4,4',5'-Hexachlorobiphenyl	PCB 157	69782-90-7
2,3',4,4',5,5'-Hexachlorobiphenyl	PCB 167	52663-72-6
2,2',3,3',4,4',5-Heptachlorobiphenyl	PCB 170	35065-30-6
2,2',3,4,4',5,5'-Heptachlorobiphenyl	PCB 180	35065-29-3
2,2',3,4,4',5',6-Heptachlorobiphenyl	PCB 183	52663-69-1
2,2',3,4',5,5',6-Heptachlorobiphenyl	PCB 187	52663-68-0
2,3,3',4,4',5,5'-Heptachlorobiphenyl	PCB 189	39635-31-9
2,2',3,3',4,4',5,5'-Octachlorobiphenyl	PCB 194	35694-08-7
2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	PCB 206	40186-72-9
Decachlorobiphenyl	PCB 209	2051-24-3
Organochlorines		
Pentachlorobenzene	PECB	608-93-5
Hexachlorobenzene	HCB	118-74-1
Hexachlorobutadiene	HCBD	87-68-3
Organophosphorus Flame Retardants (OPFRs)		
Triethyl phosphate	TEP	78-40-0
Tris(2-chloroethyl) phosphate	TCEP	115-96-8
Tripropyl phosphate	TPrP	513-08-6
Tris(1-chloropropyl) phosphate	TCPP	13674-84-5
Triisobutyl phosphate	TiBP	126-71-6

Butyl diphenyl phosphate	BdPhP	2752-95-6
Dibutyl phenyl phosphate	DBPhP	2528-36-1
Triphenyl phosphate	TPhP	115-86-6
Tri-n-butyl phosphate	TnBP	126-73-8
Tris(1,3-dichloro-2-propyl) phosphate	TDCP	13674-87-8
Tris(2-butoxyethyl) phosphate	TBEP	78-51-3
Tricresyl phosphate	TCP	1330-78-5
2-Ethylhexyl diphenyl phosphate	EHDPP	1241-94-7
Tris(2-ethylhexyl) phosphate	TEHP	78-42-2
Tris(4-isopropylphenyl) phosphate	TIPPP/T4IPP	26967-76-0
Tris(4-Tert-butylphenyl) phosphate	TTBPP	78-33-1
Tri(2,4-di-t-butylphenyl) phosphate	TDTBPP	95906-11-9
O,O,O-triphenylphosphorothiate	TPPT	597-82-0
Phenols		
4-[2-(4-hydroxyphenyl)propan-2-yl]phenol	4,4-bisphenol A	80-05-7
2-[2-(4-hydroxyphenyl)propan-2-yl]phenol	2,4-bisphenol A	837-08-1
4-[2-(4-hydroxy-3-propan-2-ylphenyl)propan-2-yl]-2-propan-2-ylphenol	Bisphenol G	127-54-8
4-[1-(4-hydroxyphenyl)-1-phenylethyl]phenol	Bisphenol AP	1571-75-1
4-[9-(4-hydroxyphenyl)fluoren-9-yl]phenol	Bisphenol FL	3236-71-3
4-[1-(4-hydroxyphenyl)-3,3,5-trimethylcyclohexyl]phenol	Bisphenol TMC	129188-99-4
4-[2-(4-hydroxyphenyl)butan-2-yl]phenol	Bisphenol B	77-40-7
4-(4-hydroxyphenyl)sulfonylphenol	4,4-bisphenol S	80-09-1
2-(4-hydroxyphenyl)sulfonylphenol	2,4-bisphenol S	5397-34-2
4-[(4-hydroxyphenyl)methyl]phenol	4,4-bisphenol F	620-92-8
2-[(4-hydroxyphenyl)methyl]phenol	2,4-bisphenol F	2467-03-0
2,6-ditert-butyl-4-[(3,5-ditert-butyl-4-hydroxyphenyl)methyl]phenol	AO-MB1	118-82-1
4-[2-[4-[2-(4-hydroxyphenyl)propan-2-yl]phenyl]propan-2-yl]phenol	Bisphenol P	2167-51-3
4-[2-[3-[2-(4-hydroxyphenyl)propan-2-yl]phenyl]propan-2-yl]phenol	Bisphenol M	13595-25-0
4-[1-(4-hydroxyphenyl)cyclohexyl]phenol	Bisphenol Z	843-55-0
4-[1,1,1,3,3,3-hexafluoro-2-(4-hydroxyphenyl)propan-2-yl]phenol	Bisphenol AF	1478-61-1
2,6-dibromo-4-[2-(3,5-dibromo-4-hydroxyphenyl)propan-2-yl]phenol	TBBPA	79-94-7
4-(2,4,4-trimethylpentan-2-yl)phenol	4-tert-octylphenol	140-66-9
4-octylphenol	4-octylphenol	1806-26-4
4-(7-methyloctyl)phenol	4-nonylphenol, branched and linear	104-40-5, 84852-15-3
Dodecylphenol	Dodecylphenol	27193-86-8, 104-43-8, 121158-58-5
4-[1-(4-hydroxyphenyl)ethyl]phenol 1,1-Bis(4-hydroxyphenyl)ethane	Bisphenol E	2081-08-5
Per- and polyfluoroalkyl substances (PFAS)		

PFCA (perfluorinated carboxylate acids)		
Perfluorinated butanoic acid	PFBA	375-22-4
Perfluorinated pentanoic acid	PFPA	2706-90-3
Perfluorinated hexanoic acid	PFHxA	307-24-4
Perfluorinated heptanoic acid	PFHpA	375-85-9
Perfluorinated octanoic acid	PFOA	335-67-1
Perfluorinated nonanoic acid	PFNA	375-95-1
Perfluorinated decanoic acid	PFDA	335-76-2
Perfluorinated undecanoic acid	PFUnDA	2058-94-8
Perfluorinated dodecanoic acid	PFDoDA	307-55-1
Perfluorinated tridecanoic acid	PFTrDA	72629-94-8
Perfluorinated tetradecanoic acid	PFTeDA	376-06-7
Perfluorinated hexadecanoic acid	PFHxDA	67905-19-5
Perfluorinated octadecanoic acid	PFOcDA	16517-11-6
PFSA (Perfluoroalkane sulfonic acids)		
Perfluorinated butane sulfonic acid	PFBS	375-73-5
Perfluorinated pentane sulfonic acid	PFPS	2706-91-4
Perfluorinated hexane sulfonic acid	PFHxS	355-46-4
Perfluorinated heptane sulfonic acid	PFHpS	375-92-8
Perfluorinated octane sulfonic acid (linear)	PFOS	2795-39-3
Perfluorinated octane sulfonic acid (branched)	brPFOS	1763-23-1
Perfluorinated nonane sulfonic acid	PFNS	474511-07-4
Perfluorinated decane sulfonic acid	PFDS	335-77-3
Perfluoroundecane sulfonic acid	PFUnDS	441296-91-9
Perfluorododecane sulfonic acid	PFDoDS	79780-39-5
Perfluorotridecane sulfonic acid	PFTrDS	791563-89-8
Perfluorotetradecane sulfonic acid	PFTeDS	1379460-39-5
nPFAS (polyfluorinated neutral compounds)		
Perfluorobutylsulphonamide	PFBSA	30334-69-1
n-(methyl)nonafluorobutanesulfonamide	N-MeFBSA	68298-12-4
N-ethyl-perfluorobutane-1-sulfonamide	N-EtFBSA	40630-67-9
Perfluorooctane sulfonamide	PFOSA	754-91-6
N-Methyl perfluorooctane sulphonamide	N-MeFOSA	31506-32-8
N-Ethyl perfluorooctane sulfonamide	N-EtFOSA	4151-50-2
N-Methyl perfluorooctane sulfonamidoethanol	N-MeFOSE	24448-09-7
N-Ethyl perfluorooctane sulfonamidoethanol	N-EtFOSE	1691-99-2
N-Ethyl perfluorooctane sulfonamidoacetic acid	N-EtFOSAA	2991-50-6
newPFAS		
4:2 Fluorotelomer sulfonic acid	4:2 FTS	757124-72-4
6:2 Fluorotelomer sulfonic acid	6:2 FTS	27619-97-2
8:2 Fluorotelomer sulfonic acid	8:2 FTS	481071-78-7
10:2 Fluorotelomer sulfonic acid	10:2 FTS	120226-60-0
12:2 Fluorotelomer sulfonic acid	12:2 FTS	149246-64-0
Sodium Dodecafluoro-3H- 4,8-dioxanonanoate	ADONA	958445-44-8
Cyclohexanesulfonic acid	PFECHS	67584-42-3

2,3,3,3-Tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy)propanoic acid (Gen-X)	HFPO-DA (Gen-X)	13252-13-6
UV Chemicals		
Benzophenone-3	BP3	131-57-7
Ethylhexylmethoxycinnamate Z	EHMC-Z	177352-99-7
Ethylhexylmethoxycinnamate E	EHMC-E	5466-77-3
Octocrylene	OC	6197-30-4
UV-329	UV-329	3147-75-9
UV-328	UV-328	25973-55-1
UV-327	UV-327	3864-99-1
Homosalate	Homosalate	118-56-9
3-(2H-benzotriazol-2-yl)-5-(1,1-dimethylethyl)-4-hydroxy-benzenepropanoic acid l	M1-UV328	84268-36-0
Dechloranes		
Dibromoaldrin	DBA	20389-65-5
Dechlorane 602	Dec-602	31107-44-5
Dechlorane 603	Dec-603	13560-92-4
Dechlorane 604	Dec-604	34571-16-9
Dechlorane 601	Dec-601	3560-90-2
Dechlorane plus syn	syn-DP	135821-03-3
Dechlorane plus anti	anti-DP	135821-74-8
Quaternary ammonium compounds		
Trimethyloctylammonium	ATAC-C8	2083-68-3
Decyltrimethylammonium	ATAC-C10	2082-84-0
Dodecyltrimethylammonium	ATAC-C12	1119-94-4
Tetradecyltrimethylammonium	ATAC-C14	1119-97-7
Hexadecyltrimethylammonium	ATAC-C16	57-09-0
Trimethyloctadecylammonium	ATAC-C18	1120-02-1
ATAC-C20	ATAC-C20	15809-05-9
ATAC-C22	ATAC-C22	17301-53-0
Dimethyldioctylammonium	DADMAC-C8	3026-69-5
Didecyldimethylammonium	DADMAC-C10	2390-68-3
Didodecyldimethylammonium	DADMAC-C12	3282-73-3
Dimethylditetradecylammonium	DADMAC-C14	68105-02-2
Dihexadecyldimethylammonium	DADMAC-C16	70755-47-4
Dimethyldioctadecylammonium	DADMAC-C18	3700-67-2
Benzyldimethyloctylammonium	BAC-C8	959-55-7
Benzyldimethyldecylammonium	BAC-C10	965-32-2
Benzyldimethyldodecylammonium	BAC-C12	139-07-1
Benzyldimethyltetradecylammonium	BAC-C14	139-08-2
Benzyldimethylhexadecylammonium	BAC-C16	122-18-9
Benzyldimethyloctadecylammonium	BAC-C18	122-19-0
Musks		
Galaxolide	HHCB	1222-05-5
Tonalide	TONA	21145-77-7

Traseolide	TRAS	68140-48-7
Phantolide	PANT	15323-35-0
Celestolide	KELE	13171-00-1
Iso-E-super	OTNE	54464-57-2
Acetyl cedrene	MCKETON	32388-55-9
Benzothiazoles		
Mercaptobenzothiazole	MBT	149-30-4
Benzotriazole	BTZ	95-14-7
Benzothiazole	BT	95-16-9
2(3H)-Benzothiazolone	OHBT	934-34-9
Methyl-1H-benzotriazole	MeBTZ	29385-43-1
N-cyclohexylbenzothiazole-2-sulfenamide	CBS	95-33-0
Phthalates		
Bis(2-methoxyethyl) phthalate	BMEP (DMEP)	117-82-8
Diethyl phthalate	DEP	84-66-2
Bis(2-ethoxyethyl) phthalate	BEEP	605-54-9
Diisobutyl phthalate	DIBP	84-69-5
Di-n-butyl phthalate	DNBP	84-74-2
Butylbenzyl phthalate	BBP	85-68-7
Bis(2-butoxyethyl) phthalate	BnBP (DBOEP)	117-83-9
Dicyclohexyl phthalate	DcHP	84-61-7
Dipentylphthalate	DDP	131-18-0
Bis(4-methyl-2-pentyl) phthalate	DMPP	84-63-9
Dihexylphthalate	DHxP	84-75-3
Bis(2-ethylhexyl) phthalate	DEHP	117-81-7
Dioctyl phthalate	DOP	117-84-0
Diisononyl phthalate	DINP	28553-12-0
Diisodecyl phthalate	DIDP	26761-40-0
Diundecyl phthalate, branched and linear	DiUP	85507-79-5
Dimethyl phthalate	DMP	131-11-3
Diallylphthalate	DAIP	131-17-9
Dipropylphthalate	DPP (dipropylphthalate)	131-16-8
Chlorinated paraffins		
Short-chain chlorinated paraffins (C10-C13)	SCCP	85535-84-8
Medium-chain chlorinated paraffins (C14-C17)	MCCP	85535-85-9
Long-chain chlorinated paraffins (C>17)	LCCP	85535-86-0
Support parameters		
Stable isotopes $\delta^{15}N$, $\delta^{13}C$		
Lipid content (biota)		
Length/weight (fish)		

Stable isotopes

The results of the individual stable isotope-analysis of C and N are given in Table 8.

Stable isotopes of carbon and nitrogen are useful indicators of food origin and trophic levels. $\delta^{13}C$ gives an indication of carbon source in the diet or a food web. $\delta^{15}N$ increases in organisms with higher trophic level because of a greater retention of the heavier isotope (^{15}N) and provides a continuous descriptor of trophic position.

Figure 23 shows an increase in $\delta^{15}N$ with expected increase in trophic position. Herring gull display low $\delta^{15}N$, but also low $\delta^{13}C$, suggesting a more terrestrial carbon source, as previously discussed (see e.g. Grung et al. 2021). There was no significant relationship between $\delta^{15}N$ and fish length for cod or herring (see electronic Appendix).

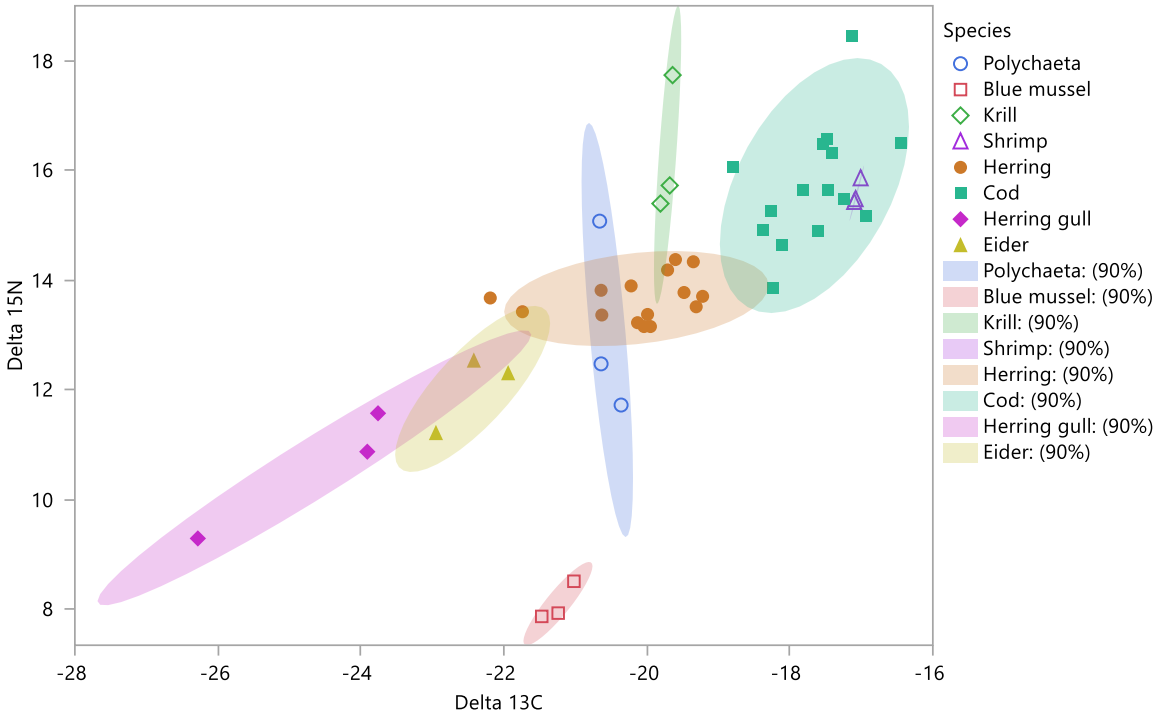


Figure 23. $\delta^{15}N$ plotted against $\delta^{13}C$ in all species collected from the Inner Oslofjord (individual samples where available). The 90% confidence areas are indicated. Birds (herring gull and eider) are represented by the isotopic signatures in egg.

Herring gull displays bot lower $\delta^{15}N$ and $\delta^{13}C$ than eider (Figure 24). When blood and eggs are compared, the two matrices show approximately the same $\delta^{15}N$ within each species. However, $\delta^{13}C$ is lower in eggs than in blood, for both species, likely because of higher lipid content in the eggs, as previously discussed (see e.g. Grung et al. 2021).

I.e. The stable isotopes displayed very much the same patterns as in 2022 (Ruus et al. 2023).

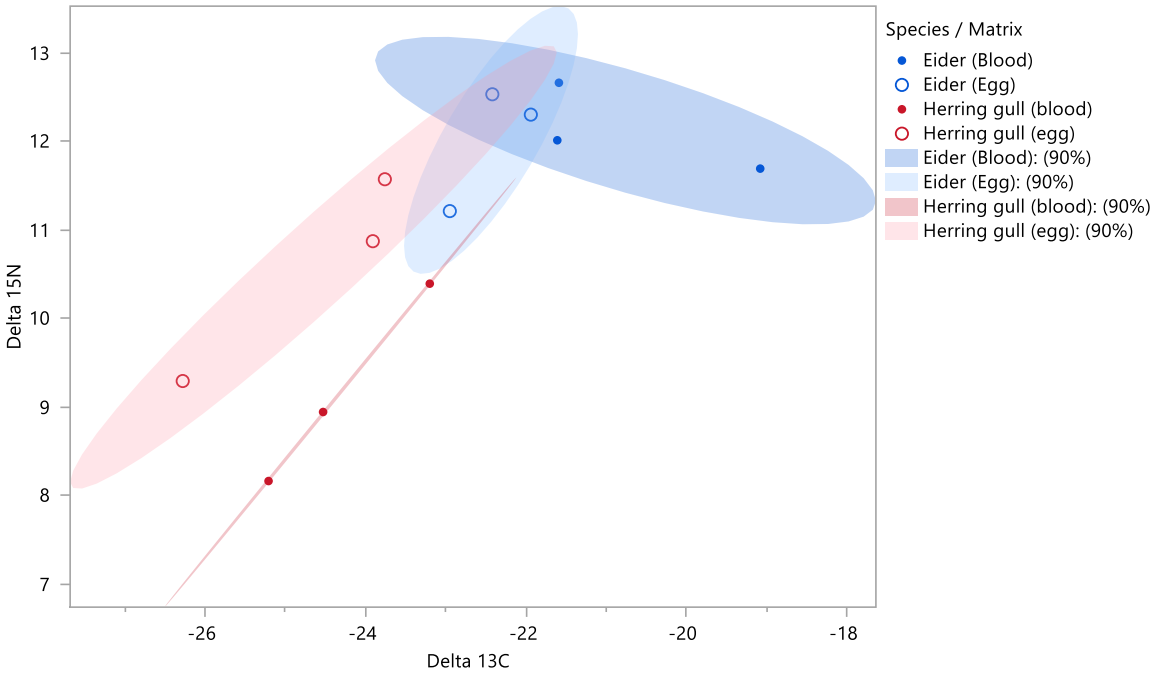


Figure 24. $\delta^{15}N$ plotted against $\delta^{13}C$ in herring gull and eider, both blood and egg. The 90% confidence areas are indicated.

Table 8. Biometric data for individual specimens of cod (A), herring (B), herring gull (C), eider (D) and invertebrates (E) from the inner Oslofjord.

A. (Cod)

Ind. No.	$\delta^{13}C$	$\delta^{15}N$	W%C	W%N	Part of pooled sample	Length (cm)	Weight (g)	Sex	Trophic Level
1	-17.53	16.47	48.2	14.5	1	35	410	M	4.46
2	-17.24	15.47	47.6	14.5	1	33.5	370	F	4.17
3	-18.11	14.63	47.3	14.5	1	35	260	M	3.92
4	-17.48	16.57	48.4	14.5	1	31	290	F	4.49
5	-18.27	15.25	47.9	14.7	1	30	290	M	4.10
6	-17.61	14.89	47.3	14.5	2	32	310	M	4.00
7	-17.47	15.64	47.8	15	2	30	220	F	4.22
8	-18.23	13.85	45.4	13.6	2	30.5	260	M	3.69
9	-17.81	15.63	48.3	14.8	2	28.5	220	M	4.21
10	-16.45	16.5	49.2	15.5	2	29	220	M	4.47
11	-18.79	16.05	48.1	14.9	3	35.5	420	F	4.34
12	-18.38	14.9	47.3	14.6	3	32	320	M	4.00
13	-17.41	16.31	47.8	15	3	32	300	M	4.41
14	-17.13	18.44	34.4	10.6	3	43	780	F	5.04
15	-16.93	15.17	48.1	15	3	36	400	M	4.08

B. (Herring)

Ind. No.	$\delta^{13}C$	$\delta^{15}N$	W%C	W%N	Part of pooled sample	Length (cm)	Weight (g)	Sex	Trophic Level
1	-20.64	13.81	50.4	12.2	1	27	140	F	3.68
2	-20.04	13.15	48.7	13.7	1	26.5	137	F	3.48
3	-20.13	13.22	48.9	13.9	1	27	129	F	3.50
4	-22.19	13.67	57.4	9.71	1	28.5	149	F	3.64
5	-19.35	14.33	49.3	13	1	27.5	115	M	3.83
6	-19.95	13.15	54.4	12.1	2	28	128	F	3.48
7	-21.74	13.42	55.4	11	2	27	133	F	3.56
8	-20.22	13.89	50.8	12.6	2	28	139	F	3.70
9	-20.63	13.36	50.3	12.2	2	26.5	123	F	3.55
10	-19.22	13.7	48.3	13.6	2	24.5	104	M	3.65
11	-19.31	13.51	48.8	14	3	26.5	113	F	3.59
12	-19.48	13.77	48.8	13.9	3	27	114	F	3.67
13	-19.6	14.37	49	13.1	3	27.5	119	F	3.84
14	-19.71	14.18	52.7	13.1	3	28	127	M	3.79
15	-19.99	13.37	48.8	12.3	3	26	109	F	3.55

C. (Herring gull)

Ind.	Marking	$\delta^{13}C$	$\delta^{15}N$	W%C	W%N	Weight (g)	Wing (mm)	Head (mm)	Sex	Trophic Level
Blood										
JA0C0	4298225	-24.53	8.94	57.9	11	950	429	115.4	F	2.54
JA1C0	4298031	-23.2	10.39	57.7	12.2	940	424	115.2	F	2.97
JLA29	FA54605	-25.21	8.16	58.3	12.5	1080	431	118.5	F	2.31
Egg										
(JA0C0)	(4298225)	-23.91	10.87	59.4	8.68					3.11
(JA1C0)	(4298031)	-23.76	11.57	55.1	10.5					3.31
(JLA29)	(FA54605)	-26.28	9.29	57.6	9.07					2.64

D. (Eider)

Ind.	Marking	$\delta^{13}C$	$\delta^{15}N$	W%C	W%N	Weight (g)	Wing (mm)	Head (mm)	Sex	Trophic Level
Blood										
A55	CA46393	-21.61	12.01	56.7	12.7	2410	301	125.95	F	3.44
P06	CA55116	-21.59	12.66	55.5	12	1810	302	123.93	F	3.63
J12	CA55114	-19.08	11.69	48.9	14	1890	302	125.1	F	3.35
Egg										
(A55)	(CA46393)	-21.94	12.3	63.1	7.32					3.53
(P06)	(CA55116)	-22.95	11.21	60	5.95					3.21
(J12)	(CA55114)	-22.42	12.53	64.6	6.15					3.60

E. (Invertebrates)

Species/Matrix	Sample No.	$\delta^{13}C$	$\delta^{15}N$	W%C	W%N	Trophic Level
Blue mussel	1	-21.47	7.87	46.4	8.09	1.93
Blue mussel	2	-21.02	8.51	46.9	8.57	2.12
Blue mussel	3	-21.24	7.93	46.9	8.13	1.95
Polychaeta	1 (Bq41)	-20.36	11.72	29.1	7.03	3.06
Polychaeta	2 (Al1)	-20.66	15.07	36.9	8.22	4.05
Polychaeta	3 (Cm21)	-20.64	12.47	38.8	6.72	3.28
Krill	1	-19.81	15.39	42.6	10.2	4.14
Krill	2	-19.68	15.72	39.4	9.43	4.24
Krill	3	-19.64	17.73	40.5	9.51	4.83
Shrimp	1	-17.08	15.47	45.4	13.1	4.17
Shrimp	2	-17.01	15.85	44.2	12.8	4.28
Shrimp	3	-17.1	15.42	45.4	13	4.15

5 References

Alling V, Lund E, Lusher A, Rødland E, Knight J, Schmidt N, Herzke D, Pakhomova S, Hjelset S, Consolaro C, Collard F, Gjeitnes M, Galtung K, Snekkevik VK. 2025. MIKRONOR 2024 - Monitoring of microplastics and tyre wear particles in the Norwegian environment. NIVA-report 8131-2025. Report M-3032 from the Norwegian Environment Agency. 59 pp + appendix.

Amlund H. 2005. The disposition of arsenobetaine in Atlantic salmon, *Salmo salar L.*, and Atlantic cod, *Gadus morhua L*. Dissertation for the degree of Doctor Scientiarum, University of Bergen, Norway.

Ask AV, Jaspers VLB, Zhang J, Asimakopoulos AG, Frøyland SH, Jolkkonen J, Prian WZ, Wilson NM, Sonne C, Hansen M, Öst M, Koivisto S, Eeva T, Vakili FS, Arzel C. 2025. Contaminants of emerging concern in an endangered population of common eiders (*Somateria mollisima*) in the Baltic Sea. *Environmental Pollution* 365:125409. doi:10.1016/j.envpol.2024.125409.

Grung M, Jartun M, Bæk K, Ruus A, Rundberget T, Allan I, Beylich B, Vogelsang C, Schlabach M, Hanssen L, Borgå K, Helberg M. 2021. Environmental contaminants in an urban fjord, 2020. NIVA-report 7674-2021. Report M-2073 from the Norwegian Environment Agency. 100 pp + appendix.

McLennan SM. 2001. Relationships between the trace element composition of sedimentary rocks and upper continental crust. *Geochemistry Geophysics Geosystems 2*. Doi:10.1029/2000gc000109.

Migaszewski ZM, Galuszka A. 2015. The Characteristics, Occurrence, and Geochemical Behavior of Rare Earth Elements in the Environment: A Review. *Critical Reviews in Environmental Science & Technology* 45:429-471. Doi:10.1080/10643389.2013.866622.

Miljødirektoratet. (2026, 13. mai). Veileder for klassifisering av miljøtilstand i kyst- og ferskvann.

Olmez I, Sholkovitz ER, Hermann D, Eganhouse RP. 1991. Rare-earth elements in sediments off Southern California - A new anthropogenic indicator. *Environmental Science & Technology* 25:310-316. Doi:10.1021/es00014a015.

Ruus A, Grung M, Bæk K, Rundberget T, Vogelsang C, Beylich B, Lund E, Eriksen TE, Jenssen MTS, Ribeiro AL, Hansen L, Enge EK. 2025. Environmental contaminants in an urban fjord, 2024 – Emphasis on Alna River. NIVA-report 8118-2025, Report M-3001 from the Norwegian Environment Agency. 89 pp.

Ruus A, Grung M, Jartun M, Bæk K, Rundberget T, Beylich B, Hansen L, Enge EK, Borgå K, Helberg M. 2023. Environmental contaminants in an urban fjord, 2022. NIVA-report 7873-2023, Report M-2541 from the Norwegian Environment Agency. 91 pp.

Schøyen M, Grung M, Lund E, Hjermann DØ, Ruus A, Øxnevad S, Christensen G, Beylich B, Jenssen MTS, Tveiten L, Håvardstun J, Sagerup K, Eftevåg V, Misaq D, Bæk K. 2025. Contaminants in coastal waters 2024. NIVA-report 8158-2025, Report M-3096 from the Norwegian Environment Agency. 100 pp.

Taylor SR, McLennan SM. 1985. *The continental crust: its composition and evolution*. Blackwell Scientific Publications, Oxford, UK. 312 pp.

Wang W, Cho HS, Kim K, Park K, Oh JE. 2021. Tissue-specific distribution and bioaccumulation of cyclic and linear siloxanes in South Korean crucian carp (*Carassius Carassius*). *Environmental Pollution* 288:117789. Doi:10.1016/j.envpol.2021.117789.

Yuan B, McLachlan MS, Roos AM, Simon M, Strid A, de Wit CA. 2021. Long-Chain Chlorinated Paraffins Have Reached the Arctic. *Environmental Science & Technology Letters*. 8(9):753–759. Doi:10.1021/acs.estlett.1c00470.

Yuan B, Rüdel H, de Wit CA, Koschorreck J. 2022. Identifying emerging environmental concerns from long-chain chlorinated paraffins towards German ecosystems. *Journal of Hazardous Materials*. 424:127607. Doi:10.1016/j.jhazmat.2021.127607.

Yuan B, Vorkamp K, Roos AM, Faxneld S, Sonne C, Garbus SE, Lind Y, Eulaers I, Hellström P, Dietz R, et al. 2019. Accumulation of Short-, Medium-, and Long-Chain Chlorinated Paraffins in Marine and Terrestrial Animals from Scandinavia. *Environmental Science & Technol*ogy 53(7):3526–3537. Doi:10.1021/acs.est.8b06518.

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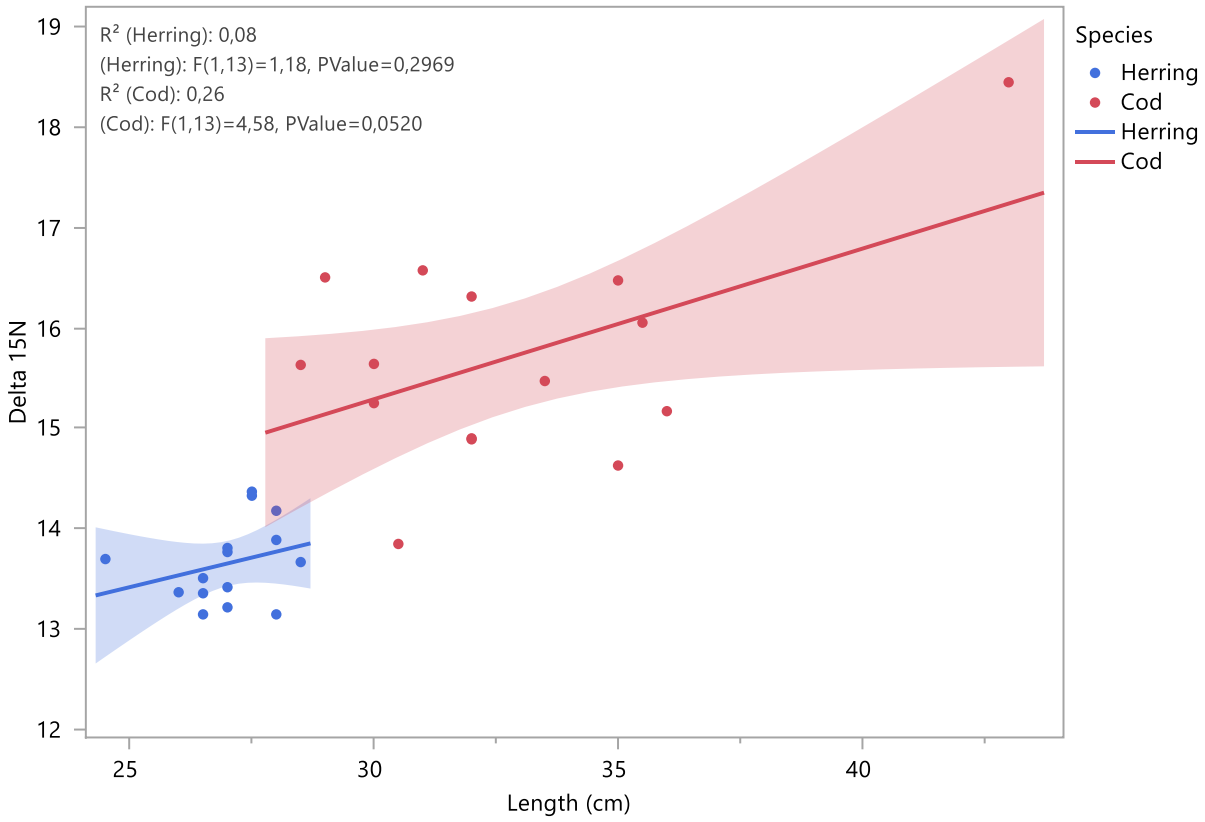
We are Norway's premier research institute in the fields of water and the environment. We are experts on ecosystems in both freshwater and marine environments, from mountains, lakes and rivers, to fjords, coasts and oceans. We develop science-based knowledge and solutions to challenges related to the interaction between water and climate, the environment, nature, people, resources and society.

Appendix: Results from the "Urban fjord" programme 2025

Stable isotopes:

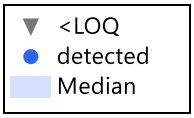


The figure depicts $\delta^{15}N$ vs length in herring and cod.

All concentrations:

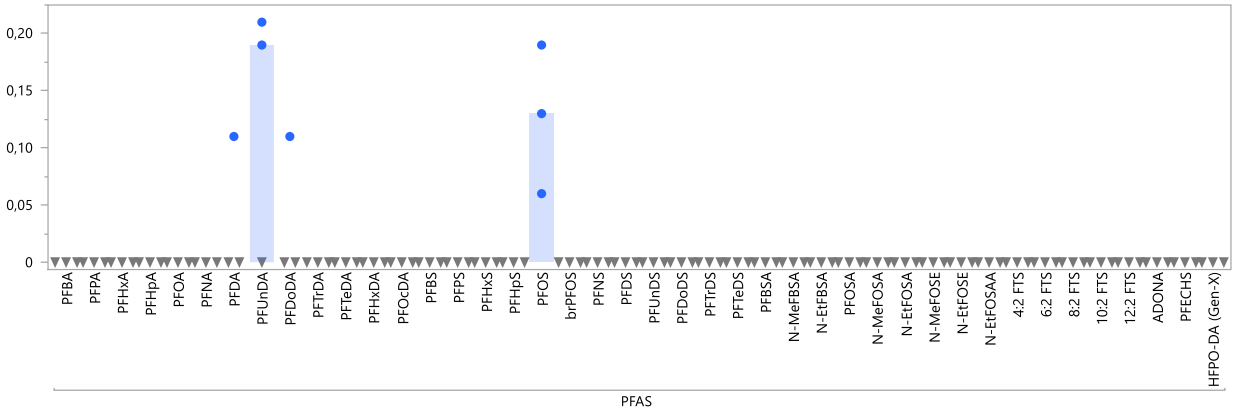
Concentrations (ng/g wet wt. in biota and ng/g dry wt. in sediment) of all compounds in all matrices. The bars represent median and individual observations are superimposed. Non-detects are assigned a value of zero (0). These are shown by grey triangles.

Legend for all figures in the following:

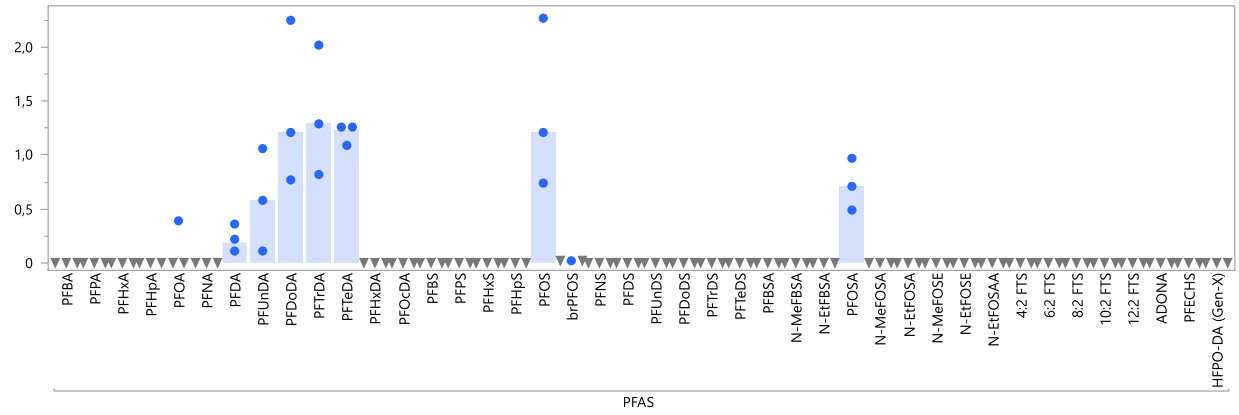


PFAS:

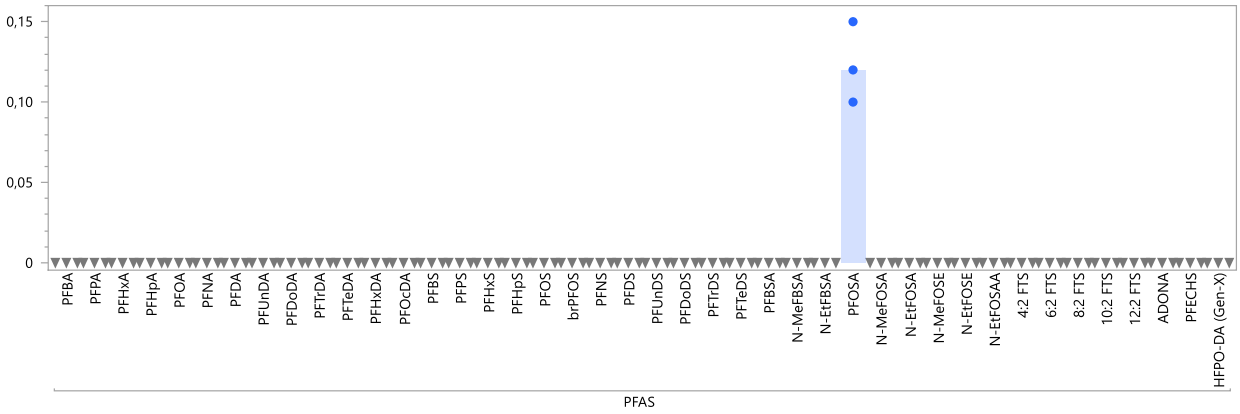
PFAS in Sediment (ng/g dry wt.):



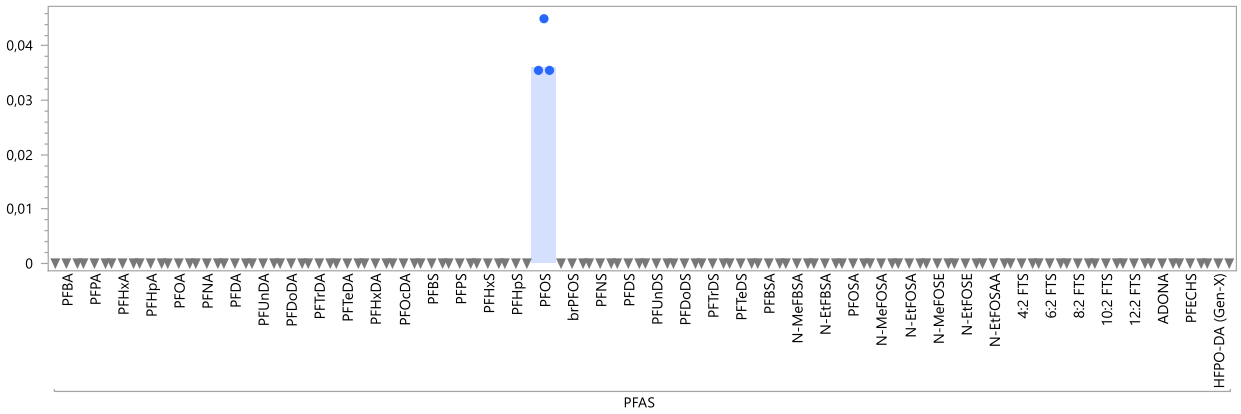
PFAS in Polychaeta (ng/g wet wt.):



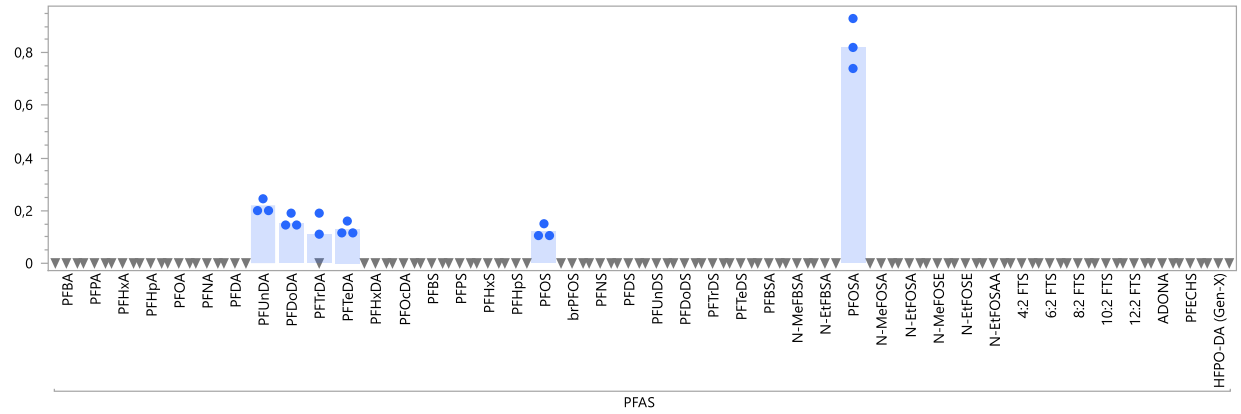
PFAS in Blue mussel (ng/g wet wt.):



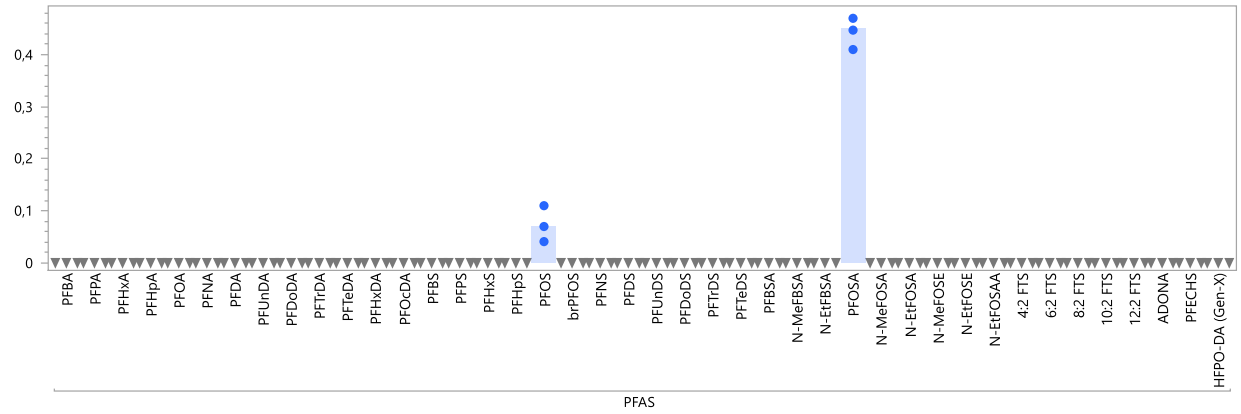
PFAS in Krill (ng/g wet wt.):



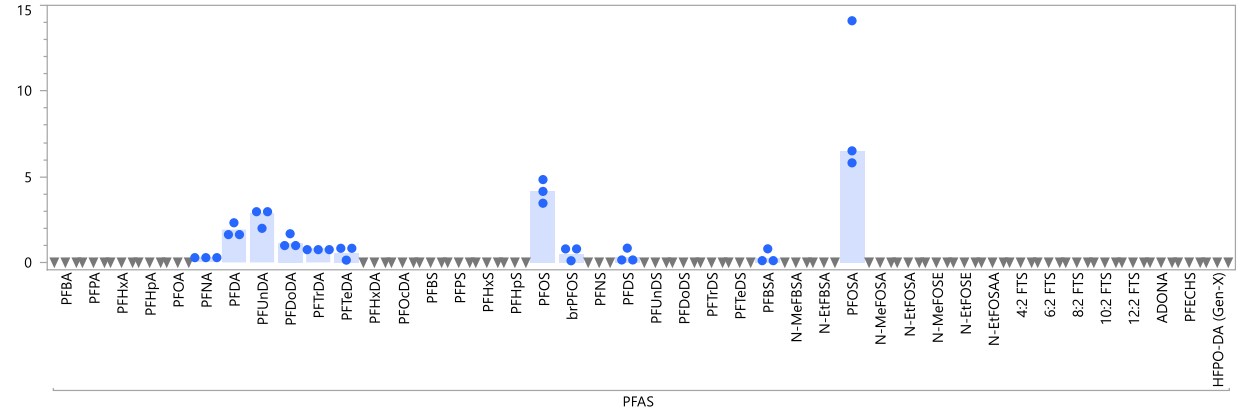
PFAS in Shrimp (ng/g wet wt.):



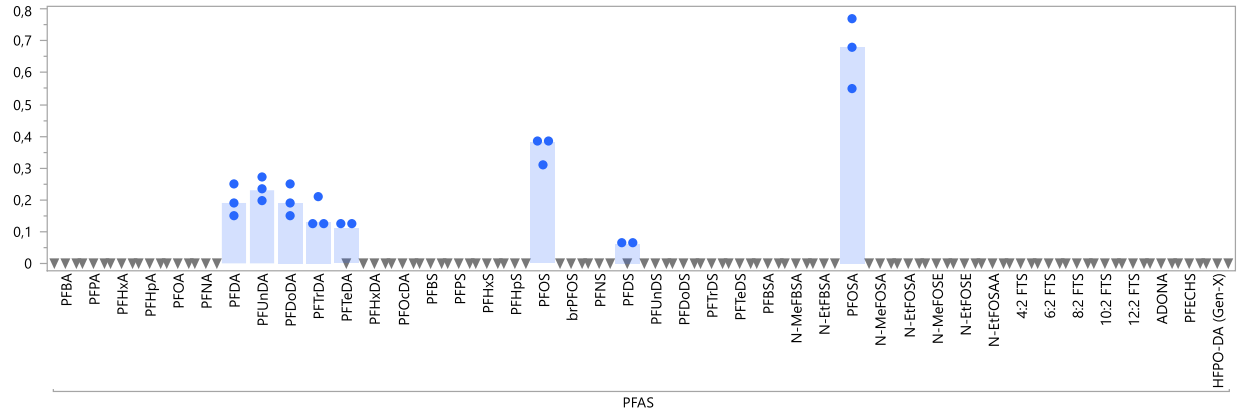
PFAS in Herring (muscle) (ng/g wet wt.):



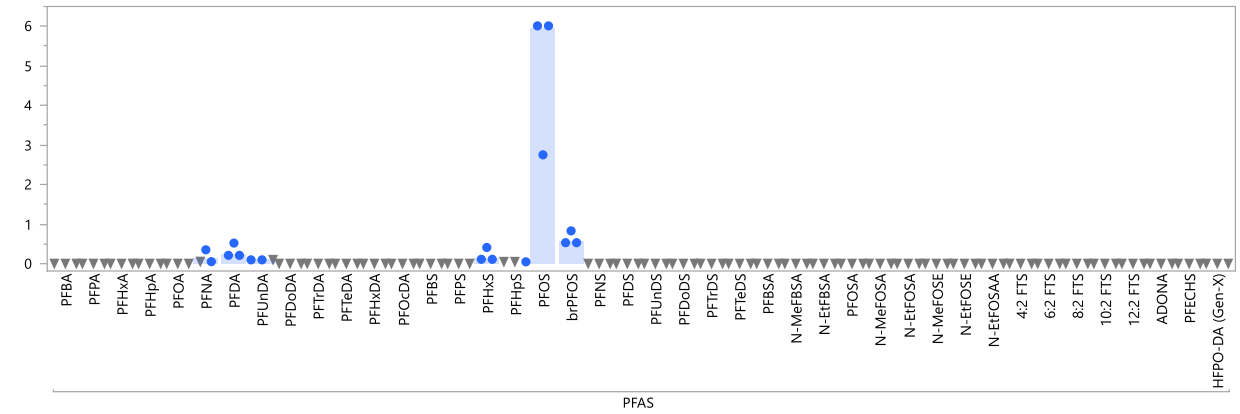
PFAS in Cod (liver) (ng/g wet wt.):



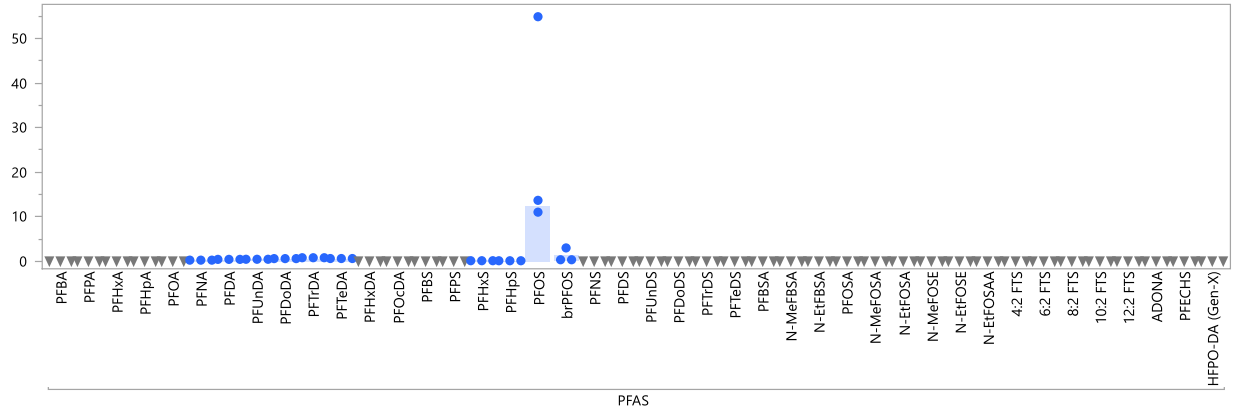
PFAS in Cod (muscle) (ng/g wet wt.):



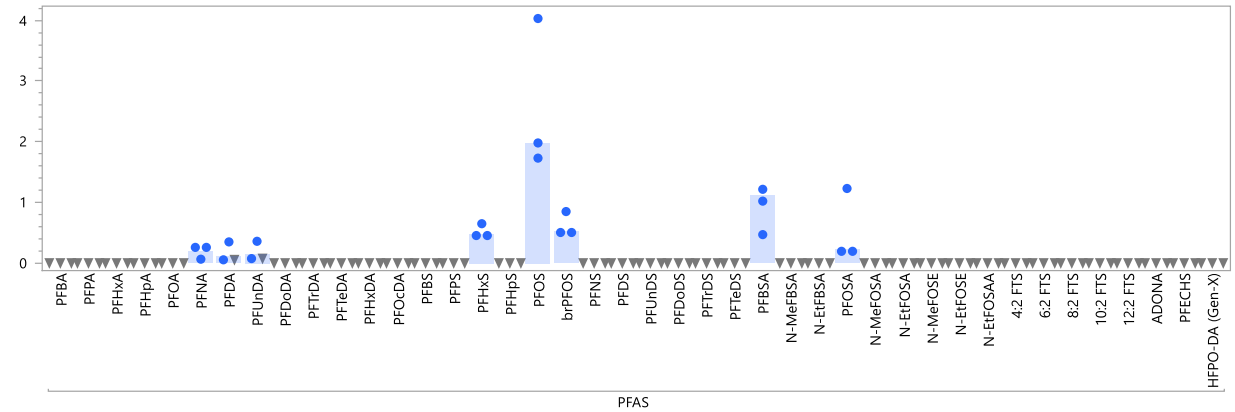
PFAS in Herring gull (blood) (ng/g wet wt.):



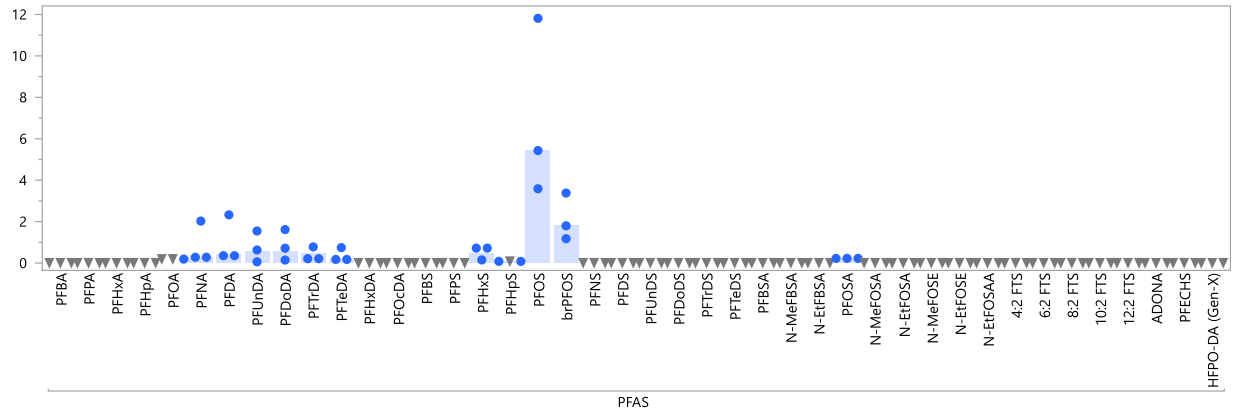
PFAS in Herring gull (egg) (ng/g wet wt.):



PFAS in Eider (blood) (ng/g wet wt.):

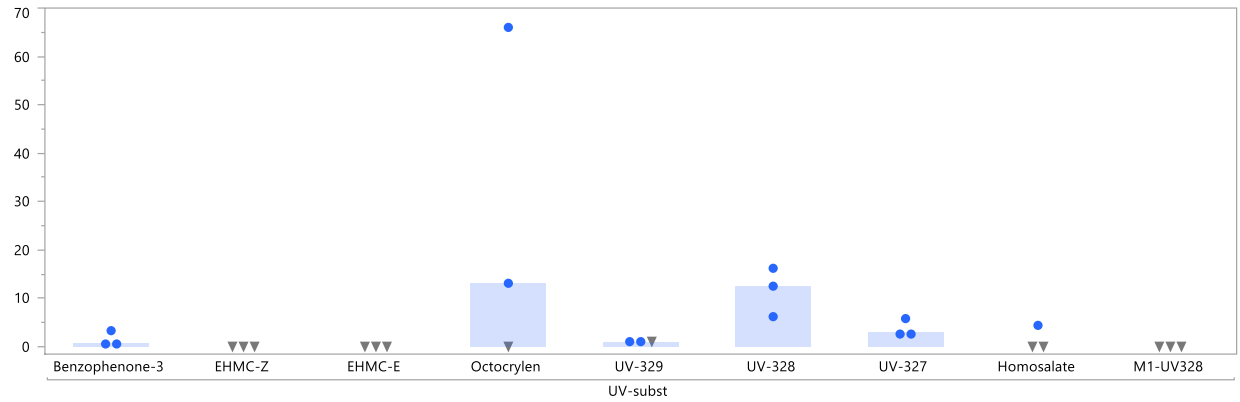


PFAS in Eider (egg) (ng/g wet wt.):

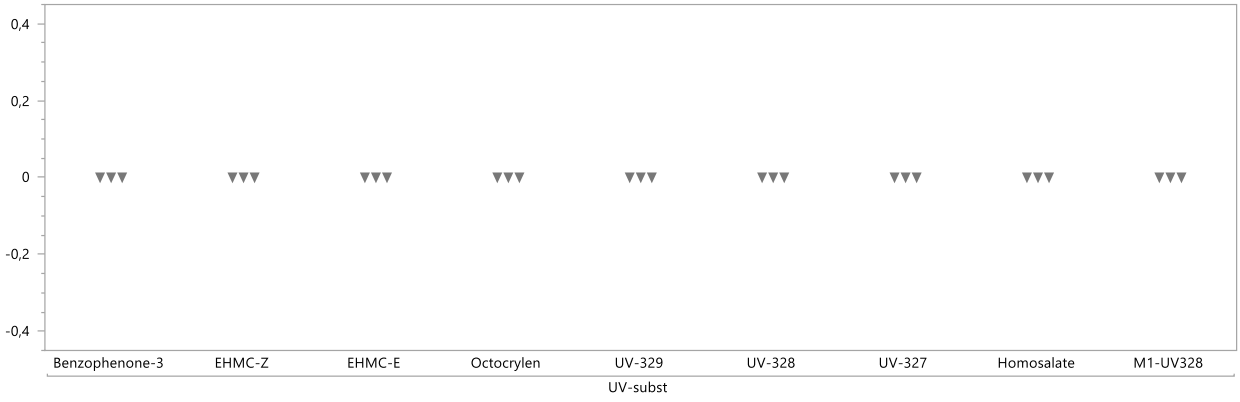


UV-Substances

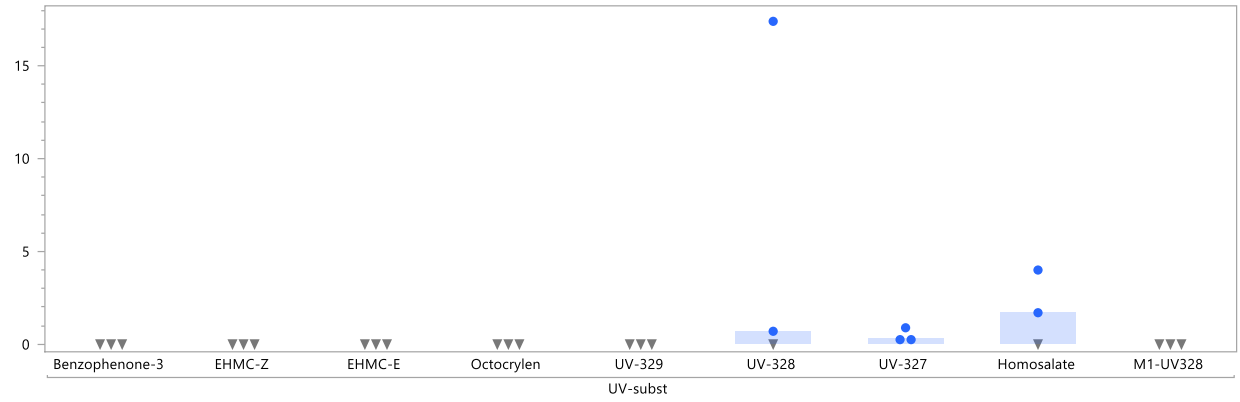
UV-substances in Sediment (ng/g dry wt.):



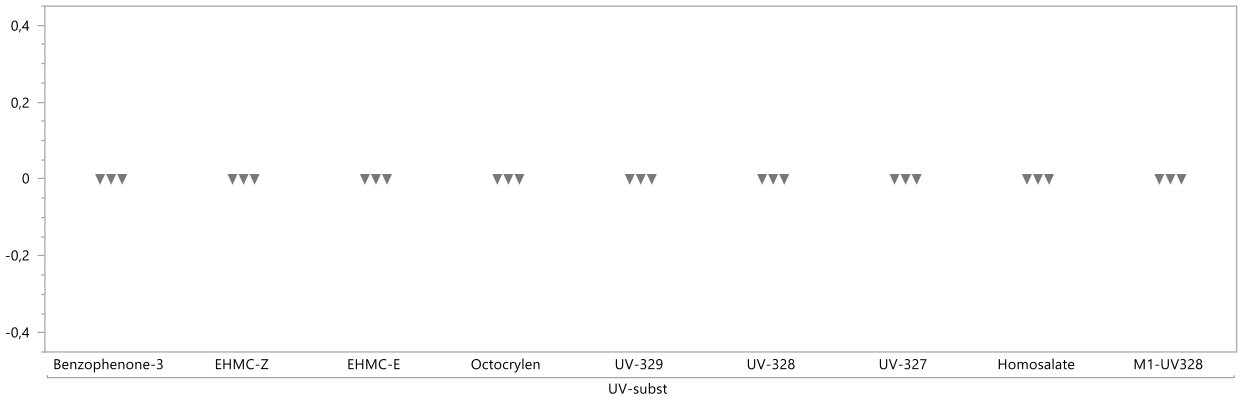
UV-substances in Herring gull (blood) (ng/g wet wt.):



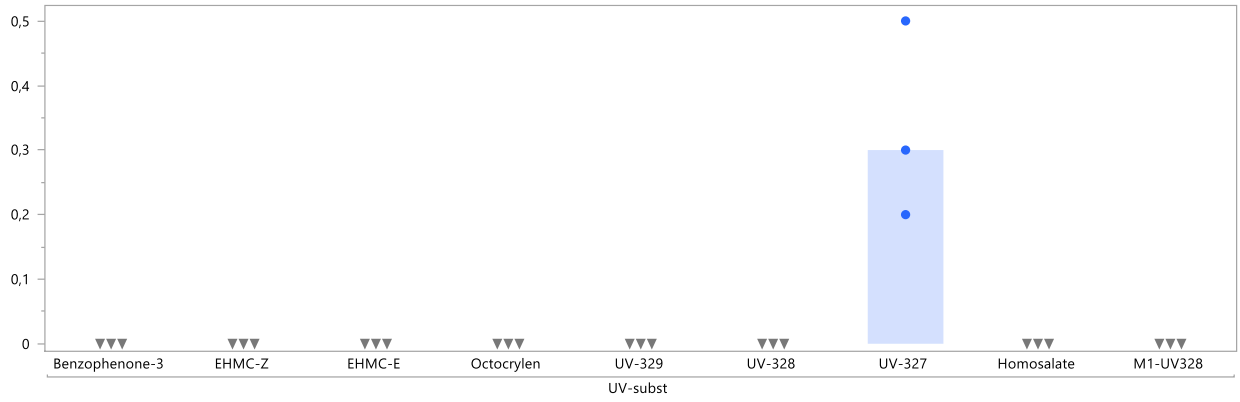
UV-substances in Herring gull (egg) (ng/g wet wt.):



UV-substances in Eider (blood) (ng/g wet wt.):

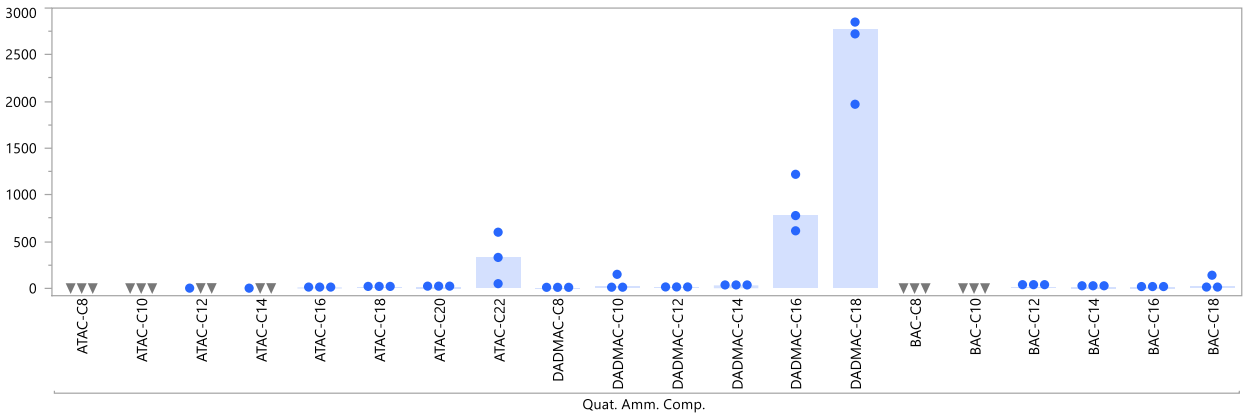


UV-substances in Eider (egg) (ng/g wet wt.):

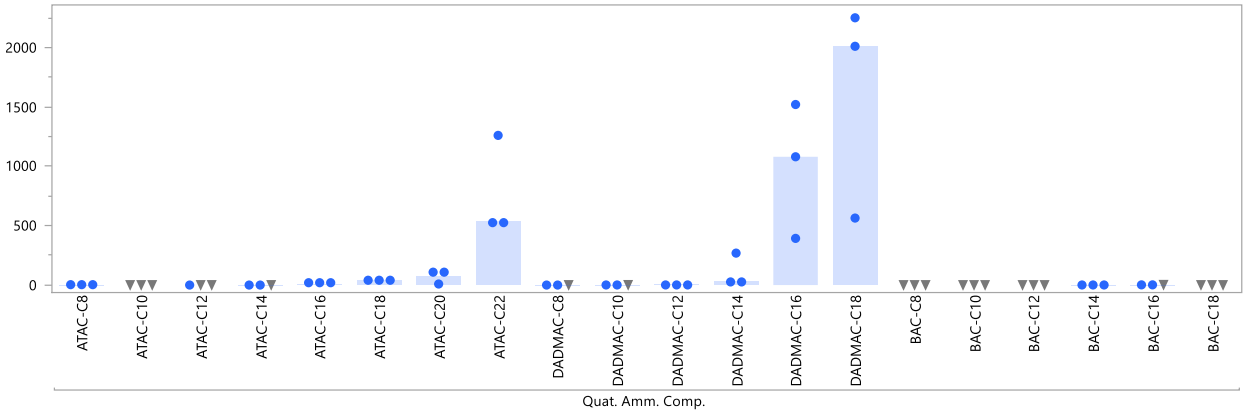


Quaternary ammonium compounds (QACs)

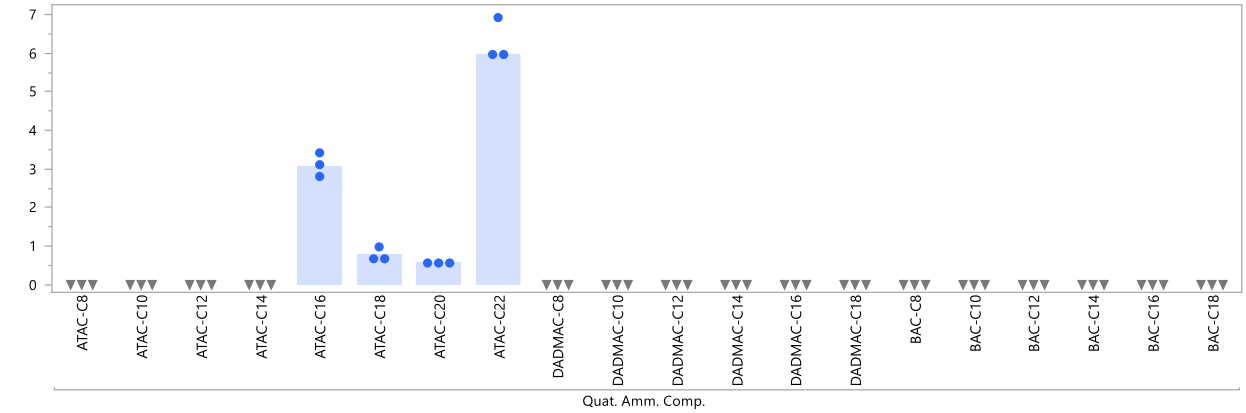
Quaternary ammonium compounds in Sediment (ng/g dry wt.):



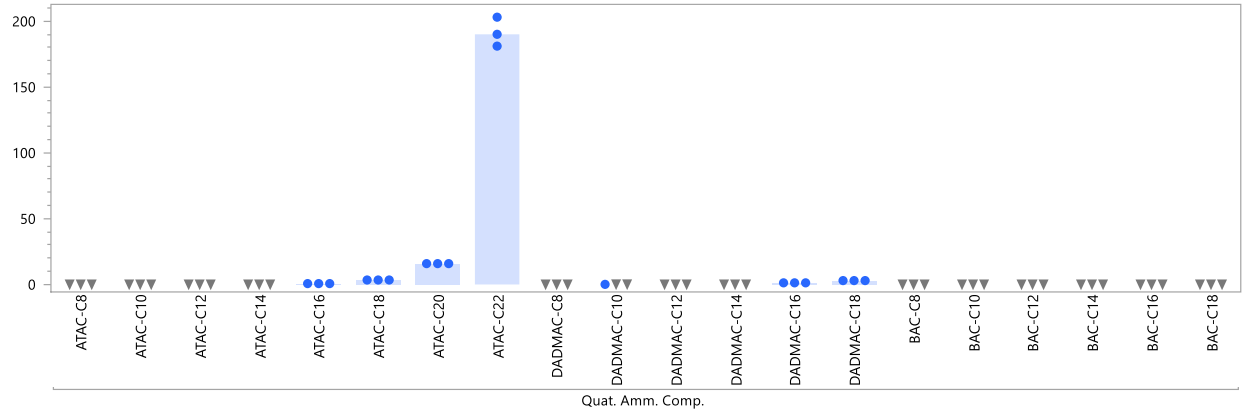
Quaternary ammonium compounds in Polychaeta (ng/g wet wt.):



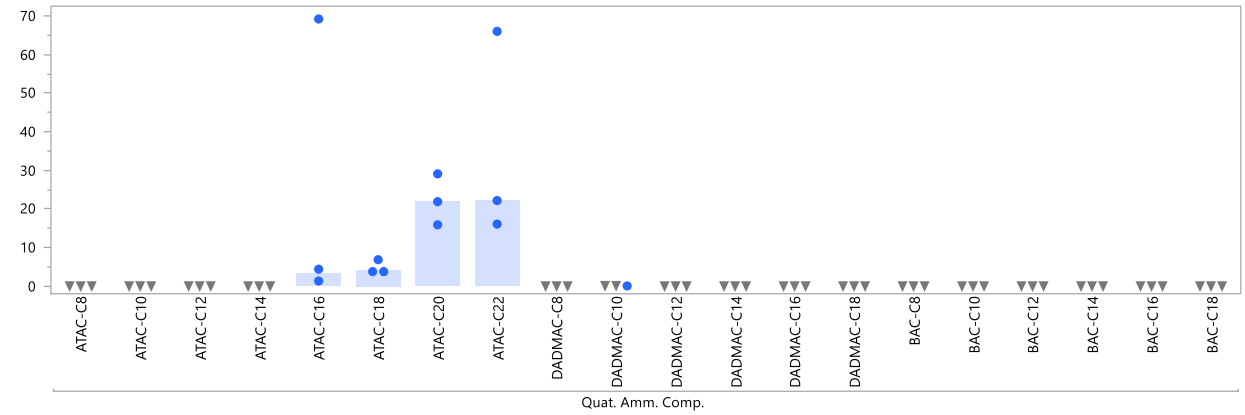
Quaternary ammonium compounds in Blue mussel (ng/g wet wt.):



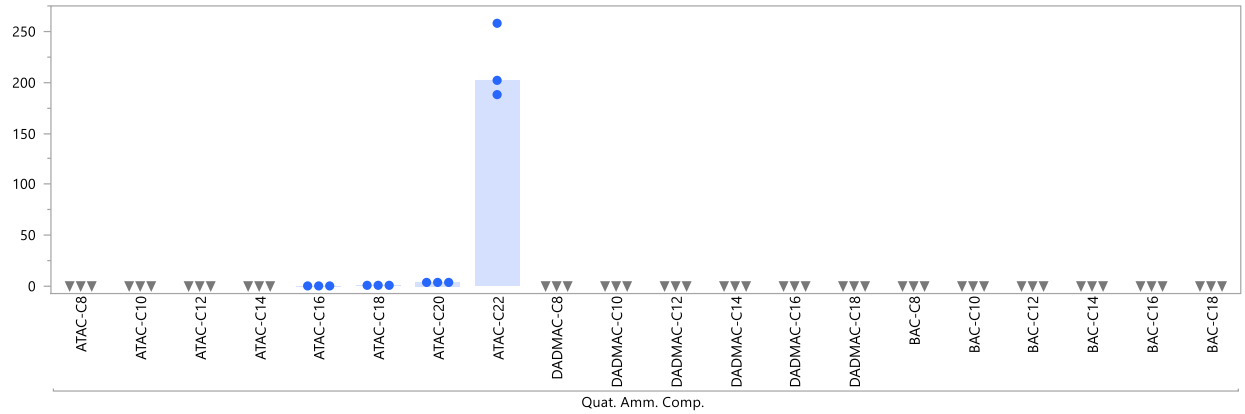
Quaternary ammonium compounds in Krill (ng/g wet wt.):



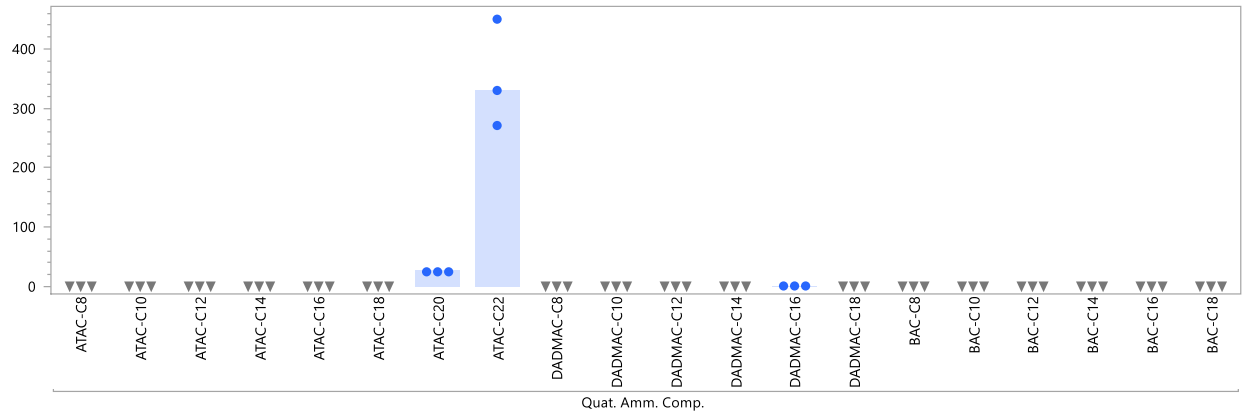
Quaternary ammonium compounds in Shrimp (ng/g wet wt.):



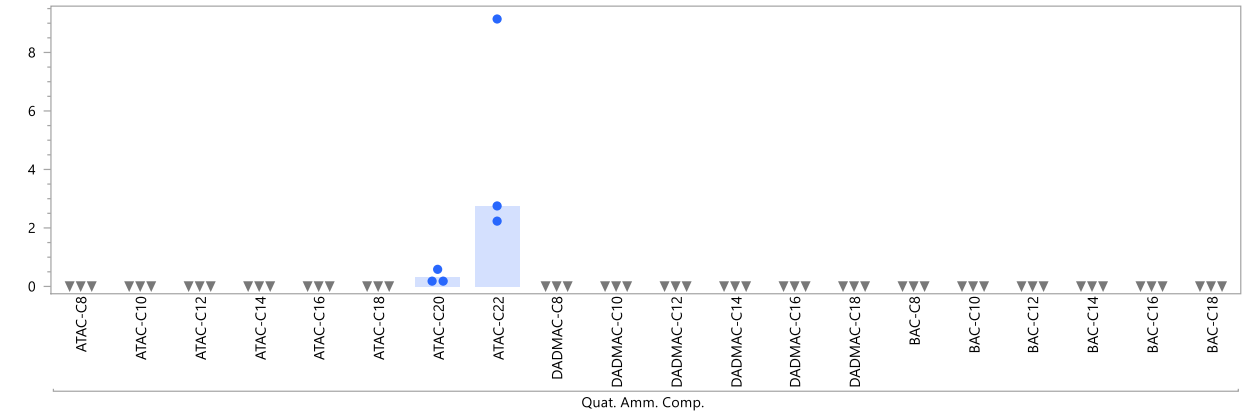
Quaternary ammonium compounds in Herring (muscle) (ng/g wet wt.):



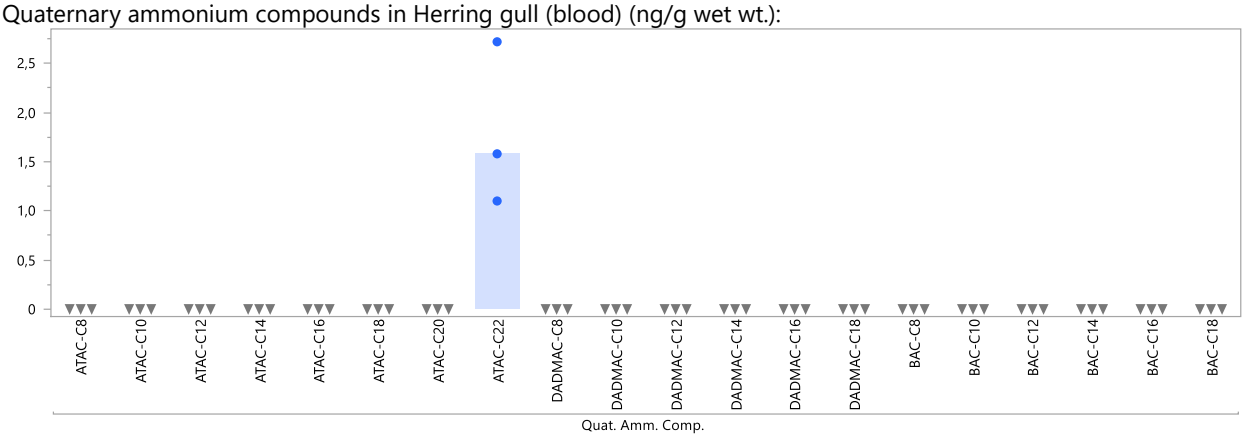
Quaternary ammonium compounds in Cod (liver) (ng/g wet wt.):



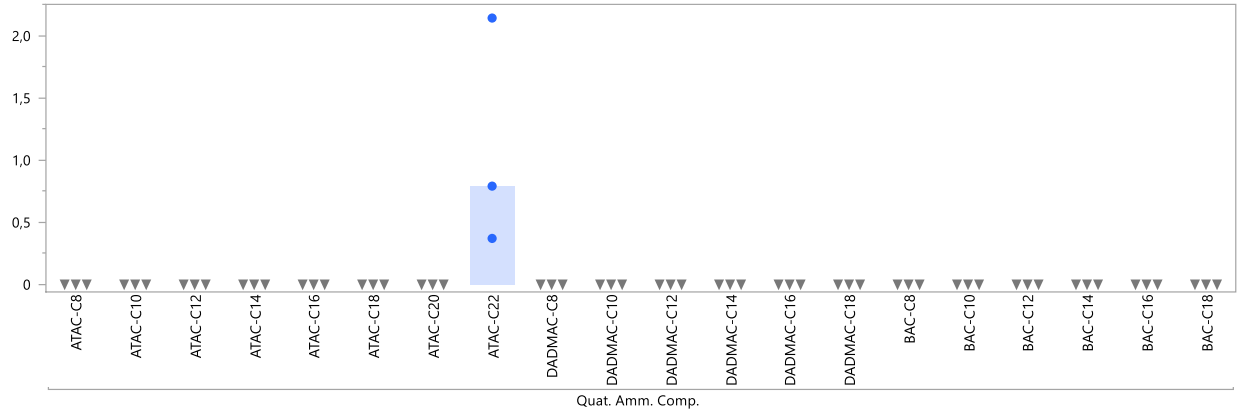
Quaternary ammonium compounds in Cod (muscle) (ng/g wet wt.):



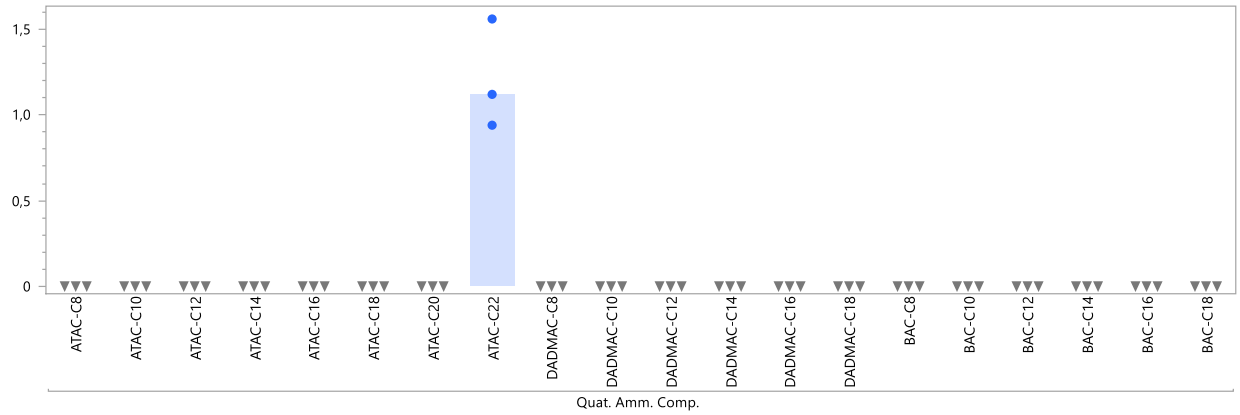
Quaternary ammonium compounds in Herring gull (blood) (ng/g wet wt.):



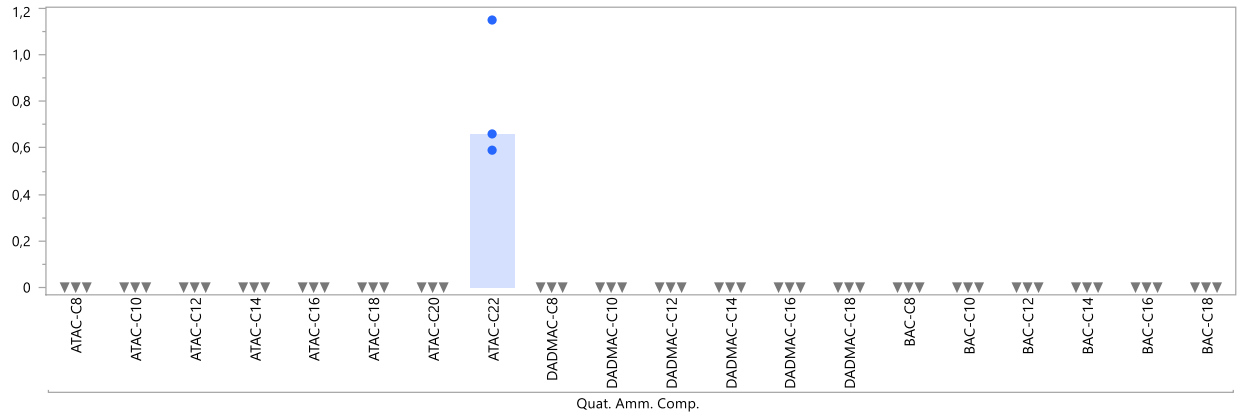
Quaternary ammonium compounds in Herring gull (egg) (ng/g wet wt.):



Quaternary ammonium compounds in Eider (blood) (ng/g wet wt.):

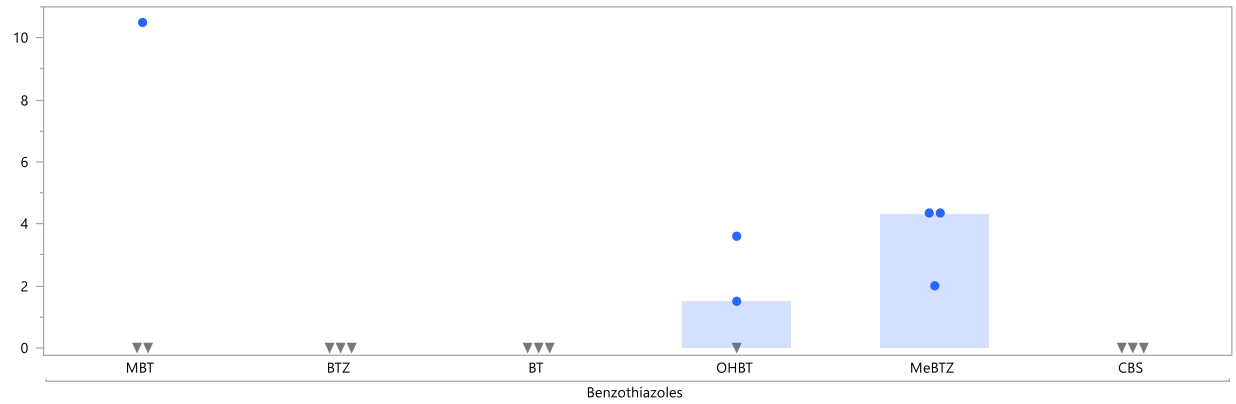


Quaternary ammonium compounds in Eider (egg) (ng/g wet wt.):

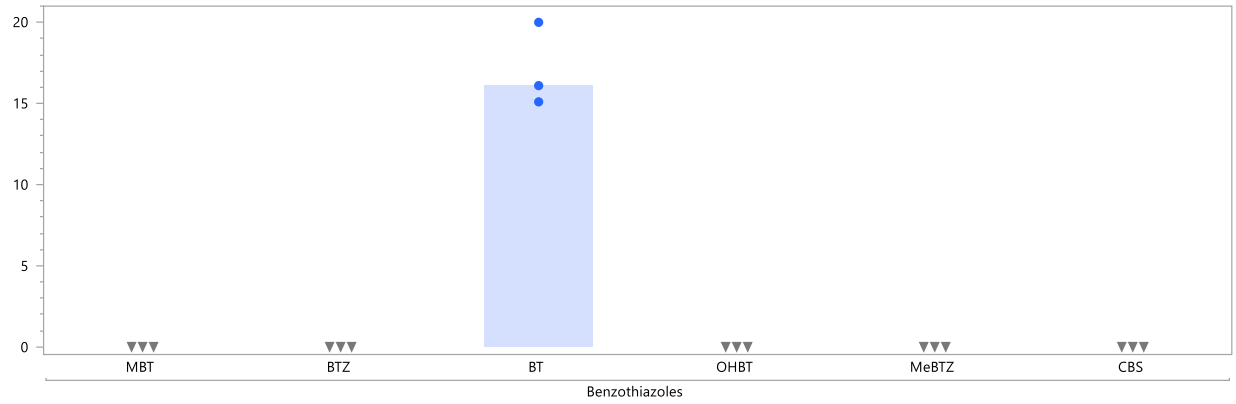


Benzothiazoles

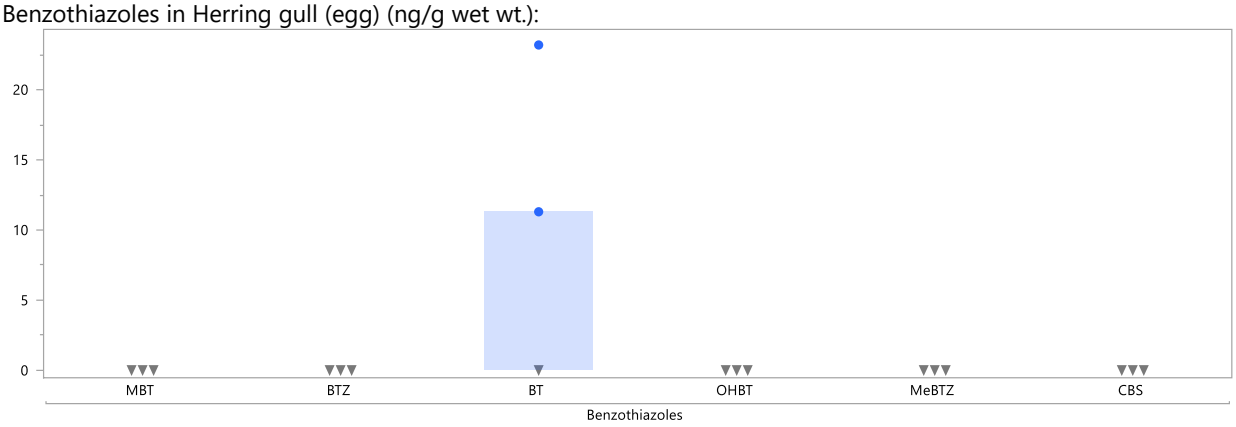
Benzothiazoles in Sediment (ng/g dry wt.):



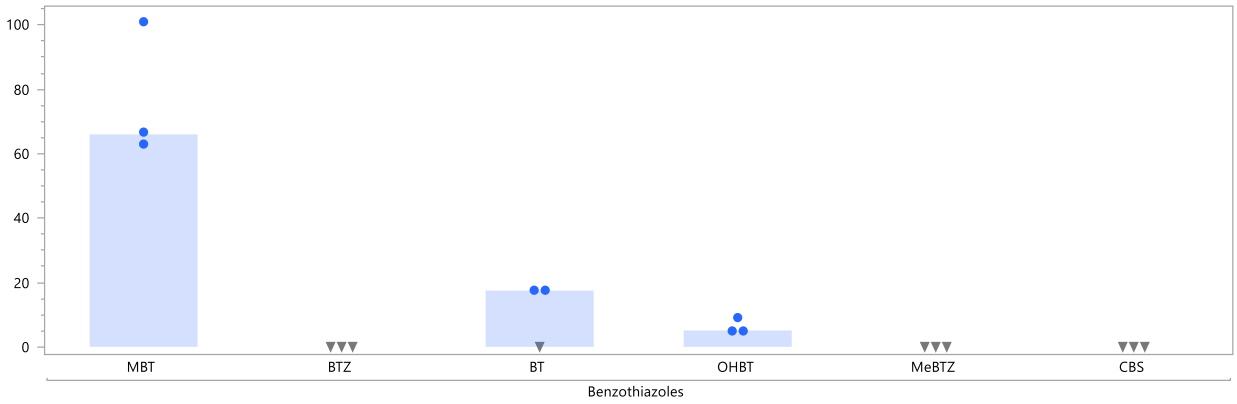
Benzothiazoles in Herring gull (blood) (ng/g wet wt.):



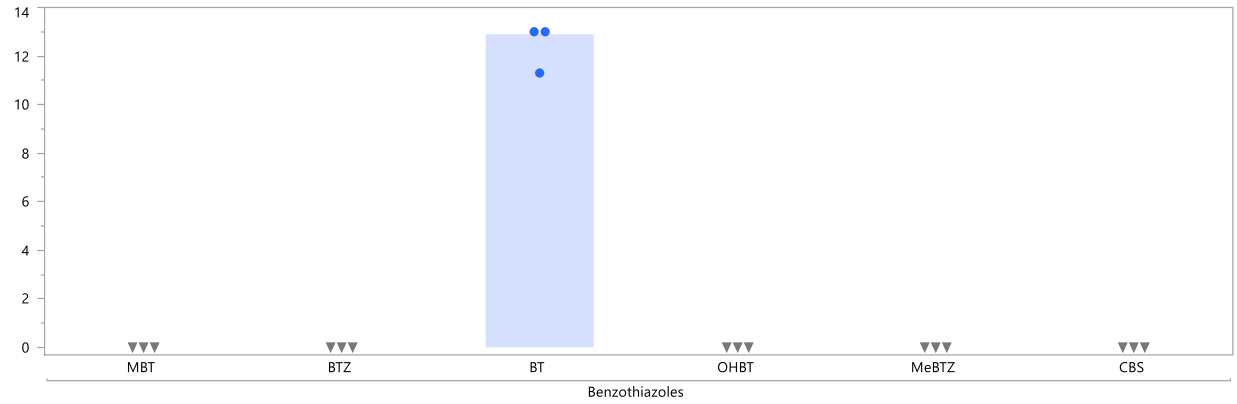
Benzothiazoles in Herring gull (egg) (ng/g wet wt.):



Benzothiazoles in Eider (blood) (ng/g wet wt.):

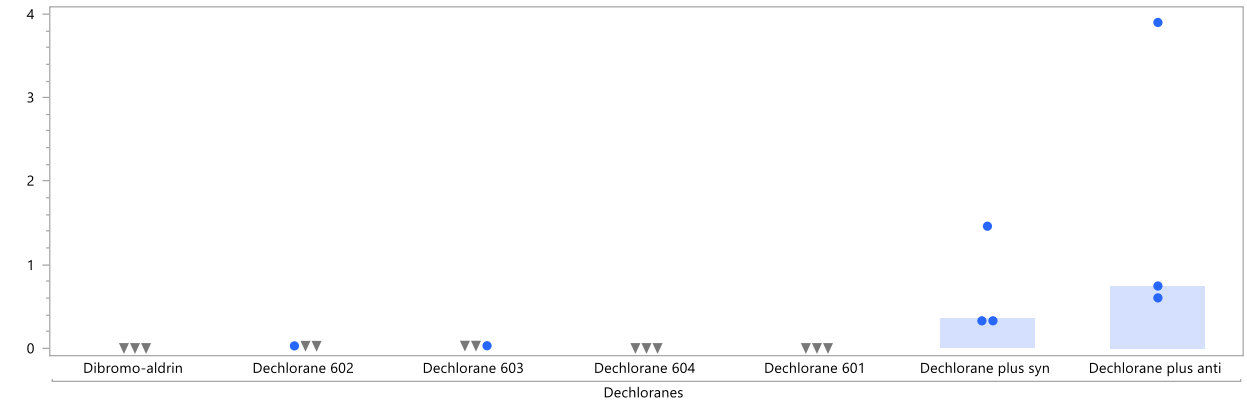


Benzothiazoles in Eider (egg (ng/g wet wt.):

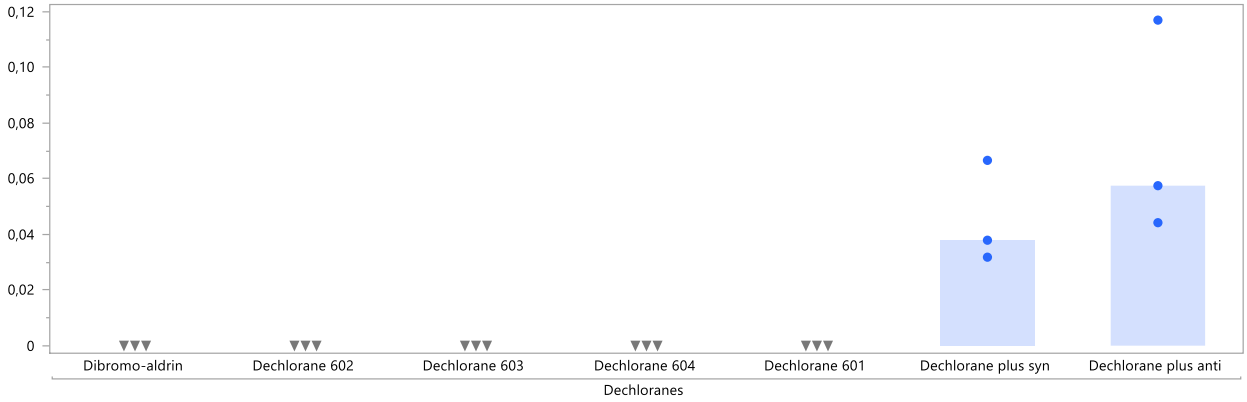


Dechloranes

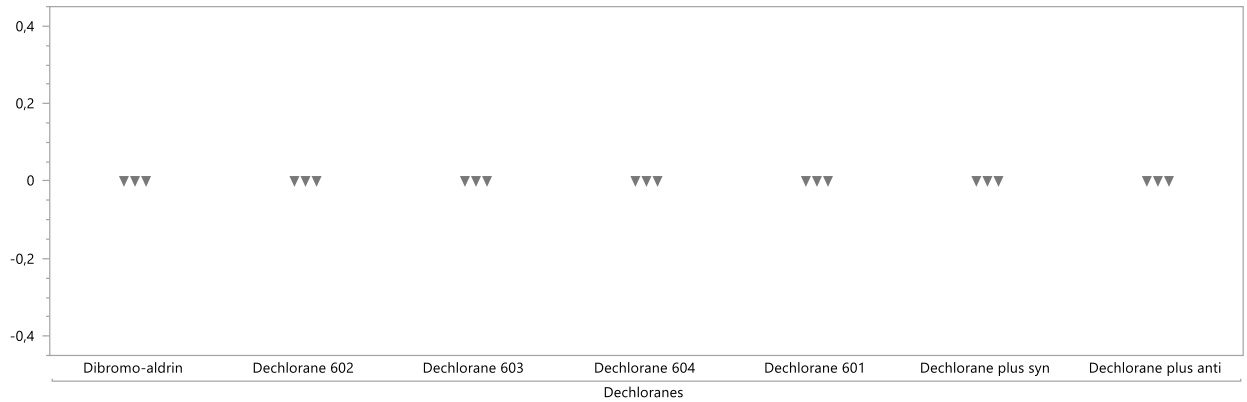
Dechloranes in Sediment (ng/g dry wt.):



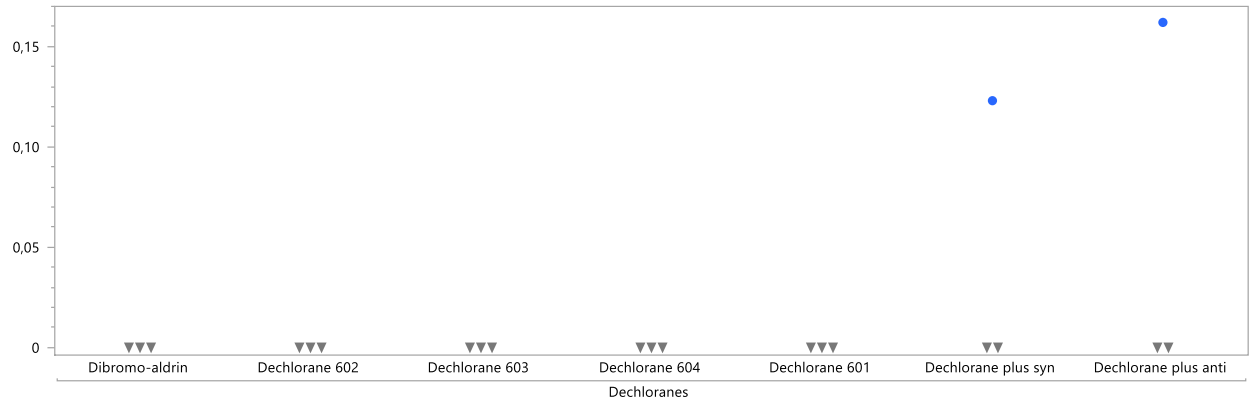
Dechloranes in Polychaeta (ng/g wet wt.):



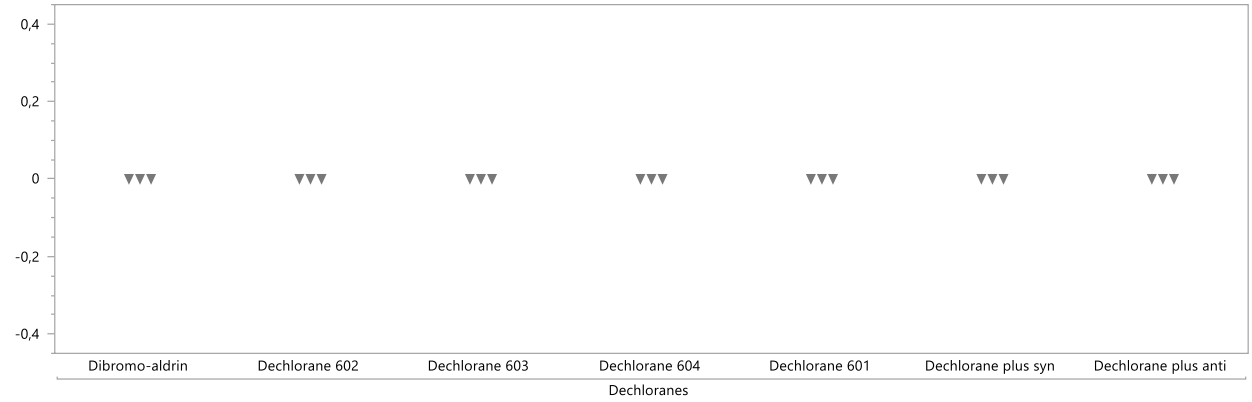
Dechloranes in Blue mussel (ng/g wet wt.):



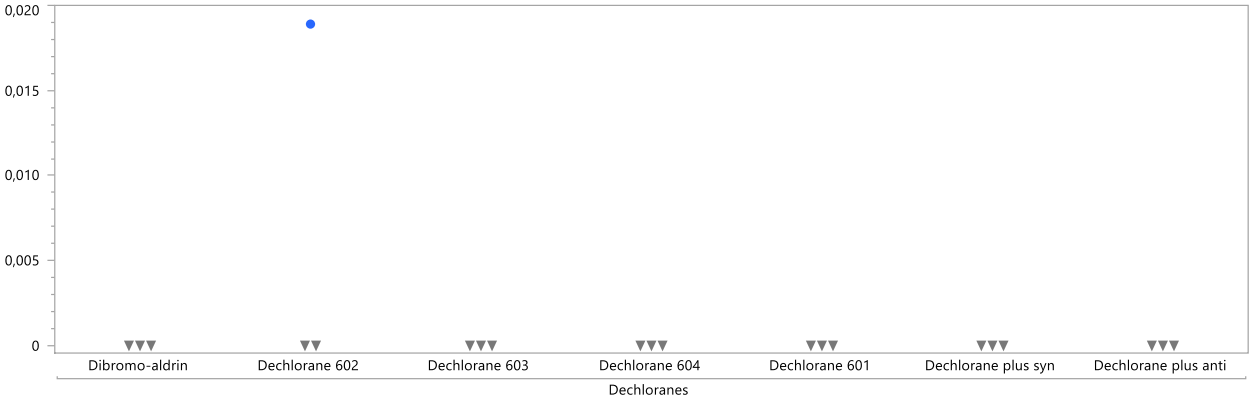
Dechloranes in Krill (ng/g wet wt.):



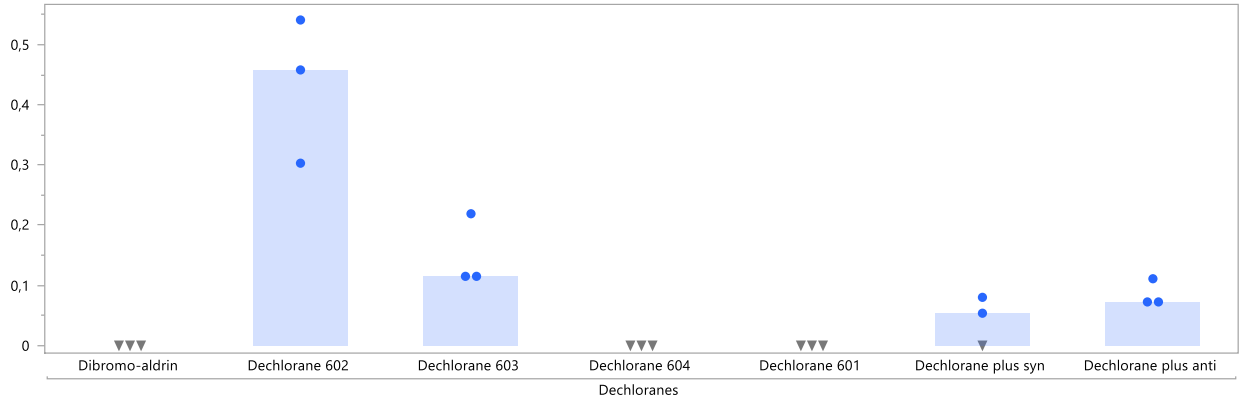
Dechloranes in Shrimp (ng/g wet wt.):



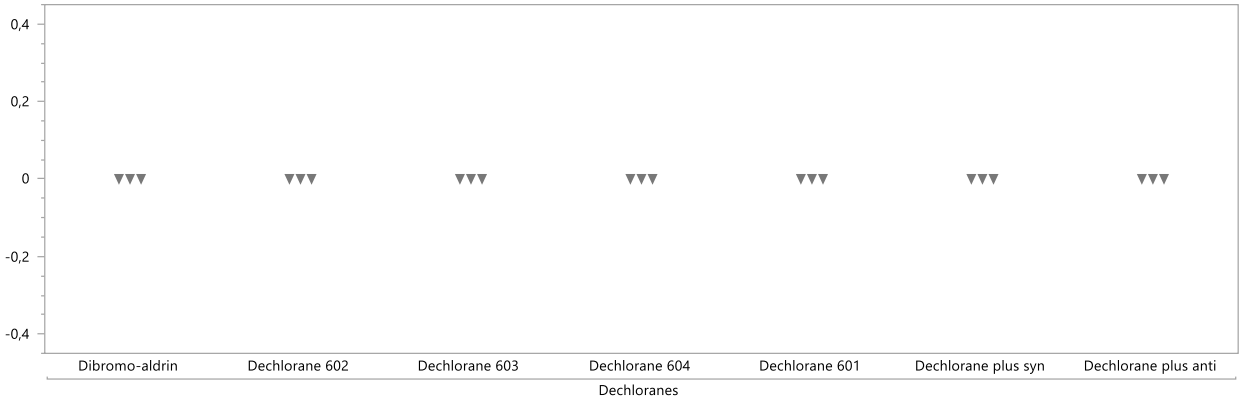
Dechloranes in Herring (muscle) (ng/g wet wt.):



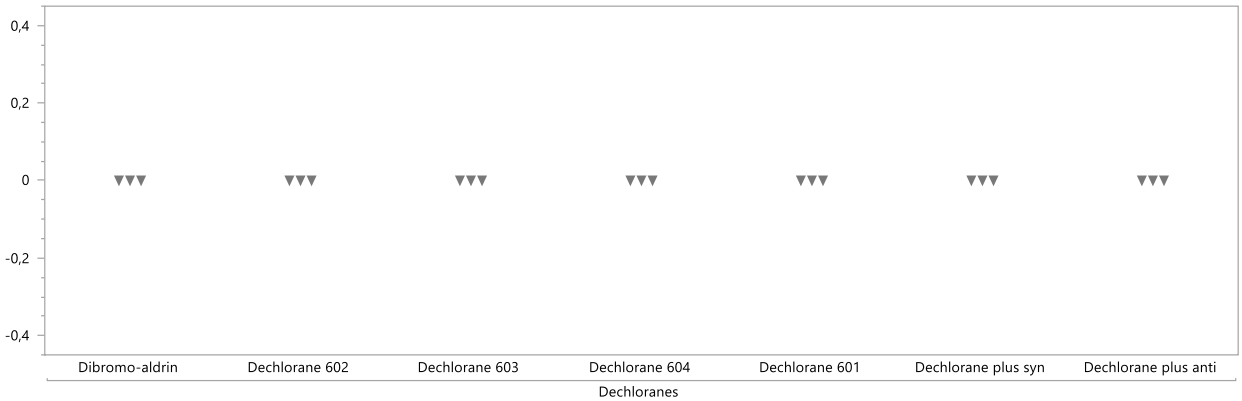
Dechloranes in Cod (liver)(ng/g wet wt.):



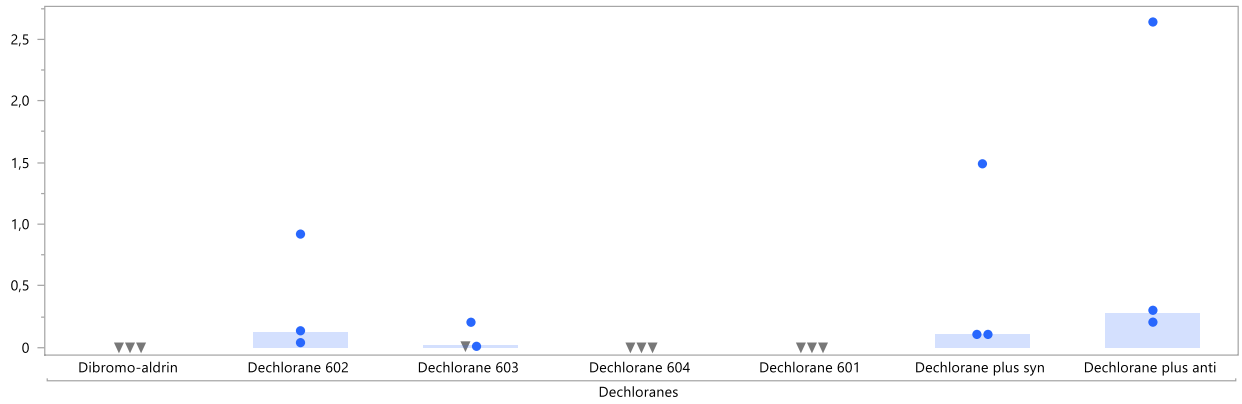
Dechloranes in Cod (muscle) (ng/g wet wt.):



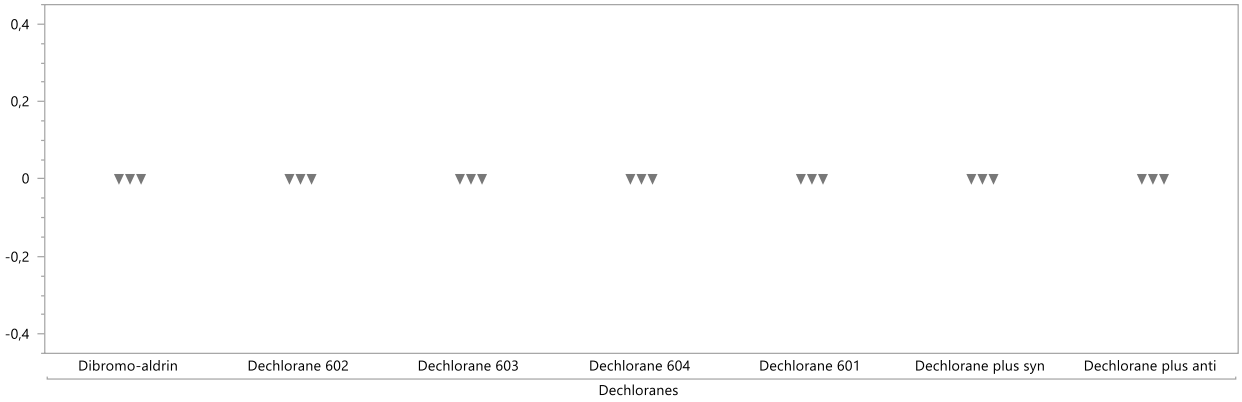
Dechloranes in Herring gull (blood) (ng/g wet wt.):



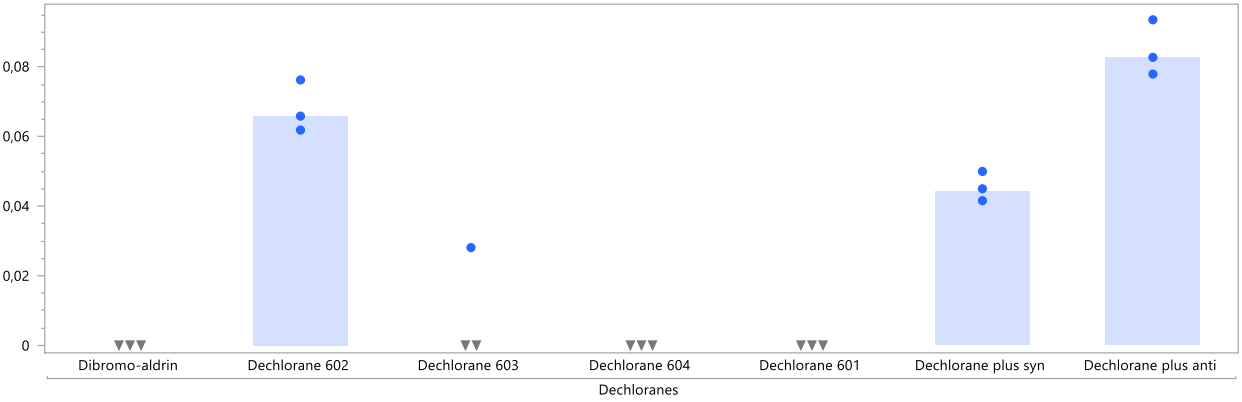
Dechloranes in Herring gull (egg) (ng/g wet wt.):



Dechloranes in Eider (blood) (ng/g wet wt.):

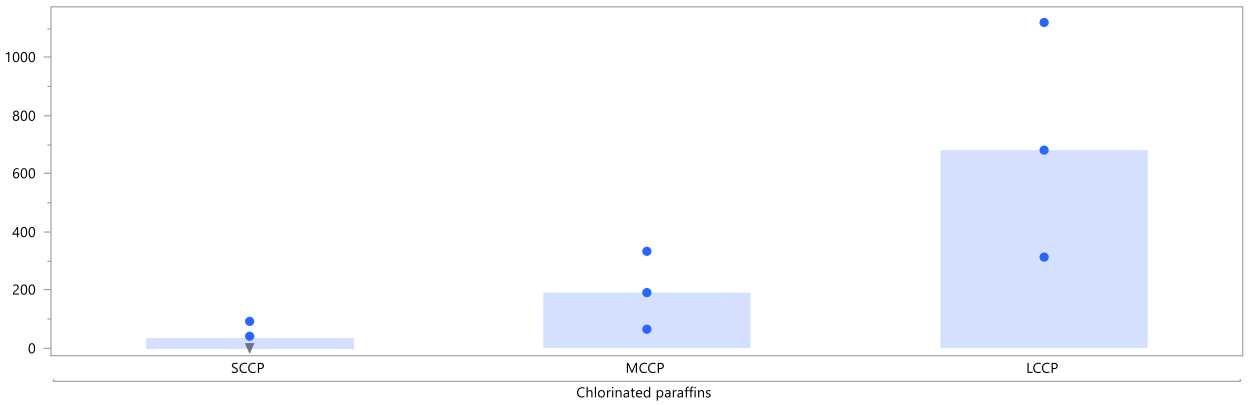


Dechloranes in Eider (egg) (ng/g wet wt.):

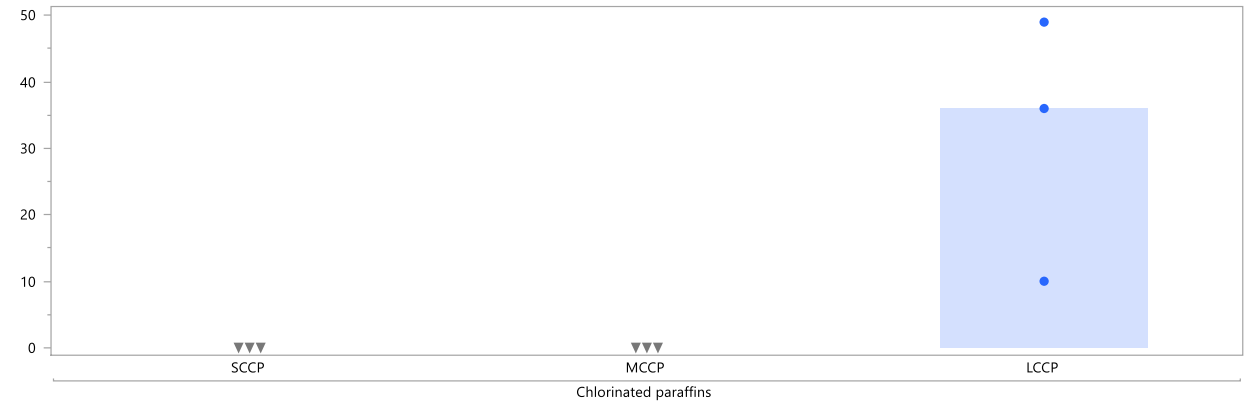


Chlorinated paraffins

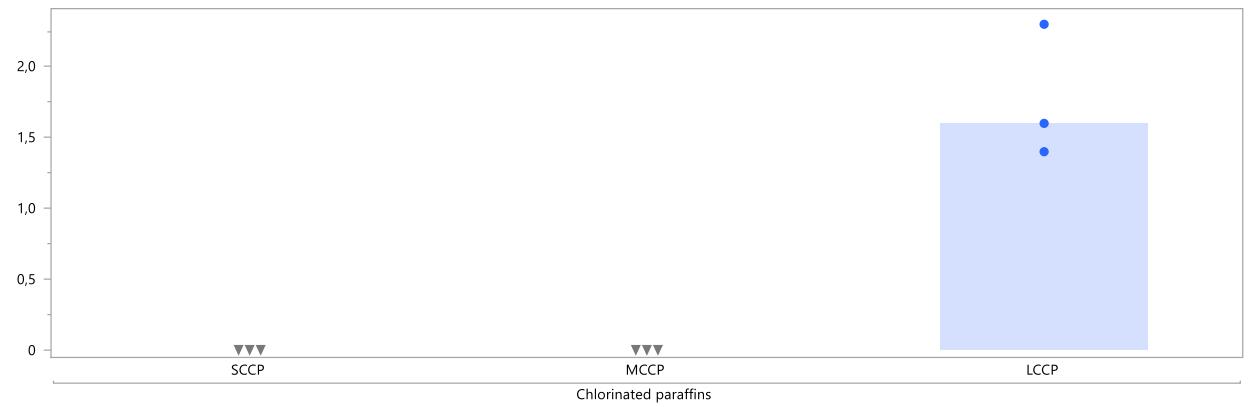
Chlorinated paraffins in Sediment (ng/g dry wt.):



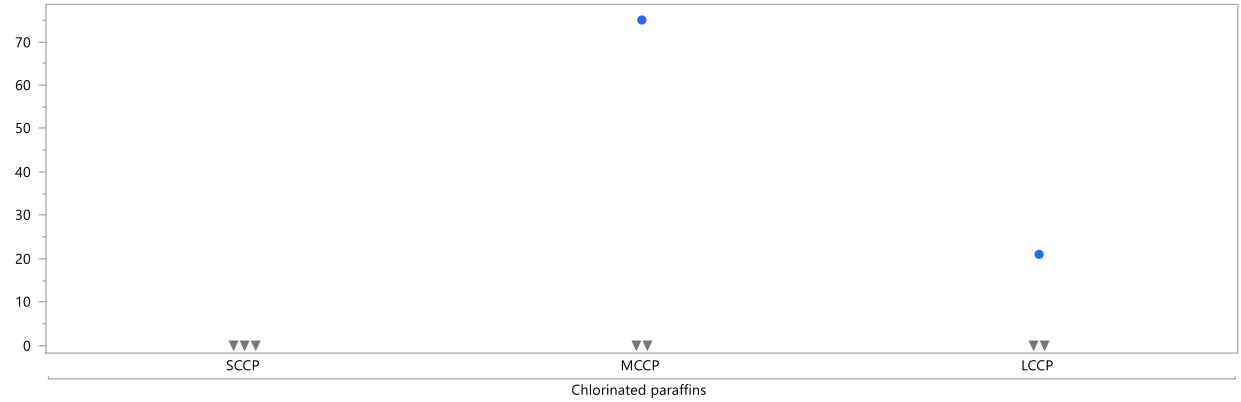
Chlorinated paraffins in Polychaeta (ng/g wet wt.):



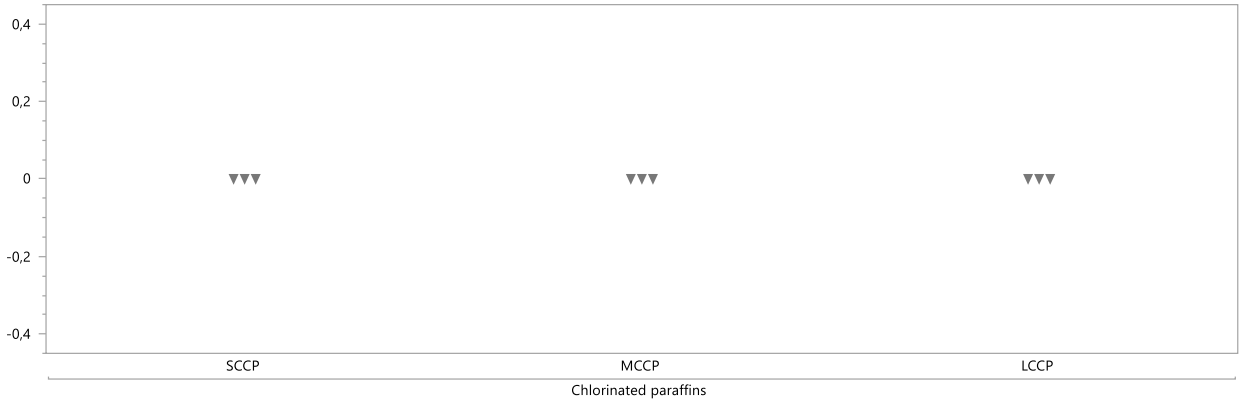
Chlorinated paraffins in Blue mussel (ng/g wet wt.):



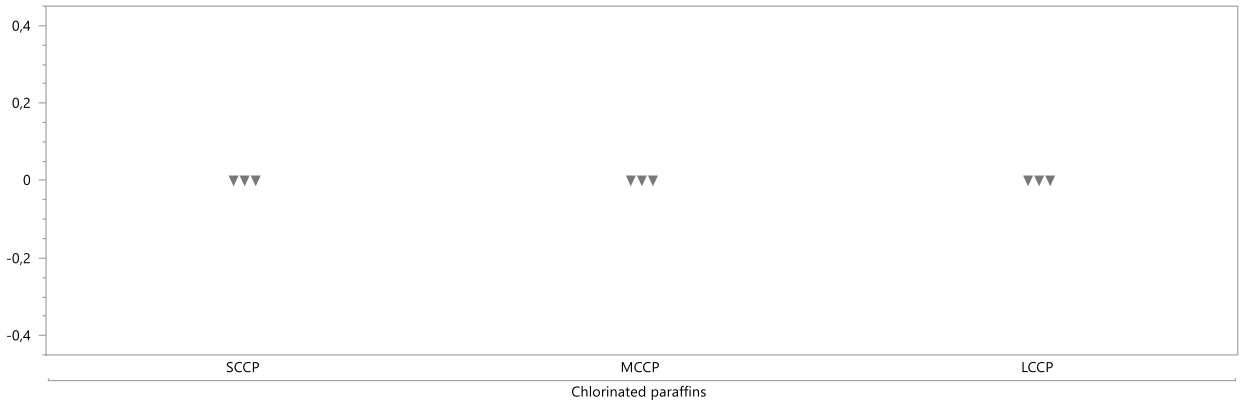
Chlorinated paraffins in Krill (ng/g wet wt.):



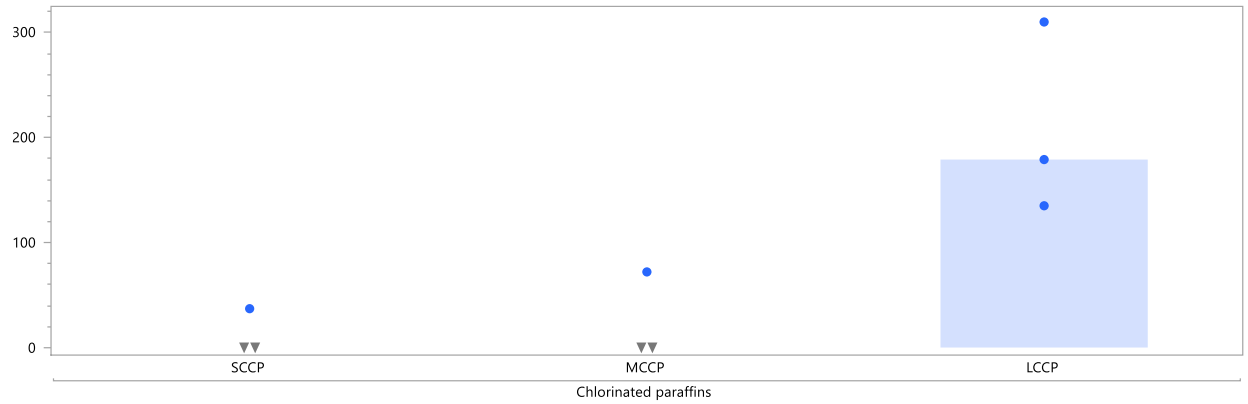
Chlorinated paraffins in Shrimp (ng/g wet wt.):



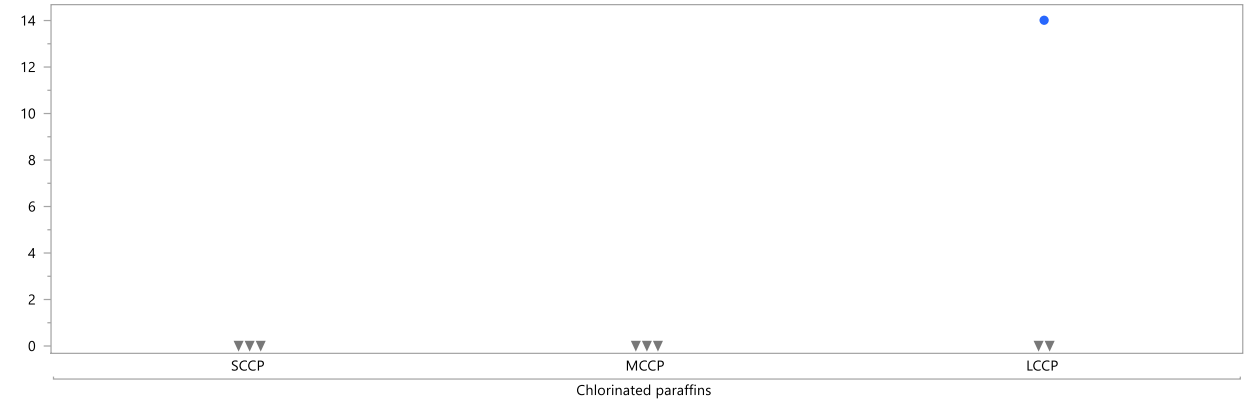
Chlorinated paraffins in Herring (muscle) (ng/g wet wt.):



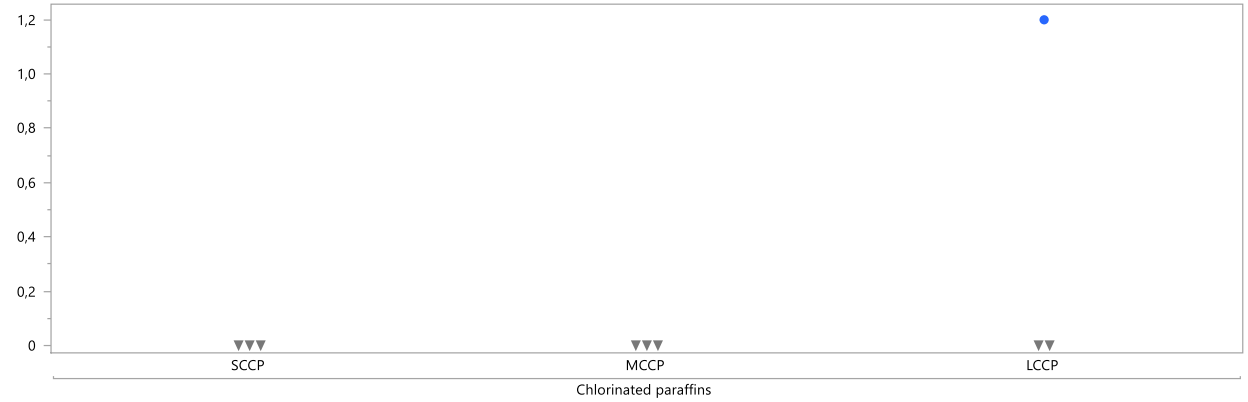
Chlorinated paraffins in Cod (liver) (ng/g wet wt.):



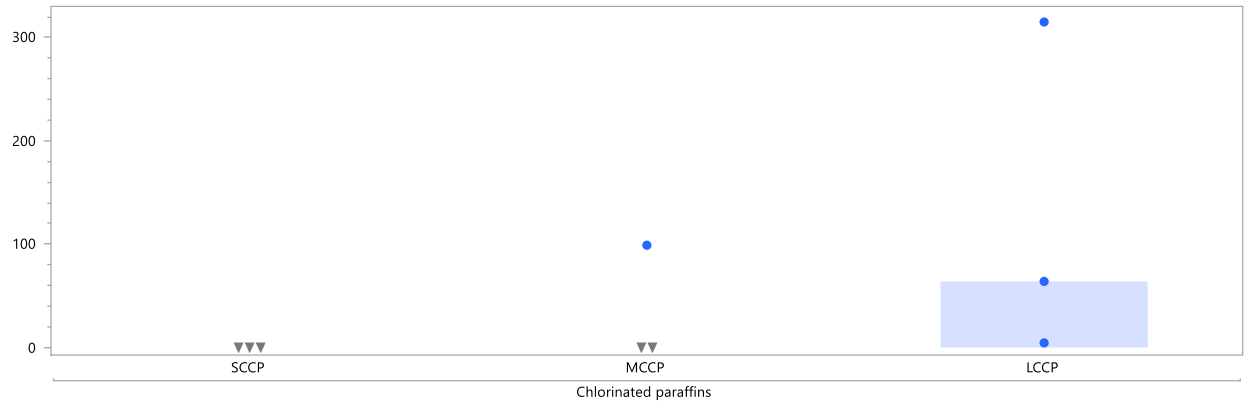
Chlorinated paraffins in Cod (muscle) (ng/g wet wt.):



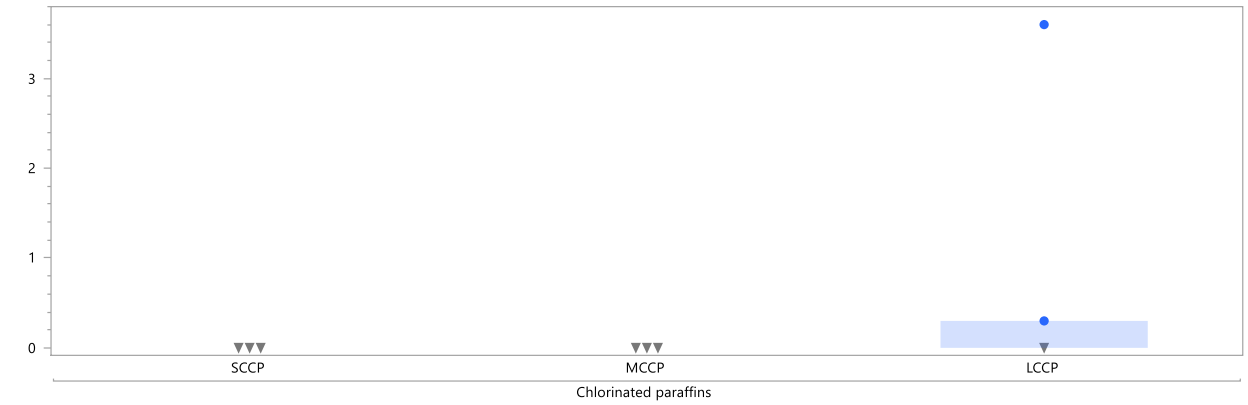
Chlorinated paraffins in Herring gull (blood) (ng/g wet wt.):



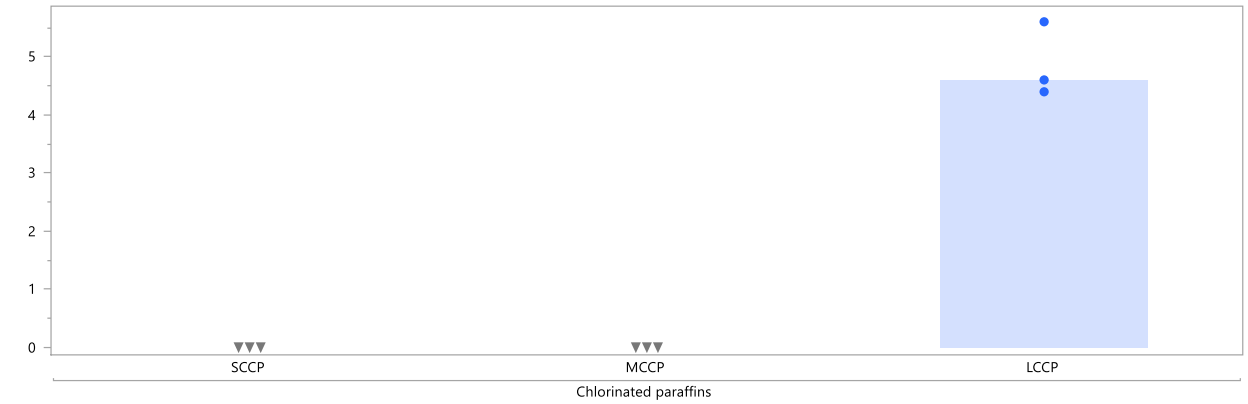
Chlorinated paraffins in Herring gull (egg) (ng/g wet wt.):



Chlorinated paraffins in Eider (blood) (ng/g wet wt.):

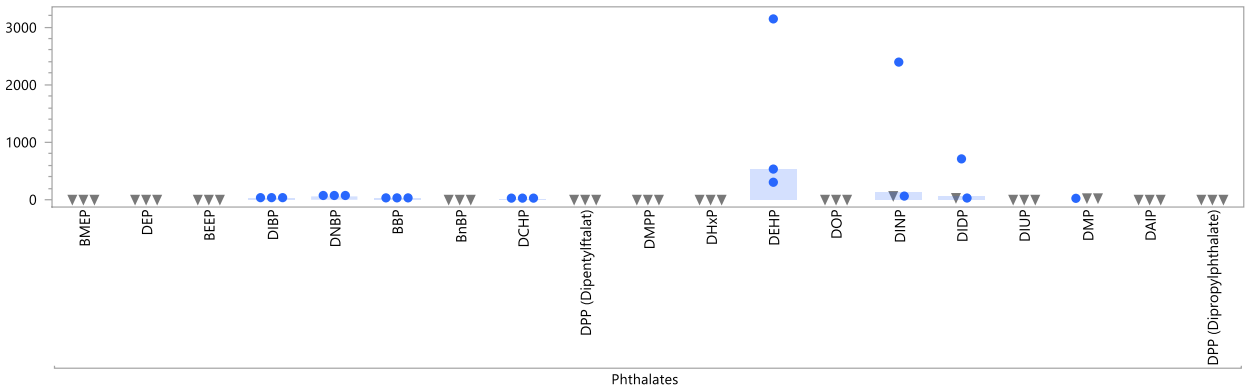


Chlorinated paraffins in Eider (egg) (ng/g wet wt.):



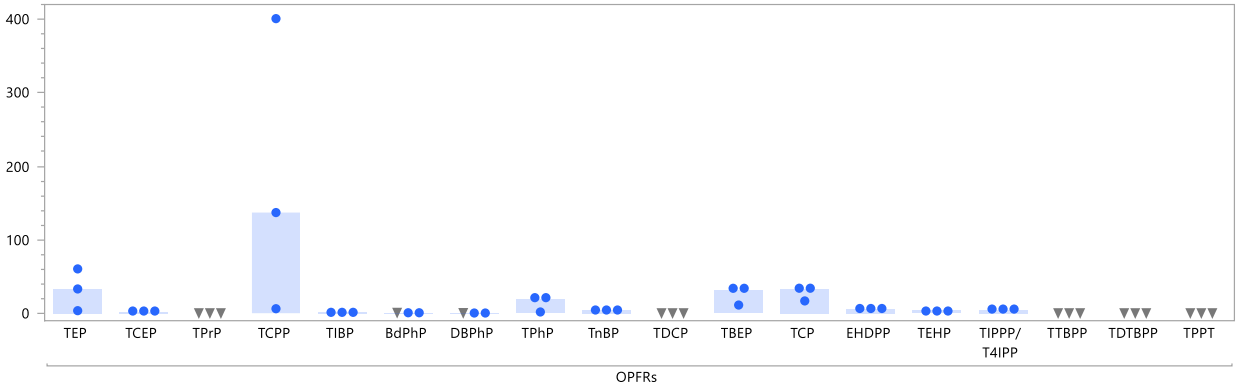
Phthalates

Phthalates in Sediment (ng/g dry wt.):



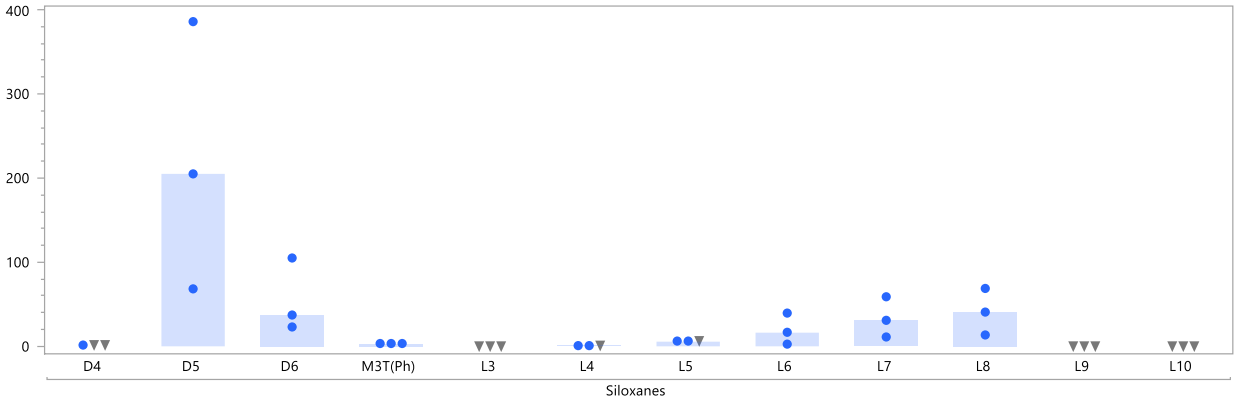
OPFRs

OPFRs in Sediment (ng/g dry wt.):

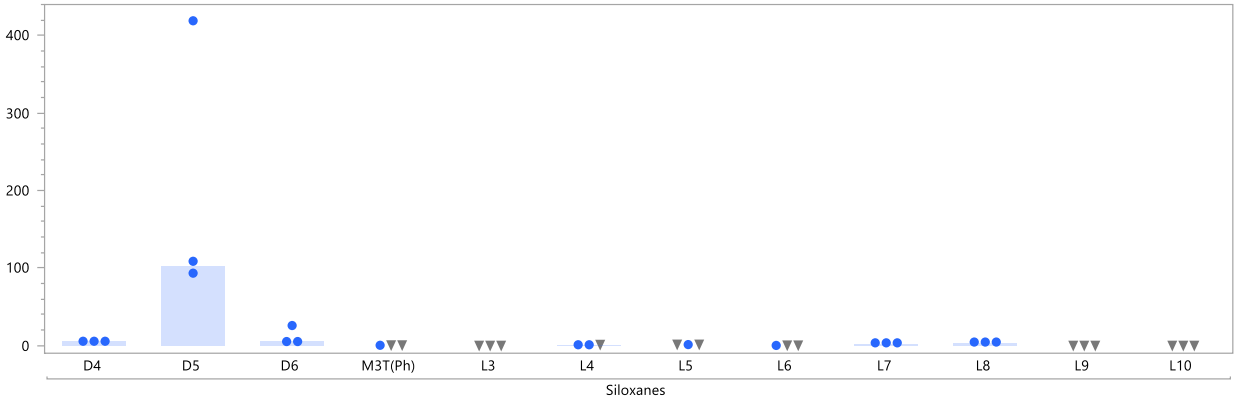


Siloxanes

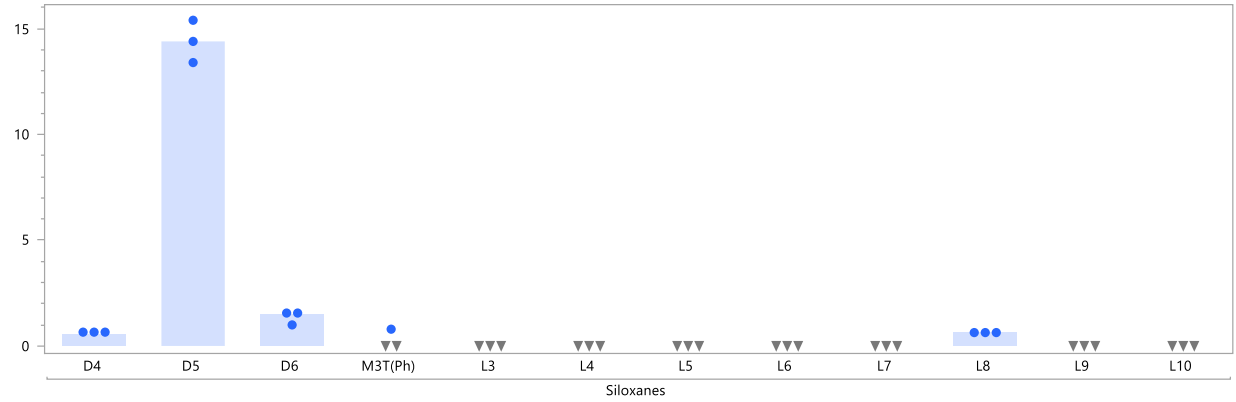
Siloxanes in Sediment (ng/g dry wt.):



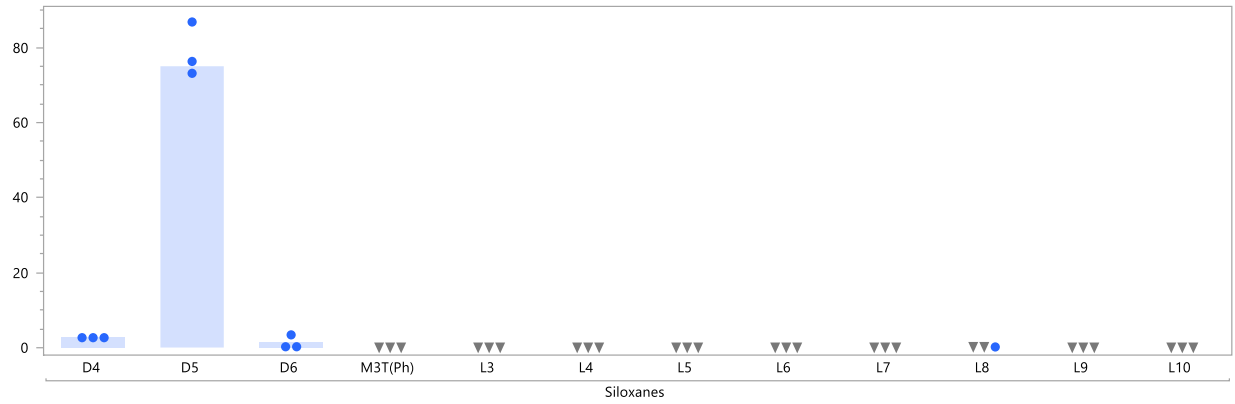
Siloxanes in Polychaeta (ng/g wet wt.):



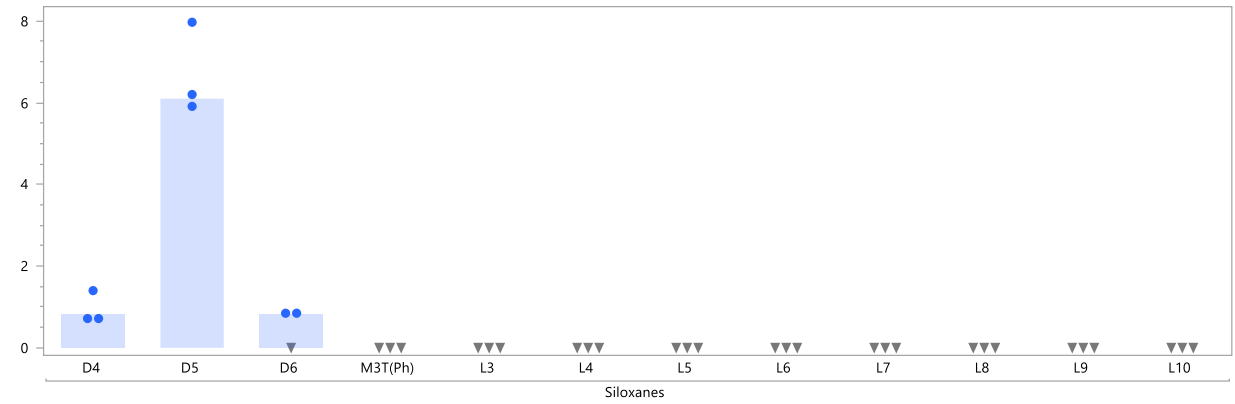
Siloxanes in Blue mussel (ng/g wet wt.):



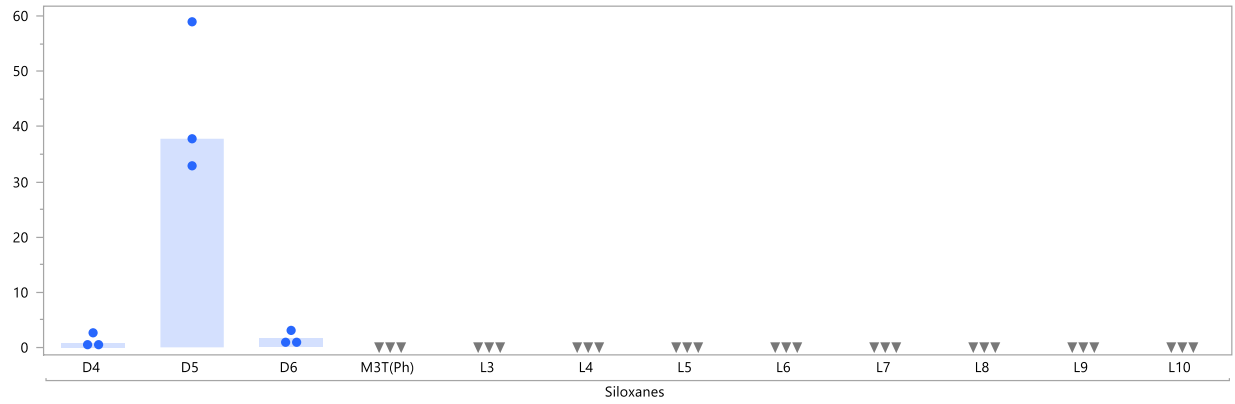
Siloxanes in Krill (ng/g wet wt.):



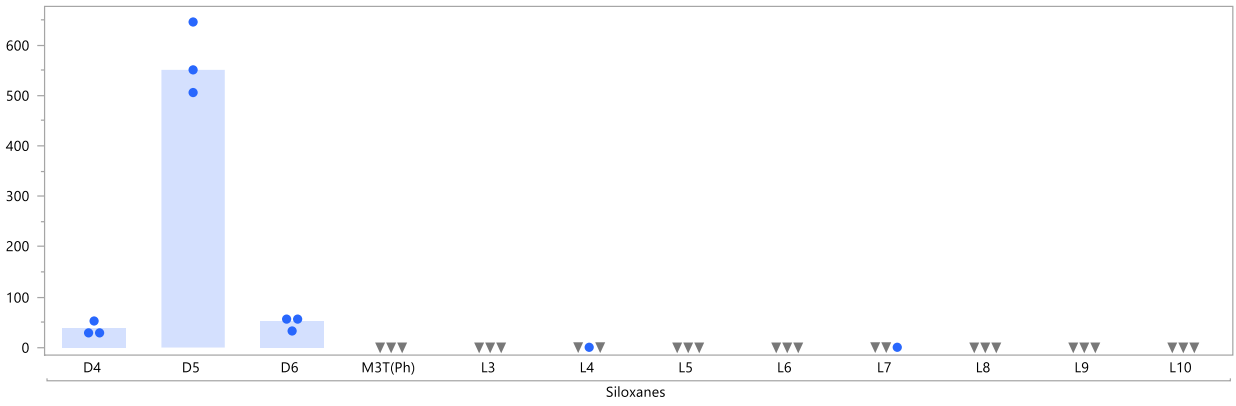
Siloxanes in Shrimp (ng/g wet wt.):



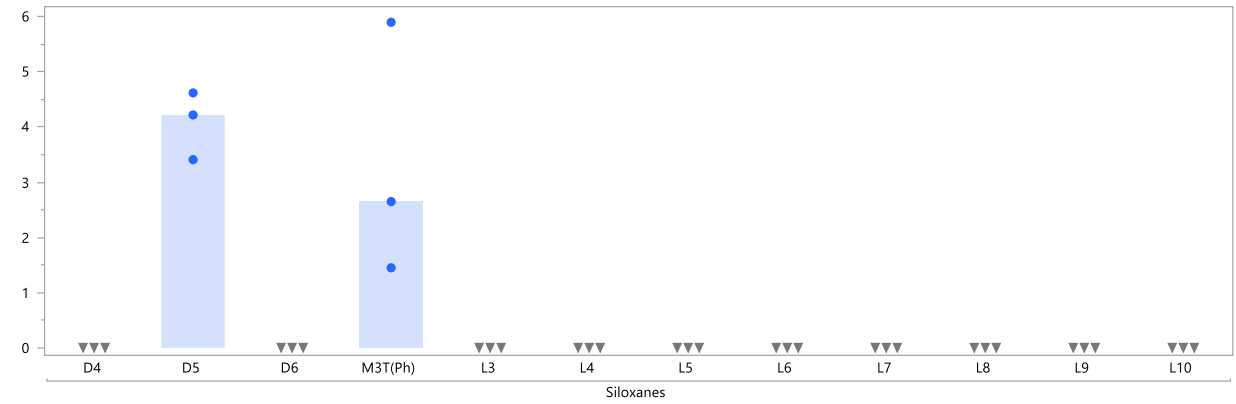
Siloxanes in Herring (muscle) (ng/g wet wt.):



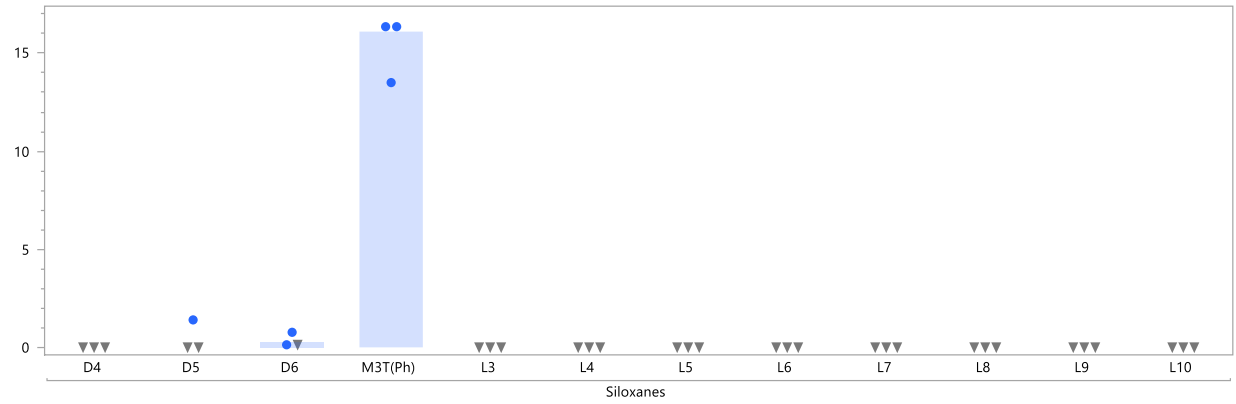
Siloxanes in Cod (liver) (ng/g wet wt.):



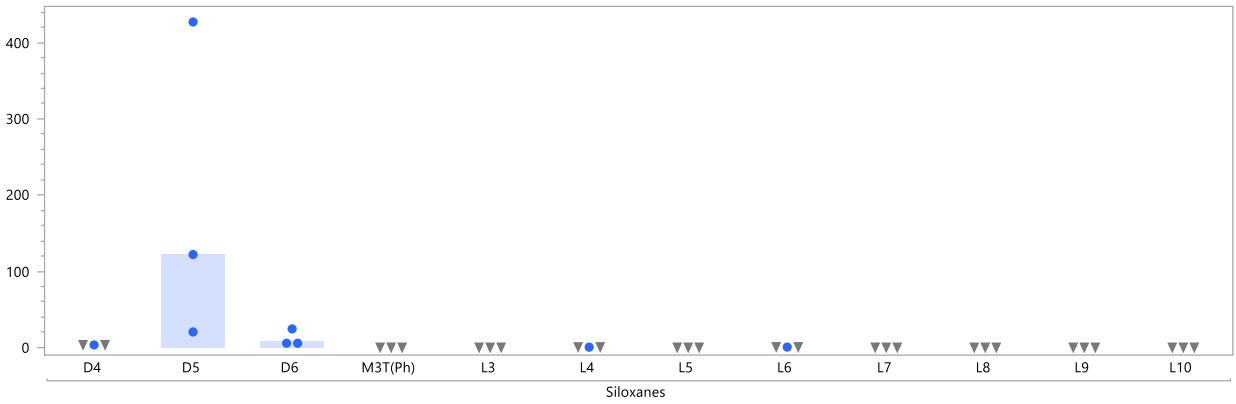
Siloxanes in Cod (Muscle) (ng/g wet wt.):



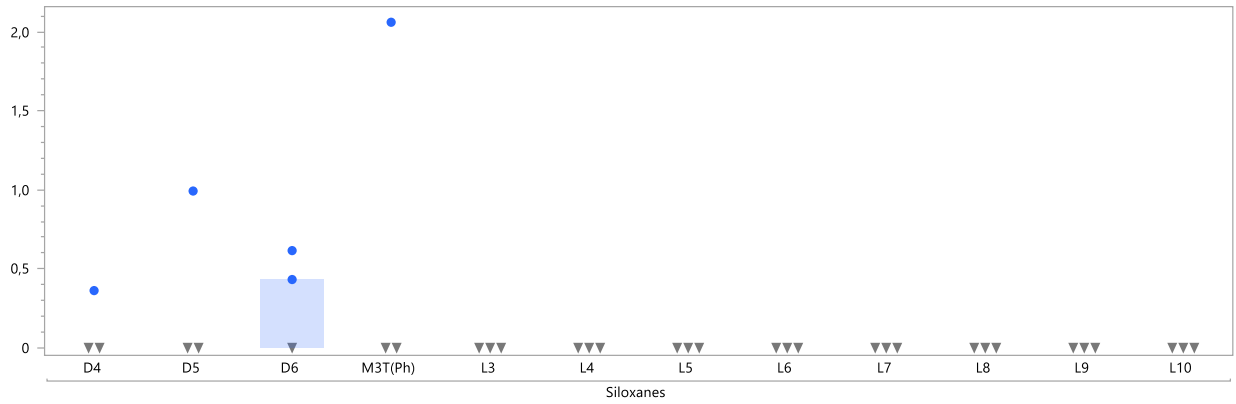
Siloxanes in Herring gull (blood) (ng/g wet wt.):



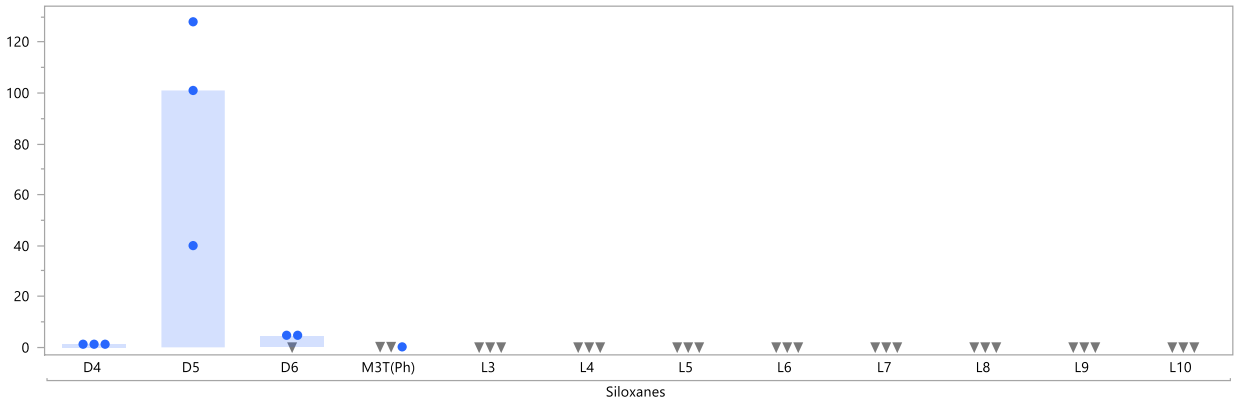
Siloxanes in Herring gull (egg) (ng/g wet wt.):



Siloxanes in Eider (blood) (ng/g wet wt.):

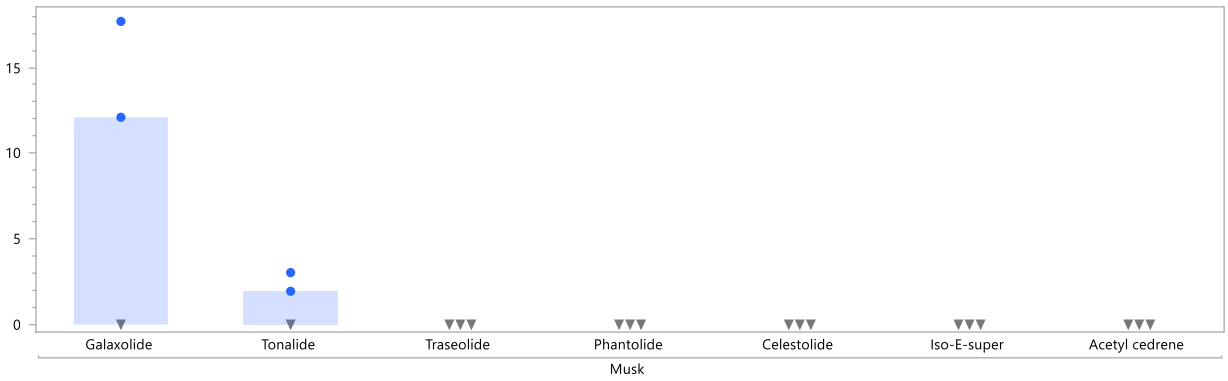


Siloxanes in Eider (egg) (ng/g wet wt.):



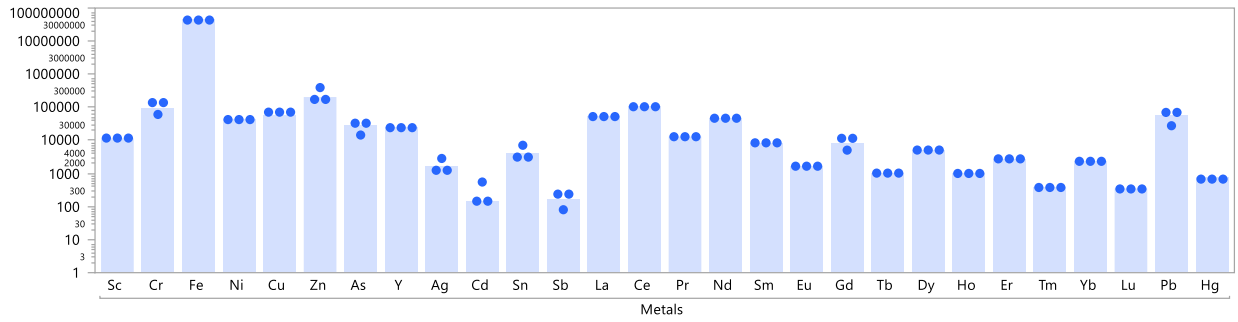
Musk

Musk in Sediment (ng/g dry wt.):

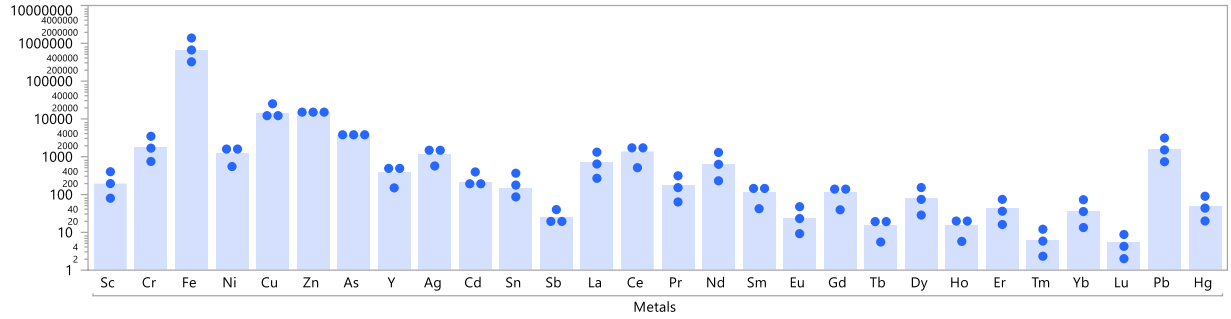


Metals (note logarithmic scale on concentration axis):

Metals in Sediment (ng/g dry wt.):

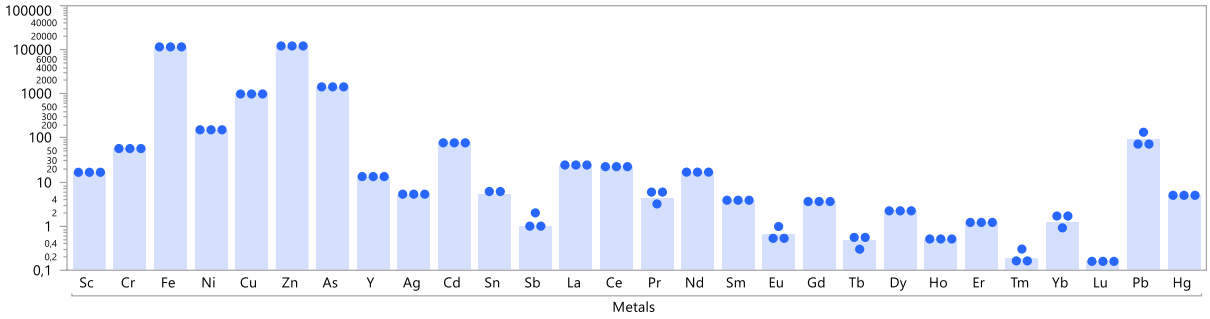


Metals in Polychaeta (ng/g wet wt.):



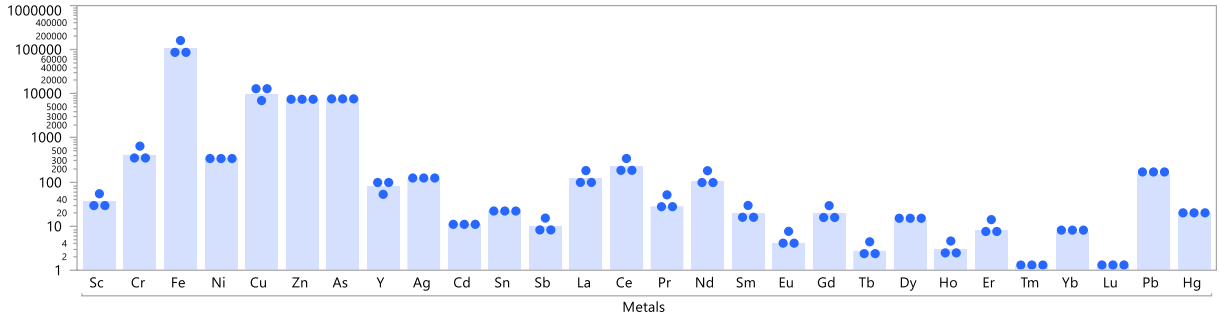
Crude table grouping[Abbrev] / Compound[Abbrev] ordered by Order combined[Abbrev] (ascending)

Metals in Blue mussel (ng/g wet wt.):

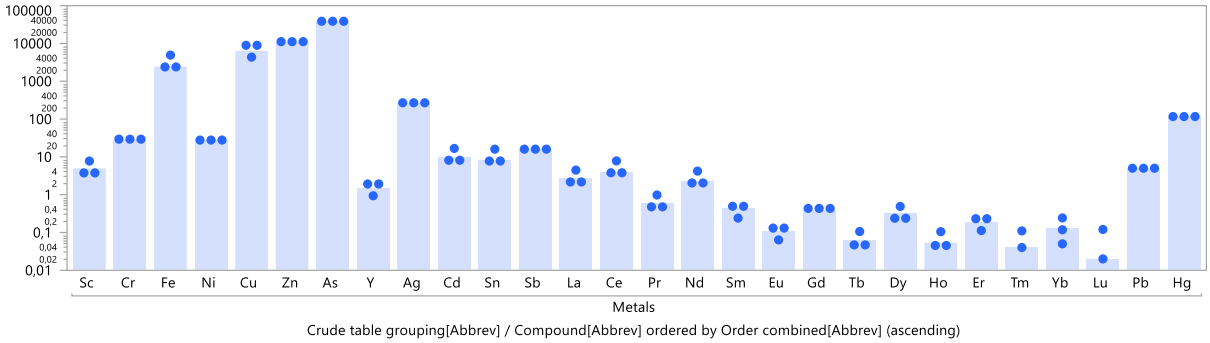


Crude table grouping[Abbrev] / Compound[Abbrev] ordered by Order combined[Abbrev] (ascending)

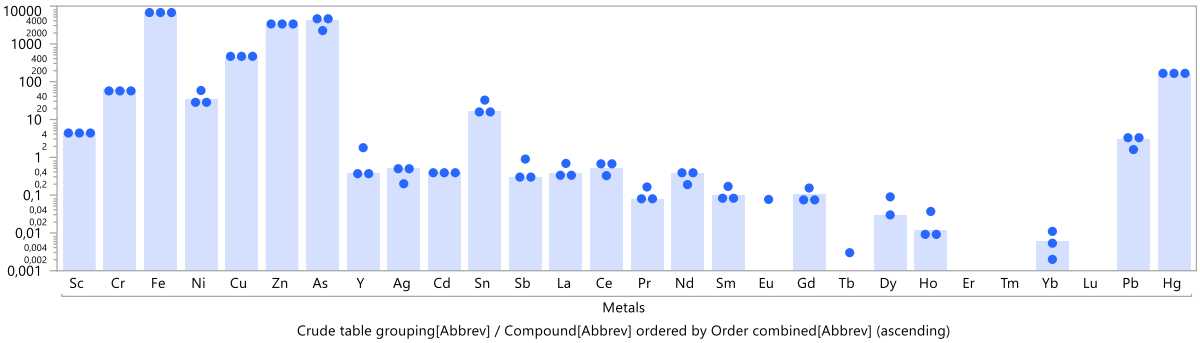
Metals in Krill (ng/g wet wt.):



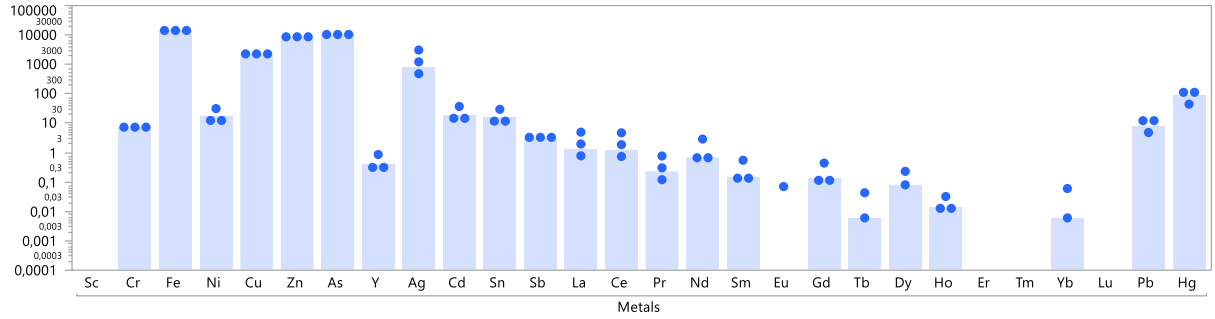
Metals in Shrimp (ng/g wet wt.):



Metals in Herring (muscle) (ng/g wet wt.):

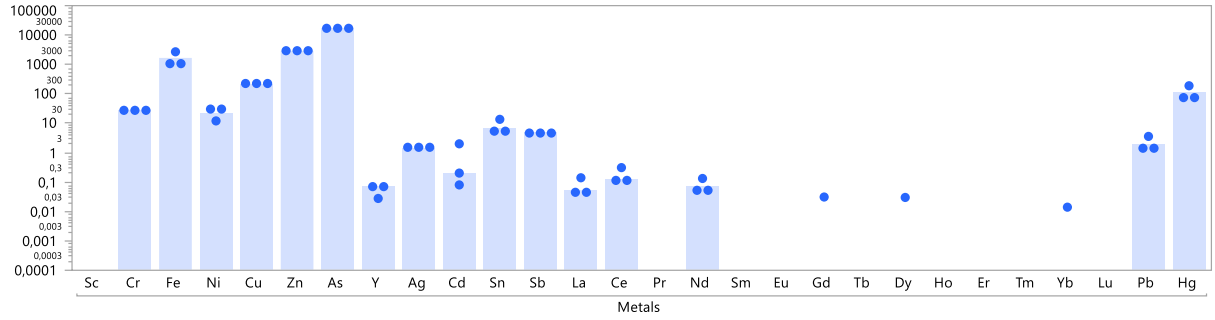


Metals in Cod (liver) (ng/g wet wt.):



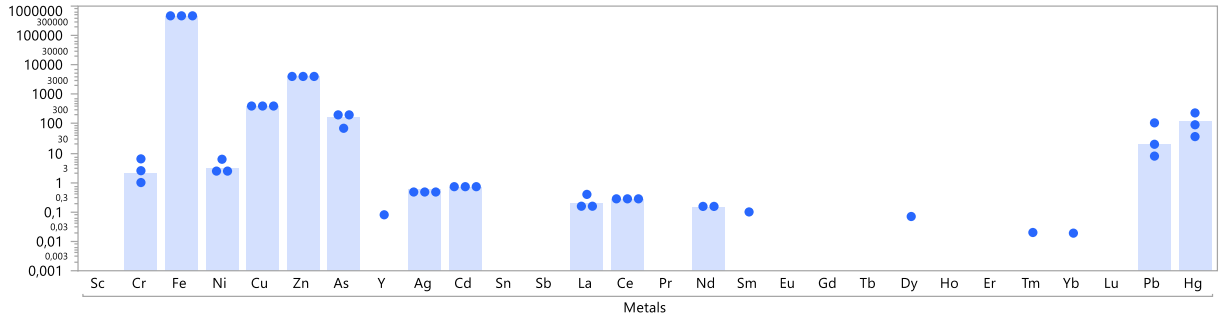
Crude table grouping[Abbrev] / Compound[Abbrev] ordered by Order combined[Abbrev] (ascending)

Metals in Cod (muscle) (ng/g wet wt.):



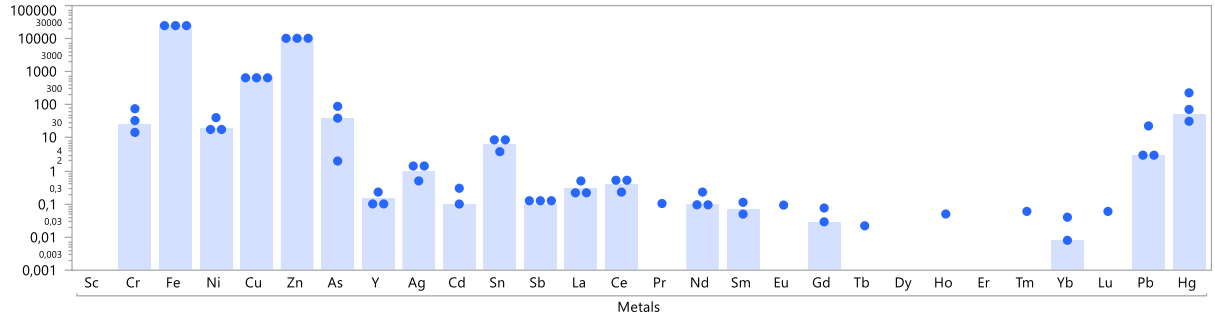
Crude table grouping[Abbrev] / Compound[Abbrev] ordered by Order combined[Abbrev] (ascending)

Metals in Herring gull (blood) (ng/g wet wt.):



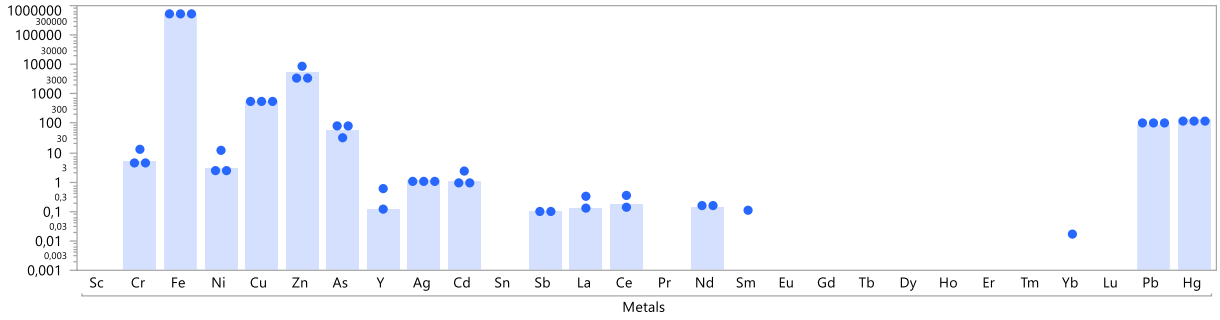
Crude table grouping[Abbrev] / Compound[Abbrev] ordered by Order combined[Abbrev] (ascending)

Metals in Herring gull (egg) (ng/g wet wt.):



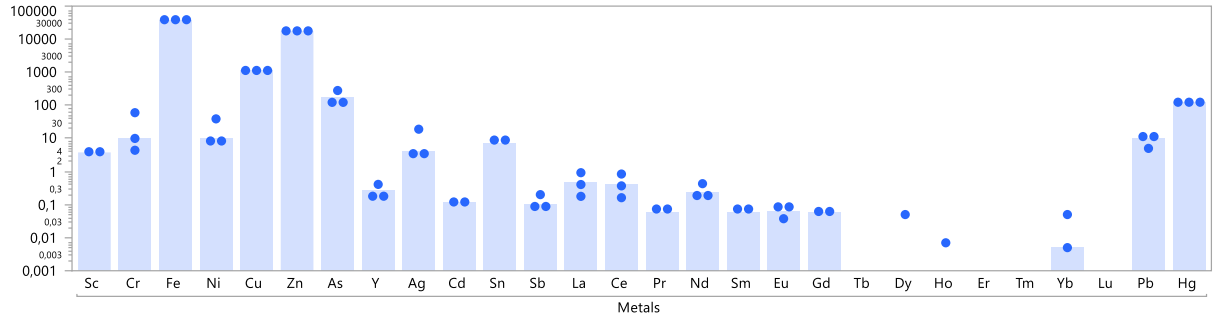
Crude table grouping[Abbrev] / Compound[Abbrev] ordered by Order combined[Abbrev] (ascending)

Metals in Eider (blood) (ng/g wet wt.):



Crude table grouping[Abbrev] / Compound[Abbrev] ordered by Order combined[Abbrev] (ascending)

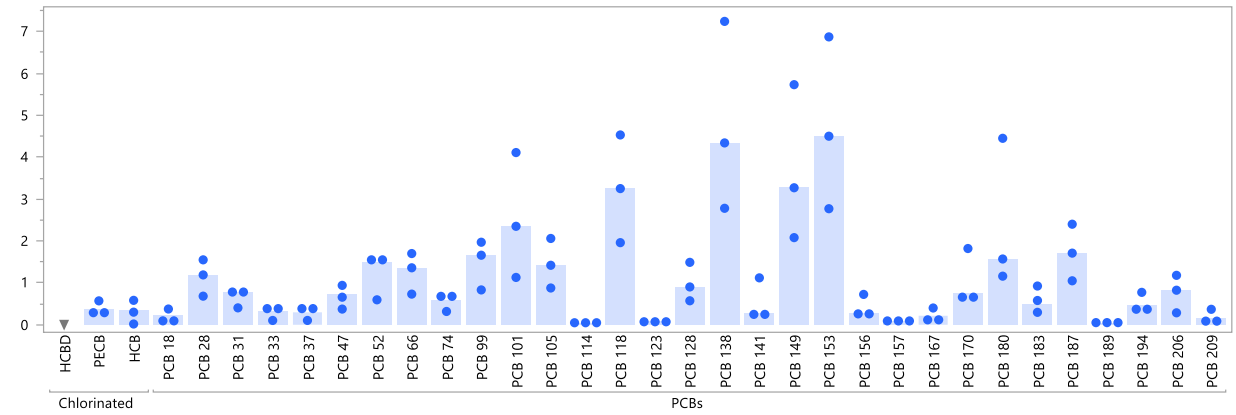
Metals in Eider (egg) (ng/g wet wt.):



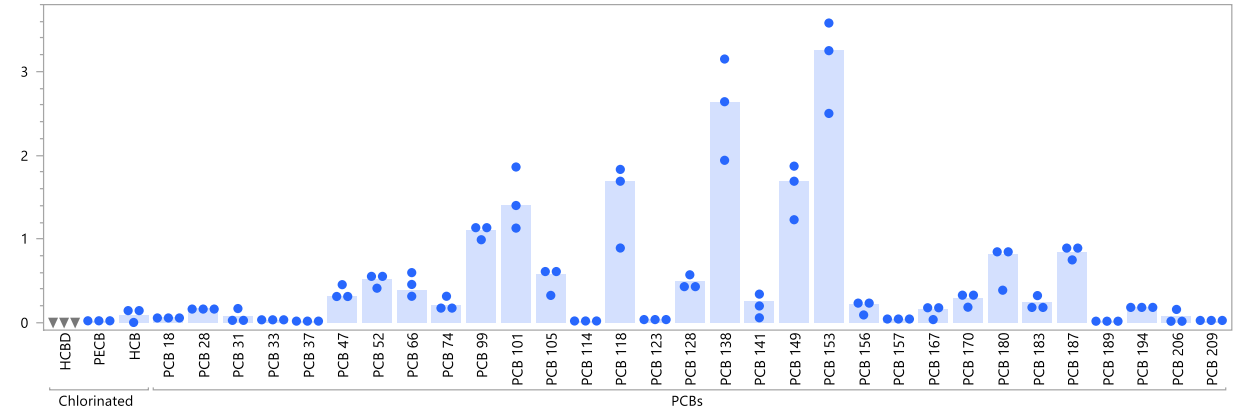
Crude table grouping[Abbrev] / Compound[Abbrev] ordered by Order combined[Abbrev] (ascending)

Organochlorines and PCBs

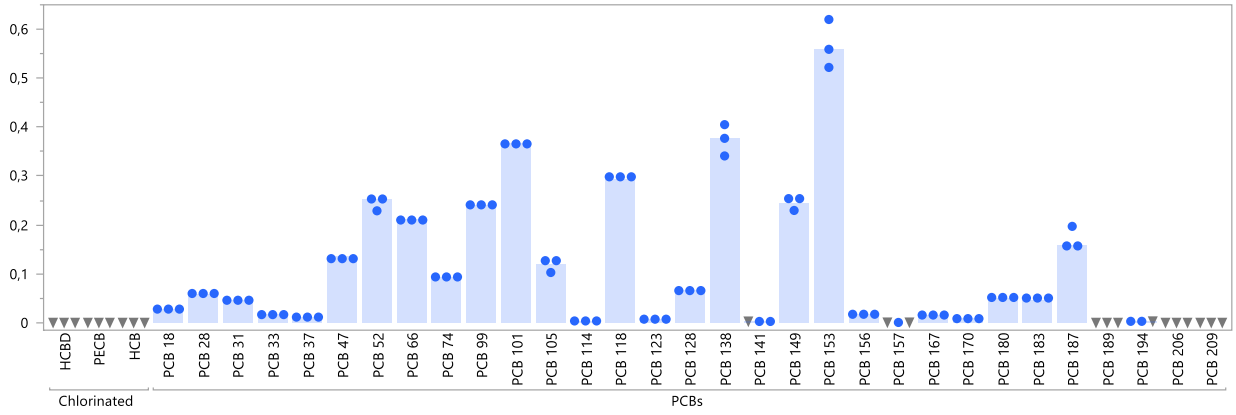
Organochlorines and PCBs in Sediment (ng/g dry wt.):



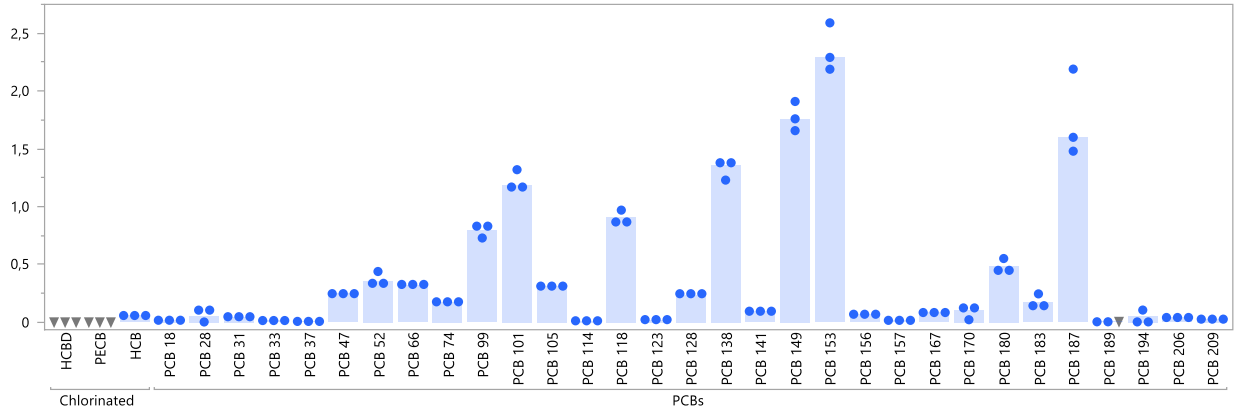
Organochlorines and PCBs in Polychaeta (ng/g wet wt.):



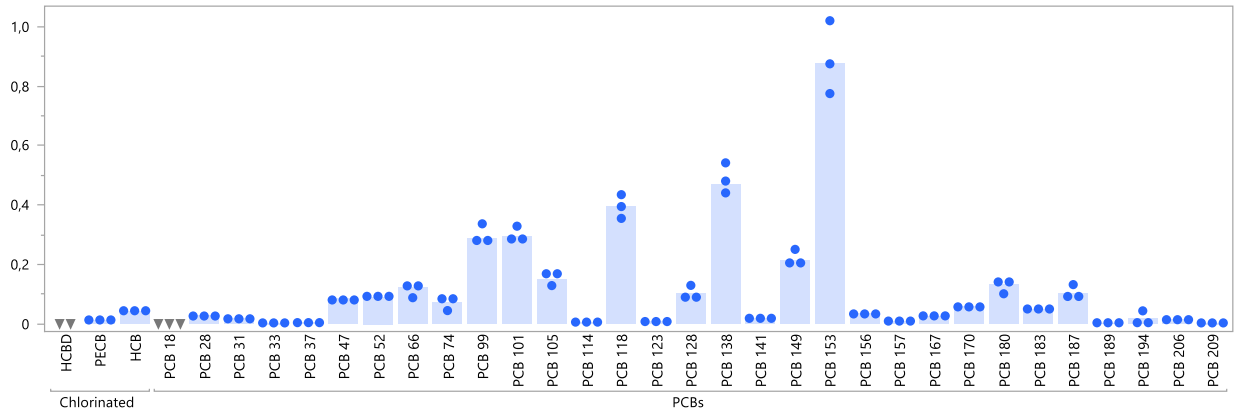
Organochlorines and PCBs in Blue mussel (ng/g wet wt.):



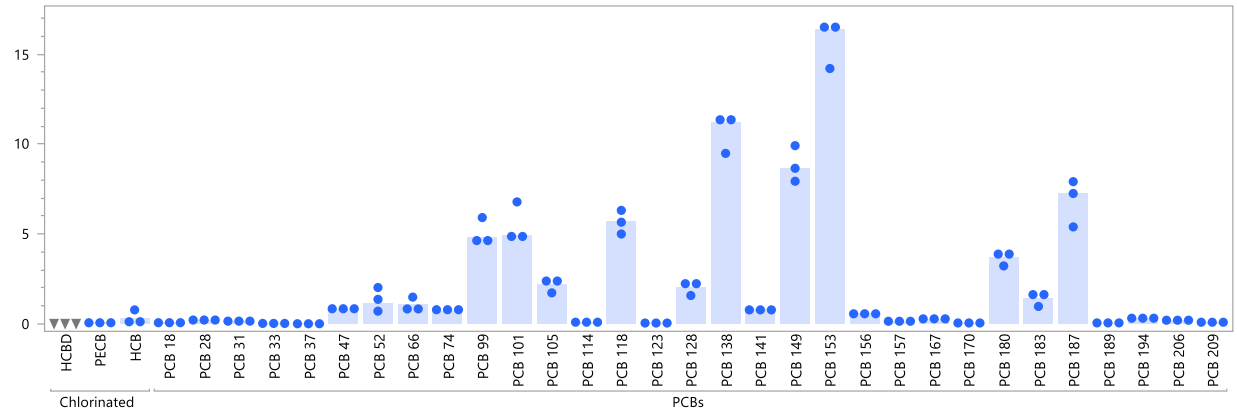
Organochlorines and PCBs in Krill (ng/g wet wt.):



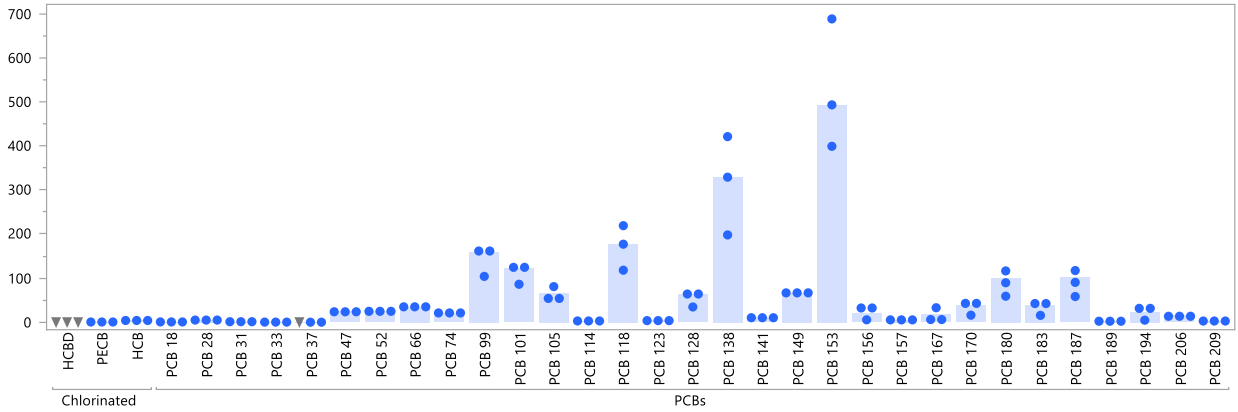
Organochlorines and PCBs in Shrimp (ng/g wet wt.):



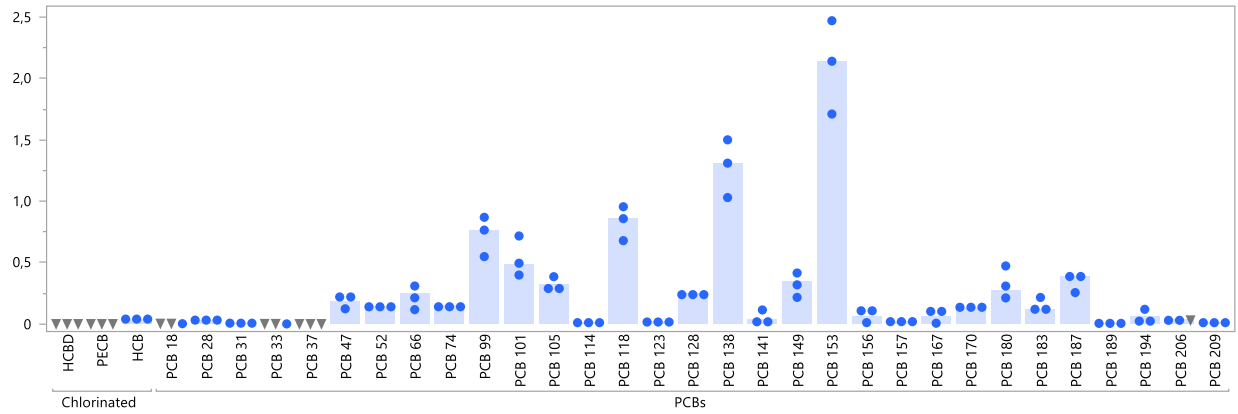
Organochlorines and PCBs in Herring (muscle) (ng/g wet wt.):



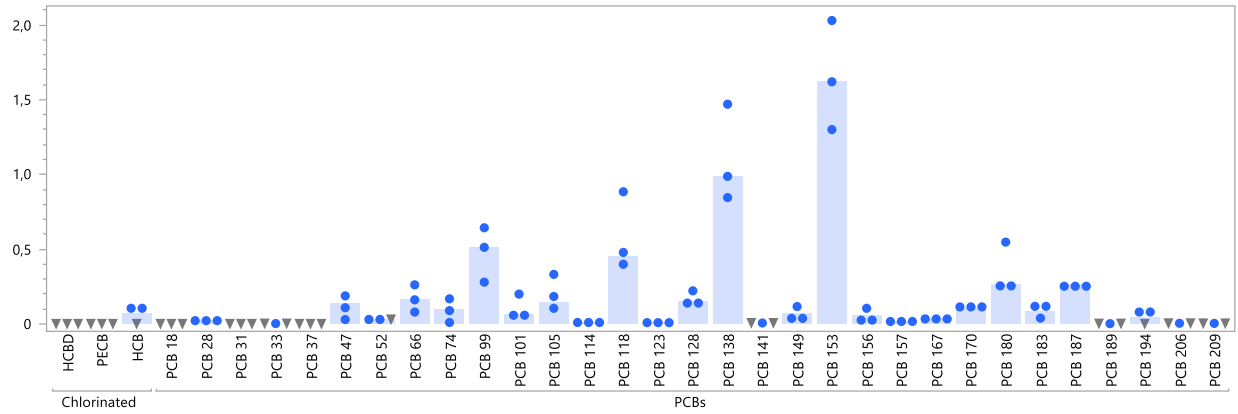
Organochlorines and PCBs in Cod (liver) (ng/g wet wt.):



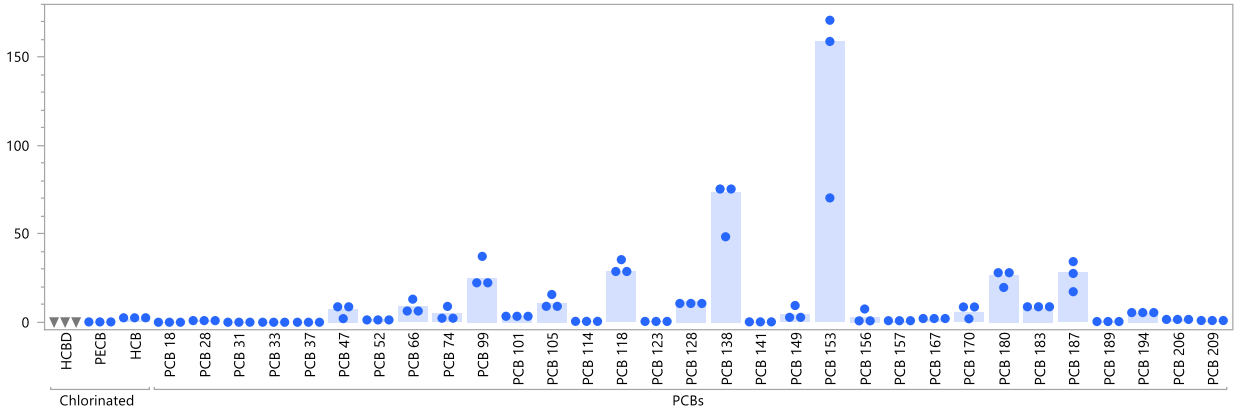
Organochlorines and PCBs in Cod (muscle) (ng/g wet wt.):



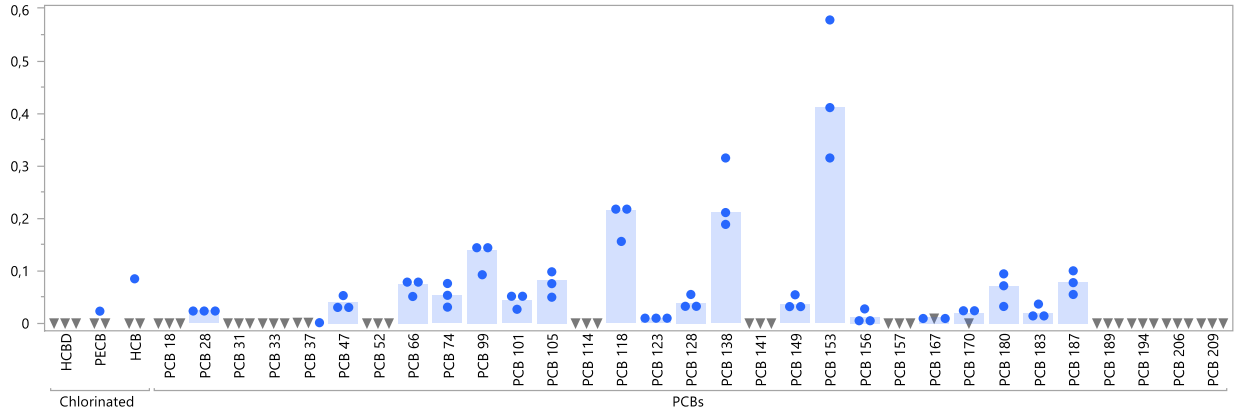
Organochlorines and PCBs in Herring gull (blood) (ng/g wet wt.):



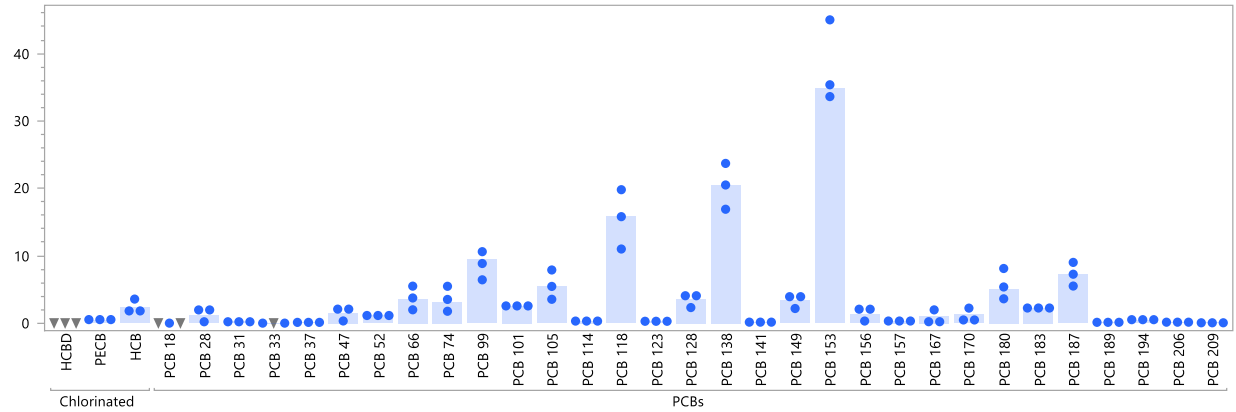
Organochlorines and PCBs in Herring gull (egg) (ng/g wet wt.):



Organochlorines and PCBs in Eider (blood) (ng/g wet wt.):

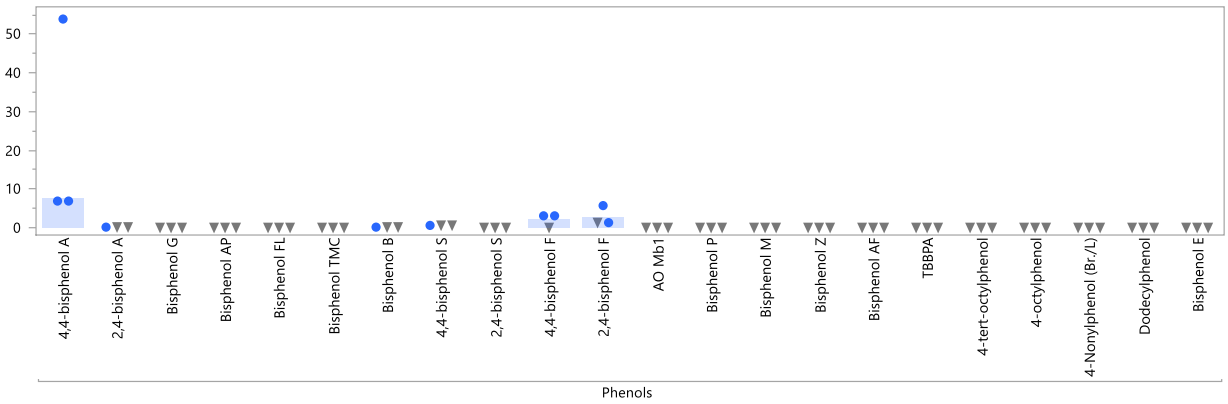


Organochlorines and PCBs in Eider (egg) (ng/g wet wt.):



Phenolic compounds

Phenolic compounds in Sediment (ng/g dry wt.):



Phenolic compounds in Cod (bile) (ng/g wet wt.):