Norsk institutt for luftforskning
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Environmental pollutants in the terrestrial and urban environment 2019

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ABSTRACT

Samples from the urban terrestrial environment in the Oslo area were analysed for various inorganic and organic environmental pollutants. The selected species were earthworm, fieldfare, sparrowhawk, brown rat, red fox and tawny owl. Air- and soil-samples were also included in the study to further the understanding on sources and uptake of pollutants. A foodchain approach was used to investigate trophic magnification of the different compounds.

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Miljøgifter i terrestrisk og bynært miljø 2019

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POPs PFAS Heavy Metals

ABSTRACT (in Norwegian)

Prøver fra det urbane terrestriske miljøet i Oslo-området ble analysert for flere uorganiske og organiske miljøgifter. De utvalgte artene var meitemark, gråtrost, spurvehauk, brunrotte, rødrev og kattugle. Luft- og jordprøver ble også analysert for å øke forståelsen av kilder og opptak av miljøgifter. En næringskjedetilnærming ble valgt for å undersøke trofisk magnifisering av de forskjellige stoffene.

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Summary

On behalf of the Norwegian Environment Agency, NILU- Norwegian Institute for Air Research, in collaboration with the Norwegian Institute for Nature Research (NINA) and the Norwegian Institute for Water Research (NIVA), analysed air, soil and biological samples from the terrestrial and urban environment for various inorganic and organic environmental pollutants.

The monitoring programme has the following key goals:

- Report concentrations of selected environmental pollutants in several trophic levels of a terrestrial food web;
- Compare the concentration of the selected pollutants across samples and species;
- Evaluate potential trophic magnification of the different pollutants using a foodchain approach

This report presents the findings from the seventh year of the urban terrestrial programme. Samples for this monitoring period were collected in 2019.

A broad range of environmental pollutants, consisting both of persistent organic pollutants, organic phenolic pollutants, biocides, UV compounds, PFAS, siloxanes, chlorinated paraffins, organic phosphorous flame retardants and metals, were measured in air-, soil- and biota-samples. The concentrations of the selected pollutants were compared across species and to data from previous years. In addition, the levels of the various pollutant groups were evaluated for each species. Potential biomagnification was also investigated.

Below follows a short summary for each compound class investigated. Where a comparison of concentrations was performed for hydrophobic pollutants (PCB, PBDE, CP, Cyclic siloxanes, Biocides, UV compounds) between species and organs, this was done on a lipid weight basis.

Metals: In agreement with results from previous years in the urban terrestrial programme, toxic metal (Hg, Pb, Cd, As) concentrations were highest in soil. Of the biological matrices analysed, earthworms, brown rats and red foxes contained the highest levels of metals. In agreement with previous years, the site Frognerseteren revealed highest Pb concentrations in soil and earthworm samples. The threshold value for Pb, when soil is considered contaminated, was exceeded at Frognerseteren. The concentration of Pb in earthworm from Frognerseteren exceeded the predicted no effect concentrations (PNEC) for predators where earthworm is important prey. The pooled sample of two fieldfare eggs from the site Kjelsås had a lower Pb-concentration (51 ng/g ww) in 2019 compared to previous years' data. One extremely high Pb-concentration was detected in red fox liver, and is most probably due to the use of Pb in ammunition when the animal was shot. As in 2018, Hg-concentrations were highest in earthworm and sparrowhawk egg samples with median values of 177 and 142 ng/g ww, respectively.

PCB: In agreement with results from 2018, data across all species revealed that the two sparrowhawk eggs had the highest median concentrations of sumPCB with 1704 ng/g lipid weight (lw) followed by fieldfare and tawny owl eggs with 785 ng/g lw and 566 ng/g lw respectively. The highest sumPCB-concentration in sparrowhawk eggs was 1313 ng/g ww (20511 ng/g lw). Although this concentration is lower than a general reported no observed effect level (NOEL) value for wild birds of 4000 ng/g ww for PCB, potential effects cannot be excluded due to different sensitivity among bird species. PCB-153 dominated in almost all matrices, except for foxes where PCB-180 dominated, and air where the more volatile PCB-52 and -101 dominated. The air concentrations of PCB at the urban sites, especially the sites in Slottsparken (0.48 ng/day) and at Alnabru (0.13 ng/day), were much higher than those

measured at background air monitoring stations in Norway, suggesting the urban area to be a source to PCB.

PBDE: As shown also in previous years, the levels of PBDE-congeners were lower in all environmental matrices compared to PCB and PFAS. The two sparrowhawk eggs had the highest median or mean concentration of sumPBDE (859 ng/g lw) followed by fieldfare egg (140 ng/g lw), brown rat liver (29 ng/g lw) and tawny owl eggs (27 ng/g lw). As observed earlier, BDE-99 had in general higher concentrations than BDE-100, 153 and 47 in bird eggs, while BDE-207 and 209 dominated in liver-samples. The egg with the highest PBDE concentrations also had highest sum concentrations of the other contaminant groups. The highest measured sumPBDE-concentration is ten times lower than a threshold level of 1000 ng/g ww for reduction of reproductive performance in osprey. The passive air samplers detected the congeners BDE-47, 99 and 100 at all sites. The site Alnabru had highest sumPBDE (0.14 ng/day) where several congeners were detected, and BDE-209 dominated. These levels indicate that the urban area is a source of PBDE detected in air.

New BFR: The new BFR compounds were detected in lower frequencies and at lower concentrations than PBDE in the various samples, except for air where α-TBECH, β–TBECH and PBT were detected in higher concentrations than the PBDE. DBDPE, which dominated in year 2018, was only detected in two egg samples of sparrowhawk and tawny owl of 341 and 203 ng/g lw, and in one sample of rat liver (534 ng/g lw). The sparrowhawk eggs had highest median sum-concentrations followed by tawny owl eggs of 277 and 42 ng/g lw, respectively.

PFAS: As in year 2018, the dominating PFAS-compound in 2019 was PFOS in all environmental matrices, except for air where PFBS dominated. The highest PFOS-concentration (sum of linear and branched isomers) was detected in fieldfare eggs from Grønmo and brown rat liver; both with 297 ng/g ww; followed by sparrowhawk eggs (153 ng/g ww). As previous years have revealed, the PFOS-concentration in fieldfare from Grønmo was more than ten times higher than the average of the other fieldfare samples. Soil samples revealed that the highest PFOS-concentrations were found at Bøler, Grønmo and Alnabru. Earthworm samples had highest PFOS-concentrations at the sites Grønmo and Alnabru. The highest concentrations of PFOS in earthworm and fieldfare eggs exceeded PNEC for predators where these organisms are substantial part of the diet. The site Frognerseteren had highest concentrations of perfluorinated carboxylates (PFCA) in both soil and earthworm samples.

The level of PFOS in earthworm from Alnabru with 52 ng/g ww in 2019 was comparable to year 2018 (69 ng/g ww), and much lower than detected in 2017 (531 ng/g ww). This year, the median concentration of sumPFAS was highest in sparrowhawk eggs (204 ng/g ww) followed by rat livers (166 ng/g ww) and fieldfare eggs (52 ng/g ww).

Fluorotelomer sulfonate (4:2 FTS, 6:2 FTS, 8:2 FTS, 10:2 FTS) compounds were detected in some species. 6:2- and 8:2 FTS dominated in earthworm, and 8:2 and 10:2 FTS were detected in many samples of fieldfare eggs, sparrowhawk eggs and brown rat liver. The highest concentration was found for 10:2 FTS (69 ng/g ww) in rat liver, followed by 8:2FTS (48 ng/g ww) in sparrowhawk eggs. The neutral PFAS-compound PFOSA was detected in all samples, except soil. Highest concentration of PFOSA was found in rat liver (1.6 ng/g ww), followed by sparrowhawk and fieldfare eggs. None of the other neutral compounds as FOSEs, FOSEAs and FTOHs were detected.

SCCP/MCCP:

Chlorinated paraffins (CP) were detected in fewer samples in 2019 compared to 2018. The concentration ranges were comparable with findings from 2018, but more samples were below and near detection limit. As previous year's results, our data from Oslo in 2019 revealed higher concentrations compared to other published data. SCCP and MCCP in soil were below PNEC for soil living organisms and none of the levels found in earthworm and fieldfare eggs exceeded the PNECoral for predators where earthworm or fieldfare are important prey. The highest concentrations were detected in sparrowhawk eggs with 31390 ng/g lw (2009 ng/g ww) of SCCP and tawny owl eggs of 17783 ng/g lw (2571 ng/g ww) of MCCP. Estimated air-concentrations at Slottsparken and VEAS sites were approximately five times higher than annual mean concentrations measured at background stations in Norway and indicate local emissions in the urban Oslo area.

Cyclic siloxanes (cVMS): D4, D5 and D6 were detected at all seven air sites and revealed, as previous years, that cVMS was the contaminant group with highest concentrations in air-samples. Very high concentrations were detected as VEAS, especially for D5. Next after VEAS, Slottsparken had sum-concentration of 69 ng/day and comparable to 2018 results with 51 ng/day. The estimated air-concentrations were significantly higher than measured in air from backgrounds stations in 2017. As last year, D4, D5, D6 were only sparsely detected in the other samples. Two soil samples had detectable concentrations where one sample from Bøler had highest concentrations. For the biological samples, fieldfare eggs had the highest detection rate (detected for D6), and tawny owl had highest mean and maximum concentrations, detected for D4 and D5.

OPFR: As with siloxanes, air samples had high levels of OPFR with sumOPFR ranging from 1.6 to 16.6 ng/day. Highest sumOPFR were observed at sites Alnabru and VEAS. EHDP followed by TCPP was the dominating compounds at all sites. In 2018 and 2017, TCPP was the dominating compound at all sites. OPFR was only analysed in one pooled sample of soil and one pooled sample of earthworms. TCPP was detected in highest concentrations in both soil and earthworm, where the pooled soil sample had a very high concentration. The TCPP-concentration in this single pooled sample of soil exceeded the PNEC for soil living organisms.

Dechloranes; Dechloranes were analysed in all samples together with related compounds including the flame retardant dibromoaldrin and 1,3- and 1,5-Dechlorane Plus monoadducts (DPMA) which are positional isomers, and are thought to arise from the incomplete reaction of Dechlorane Plus (DP) or impurities in the DP starting material during its manufacture. Dibromoaldrin, Dec-601, Dec-604, 1,3-DPMA and 1,5-DPMA were not detected in any samples. All four dechlorane-compounds Dec-602, Dec-603, syn-DP and anti-DP were detected in bird eggs, where Dec-602 and Dec-603 had highest detection frequencies. In fox liver, only Dec-602 was detected and in low concentration. In rat liver, syn- and anti-DP dominated. Anti-DP-concentrations dominated in most samples, except earthworm where only syn-DP and Dec-602 were detected. The highest median sum-concentration was detected in sparrowhawk and fieldfare eggs of 55 and 30 ng/g lw.

UV-compounds: In 2019, fewer compounds were detected in the pooled samples compared to 2018, except in the rat liver samples. The compound Octocrylene (OC) was not detected in 2019, in contrast to the results from 2018. In general, lower concentrations were detected in 2019 compared to 2018. The highest number of detected UV-compounds were found in brown rat liver and sparrowhawk eggs with maximum concentrations of 0.60 ng/g ww and 0.76 ng/g ww of UV-328, respectively. Highest sum-concentration was detected in the one pooled earthworm with 56 n/g lw where Benzophenone-3 (BP3) dominated, followed by sparrowhawk egg (22 ng/g lw) and rat liver (21 ng/g lw).

Biocides (rodenticides): A selection of five rodenticides were measured in fox and rat liver samples. As previous years, highest detection frequencies and highest concentrations were observed for red fox liver, and bromadiolone dominated in both red fox and rat liver samples. The highest concentration of bromadiolone detected in 2019 was 1923 ng/g ww which was lower than in 2018 (3473 ng/g ww) in red fox liver. Bromadiolone exceeded a proposed a threshold for secondary toxicity in liver of 200 ng/g in six red fox liver samples and in two brown rat liver samples.

Phenols: Many of the phenolic compounds were not detected in the various samples. The highest detection rate and highest concentrations were observed for Bisphenol A as last year. The highest concentrations were detected in brown rat liver. Highest concentration in rat liver in 2019 was 345 ng/g ww of Bisphenol A compared to 124 ng/g ww in 2018.

Dominant pollutant groups in each matrix
The median of sum-concentrations of the dominant pollutant group for each matrix in the investigated species in 2019 is given below. ToxicMetals is the sum of Hg, Cd, Pb and As.

- Air : cVMS >> CP > OPFR >>PCB
- Soil : ToxicMetals (~OPFR)* >>CP > Phenols
- Earthworm : ToxicMetals >> CP> PFAS ~ Phenols
- Fieldfare egg : PFAS ~CP > ToxicMetals ~PCB
- Sparrowhawk egg** : CP > PCB > PFAS > ToxicMetals
-Tawny owl : CP > ToxicMetals > PCB >PFAS
- Red fox liver : Biocides > ToxicMetals > CP> PFAS
- Brown rat liver : ToxicMetals >>PFAS> Phenols> CP

*TCPP extreme high concentration in one pooled sampled
** Only two eggs in 2019

Trophic magnification factors (TMFs): A foodchain approach with earthworm-fieldfare-sparrowhawk was used in order to calculate TMF based on concentrations and δ^{15}N data from the years 2014 to 2019. The typical hydrophobic and well-known POPs, such as PCB and PBDE, were found to have TMF-values from 2.8 to 6.6, indicating a high potential for biomagnification in the food chain earthworm-fieldfare-sparrowhawk. PFOS had a TMF of 1.8 and the long chain perfluorinated carboxylates from PFUnA to PFDoA had TMFs from 1.5 to 1.9.

Sammendrag

På oppdrag fra Miljødirektoratet analyserte NILU- Norsk institutt for luftforskning, i samarbeid med Norsk institutt for naturforskning (NINA) og Norsk institutt for vannforskning (NIVA), en lang rekke uorganiske og organiske miljøgifter i luft, jord og dyrearter fra bynært og terrestrisk miljø.

Prosjektet hadde følgende delmål:
- Rapportere konsentrasjoner av utvalgte miljøgifter på flere trofiske nivå av et terrestrisk næringsnett
- Sammenstille og vurdere fordeling av miljøgiftklassene på tvers av prøver og arter
- Vurdere biomagnifiseringspotensialet av miljøgifter ved bruk av næringskjedetilnærming

Denne rapporten presenterer funnene fra det syvende året av det urbane terrestriske programmet. Prøver fra denne overvåkingsperioden ble samlet inn i 2019.

Et stort spekter av kjemiske stoffer ble analysert; persistente organiske miljøgifter, bisfenoler, biocider, UV-forbindelser, regulerte og nye PFAS-stoffer, siloksaner, klorerte parafiner, organiske fosforflammehemmere og metaller i de ulike prøvene. For hver stoffgruppe ble forurensingsnivåene sammenlignet på tvers av arter og prøver. I tillegg har vi vurdert hvilke stoffgrupper som dominerte i de ulike prøvene og artene. Potensialet for biomagnifisering ble også undersøkt.

Under følger en kort oppsummering for hver komponentgruppe som ble analysert i prøvene. Der vi har sammenlignet arter og ulike organer, er konsentrasjoner av hydrofobe miljøgifter normalisert til fettvekt (fv).

Metaller: I samsvar med resultatene fra tidligere år i det urbane terrestriske programmet, var konsentrasjonene av de metallene Hg, Pb, Cd, As høyest i jord. Av de biologiske prøvene, hadde meitemark, brunrotte og rødrev de høyeste konsentrasjonene. I samsvar med tidligere år hadde Frognerseteren høyeste Pb-konsentrasjoner i jord- og meitemarkprøver. Normverdien for Pb i jord ble overskredet på Frognerseteren, og konsentrasjon av Pb i meitemark fra Frognersteren var høyere enn predikert ikke-effekt konsentrasjon (PNEC) for rovdyr hvor meitemark utgjør en stor del av dietten. Gråtrostegg fra Kjelsås hadde en lavere Pb-konsentrasjon (51 ng/g vv) i 2019 sammenlignet med tidligere års data. En ekstremt høy Pb-konsentrasjon ble påvist i rødrevlever, mest sannsynlig på grunn av at Pb-holdig ammunisjon ble brukt når dyret ble avlivet. Som i 2018, var Hg-konsentrasjonene høyest i meitemark og spurvehaukegg med medianverdier på henholdsvis 177 og 142 ng/g vv.

PCB: I samsvar med resultatene fra 2018, hadde egg fra spurvehauk de høyeste mediankonsentrasjoner av sumPCB på 1704 ng/g fv etterfulgt av egg fra gråtrost og kattugle med henholdsvis 785 ng/g fv og 566 ng/g fv. Den høyeste sumPCB-konsentrasjonen i spurvehaukegg var 1313 ng/g vv (20511 ng/g fv). Selv om denne konsentrasjonen er lavere enn en generell rapportert ikke-observerbar effektnivå (NOEL) verdi for ville fugler på 4000 ng/g vv for PCB, kan man ikke utelukke potensielle effekter på grunn av ulik følsomhet blant fuglearter. PCB-153 dominerte i nesten alle prøvene, bortsett fra i rødrev der PCB-180 dominerte, og luft der de mer flyktige PCB-52 og -101 dominerte. Luftkonsentrasjonen av PCB på de urbane områdene, spesielt stedene i Slottsparken (0.48 ng/dag) og på Alnabru (0.13 ng / dag), var mye høyere enn de som ble målt på bakgrunnsstasjoner i Norge, noe som antyder at byområdet kan være en kilde til PCB.

PBDE: Som vist tidligere år, var nivåene av PBDE-ene lavere i alle miljøprøvene enn PCB og PFAS. De to eggene fra spurvehauk hadde de høyeste median- eller gjennomsnittskonsentrasjonen av sumPBDE (859 ng/g fv) etterfulgt av egg fra gråtrost (140 ng/g fv), lever fra brunrotte (29 ng/g fv) og egg fra kattugle (27 ng/g fv). Som observert i årene før, hadde fugleeggene generelt høyere konsentrasjoner av BDE-99 enn -100, -153 og -47, mens BDE-207 og -209 dominerte i leverprøver. Egg fra spurvehauk med høyest PBDE-konsentrasjon hadde også høyeste sumkonsentrasjoner av de andre miljøgiftgruppene. Den høyeste målte sumPBDE-konsentrasjonen er ti ganger lavere enn terskelverdien for reproduksjonseffekter hos fiskeørn på 1000 ng/g vv. BDE-47, -99 og -100 ble detektert i luft på alle lokalitetene. Alnabru hadde høyest sumPBDE (0.14 ng/dag) der flere kongenere ble detektert, og BDE-209 dominerte. Disse nivåene indikerer at byområdet er en kilde til PBDEer i luft.

Nye BFR: De forskjellige stoffene i denne gruppen ble påvist i færre prøver og ved lavere konsentrasjoner enn PBDEer, bortsett fra luft hvor α-TBECH, β-TBECH og PBT ble påvist i høyere konsentrasjon enn PBDE. DBDPE, som dominerte i 2018, ble bare påvist i to prøver av egg fra spurvehauk og kattugle på 341 og 203 ng/g fv, og i en prøve av rottelever (534 ng/ g fv). Spurvehauk og kattugle hadde høyeste median sumkonsentrasjon på henholdsvis 277 og 42 ng/g fv.

PFAS: Som i 2018 var PFOS den dominerende PFAS-forbindelsen i alle prøvene, bortsett fra luft der PFBS dominerte. Den høyeste PFOS-konsentrasjonen (summen av lineære og forgrenete isomere) ble påvist i gråtrostegg fra Grønmo og i lever fra brunrotte; begge med konsentrasjon 297 ng/g vv; etterfulgt av spurvehaukeegg (153 ng/g vv). Som tidligere år har vist, var PFOS-konsentrasjonen i gråtrost fra Grønmo mer enn ti ganger høyere enn gjennomsnittet av de andre gråtrosteggene. Jordprøvene viste høyeste PFOS-konsentrasjon på Bøler, Grønmo og Alnabru. Lokalitetene Grønmo og Alnabru hadde også høyeste PFOS-konsentrasjon i meitemarkprøvene. De høyeste konsentrasjonene av PFOS i meitemark og gråtrostegg overskred PNEC for predatorer hvor disse inngår i store deler av dietten. Lokaliteten Frognerseteren hadde høyeste konsentrasjon av perfluorerte karboksylater (PFCA) i både jord- og meitemarkprøvene. Nivået av PFOS i meitemark fra Alnabru på 52 ng/g vv var sammenlignbart med konsentrasjonen i 2018 (69 ng/g vv), og mye lavere enn det som ble detektert i 2017 (531 ng/g vv). I år var mediankonsentrasjonen av sumPFAS høyest i spurvehaukegg (204 ng/g vv) etterfulgt av rottelever (166 ng/g vv) og gråtrostegg (52 ng/g vv).

Fluorotelomersulfonatene (4:2 FTS, 6:2 FTS, 8:2 FTS, 10:2 FTS) ble påvist i noen arter. 6:2 og 8:2 FTS dominerte i meitemark, og 8:2 og 10:2 FTS ble påvist i mange prøver av gråtrostegg, spurvehaukegg og lever fra brunrotte. Høyeste konsentrasjon ble funnet for 10:2 FTS (69 ng/g vv) i rottelever, fulgt av 8:2 FTS (48 ng/g vv) i spurvehaukeegg. Den nøytrale PFAS-forbindelsen PFOSA ble påvist i alle prøvene, unntatt jord. Den høyeste konsentrasjonen av PFOSA ble funnet i rottelever (1.6 ng/g vv), etterfulgt av egg fra spurvehauk og gråtrost. Ingen av de andre nøytrale forbindelsene som FOSE, FOSEA og FTOH ble detektert.

SCCP/ MCCP: Klorerte parafiner (CP) ble påvist i færre prøver i 2019 sammenlignet med 2018. Nivåene var sammenlignbare med resultater fra 2018, men flere prøver var nær og under deteksjonsgrensen. Som forrige års resultater, viste 2019 høyere konsentrasjoner sammenlignet med andre publiserte data. SCCP og MCCP i jord var under PNEC for jordlevende organismer, og ingen av nivåene i meitemark og gråtrostegg overskred PNECoral for predatorer hvor meitemark eller gråtrost er viktige byttedyr. Høyeste konsentrasjoner ble påvist i egg fra spurvehauk med 31390 ng/g fv (2009 ng/g vv) for SCCP og egg fra kattugle med 17783 ng/g fv (2571 ng/g vv) for MCCP. Estimerte luftkonsentrasjoner i Slottsparken og VEAS-områdene var omtrent fem ganger høyere enn årlige gjennomsnittlige konsentrasjoner målt på bakgrunnsstasjoner i Norge, og indikerer lokale utslipp i det urbane Oslo-området.

Sykliske siloksaner (cVMS): D4, D5 og D6 ble påvist i luft på alle syv lokalitetene og, som tidligere år, dominerer siloksaner med høyest konsentrasjoner i luftprøver. Svært høye konsentrasjoner ble påvist på VEAS, spesielt for D5. Neste etter VEAS, hadde Slottsparken en sumkonsentrasjon på 69 ng/dag, sammenlignet med 2018-resultater på 51 ng/dag. De estimerte luftkonsentrasjonene var betydelig høyere enn målt i luft fra bakgrunnsstasjoner i 2017. Som i fjor, ble D4, D5, D6 bare påvist i enkelte av de andre prøvetypene. To jordprøver hadde påvisbare konsentrasjoner der en prøve fra Bøler hadde høyeste konsentrasjoner. For de biologiske prøvene hadde gråtrostegg den høyeste deteksjonsraten (deteksjon av D6), og egg fra kattugle hadde høyeste gjennomsnitt- og maksimumkonsentrasjoner for D4 og D5.

OPFR: Som for siloksaner, hadde luftprøvene høye nivåer av OPFR med sumOPFR fra 1.6 til 16.6 ng/dag. Høyeste sumOPFR ble observert på lokalitetene Alnabru og VEAS. EHDP, etterfulgt av TCPP, var de dominerende forbindelsene på alle lokalitetene. I 2018 og 2017 var TCPP den dominerende forbindelsen. OPFR ble bare analysert i en samleprøve av jord og en samleprøve av meitemark. TCPP ble påvist i høyeste konsentrasjoner i både jord og meitemark, der jordprøven hadde en veldig høy konsentrasjon. TCPP-konsentrasjonen i denne ene samleprøven av jord overskred PNEC for jordlevende organismer.

Dekloraner: Dekloraner ble analysert i alle prøvene sammen med relaterte forbindelser som flammehemmeren dibromoaldrin og forbindelsene 1,3- og 1,5-Dekloran Plus monoaddukter (DPMA), som er strukturelle isomere, og som mest sannsynlig dannes ved ufullstendig reaksjon av Dekloran Plus (DP), eller som forurensinger i startmaterialet ved produksjon av DP. Dibromoaldrin, dec-601, dec-604, 1,3-DPMA og 1,5- DPMA ble ikke påvist i noen av prøvene. Alle fire dekloranforbindelsene dec-602, dec-603, syn-DP og anti-DP ble påvist i fugleegg, der dec-602 og dec-603 ble funnet i flest av prøvene. I lever fra rødrev ble kun dec-602 påvist og i lav konsentrasjon. I lever fra rotte dominerte syn- og anti-DP. Anti-DP-konsentrasjoner dominerte i de fleste prøver, bortsett fra meitemark der bare syn-DP og Dec-602 ble detektert. Høyeste median sumkonsentrasjon ble påvist i egg fra spurvehauk og gråtrostegg på 55 og 30 ng/g fv.

UV-forbindelser: I 2019 ble det påvist færre forbindelser i samleprøvene sammenlignet med 2018, bortsett fra i lever fra rotte. Forbindelsen Octacrylene (OC) ble ikke påvist i 2019, i motsetning til i 2018. Generelt ble lavere konsentrasjoner påvist i 2019 sammenlignet med 2018. Det høyeste antall UV-forbindelser ble funnet i rottelever og spurvehaukegg med maksimumskonsentrasjoner på henholdsvis 0.60 ng/g vv og 0.76 ng/g vv for UV-328. Høyeste sumkonsentrasjon ble påvist i den ene samleprøven fra meitemark med 56 ng/g lw der Benzophenone-3 (BP3) dominerte, etterfulgt av spurvehaukeegg (22 ng/g fv) og rottelever (21 ng/g fv).

Biocider (rodenticider): Et utvalg av fem rodenticider ble målt i leverprøvene av rødrev og brunrotte. Som tidligere år ble det detektert flest forbindelser i rødrev i tillegg til høyeste konsentrasjoner. Bromadiolon dominerte i både lever fra rødrev og brunrotte. Den høyeste konsentrasjonen av bromadiolon i 2019 var 1923 ng/g vv i rødrev lever, som var lavere enn i 2018 (3473 ng/g vv). Bromadiolon overskred en foreslått terskelverdi for sekundær forgiftning i lever på 200 ng/g i seks leverprøver fra rødrev og i to leverprøver fra brunrotte.

Fenoler: Mange av de fenoliske forbindelsene ble ikke påvist i de ulike prøvene. Bisfenol A ble som i 2018 funnet i flest prøver og med høyeste konsentrasjon. Høyeste konsentrasjoner ble påvist i lever fra brunrotte. Høyeste konsentrasjon i rottelever i 2019 var 345 ng/g vv av bisfenol-A, sammenlignet med 124 ng/g vv i 2018.

Dominerende stoffgrupper i de ulike miljøprøvene

Median for sumkonsentrasjoner av den dominerende forurensningsgruppen for hver matrise i den undersøkte arten i 2019 er gitt nedenfor. ToxicMetals er summen av Hg, Cd, Pb og As.

- Luft:	cVMS >> CP> OPFR >> PCB
- Jord:	ToxicMetals (~ OPFR) * >> CP> Phenols
- Meitemark:	ToxicMetals >> CP > PFAS ~ Phenols
- Gråtrost egg:	PFAS ~CP > ToxicMetals ~ PCB
- Spurvehauk egg **:	CP> PCB> PFAS> ToxicMetals
-Kattugle egg:	CP> ToxicMetals> PCB> PFAS
- Rødrev lever:	Biocider> ToxicMetals> CP> PFAS
- Brunrotte lever:	ToxicMetals >> PFAS >Phenols >CP

*TCPP ekstrem høy konsentrasjon in en samleprøve av jord

** Kun to egg i 2019

Trofisk magnifiseringsfaktor (TMF): En næringskjedetilnærming med meitemark-gråtrost-spurvehauk ble anvendt for å beregne TMF basert på konsentrasjoner og δ15N-data av ulike miljøgifter fra årene 2014 til 2019. De typiske hydrofobe og velkjente POP-ene, som PCB og PBDE, hadde TMF-verdier fra 2.8 til 6.6, som indikerer et stort potensial for biomagnifisering i denne næringskjeden. PFOS hadde en TMF på 1.8 og de langkjedete perfluorerte karboksylatene fra PFUnA til PFDoA hadde TMF fra 1.5 til 1.9.

Abbreviations

BAF	bioaccumulation factor
BFR	brominated flame retardants
CI	confidence interval
CP	chlorinated paraffins
cVMS	cyclic volatile methyl siloxanes
dw	dry weight
EI	electron impact ionization
ESI	electrospray ionization
fv	fettvekt
GC-MS	gas chromatography – mass spectrometry
GC-HRMS	gas chromatography – high resolution mass spectrometry
GPC	gel permeation chromatography
ICP MS	inductive coupled plasma – mass spectrometry
LC-MS	liquid chromatography – mass spectrometry
LOD	limit of detection
LOEL	lowest observed effect level
MEC	measured environmental concentration
lw	lipid weight
MCCP	medium-chain chlorinated paraffins
M-W U	Mann–Whitney *U* test
N	detected/measured samples
n.a.	not analysed
NCI	negative chemical ionization
NOEC	no observed effect concentration
NOAEL	no observed adverse effect level
NOEL	no observed effect level
n-PFAS	neutral polyfluorinated compounds
newPFAS	new polyfluorinated compounds
NP-detector	nitrogen-phosphorous detector
OPFR	organophosphorus compounds
PBDE	polybrominated diphenylethers
PCA	principal component analysis
PCB	polychlorinated biphenyls
PCI	positive chemical ionization
PEC	predicted environmental concentration
PFAS	per- and polyfluorinated alkylated substances
PNEC	predicted no effect concentration
PSA	primary/secondary amine phase
SCCP	short-chain chlorinated paraffins
SSD	species sensitivity distribution
SIR	selective ion reaction
SPE	solid phase extraction
TL	Trophic level
TMF	Trophic magnification factor
UHPLC	ultra high pressure liquid chromatography
vv	våtvekt
ww	wet weight

Environmental pollutants in the terrestrial and urban environment 2019

1 Sampling

The main objective of the project was to assess the presence of the targeted pollutants in a terrestrial urban environment in Norway, and to assess the bioaccumulation potential of the pollutants. The various samples were collected at the same locations when possible. This was most relevant for sampling of air, soil, earthworms and, when possible, fieldfare eggs, see Table 1**.** In additions, locations were selected to reflect the different area uses in an urban setting: Alnabru, an industrialised site; Slottsparken, a central urban park surrounded by traffic; Frognerseteren, a popular recreational and skiing area, also used for international competitions; Grønmo, an area with a recycling station for waste and a former and largest landfill site in Oslo which was shut down in 2007; and VEAS, Vestfjorden Wastewater Treatment Plant, Norway's largest sewage treatment plant. The area at Grønmo landfill site is now earmarked for outdoor areas, planting, sporting activities and recreation. In addition to these five locations in 2019, two additional locations Bøler and Kjelsrud were chosen. The location Bøler was chosen for air, soil and earthworm samples due to the detection of high concentrations of chlorinated paraffins in fieldfare eggs from Bøler. Kjelsrud was chosen due to its proximity to the industrialized Alnabru area and due to plans for residential development in the area.

The different biota species included in the study were selected to represent different trophic levels, from primary consumers (earthworm) via secondary consumers (fieldfare) to a top predator (sparrowhawk). In addition, two omnivore generalists representing a truly urban environment, the red fox and the brown rat, were chosen. Sparrowhawk were used in this study to give insights to how terrestrial top predators within both urban and rural habitats are affected by pollution levels and their biomagnification potentials. An overview over the analysed species and samples is given in Table 1. All samples were sampled and handled according the guidelines given in OSPAR/ JAMP, 2009.

Table 1: Location and selection of samples (Coordinates can be found in the Appendix 2).

Sample type	No. of samples	Location	Date	Sampling strategy
Air	7	Oslo	2019	Passive air samples
Soil	7	Oslo	2019	Pool of individual samples
Earthworms (*Lumbricidae*)	7	Oslo	2019	Pool of individual samples
Fieldfare (*Turdus pilaris*)	9	Oslo	2019	Pool of 2 eggs from the same nest
Sparrowhawk (*Accipiter nisus*)	2	Oslo	2019	Fresh eggs
Tawny owl (*Strix aluco)*	11	Halden and Aremark	2019	Addled eggs
Brown rat (*Rattus norvegicus*)	10	Oslo	2019	Pool of 2 individual samples for some samples
Red fox (*Vulpes vulpes*)	10	Oslo	2019/18	Individual liver samples

Figure 1: Sampling locations in the 2019 monitoring project. See table below for overview of sample types sampled in different locations, and Appendix 2 for coordinates of the various sites.

Table 2: Locations of the various samples. Locations are shown in the map in Figure 1.

Sampling sites	Air	Soil	Earthworm	Brown rat	Fieldfare	Red fox	Sparrowhawk	Tawny owl
Alnabru	x	x	x		x[1]			
BR1-BR8[2]				x				
Bøler	x	x	x		x			
Ekeberg					x			
Frognerseteren	x	x	x					
Grønmo	x	x	x		x			
Holmen					x			
Kjelsrud (Stokstad)	x	x	x					
Kjelsås					x			
Hellerudmyra						x		
Halden and Aremark[3]								x
Oslo area[3]							x	
Slottsparken	x	x	x					
VEAS (Arnestad)	x	x	x		x			

[1]three locations, Alnabru 1, 2 and 3, [2]Locations for brown rats, see Appendix 2 for details, [3]not shown in map, for species conservation

Air

Air concentrations were measured using two types of passive air samplers (PAS) at the seven locations; Grønmo, VEAS, Alnabru, Slottsparken, Frognerseteren, Bøler and Kjelsrud, the same sites as for soil and earthworms. The PAS were prepared, deployed and retrieved by NILU personnel. Each PAS type was exposed for approximately three months (Table 3) according to standard routines in the guidance document for the Global Monitoring Plan of the Stockholm convention, GMP (UNEP, 2015). Field blanks for air samples were continuously included. These were transported and stored together with the exposed samples to provide information about any contamination during sampling or storage. For the sampling at VEAS, the air samplers were installed at the pipe outlet in order to capture potential polluted air directly from the plant.

Table 3: Locations and number of exposure days for passive air samples

Air samples	Deployed 2019	Retrieved 2019	Number of exposure days
Slottsparken (Dronningparken)	June 27	October 1	95
Frognerseteren (Holmenkollen)	June 27	October 1	95
Grønmo	June 27	October 1	95
Alnabru	June 28	October 1	95
VEAS	July 25	October 29	97
Bøler	June 27	October 1	95
Kjelsrud (Stokstad)	June 27	October 1	95

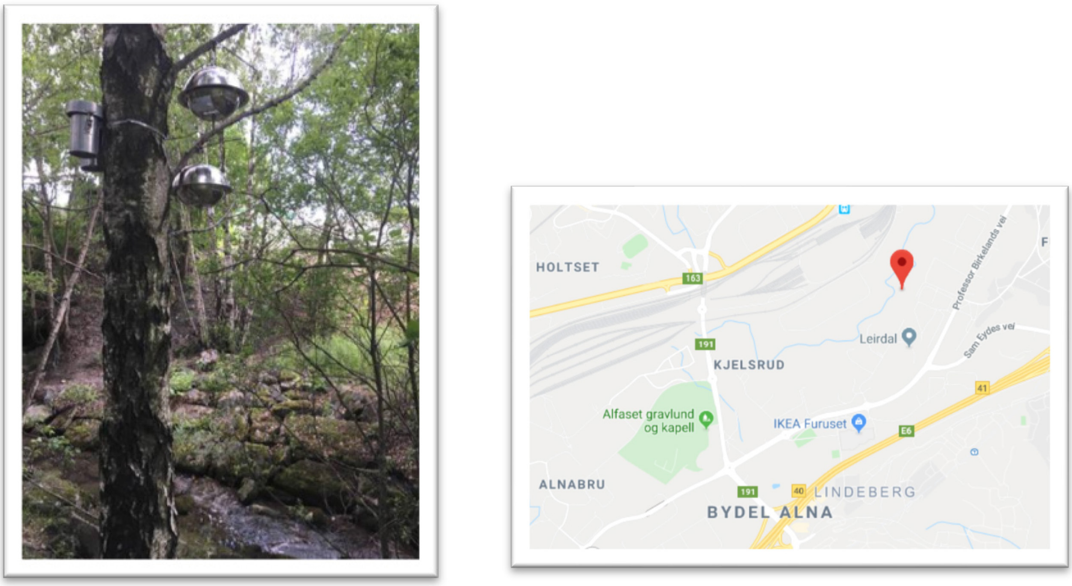

Figure 2. To the left: Air samples (PUF and XAD) installed at the new site Stokstad (Kjelsrud), near to the creek Loelva; To the right: Map with where the location is shown with a red marker.

Soil

Soil samples were collected at the same seven locations as air samples, Table 4. The upper layer of 0-20 cm of soil was sampled. The different locations varied between forest soil (Holmenkollen), and urban soil characterized by little plant debris and artificial fertilisation (Slottsparken), and potential industrially affected soil (Alnabru, Grønmo, Kjelstrup, Bøler and VEAS). The soil site for Bøler is shown in Figure 3.

Figure 3: Soil and earthworm sampling site at Bøler

Earthworms (*Lumbricidae*)

Earthworms were collected at the same seven locations in Oslo as the soil and air samples to allow direct comparison between soil and earthworm. All pooled samples consisted of up to 20 individuals. To purge their guts, earthworms were kept in plastic containers lined with moist paper sheets for three days before being frozen at -21°C.

Table 4: Locations for soil and earthworm sampling.

Location for soil and earthworms	Date	Soil depth	Site description
Slottsparken	September 9	5-20 cm	Castle park, tourism, park, good soil
Frognerseteren	August 18	20-30 cm	Recreation, tracks, aery soil with roots
Grønmo	August 14	20-30 cm	Landfill, golf, road, some plastics and metals in soil
Alnabru	August 18	15-30 cm	Industry, railway, compact humid soil with clay
VEAS	August 18	10-20 cm	Road, schools, VEAS STP, compact soil with clay
Bøler	August 18	~20 cm	Recreation near residential area, organic soil with metals and glass pieces
Kjelsrud	August 18	~20 cm	Birch forest at creek and track

Fieldfare *(Turdus pilaris)*

Two fieldfare eggs were collected from each out of ten nests in the Oslo area, Table 5, under permission from the Norwegian Environment Agency. The laying order of the eggs was not taken into account when collecting the eggs due to practical considerations as not to disturb the nest more than necessary. The eggs were kept individually in polyethylene bags in a refrigerator (+4°C), before being shipped by express mail to NINA for measurements and emptying. When emptying, the whole content of the eggs was removed from the shell and transferred to clean glass vials for storage at − 21 °C. The dried eggshells were measured (length, breadth and weight of shell) in order to calculate the eggshell index, which is a measure of eggshell quality (Ratcliffe, 1970). In addition, the shell thickness was measured using a special calliper (Starrett model 1010).

Table 5: Locations and collection date for fieldfare egg sampling (Coordinates for the sites are given in Appendix 2)

Location for fieldfare egg sampling	Collection date	Information
Holmen (7328/7329)	16.05.2019	embryo
Grønmo (7315)	12.05.2019	chick
VEAS (Arnestad) (7330/7331)	16.05.2019	embryo
Alnabru 1 (7320/7321)	12.05.2019	chick
Alnabru 2 (7322/7323)	12.05.2019	embryo
Alnabru 3 (7324/7325)	12.05.2019	no development
Bøler (7318/7319)	12.05.2019	chick in one egg
Kjelsås (7326/7327)	16.05.2019	embryo
Ekeberg (7316/7317)	12.05.2019	no development

Sparrowhawk *(Accipiter nisus)*

Sparrowhawk eggs were collected at two different locations in the Oslo area (N=2). The exact location of the nests is known to the authors and the contractor, but will not be published here to protect the nesting sites. Nests were located early in the breeding season and sampled in May just after eggs had been laid. The eggs were handled by the same method as the fieldfare eggs at NINA.

Brown rat *(Rattus norvegicus)*

Brown rats were caught during winter time using clap-traps (no rat poison involved) in residential areas of Oslo city. The traps were usually inspected daily, and the rats were placed in the freezer as fast as possible on the day of collection. Most samples were from Slemmestad and Furuset, see Appendix 2. Six liver samples were individual samples, and four samples consisted of two individuals, using individuals of same gender and age. This was done in order to obtain sufficient material for all the component analyses. The final sample number was five liver samples of female rats and five liver samples of male rats. The bodyweight of the rats ranged between 70 g and 422 g.

Red fox *(Vulpes vulpes)*

Ten red foxes were shot by local hunter at Hellerudmyra, Oslo, the same location as in year 2018. This hunting location is in a large forest area, but only 5- 10 km away from highly populated areas of Oslo and Bærum. The area between the forest and city, is a mix of agriculture and forest. The home ranges of the foxes will therefore include both forest-, agriculture- and urban areas. The weight of the animals varied from 4.1 to 7.2 kg and the body length from 16 to 18 cm. Among the sampled foxes, there were five males and five females. Their sex was determined by inspection of the gonads (Morris, 1972).

Tawny owl (*Strix aluco*)

The tawny owl eggs were sampled this year in Halden and Aremark municipalities, in the county Viken, located 80-90 km south/southeast of Oslo. We sampled in this area in 2019 because tawny owls lost their eggs to predation in Vestby and Ås municipalities, the areas in the original sampling design.

2 Results

List of compounds with abbreviations and cas.no can be found in Appendix 1, Table 28. In addition, Appendix 1 gives information about the various species, compound classes and the analytical and statistical methods.

In total, 132 individual compounds were analysed this year. Metals were not measured in air samples, and biocides only in liver samples of fox and brown rat. Some compounds such as OPFR and UV substances were only analysed in one or three pooled samples prepared from single samples. In addition to the 132 compounds, benzothiazoles were analysed in one sample of soil, earthworm and fieldfare from the site Kjelsås, and are not shown in Table 6.

In the chapters below, tables with mean, minimum and maximum concentrations are given for each component in the various compound classes. In addition, box and whiskers plots (IBM SPSS Statistics 26) are provided. The upper and lower boundaries of the box are represent the 25th and 75th percentile, and the horizontal line in the box marks the median. Outliers are plotted as circle (1.5-3 IQR from end of box) or asterisk (>3 IQR from the end of the box). The whiskers represent the minimum and maximum values without outliers. For sparrowhawk sample size (N) is 2. The upper and lower boundaries of the box are then the values of the two samples. Median is the same as the mean when N=2. However, note that the position of the line for the median is wrong for the box plots with a log-scaled y-axis, not when y-axis is linear. The reason is an error in the graph program, placing the median in the middle of the box when N=2. Hence, for sparrowhawk (N=2) the reader will find the correct median (=mean) in the tables. To improve readability, most box plots are presented with a log-scaled y-axis due to the high variation in concentrations among species.

We mainly discuss components and the sum for each group of pollutants investigated with comparison to results from previous years in this monitoring programme. Concentrations for each pollutant class and individual data can be found in the Appendix 3.

Table 6 below shows the ratio of detected to analysed chemicals in the samples (n/N) in the different sample types. As can be seen, metals were detected in almost all samples which is also the case with PCB, many of the perfluorinated sulfonates (PFSA) and carboxylates (PFCA).

Table 6: Ratio of detected to analysed chemicals in the samples (n/N) in the different sample types. n.a.: not analysed

Components	Air	Soil	Earthworm	Fieldfare egg	Sparrowhawk egg	Red fox liver	Brown rat liver	Tawny owl egg
Cr	n.a.	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Ni	n.a.	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Cu	n.a.	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Zn	n.a.	1.0	1.0	1.0	1.0	1.0	1.0	1.0
As	n.a.	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Ag	n.a.	1.0	1.0	0.9	1.0	1.0	1.0	1.0
Cd	n.a.	1.0	1.0	1.0	0.5	1.0	1.0	1.0
Pb	n.a.	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Hg	n.a.	1.0	1.0	1.0	1.0	1.0	1.0	1.0
PCB28	1.0	0.6	1.0	0.3	1.0		0.3	1.0
PCB52	1.0	1.0	1.0	1.0	1.0	0.9	1.0	0.6
PCB101	1.0	0.9	0.6	1.0	1.0		0.4	1.0
PCB118	1.0	0.9	0.4	1.0	1.0	0.3	0.9	1.0
PCB138	1.0	0.9	0.6	1.0	1.0	0.8	1.0	1.0
PCB153	1.0	0.9	0.6	1.0	1.0	1.0	1.0	1.0
PCB180	1.0	0.9	0.6	1.0	1.0	1.0	1.0	1.0
BDE47	1.0	0.1		1.0	1.0	0.6	0.8	1.0
BDE99	1.0	0.7	0.4	1.0	1.0	0.3	0.7	1.0
BDE100	0.9	0.6	0.1	1.0	1.0	0.7	0.9	0.8
BDE126	0.1				0.5			
BDE153	0.3			0.9	1.0	0.7	0.3	0.9
BDE154	0.3			0.9	1.0			0.9
BDE175/BDE180	0.3				1.0	0.4		0.6
BDE190	0.1			0.1		0.1		
BDE196				0.1	1.0	0.1		
BDE202				0.1	1.0	0.1		0.1
BDE206	0.1		0.1	0.1		0.2		0.1
BDE207	0.1		0.0	1.0	1.0	0.2	0.3	0.2
BDE209	0.1	0.9	0.4	0.2	0.5	0.7	0.7	0.7
PFBS	0.9	0.1	1.0	0.1				
PFPS								
PFHxS	1.0	0.6	0.9	1.0	1.0	1.0	0.9	1.0
PFHpS		0.4	0.9	1.0	1.0	1.0	0.9	0.8
brPFOS	0.3	0.9	0.3	0.3		0.4	1.0	0.7
PFOS	0.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0
PFNS	0.1		0.3	0.7	1.0		0.3	
PFDcS			0.4	1.0	1.0	0.6	1.0	1.0
PFUnDS								
PFDoDS								
PFBA								
PFPA	0.1	0.1	0.7	0.1		0.1	0.7	
PFHxA	0.1	0.9					0.1	
PFHpA	0.7	1.0	1.0					
PFOA		1.0	1.0	1.0	1.0	0.3	0.3	
PFNA		1.0	1.0	1.0	1.0	1.0	1.0	1.0
PFDcA		0.9	1.0	1.0	1.0	1.0	1.0	1.0
PFUnA		0.9	1.0	1.0	1.0	1.0	1.0	1.0
PFDoA		0.4	1.0	1.0	1.0	1.0	1.0	1.0
PFTriA			1.0	1.0	1.0	1.0	1.0	1.0
PFTeA			1.0	1.0	1.0	0.9	0.9	1.0
PFHxDA			1.0	0.9	1.0		0.2	0.1
PFOcDA	0.7		0.6					

Cont. Table 6: Ratio of detected to analysed chemicals in the samples (n/N) in the different sample types

Components	Air	Soil	Earthworm	Fieldfare egg	Sparrowhawk egg	Red fox liver	Brown rat liver	Tawny owl egg
PFOSA			0.7	1.0	0.7	0.8	0.9	0.2
meFOSA	n.a.							
etFOSA	n.a.							
meFOSEA	n.a.							
meFOSE	n.a.							
etFOSE	n.a.							
6:2 FTOH	n.a.					0.4		
8:2 FTOH	n.a.							
10:2 FTOH	n.a.							
12:2 FTOH	n.a.							
4:2 FTS				0.1			0.3	0.1
6:2 FTS			1.0				0.4	0.2
8:2 FTS			0.9	1.0	1.0		1.0	0.1
10:2 FTS		0.1		0.5	1.0		0.7	0.1
SCCP	1.0	0.9	0.6	0.4	0.5	0.4	0.8	0.4
MCCP	0.9	0.6	0.3	0.4	0.5	0.3	0.4	0.6
D4	1.0	0.3		0.1	0.5	0.1	0.6	0.5
D5	1.0	0.3		0.6	0.5		0.5	0.5
D6	1.0	0.3		0.9			0.4	0.2
TCEP	0.7	1.0		n.a.	n.a.	n.a.	n.a.	n.a.
TPrP				n.a.	n.a.	n.a.	n.a.	n.a.
TCPP	0.4	1.0	1.0	n.a.	n.a.	n.a.	n.a.	n.a.
TiBP	0.1		1.0	n.a.	n.a.	n.a.	n.a.	n.a.
BdPhP	1.0			n.a.	n.a.	n.a.	n.a.	n.a.
TPP	1.0		1.0	n.a.	n.a.	n.a.	n.a.	n.a.
DBPhP	1.0			n.a.	n.a.	n.a.	n.a.	n.a.
TnBP	1.0		1.0	n.a.	n.a.	n.a.	n.a.	n.a.
TDCPP	1.0	1.0		n.a.	n.a.	n.a.	n.a.	n.a.
TBEP	0.1	1.0		n.a.	n.a.	n.a.	n.a.	n.a.
TCP	0.7	1.0	1.0	n.a.	n.a.	n.a.	n.a.	n.a.
EHDP	1.0	1.0	1.0	n.a.	n.a.	n.a.	n.a.	n.a.
TXP		1.0	1.0	n.a.	n.a.	n.a.	n.a.	n.a.
TEHP	0.9	1.0		n.a.	n.a.	n.a.	n.a.	n.a.
ATE (TBP-AE)				0.3	0.5	0.4		0.3
a-TBECH	1.0			0.2	1.0	0.4		0.4
b-TBECH	0.9			0.2	1.0	0.4		0.4
g/d-TBECH	0.6			0.2	1.0	0.4		0.5
BATE				0.2	0.5	0.4		0.5
PBT	0.9			0.2	1.0	0.3		0.4
PBEB				0.3	1.0	0.3		0.5
PBBZ	0.1					0.3		
HBB	0.1	0.1	0.1	0.4	1.0	0.5	1.0	0.6
DPTE	0.7			0.6	1.0	0.4		0.5
EHTBB	0.3			0.3	0.5			0.4
BTBPE	0.1	0.1		0.2	1.0	0.1		0.8
TBPH(BEH /TBP)	0.4				0.5		0.1	0.5

Cont. Table 6 : Ratio of detected to analysed chemicals in the samples (n/N) in the different sample types. n.a.: not analysed

Components	Air	Soil	Earthworm	Fieldfare egg	Sparrowhawk egg	Red fox liver	Brown rat liver	Tawny owl egg
DBDPE					0.5		0.1	0.1
DBA								
Dec-602		0.4	0.3	1.0	1.0	1.0	0.3	0.9
Dec-603				0.9	1.0		0.1	0.6
Dec-604								
Dec-601							0.0	
syn-DP	0.6	0.6	0.6	0.4	0.5		0.7	0.4
anti-DP	1.0	0.7		0.7	1.0		0.8	0.6
1,3-DPMA								
1,5-DPMA								
BP3	n.a.		1.0	n.a.				
EHMC-Z	n.a.		1.0	n.a.		0.3		
EHMC-E	n.a.			n.a.			0.3	
OC	n.a.			n.a.				
UV-327	n.a.	1.0		n.a.	1.0		0.3	
UV-328	n.a.	1.0		n.a.	0.5		0.3	
UV-329	n.a.			n.a.	1.0			
Bromodiolone	n.a.	n.a.	n.a.	n.a.	n.a.	1.0	0.9	
Brodifacoum	n.a.	n.a.	n.a.	n.a.	n.a.	0.8	0.3	0.1
Flocumafen	n.a.	n.a.	n.a.	n.a.	n.a.		0.2	
Difenacoum	n.a.	n.a.	n.a.	n.a.	n.a.	0.2	0.2	
Difethialone								
4,4-bis A	n.a.		0.5	0.3		0.1	1.0	0.5
2,4-bis A	n.a.							
4,4-bis- S	n.a.		0.3		0.5			
2,4-bis-S	n.a.							
4,4-bis-F	n.a.			0.3	0.5			0.1
2,4-bis-F	n.a.	0.1			0.5	0.1		0.1
2,2-bis-F	n.a.		0.3					0.1
TBBPA(1)	n.a.							
4-t-octylphenol	n.a.						0.3	
4-octylphenol	n.a.							
4-nonylphenol	n.a.							

2.1 Metals

2.1.1 Soil

As last year in 2018, Zn and Cr were the dominating metals in all soils, except for soil from Frognerseteren, were the Pb concentration was highest with 97915 ng/g dw, see Figure 4 and Table 7. The same was observed in previous years' findings. (Herzke et al., 2017, Heimstad et al., 2018). The sum concentrations of the subgroup toxic metals (Cd, Pb, Hg, As) ranged from 21 087 ng/g dw at VEAS to 102 247 ng/g dw in soil from Frognerseteren. The following order of sum toxic metal concentrations was found in decreasing order: Frognerseteren > Slottsparken >Grønmo> Kjelsrud~Alnabru >Bøler> VEAS. As observed in 2018, the expected more polluted site Alnabru was not the one with highest sum of the metals Cd, Pb, Hg and As.

According to the Norwegian guidelines on classification of environmental quality of soil (normative values), 8 000 ng/g dw of As, 60 000 ng/g dw of Pb, 1 500 ng/g dw of Cd, 1 000 ng/g dw of Hg, 100 000 ng/g Cu, 200 000 ng/g Zn, 50 000 ng/g dw of Cr (III) and 60 000 ng/g dw of Ni represent the threshold value for when soil is considered contaminated (Lovdata, kap.2, vedlegg 1[1]).

Threshold values were exceeded for Pb, Cr and Ni at the following locations:

- Pb: Frognerseteren
- Cr: VEAS, Alnabru, Slottsparken, Kjelsrud
- Ni: VEAS

For As, Zn, Cd, Cu and Hg, no locations exceeded the threshold values.

For comparison, Luo et al, reported a median of 25 000 ng/g dw for Pb and 13 000 ng/g dw for Cr in urban park surface soils of Xiamen City, China (Luo, et al., 2012), which is lower than what was found in Oslo this year with a median of 30 000 ng/g dw for Pb and 56 000 ng/g dw for Cr.

In Torino, Italy, soil concentrations of 288 000 ng/g dw for Cr and 1 405 000 ng/g dw for Pb were reported, all considerably higher than in Oslo soils (Madrid et al., 2006).

In soil in parks from Bristol, UK, these mean concentrations were observed; 22 000 ng/g for As, 180 000 ng/g dw for Pb, 500 ng/g dw of Cd, 40 000 ng/g dw for Cu, 250 000 ng/g for Zn, 20 000 ng/g dw for Cr and 25 000 ng/g dw for Ni was found (Giusti, 2011). When comparing these Bristol concentrations with our data from Oslo, only mean value of Ni was comparable with the results from Bristol, Cr from Oslo was higher, and the rest of metals from Oslo had lower mean concentrations than Bristol this year 2019 and also in 2018. With 450 000 inhabitants, Bristol is of comparable size as Oslo, also both are coastal cities.

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[1] https://lovdata.no/dokument/SF/forskrift/2004-06-01-931/KAPITTEL_1-2#KAPITTEL_1-2

2.1.2 Earthworm

A In agreement with previous years' earthworm and soil data, a very high Pb concentration (58 261 ng/g ww) was detected in earthworm from Frognerseteren, approximately 14 times higher than the second highest concentration found in earthworm from Bøler. This high Pb concentration at Frognerseteren exceeded the PNECoral for predators of 10 900 ng/g ww food[2]. This indicates that animals eating earthworms form this area in large amount may experience toxic effects. Earthworms from the other sites were below the PNECoral value.

When comparing the different urban locations where earthworm was collected, the highest sum toxic metal (sum of Cd, Pb, Hg and As) concentration was found in Frognerseteren 62 986 ng/g ww (59 016 ng/g ww in 2018) followed by Bøler (6692 ng/g ww), Slottsparken (5 960 ng/g ww), Grønmo (5 490 ng/g ww), VEAS (4 449 ng/g ww), Alnabru (3 449 ng/g ww) and Kjelsrud (2 588 ng/g ww).

Latif et al., 2013 found Pb and Cd mean concentrations in three different earthworm species varying between 100 to 600 ng/g for Pb and 200 to 350 ng/g for Cd, which is much lower than found in the samples from the Oslo area. Possible harmful effects caused by the concentration of certain metals may be difficult to assess, as this seems to be species- and site specific (Lock and Janssen 2001). Even so, Zn concentrations in the earthworm species E. fetida, has been found to be physiologically regulated to a relatively constant concentration of 100 000-200 000 ng/g independent of Zn concentration in the surrounding soil (Lock and Janssen 2001). Other authors report findings of higher body burdens, even at fairly low contaminated sites (Lukkari 2004; Kennette et al. 2002).

Song et al 2002, investigated acute and sub-acute lethal effects of single and combined Cu, Zn, Pb and Cd on earthworm in meadow brown soil. In this study concentrations leading to death in individual earthworms was estimated to be 300 000 ng/g for Cu, 1 300 000 ng/g for Zn, 1 700 000 ng/g for Pb, 300 000 ng/g for Cd. LC50 in was 400-450 000 ng/g for Cu, 1 500-1 900 000 ng/g for Zn, 2 350-2 400 000 ng/g for Pb and 900 000 ng/g for Cd (Song et al 2002). They concluded that combined effects of single Cu, Zn, Pb and Cd, to conduce more than 10% of the death rate of earthworm, could result in 100% of the death rate of earthworm, revealing strong synergistic joint effect of the heavy metals (Song et al, 2002). Our study from Oslo in 2018 revealed lower concentrations than these thresholds for Cu, Zn, Pb and Cd; however, we cannot exclude combined and synergistic effects of these same metals that may affect the earthworms.

2.1.3 Fieldfare

As in 2018 and previous years, Zn and Cu dominated in fieldfare eggs. However, Zn and Cu are physiologically regulated and supposed to have little toxicological effect (Lukkari et al. 2004). Of the toxic metals investigated, Pb, Hg and As were the most abundant ones and in agreement with previous years' results. The mean value of Pb (22 ng/g ww) was in agreement with data from 2018 (28 ng/g ww). Hg and As concentrations were slightly lower than previous year data with 13.7 and 4.6 ng/g ww, respectively.

Tsipoura et al., reported on metal concentrations in three species of passerine birds breeding in New Jersey, US (Tsipoura et al., 2008). Concentrations in eggs of 38, 120 and 48 ng/g respectively were reported for Pb, Cr and Hg besides 6 ng/g for arsenic and 0.3 ng/g for Cd in the red-winged blackbird (*Agelaius phoeniceus*) a passerine bird, feeding on seeds, insects and worms. These concentrations are slightly higher or the double of the average levels of these metals in this years' study. Further, lead levels as low as 0.4 ppm (400 ng/g) in blood can result in adverse physiological effects, while 4 ppm in feathers is associated with negative effects on behaviour, thermoregulation, locomotion, and depth perception resulting in lowered nestling survival (Tsipoura et al, 2008).

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[2] https://echa.europa.eu/brief-profile/-/briefprofile/100.028.273

As last year, one egg from Kjelsås had the maximum Pb concentration of 51 ng/g, which is lower than 136 ng/g ww in 2018 and 206 ng/g ww in 2017. The same location Kjelsås had highest Pb concentration of 494 ng/g ww in 2016, an exceptionally elevated level, crossing the effect-level mentioned above. Eggs form Alnabru 3 had maximum concentration of Ni of 182 ng/g ww, 6 times higher the second highest concentration (Alnabru 1). The same sample from Alnabru had highest Cr concentration of 282 ng/g ww, approximately 3 times higher than second highest concentration at Alnabru 1.

In a study from Poland metal concentrations in non-embryonated and embryonated eggs (2010-2013) of Eurasian Reed Warbler were reported (Orlowski et al, 2016). Median concentration of Ni was 350 ng/g ww in non-embryonated eggs and 530 ng/g ww in embryonated eggs. Pb median concentrations were 550 ng/g ww in non-embryonated eggs, and 1060 ng/g ww in embryonated eggs. Cd median concentrations were 140 ng/g ww in non-embryonated eggs and 200 ng/g ww in embryonated eggs. The sample sizes were 62 and 85 for non-embryonated eggs and embryonated eggs, respectively. The study revealed significantly higher concentrations (≥ 22.7%) of all the focal elements in the contents of embryonated eggs in comparison with non-embryonated eggs, and a very pronounced one for Ca (nearly twice as high). The authors concluded that higher concentrations of all elements in the content of thinner-shelled embryonated eggs suggest the parallel transfer of these elements along with Ca resorption from the shell into the egg interior during embryo formation (Orlowski et al, 2016). The median concentrations in this study from Poland are significantly higher than our data from the Oslo area for all metals, except for the median concentration of Zn which was in agreement with the Oslo data.

2.1.4 Sparrowhawk

As previous years, Zn, Cu and Hg dominated in the two sparrowhawk eggs and were comparable to levels observed in 2017 and 2018. The Zn concentrations were comparable to levels of Zn in fieldfare, Cu concentrations were double the concentrations, and Hg concentrations more than ten times higher than in fieldfare.

Since Cu and Zn are physiologically regulated in birds (Richards and Steele 1987), first and foremost Hg, Pb, Cd and As can prove toxic at concentrations that can be found in the environment (Depledge et al. 1998). Ag, Cr, Pb, Ni, Cd and As were only found at low concentrations in the two eggs from Oslo of <13 ng/g ww. Ni concentrations in the two eggs were lower than observed in 2018 (maximum level of 81 ng/g ww) and in 2017 (maximum of 16 ng/g ww).

Pb and Hg are neurotoxins that cause cognitive and behaviour deficits as well as decreased survival, growth, learning, and metabolism (Carvalho et al., 2008). As mentioned also above, in birds, Pb levels as low as 400 ng/g can cause negative effects on behaviour, thermoregulation, and locomotion. The highest level of 12 ng/g ww in the present study for sparrowhawk eggs were more than 30 times lower than this effect level.

Metals in eggs reflect those in the maternal blood and organs during egg formation (Evers et al. 2005), with the exception of several toxic metals that are not effectively transferred to eggs, such as Cd and Pb (Furness, 1996 and Spahn and Sherry, 1999).

As, Hg, and Pb belong to the non-essential metals while Cu and Zn belong to the essential metals. Cu, Zn and Cd have been shown to significantly bioconcentrate from soils to invertebrates, but to biodilute from invertebrates to birds (Hargreaves et al., 2011). Cu, Zn and Fe are essential macro elements with many important biological functions, and body concentrations are usually well-regulated. Sparrowhawk eggs collected in a period between 2005 and 2010 have been reported to have a Hg concentration of 175 ng/g ww (Nygård and Polder, 2012). This is higher than this years' maximum level, but comparable to the maximum concentration of Hg in 2017 of 162 ng/g ww in our study.

Very few available studies are present reporting metal concentrations in sparrowhawk eggs. One recent study from Denmark analysed five samples of sparrowhawk livers for Pb, Cd and Hg, sampled in year 2013 to 2016 (Kanstrup et al., 2019). The median values for Pb, Cd and Hg were 30 ng/g ww, 180 ng/g ww and 120 ng/g ww, respectively (Kanstrup et al. 2019).

An often used reproductive effect threshold level for mercury in bird eggs is 800 ng/g (Heinz 1979, Henny et al. 2002), while other investigators and ecological risk assessors may use 500 ng Hg/g as an ecological effect screening benchmark value of (RAIS 2004). A recent publication (Fuchsman et al. 2017) reported updated Hg reproductive effect thresholds of approximately 600- 2700 ng/g ww in bird egg. Mean concentration of Hg in sparrowhawk eggs in 2019 was 142 ng/g ww (range 98.6-185 ng/g ww) and is below the reported Hg reproductive effect thresholds of 600- 2700 ng/g ww in bird egg (Fuchsman et al. 2017).

2.1.5 Brown rat

As in 2018, metals in rat liver from 2019 were mostly represented by high levels of Zn (median value of 27 041), followed by Cu and As (mean value of 4402 and 1972 ng/g respectively). As previous years, 2019 data also revealed that rats contained the highest levels of As of all analysed species with mean value of 4247 ng/g ww and where eight samples were above 1000 ng/g ww. The levels of As in brown rat were in general higher in 2019 compared to 2018 data.

2.1.6 Red fox

As in 2018, the ten red foxes in 2019 were hunted in the area of Hellerudmyra. Zn was also the dominating metal detected in the ten fox livers, with median concentrations of 43000 ng/g ww (30 000 ng/g ww in 2018) followed by Cu with 12 000 ng/g ww (11 000 ng/g ww in 2018). These were followed by Cr (median 492 ng/g ww), Pb (median 296 ng/g ww) and Ni (median 148 ng/g ww).

An extreme Pb concentration was detected in one red fox liver of 3 000 836 ng/g ww (3 mg/g ww.) It is expected that the cause for this high Pb concentration is due to contamination from the use of lead ammunition, also since this liver sample had high concentration of the metal antimony, Sb. Second highest Pb concentration was 13 496 ng/g ww. The other samples varied from 44 to 760 ng/g ww.

Excluding the extreme Pb concentration, the one liver sample of 13 496 ng/g can relate to Pb toxicosis in mammals of 10 000–25 000 ng/g (Bilandžić et al, 2010). Bilandžić et al, 2010 reported Pb levels in liver from suburban red foxes (n=12) from Croatia in the range 0.024 - 0.584 mg/kg ww (24 – 584 ng/g ww) which is comparable to the Pb levels in red fox from Oslo area in 2019 when excluding the two highest extreme concentrations.

Cd concentrations in red fox livers in the study from Croatia ranged from 0.2 - 553 ng/g ww which was higher than the concentrations in red fox from Oslo in 2019 with 26.2- 352 ng/g ww. In the same Croatian red fox liver samples, the Hg levels varied from 0.3 to 80 ng/g ww, As levels from 5-36 ng/g ww and Cu levels varied from 5800 to 86800 ng/g ww (Bilandžić et al, 2010). The Hg and As concentrations from Oslo in 2019 were comparable to the levels detected in the Croatian red fox liver samples.

Dip et al. (2001) reported that liver of suburban and rural foxes contained the highest Cd concentrations, whereas urban foxes contained the highest Pb levels within the municipality of Zurich (Switzerland). In the liver of urban foxes, mean Cd levels of 520 ng/g were found (Dip et al., 2001), which is higher than our mean value of 158 ng/g. Mean value of Pb in liver in the municipality of Zurich was 1 200 ng/g which is lower than our mean value of 1 734 ng/g (excluded the extreme value). The mean Pb value excluding both the highest concentrations was 264 ng/g ww in red fox livers from Oslo. Threshold for potential liver dysfuncton in terrestrial mammals and birds for cadmium was set to 40 000 ng/g ww in the AMAP Arctic Pollution report of 2002 (AMAP, 2002).

2.1.7 Tawny owl

Tawny owl eggs from 2019 were collected from Halden and Aremark in Viken County around 114 and 112 km South-East of Oslo, i.e. further away from Oslo municipality than previous years. Cu, with a median of 1969 ng/g ww, had the second highest metal level after Zn. The median Cu values in 2017 and 2016 were 1079 and 827 ng/g ww, respectively. The median Cr concentration in 2019 (6 ng/g ww) was much lower than in 2017 and 2016 with 129 and 155 ng/g ww, respectively. Hg concentrations (24.3-65.3 ng/g ww) in 2019 were slightly higher than in 2017, and were below the reported Hg reproductive effect thresholds of 600- 2700 ng/g ww in bird egg (Fuchsman et al. 2017). Ni concentrations (median value of 3.3 ng/g ww) was lower than previous data from 2016 and 2017 with median values of 48 and 114 ng/g ww, respectively.

All other metals were present in low concentrations (median value of Pb 4.0, Ag 1.4, Cd 0.1, and As 1.0 ng/g ww). Comparable levels were found in 2017 for these metals

A recent study for Denmark (Kanstrup et al., 2019), six samples of tawny owl livers sampled in year 2013 to 2016 revealed median values for Pb, Cd and Hg of 20, 430 ng/g ww and 160 ng/g ww, respectively (Kanstrup et al. 2019).

2.1.8 Summary metals

The concentrations of the heavy metal Pb, Cr and Ni at some locations exceeded the threshold for when soil is considered contaminated. Of the biological matrices analysed, earthworms, brown rats and foxes contained the highest levels, see Figure 4 and Table 7. The levels in earthworms were most certainly caused by the feeding technique of the worms, eating their way through the soil. One red fox liver had an extreme high concentration of Pb, most probable due to ammunition contamination (3 mg/g ww), second highest Pb concentration was 13500 ng/g in the livers, more than 50 times higher than the average of the rest of the liver samples.

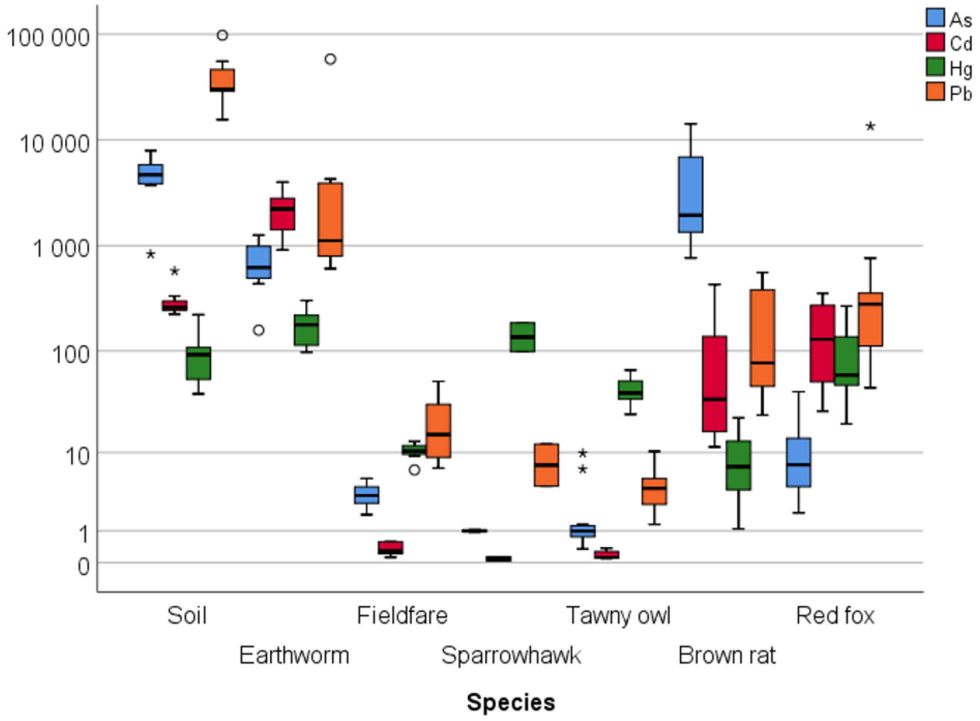

Figure 4: Box plot of selected toxic metals in environmental samples. Concentrations are given in ng/g ww, except ng/g dw in soil. The upper and lower boundaries of the box are representing the 25th and 75th percentile, the horizontal line in the box marks the median. Outliers are plotted as circle (1.5-3 IQR from end of box) or asterisk (>3 IQR from the end of the box). The whiskers represent the minimum and maximum values without outliers.

Table 7: Mean concentrations with min-max interval below in grey colour of the various metals in Soil (ng/dw), Earthworm, Fieldfare, Sparrowhawk, Red fox, Tawny owl and Brown rat. All concentrations in biological samples are given in ng/g ww.

Compounds	Soil ng/g dw	Earthworm	Fieldfare	Sparrowhawk	Red fox	Tawny owl	Brown rat
Cr	53 159 7 924-115 865	1 993 154-5 451	58.0 2.38-282	10.4 7.72-13.1	598 80.5-2 878	39.6 1.69-130	582 60.0-3019
Ni	25 615 3 588-64 387	1 084 144-2 445	31.8 3.26-182	3.02 2.67-3.37	270 25.6-1 434	12.0 1.17-43.0	129 31.0-364
Cu	21 626 8 302-36 632	2 697 1 538-3 612	587 343-826	1 561 1 017-2 106	13 451 8 454-21 867	2 126 750-3 985	4 585 3 133-7 096
Zn	83 185 27 866-160 599	159 185 94 853-223 746	11 682 5 248-29 056	10 864 4 212-17 516	40 052 24 683-49 908	14 449 9 063-31 100	27 427 21 685-35 705
As	4 696 832-7 921	718 158-1255	3.41 1.84-5.26	1.00 0.95-1.04	11.6 1.96-40.5	2.22 0.35-9.87	4 247 764-14 176
Ag	213 108-400	50.7 15.5-165	0.88 LOD-4.69	0.55 0.21-0.89	5.81 0.95-29.4	1.95 0.46-8.24	3.16 0.25-13.4
Cd	306 224-574	2270 910-3 993	0.35 0.13-0.59	0.09 0.05-0.14	158 26.2-352	0.19 0.10-0.37	111 11.4-427
Pb	42 231 15 578-97 915	9 918 604-58 621	21.8 6.86-50.9	8.27 4.31-12.2	1 734[1] 44.2-3 000 836	4.38 1.30-10.3	199 23.9-555
Hg	97 38.6-221	177 96.8-302	10.4 6.54-13.1	142 98.6-185	88.8 19.6-267	43.5 24.3-65.3	8.39 1.09-22.5

[1]: excluded one extreme concentration

2.2 PCB

2.2.1 Air

As in previous years (2016-2018) all seven PCB (PCB_7) were detected at all sampling sites, and PCB-28, -52, -101 were the dominant congeners. The highest concentrations of PCB_7 were observed at Slottsparken with sumPCB (=SumPCB_7) of 483 pg/day (913 pg/day in 2018), followed by Alnabru, Kjelsrud, VEAS, Bøler and Grønmo with 126, 60, 46, 40 and 26 pg/day, respectively.

The calculated estimated air concentrations for sum PCB_7, using an uptake rate of 4 m^3/day, ranged from 6.5 pg/m^3 at Grønmo to 121 pg/m^3 at Slottsparken.

For comparison, the concentrations of sumPCB_7 in air from the background air monitoring station at Birkenes in southern Norway (2.5-2.7 pg/m^3 in 2015-2017) are up to 12 to 40 times lower than those measured at Alnabru and Slottsparken in this study from 2019, but comparable to sumPCB at Grønmo and Frognerseteren (Bohlin-Nizzetto et al, 2015; Bohlin-Nizzetto et al, 2016; Bohlin-Nizzetto et al, 2017). The dominating congeners of PCB_7 were 28, 52 and 101 at Birkenes, in accordance with the results from the PAS measurements in Oslo in 2019. A direct comparison to data from active samplers used at monitoring stations (for example Zeppelin and Birkenes stations) should be done with caution as the accumulation in PAS and the applied uptake rates introduce factors of uncertainty.

The higher concentrations observed at Slottsparken and Alnabru in this study indicates that some specific sites in the urban area of Oslo act as significant source to PCB concentrations in air. For information, the deployment of PAS in Slottsparken had to be done using a protection felt below the samplers during all the sampling period (in order to protect the trees). Chemical analysis of these protection felts showed presence of PCB in the felts (sumPCB_7: 16 ng/100 cm^2). It cannot be excluded that the samplers in Slottsparken may have been affected by the PCB in these felts, especially if the felts have been extensively used to protect many other trees in the park. However, since the findings of PCB in both soil and earthworms from the other sites in Oslo were comparable or higher than Slottsparken, this indicate several sources in the Oslo city.

2.2.2 Soil

The highest sumPCB concentration was observed at the site Bøler with 9.2 ng/g dw followed by Slottsparken, Grønmo and Frognerseteren with approximately 3 ng/g dw. Most sites had detectable concentrations with PCB-138 and -153 as the dominating congeners. PCB-28 was not detected at Alnabru and Kjelsrud, and only PCB52 was detected at VEAS. The sum concentration at Bøler was higher and approximately twice the highest concentration detected in 2018 at Grønmo with sumPCB concentration of 5.0 ng/g dw. According to the Norwegian guidelines on classification of environmental quality of soil (normverdi), 10 ng/g dw sumPCB_7 corresponds to a good environmental status[3]. None of the samples analysed in this study exceeded this threshold value.

2.2.3 Earthworm

SumPCB concentrations in earthworms ranged from <LOD to 3.6 ng/g ww and is comparable with data from previous years. PCB-28 and -52 were detected at all sites. The other congeners were below LOD at some sites. All congeners were detected at Slottsparken, Grønmo and Alnabru, which also had the highest sumPCB concentrations. The median sumPCB concentration of 1.2 ng/g ww was the same as in year 2017, and comparable to the years 2016 and 2018 with 2.3 ng/g ww.

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[3] https://lovdata.no/dokument/SF/forskrift/2004-06-01-931/KAPITTEL_1-2#KAPITTEL_1-2

2.2.4 Fieldfare

SumPCB concentrations across the nine fieldfare eggs varied from 7.8 to 70.9 ng/g ww, compared to the 2018 data with a range of 17 to 218 ng/g ww, and 2017 data with a range from 13.3 to 60.9 ng/g ww. As previous years, PCB-153 and -138 had highest concentrations in all samples, followed by PCB-101 and -180. Highest sumPCB concentration of 70.9 ng/g ww was detected at the location Kjelsås.

The median sum value of 27.1 ng/g ww was comparable with 2018 and 2017 data of 31.0 and 38.5 ng/g ww, respectively.

For improved interspecies comparison lipid adjusted concentrations (lw) were used to compare with other published data. In our study, SumPCB varied between 160 and 6755 ng/g lw with a mean and median value of 1476 and 785 ng/g lw.

The mean value in our study is lower than what was found in eggs of great tits in Belgium (mean sumPCB$_{21}$ concentrations of 4110 ng/g lw) (Voorspoels et al., 2007). PCB in eggs of great tits collected all over Europe studied in 2009 (Van den Steen et al. 2009), included a Norwegian location as well, a suburban site close to Oslo. The PCB$_{22}$ sum concentration of nearly 1000 ng/g lw in the Norwegian location was comparable with SumPCB$_7$ (1476 ng/g lw) in our present study. A study on starling eggs (*Sturnus vulgaris*), sampled worldwide, showed less than 500 ng/g lw sumPCB at one Norwegian rural location in Northern Trøndelag (Eens et al. 2013). The lowest sum concentrations in our present study from 2019 were detected at Arnestad (VEAS) (160 ng/g lw), Bøler (376 ng/g lw) and Alnabru 1 (545 ng/g lw).

2.2.5 Sparrowhawk

Only two eggs were available for chemical analysis in 2019. The sum concentrations were 392 and 1313 ng/g ww, giving a mean and median value of 852 ng/g ww. The highest concentration was in accordance with maximum concentration from 2017 of 1299 ng/g ww. The maximum concentration in 2018 and 2016 were 1873 and 1700 ng/g ww, respectively. As previous years, PCB-153, -180 and -138 were the dominating congeners.

During the 1970's, mean PCB values of more than 23 000 ng/g ww were measured in sparrowhawks from Norway, making it one of the most contaminated species by environmental pollutants at that time. Eggshells from these birds were between 20 and 30 % thinner than normal (Nygård and Polder, 2012). However, pollutant concentrations have decreased considerably in Norwegian sparrowhawks since then. Findings from the period 2005-2010 showed a mean value of 229 ng/g PCB in sparrowhawk eggs in Norway (Nygård and Polder 2012).

The mean sumPCB value based on only two samples were 852 ng/g ww in 2019. Data from previous years revealed a mean value of sumPCB from 2018 to 2015 were 524, 460, 660 and 750 ng/g ww, respectively (Herzke et al., 2016, 2017; Heimstad et al., 2018).

Giesy et al. (1995) and Quinn et al. (2013) suggested 4000 ng PCB/g egg as a reasonable estimate of the concentration required to cause adverse effects in bird eggs. This is higher than what is observed in sparrowhawk eggs from Oslo.

Sparrowhawk feeds on other birds. Its food choice (Hagen et al. 1952), makes it vulnerable to pollutants that biomagnify via the food chain, but due to variations in local prey species, one might expect large variations in pollutant levels. The presence and still high concentrations of regulated POPs like PCB in sparrowhawks emphasize the need of continuous monitoring and for the identification of potential local urban sources. The total accumulated body burden of pollutants in mother birds are likely to be most important during egg laying. The total accumulated body burden in migratory birds like sparrowhawks would include previous accumulated PCB from exposure in wintering grounds, during migration and the amount of pollution accumulated after reaching the breeding-grounds in the spring. The migration from lower to higher latitudes during spring time is energy demanding, and it is uncertain how much of the pollutant load is still left in the fat resources of the bird upon arrival to their breeding grounds at higher latitudes. It is a disadvantage for migrating species to carry the extra burden of developing eggs on migration. It is therefore common that eggs are formed on a daily basis at the breeding-site (Perrins 1996). A study from Svalbard of snow buntings indicated that concentration of POPs in egg were influenced by local pollution (Warner et al, 2019; Kristoffersen, 2012). Significant higher concentrations (ng/g wet weight) of SumPCB$_7$ were found in the eggs from the Russian settlements (Barentsburg and Pyramiden) than in the eggs from the Norwegian (Longyearbyen and Ny-Ålesund) settlements, Warner et al, 2019; Kristoffersen, 2012).

2.2.6 Brown rats

PCB were analysed in ten samples, consisting of one, two or three single rat samples. SumPCB varied between 0.6 to 27.1 ng/g with a mean sum concentration of 7.8 ng/g ww. Maximum sumPCB was lower than data for 2018 and 2017, and comparable with sumPCB data from 2016 from <LOD and 50.2 ng/g ww. As previous years, PCB-138, PCB-153 together with 180 dominated the PCB pattern. The median of sumPCB of 3.6 ng/g ww was equal the median sum value from 2018, and slightly lower than 2017 data with a median of 15 ng/g ww.

2.2.7 Red fox

In total, 10 livers of foxes were analysed for PCB. PCB-180 and -153 were the dominant congeners. PCB-28 and -101 were not detected in any samples, and PCB-118 was only detected in a few samples. The sumPCB concentration ranged from 1.7 to 19 ng/g ww compared to 7- 310 ng/g ww in 2018, and 2.4 -261 ng/g ww in 2017. This years' median sumPCB was 5.66 ng/g ww compared to 14.7 ng/g ww in 2018, 9.2 ng/g ww in 2017 and 14.2 ng/g ww in 2016. For comparison, in a study by Mateo et al., 2012, sumPCB concentrations of 1262 ng/g ww were reported in fox liver samples from a natural reserve in south west Andalucia in Southern Spain, i.e. levels significantly higher than the maximum sumPCB concentration in our present study.

Andersen et al. reported in Arctic fox liver from Svalbard, Norway, a median sumPCB of 342 ng/g ww, more than thirty times higher than median sumPCB of the urban foxes in this study. The higher concentration in Arctic fox are explained by their marine diet (Andersen et al., 2015).

2.2.8 Tawny owl

The 11 egg samples of tawny owl from Halden and Aremark, were analysed for PCB. Most congeners were detected in all samples, only PCB-52 were not detected in five samples. PCB-153, -180 and -138 had the highest concentrations. The sumPCB values in 2019 varied between 21 and 163 ng/g ww with mean value of 58 ng/g ww, and median value of 38.8 ng/g ww. The mean sumPCB value from 2019 is comparable and slightly higher to the mean sum values from the years 2015, 2016 and 2017 with 26, 42 and 34 ng/g ww, respectively. For comparison, Bustnes et al., (2011), found higher mean SumPCB (193 ng/g ww) in tawny owl eggs collected 2009 in Trøndelag, Norway.

2.2.9 Summary of PCB results

PCB congeners were detected in many samples and as expected PCB-153 dominated the pattern in biota samples. As observed in previous years, data across all species and media revealed that sparrowhawk (only two egg samples) had the highest concentrations followed by eggs from tawny owl and fieldfare;

Table 8 and Figure 5. PCB-52 and PCB-101 dominated in air as expected due to lower chlorinated PCB and higher volatility.

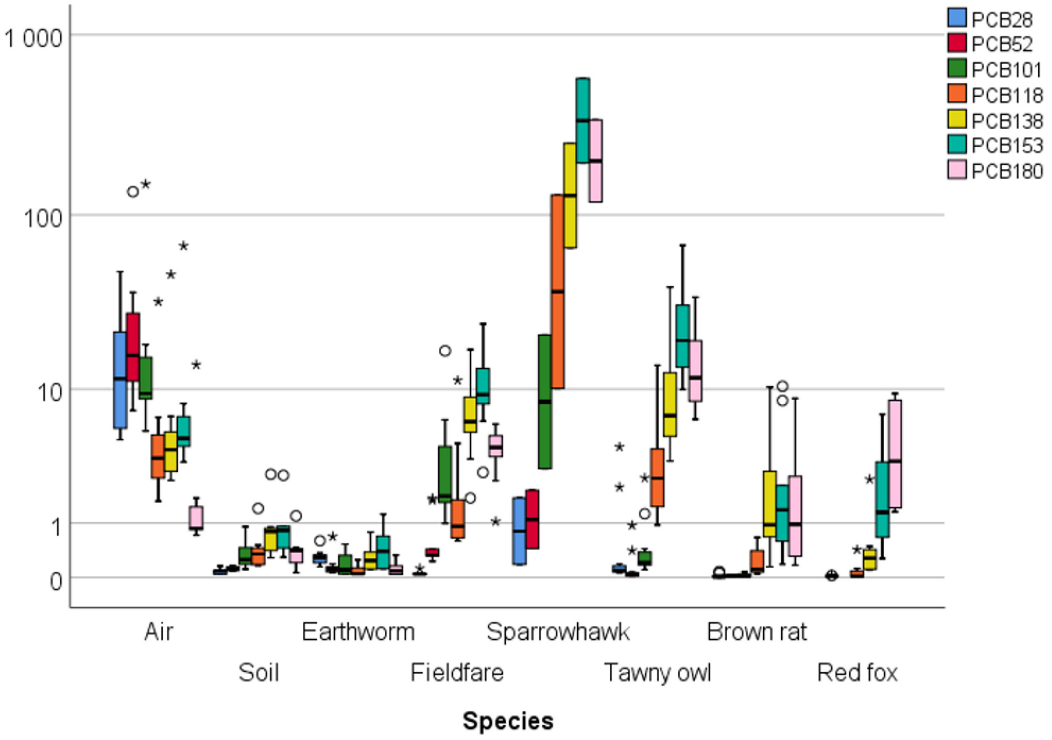

Figure 5: Box plot of PCB congeners in the various samples. The upper and lower boundaries of the box are representing the 25th and 75th percentile, the horizontal line in the box marks the median. Outliers are plotted as circle (1.5-3 IQR from end of box) or asterisk (>3 IQR from the end of the box). The whiskers represent the minimum and maximum values without outliers. Concentrations given in ng/g ww for species, soil given in ng/g dw and air in pg /day.

Table 8: Mean concentrations with min-max interval in grey below for the various PCB congeners in Air (pg/day), Soil (ng/dw), Earthworm, Fieldfare, Sparrowhawk, Red fox, Tawny owl and Brown rat. All concentrations in biological samples are given in ng/g ww. <LOD in light grey colour is given for compounds with no detected concentrations.

Compounds	Air pg/day	Soil ng/g dw	Earthworm	Fieldfare egg	Sparrowhawk	Red fox	Tawny owl	Brown rat
PCB-28	18.2 4.78-48.0	0.08 LOD-0.16	**0.30** **0.15-0.60**	0.06 <LOD-0.12	0.97 0.18-1.75	<LOD	0.66 0.06-4.27	<LOD LOD-0.08
PCB-52	34.0 7.37-135	0.12 0.08-0.14	0.19 0.07-0.68	0.64 0.23-1.74	1.24 0.45-2.03	<LOD	0.15 <LOD-0.94	0.02 0.02-0.03
PCB-101	30.3 5.45-148	0.37 LOD-0.91	0.21 LOD-0.53	4.12 1.00-16.9	12.0 3.00-20.9	<LOD	0.53 0.11-2.55	0.03 LOD-0.07
PCB-118	7.62 1.64-32.4	0.46 LOD-0.79	LOD	2.45 0.59-11.3	69.6 10.1-129	0.08 LOD-4.3	4.03 0.95-13.9	0.22 LOD-0.67
PCB-138	9.94 2.44-46.3	0.91 LOD-2.72	0.31 LOD-0.78	8.14 1.75-17.2	158 65.4-250	0.48 LOD-2.49	11.7 3.40-39.3	2.47 0.15-10.3
PCB-153	14.0 3.35-67.1	0.93 LOD-2.67	0.49 LOD-1.24	11.76 2.81-24.2	383 195-572	2.08 0.28-6.98	25.4 9.94-67.5	2.80 0.18-10.4
PCB-180	2.89 0.71-14.0	0.43 LOD-1.19	0.12 LOD-0.33	4.02 1.04-6.04	228 118-337	4.86 1.31-9.41	15.2 6.49-34.4	2.19 0.17-8.78

2.3 PBDE and new BFR

2.3.1 Air

Of the targeted PBDE congeners, the congeners BDE-47 and 99 were detected at all seven sites, Table 9 and Figure 6, and BDE-100 was detected at six out of seven sites. BDE-196 and -202 were not detected above LOD at any sites. The other congeners were sporadically detected at Alnabru and Bøler. SumPBDE was highest at Alnabru (141 pg/day), and the sum was dominated by BDE-209 (133 ng/g w). BDE-209 was not detected at the other sites. Detection of BDE-209 by the PUF-PAS should be interpreted with caution as it has been shown not to be accumulated in a reliable way by the PUF sampler. The detection of BDE-209 and the higher concentrations also of the other congeners at Alnabru suggest a local source in the Alnabru area, including BDE-209.

The sumPBDE excluding BDE-209 were 9 pg/day for Alnabru and 3-4 pg/day for the other sites. The PBDE concentrations were slightly lower than those measured in 2018, especially at Alnabru and Slottsparken. The estimated air concentrations for the sum of BDE-47, -99 and -100 ranged from 0.8 to 3 pg/day. Using an uptake rate of 2 m^3/day this corresponds to 1.5 pg/m^3 at Alnabru and 0.8 pg/m^3 at Slottsparken and VEAS. The other sites had lower concentrations, 0.35-0.65 pg/m^3.

The concentrations at these sites, and especially at the site Alnabru, are higher than annual mean concentrations of sum of BDE-47, -99 and -100 in background air at Birkenes in 2017 (0.09 pg/m^3). This indicates urban sources for PBDE.

Of the targeted new BFRs, α-TBECH, β-TBECH, PBT and TBPH were detected in highest concentrations across sites,

Table 10. α-TBECH was detected at all sites with highest concentrations at Slottsparken. The concentration range for α-TBECH and β-TBECH were similar to the concentration range from year 2018. ATE, BATE, PBEB and DBDPE were not detected at any sites.

2.3.2 Soil

Few congeners were detected above LOD at the seven sites, Table 9. BDE47 was only detected at one site (Bøler) BDE-99 detected at five sites, BDE-100 at four sites and BDE-209 at six sites. Highest sumPBDE concentration was detected at Alnabru with 4.3 ng/g dw. BDE-209 was found in highest concentrations at all sites with detectable concentration.

Of the new BFR, only HBB was detected at Frognerseteren, and BTBPE at Grønmo.

2.3.3 Earthworms

Very few BDE congeners were detected in the earthworm samples. Only BDE-99 and 209 were detected at three sites, BDe-100 and -206 at one site, the other congeners were not detected above LOD. BDE-209 dominated and had highest concentration at VEAS (1.8 ng/g dw), followed by Frognerseteren and Slottsparken. For the new brominated compounds, only HBB was detected at one site, Grønmo.

2.3.4 Fieldfare

Many BDE congeners were detected in the fieldfare eggs. The sumPBDE varied between 1.5 and 21.3 compared to the range from 2.9 to 50.8 ng/g ww in 2018. The highest sum was detected at the site Holmen. BDE-47 and -99 were the dominant congeners across the sites followed by BDE-100, -153 and 154. Median sumPBDE was 3.7 ng/g ww and comparable to median sumPBDE of 2.40, 3.2 and 2.3 ng/g ww in 2017, 2016 and 2015, respectively. BDE-209 was only detected at two sites. On average, sumPBDE concentrations in fieldfare eggs were almost four times lower than the sumPBDE concentrations found in sparrowhawk eggs.

Data for great tits (*Parus major*) were available from a Belgian study (Voorspoels et al. 2007). The authors reported that PBDE were found in eggs of great tits with levels averaging 220 ng/g lw. In our study from 2019, sumPBDE varied from 30 to 401 ng/g lw with a mean sumPBDE of 179 ng/g lw.

New BFR were detected in lower concentrations than PBDE in fieldfare eggs. HBB was detected in four samples and dominated with mean concentration of 0.12 ng/g ww. The sum for new BFR across sites varied from <LOD to 1.9 ng/g ww.

2.3.5 Sparrowhawk

As previous years' data 2014-2018 also showed, the dominating PBDE congener was BDE-99, followed by BDE-47, followed by BDE-153 and -100. BDE-126 and -209 was only detected in one egg, and BDE-191 and 206 were not detected in the two eggs. The sumPBDE concentrations in the two eggs were 16 and 92 ng/g ww.

In the absence of data from a comparable raptor species nesting in urban sites, we compared our data to data from terrestrial passerine bird eggs from the Pearl River Delta, South China, a highly industrialised area (Sun et al., 2014). In the Chinese study sumPBDE concentrations ranged between 6-14 ng/g ww, and are comparable with this year’s lowest sumPBDE value for the two sparrowhawk eggs in Oslo. However, the passerine birds that were included in the Chinese study most probably belong to a different trophic level than sparrowhawk.

A threshold level for reduction of reproduction performance in osprey of 1000 ng/g ww has been proposed by Chen et al., 2010. The levels in sparrowhawk eggs from Oslo in the present study were well below this threshold.

Several new BFR compounds were detected in the two sparrowhawk eggs. DBDPE was detected in one egg and had highest concentrations, 22 ng/g ww which corresponds to 341 ng/g lw. In a study from south China, a median concentration of DBDPE of 12 ng/g lw was measured in muscle samples of common kingfishers near an electronic waste–recycling site (Mo et al, 2012).

HBB had second highest concentration and detected in both eggs with 0.3 and 0.6 ng/g ww. Other compounds were detected as well with concentrations from 0.06 to 0.24 ng/g ww. The sum of new BFR compounds was 11 and 24 ng/g ww in the two egg samples.

2.3.6 Brown rat

SumPBDE concentrations in the ten brown rat livers varied between 0.3 and 30.8 ng/g ww with a mean and median sumPBDE of 4.5 and 1.2 ng/g ww, respectively. The sumPBDE in 2018 varied from 2 to 54.8 ng/g ww with a median of 8.9 ng/g ww.

The dominating congener in 2019 was BDE-209 and detected in 70% of samples, compared to 100% in 2018 and 50 % of the samples in 2017. BDE-207 was only detected in 30 % of the samples, BDE-47 in 80 %, BDE-99 in 70% and BDE-100 in 90 % of the samples, and at low concentrations <LOD-0.15 ng/g ww. The other congeners were below LOD. The median sumPBDE was 1.2 and lower than median sumPBDE concentration from 2018 with 8.9 ng/g ww and comparable to 2017 median sumPBDE of 2 ng/g ww. Among the new BFRs, most compounds were not detected in the rat samples, only HBB was detected in all samples and TBPH in one sample.

2.3.7 Red fox

In red fox, the sumPBDE in livers ranged from 0.14 to 2.14 ng/g ww compared to 0.32 - 5.59 ng/g ww in 2018, 0.52 - 9.63 ng/g ww in 2017, and 0.31 -3.5 ng/g ww in 2016. Median sumPBDE was 0.62 ng/g ww and in agreement with median sumPBDE in 2018 of 0.75 ng/g ww. BDE-209 was detected in 70% of the samples and had highest concentrations with a mean value of 0.57, and ranged from<LOD to 2.0 ng/ww. In 2018 the concentration of PBDE-209 ranged from 0.2 to 4.8 ng/g ww. BDE-47, -100 and -153 were detected in 60-70 % of the samples and BDE-99 only in 30 % of the samples. The concentrations for these congeners varied between <LOD and 0.15 ng/g ww. Andersen et al. reported PBDE in Arctic fox liver from Svalbard, Norway, with median BDE-47 and -153 concentrations of 0.16 and 0.08 ng/g ww respectively (Andersen et al., 2015).

None of the new BFRs were detected above 50 % in the ten samples, and DBDPE was not detected in any samples. HBB had highest detection rate with mean value of 0.08 ng/g ww. Mean concentrations across all compounds ranged from LOD to 0.08 ng/g ww.

2.3.8 Tawny owl

SumPBDE concentrations in the eleven egg samples varied from 1.2 to 8.7 ng/g ww with a median sum of 2.9 ng /g ww compared to 2.7 ng/g ww in 2017. The concentrations were comparable to the results for fieldfare, and lower than the concentrations detected in the two eggs from sparrowhawk. BDE-99, BDE-153 and BDE-209 had highest concentrations and were detected in 100, 90 and 70 % of the samples, respectively. Mean concentration for BDE209 was of 0.9 ng/g ww, followed by BDE-99 (0.8 ng/g ww) and BDE-153 (0.7 ng/g ww). The similar concentrations of BDE-99 and -153 were also observed in 2017 and 2016 for tawny owl, which is not the case in fieldfare and sparrowhawk eggs.

New BFR compounds were detected in some of the samples, where BTBPE had highest detection rate with 80 %. Highest concentration was found for DBDPE in one egg sample of 29 ng/g ww. TBPH was detected in 45 % of the samples with a mean concentration of 0.4 ng/g ww (median value of 0.2 ng/g ww). The other compounds had lower concentrations. In 2017 when tawny owl was last sampled, only DBDPE was detected in two samples with 3.8 and 3.7 ng/g ww.

2.3.9 *Summary PBDE and new BFR*

The two sparrowhawk eggs had the highest levels of PBDE (mean SumPBDE 54.2 ng/g ww) which was comparable to the mean sumPBDE value from 2018 of 40.1 ng/g ww. Fieldfare, tawny owl and brown rat had mean sumPBDE concentrations of 5.3, 4.5 and 3.5 ng/g ww, which were lower values than measured in 2018, and comparable to the 2017 results.

The new BFR compounds were detected in lower concentrations than PBDE, and at lower frequencies,

Table 10 and Figure 7 and Figure 8. Highest median sum newBFR (17.2 ng/g ww) was detected in sparrowhawk eggs (2 eggs), followed by tawny owl eggs (2.5 ng/g ww).

Table 9: Mean concentrations with min-max interval below in grey colour of the various PBDE congeners in Air (pg/day), Soil (ng/dw), Earthworm, Fieldfare, Sparrowhawk), Red fox, Tawny owl and Brown rat. All concentrations in biological samples are given in ng/g ww. <LOD in light grey colour is given for compounds with no detected concentrations.

Comp.	Air **pg/day**	Soil ng/g dw	Earthworm	Fieldfare	Sparrowhawk	Red fox	Tawny owl	Brown rat
BDE47	0.92 0.49-1.60	<LOD LOD-0.36	<LOD LOD-0.04	1.36 0.39-5.19	11.5 2.63-20.4	0.05 LOD-0.15	0.45 0.15-1.69	0.08 LOD-0.15
BDE99	0.40 0.18-1.14	0.09 LOD-0.25	<LOD LOD-0.02	2.02 0.49-8.58	19.8 6.42-33.1	<LOD LOD-0.03	0.78 0.24-1.87	0.03 LOD-0.06
BDE100	0.09 LOD-0.22	0.03 LOD-0.09	<LOD	0.92 0.24-3.76	7.67 2.13-13.2	<LOD LOD-0.03	0.30 LOD-1.11	0.02 LOD-0.04
BDE126	<LOD LOD-0.05	<LOD	<LOD	<LOD	LOD	<LOD	<LOD	<LOD
BDE153	0.26 0.06-0.89	<LOD	<LOD	0.32 0.07-1.02	8.84 2.58-15.1	0.04 LOD-0.12	0.69 LOD-2.29	0.06 LOD-0.25
BDE154	<LOD LOD-0.18	<LOD	<LOD	0.24 LOD-1.11	3.89 0.83-6.95	<LOD	0.13 LOD-0.30	<LOD
BDE 175/183	0.08 LOD-0.28	<LOD	<LOD	0.12 LOD-0.26	1.23 0.58-1.88	<LOD LOD-0.04	0.16 LOD-0.69	<LOD
BDE191	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD LOD-0.05	<LOD	<LOD
BDE196	<LOD	<LOD	<LOD	<LOD LOD-0.55	0.23 0.18-0.27	<LOD LOD-0.09	<LOD	<LOD
BDE202	<LOD	<LOD	<LOD	0.07 LOD-0.49	0.47 0.38-0.57	<LOD LOD-0.16	<LOD LOD-0.11	<LOD
BDE206	<LOD LOD-3.46	<LOD	0.03 LOD-0.15	<LOD LOD-0.49	<LOD	<LOD LOD-0.22	<LOD LOD-0.10	<LOD
BDE207	<LOD LOD-1.83	<LOD	<LOD	<LOD LOD-0.07	0.09 0.07-0.12	<LOD LOD-0.27	<LOD LOD-0.15	0.35 LOD-2.05
BDE209	20.2 LOD-133	1.38 LOD-4.24	0.46 LOD-1.77	<LOD LOD-0.21	0.45 LOD-0.74	0.57 LOD-2.01	0.88 LOD-2.22	3.97 LOD-28.5

Table 10: Mean concentrations in with min-max interval below in grey colour of the various new BFR compounds in Air (pg/day), Soil (ng/dw), Earthworm, Fieldfare,, Sparrowhawk, Red fox, Tawny owl and Brown rat. All concentrations in biological samples are given in ng/g ww. <LOD in light grey colour is given for compounds with no detected concentrations.

Compounds	Air pg/day	Soil ng/g dw	Earthworm	Fieldfare egg	Sparrowhawk	Red fox	Tawny owl	Brown rat
ATE (TBP-AE)	<LOD	<LOD	<LOD	<LOD LOD-0.14	<LOD LOD-0.06	0.05 LOD-0.20	0.05 LOD-0.25	<LOD
α-TBECH	7.30 1.16-30.8	<LOD	<LOD	<LOD LOD-0.20	0.14 0.12-0.16	<LOD LOD-0.17	0.09 LOD-0.30	<LOD
β-TBECH	3.88 LOD-17.5	<LOD	<LOD	<LOD LOD-0.10	0.15 0.13-0.17	0.05 LOD-0.17	0.08 LOD-0.26	<LOD
γ/δ-TBECH	0.22 LOD-0.98	<LOD	<LOD	0.03 LOD-0.17	0.14 0.10-0.17	0.03 LOD-0.13	0.06 LOD-0.18	<LOD
BATE	<LOD	<LOD	<LOD	0.03 LOD-0.15	0.08 LOD-0.15	0.04 LOD-0.19	0.05 LOD-0.20	<LOD
PBT	2.22 LOD-6.82	<LOD	<LOD	<LOD LOD-0.13	0.20 0.17-0.24	0.03 LOD-0.14	0.05 LOD-0.19	<LOD
PBEB	<LOD	<LOD	<LOD	0.03 LOD-0.12	0.12 0.10-0.14	0.03 LOD-0.13	0.04 LOD-0.18	<LOD
PBBZ	<LOD LOD-6.86	<LOD	<LOD	<LOD	<LOD	<LOD LOD-0.20	<LOD	<LOD
HBB	<LOD LOD-1.12	<LOD LOD-0.26	<LOD LOD-0.16	<LOD LOD-0.25	0.45 0.30-0.61	0.08 LOD-0.20	0.19 LOD-0.47	0.09 0.08-0.11
DPTE	0.18 LOD-0.51	<LOD	<LOD	<LOD LOD-0.07	0.13 0.13-0.13	0.03 LOD-0.11	0.04 LOD-0.22	<LOD
EHTBB	0.08 LOD-0.28	<LOD	<LOD	0.09 LOD-0.39	0.09 LOD-0.16	<LOD	0.13 LOD-0.46	<LOD
BTBPE	<LOD LOD-1.85	<LOD LOD-0.20	<LOD	<LOD LOD-0.14	0.12 0.11-0.12	<LOD LOD-0.04	0.14 LOD-0.41	<LOD
TBPH (BEH /TBP)	1.12 LOD-2.88	<LOD	<LOD	<LOD	<LOD LOD-0.13	<LOD	0.36 LOD-2.15	LOD LOD-2.16
DBDPE	<LOD	<LOD	<LOD	<LOD	<LOD LOD-21.8	<LOD	<LOD LOD-29.4	LOD LOD-13.5

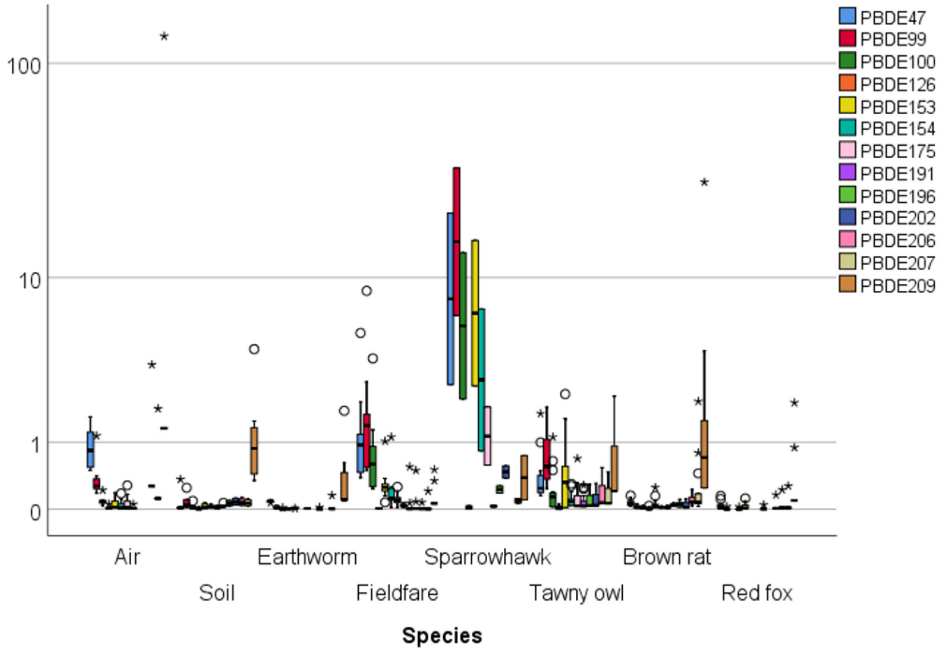

Figure 6: Box plot of PBDE congeners in the various samples. The upper and lower boundaries of the box are representing the 25th and 75th percentile, the horizontal line in the box marks the median. Outliers are plotted as circle (1.5-3 IQR from end of box) or asterisk (>3 IQR from the end of the box). The whiskers represent the minimum and maximum values without outliers. Concentrations given in ng/g ww for species, soil given in ng/g dw and air in pg /day.

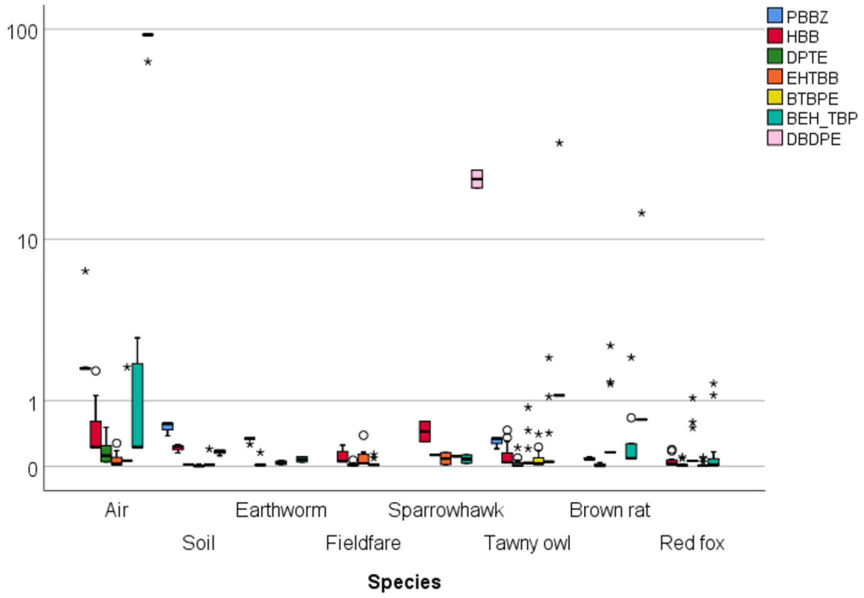

Figure 7: Box plot of NewBFR compounds in the various samples. Concentrations in ng/g ww for biota samples, ng/g dw for soil and pg/day for air. The upper and lower boundaries of the box are representing the 25th and 75th percentile, the horizontal line in the box marks the median. Outliers are plotted as circle (1.5-3 IQR from end of box) or asterisk (>3 IQR from the end of the box). The whiskers represent the minimum and maximum values without outliers.

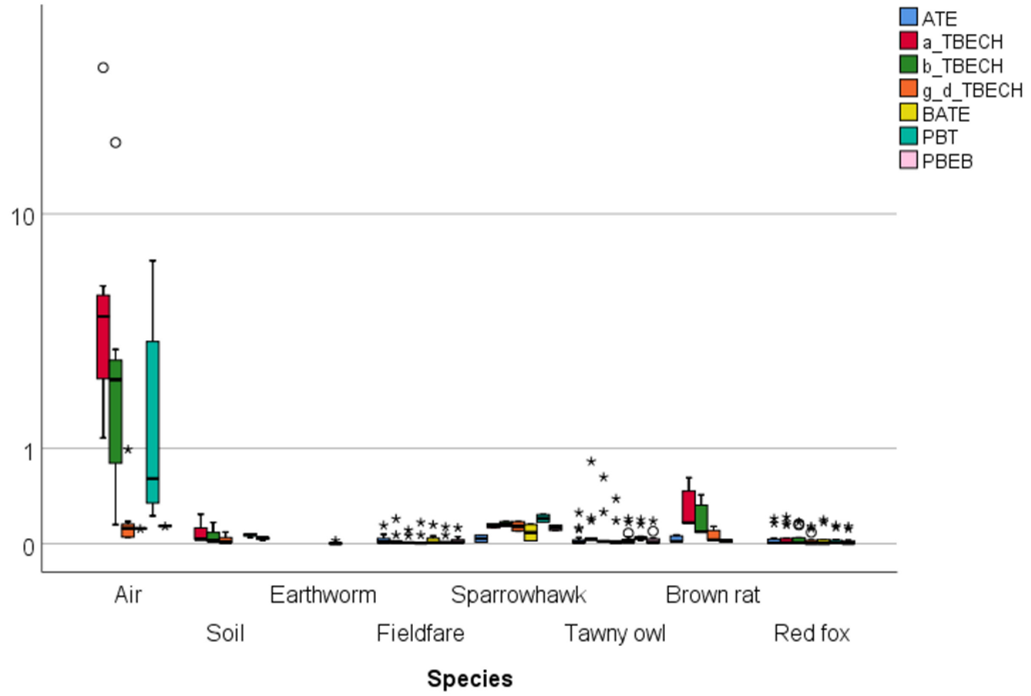

Figure 8: Box plot of NewBFR compounds in the various samples. Concentrations in ng/g ww for biota samples, ng/g dw for soil and pg/day for air. The upper and lower boundaries of the box are representing the 25th and 75th percentile, the horizontal line in the box marks the median. Outliers are plotted as circle (1.5-3 IQR from end of box) or asterisk (>3 IQR from the end of the box). The whiskers represent the minimum and maximum values without outliers.

2.4 Per- and polyfluoralkyl substances (PFAS)

The PFAS group consists of numerous per- and polyfluorinated compounds. We have chosen to separate this large class of compounds into four subgroups (see also *Table 28*) dependent on functional groups and properties: The perfluorinated sulfonates (PFSA), the perfluorinated carboxylates (PFCA), the neutral polyfluorinated compounds (nPFAS) with the compounds PFOSA, meFOSA, etFOSA, meFOSE, etFOSE, 6:2 FTOH, 8:2 FTOH, 10:2 FTOH and 12:2 FTOH; and the relatively new fluorotelomer sulfonates (newPFAS) with the compounds 4:2 FTS, 6:2 FTS, 8:2 FTS and 10:2 FTS. In this chapter and in the summary, SumPFAS is the sum of all sub-groups. For the compound PFOS, br-PFOS is consisting of the group of branched isomers, and PFOS is the linear isomer.

2.4.1 Air

In 2019, PFBS and PFHxS were detected with highest frequency in 90 and 100 % in the XAD-PAS samplers used to collect PFAS in air. PFBS concentrations (<LOD-22 pg/day) dominated with a median value of 18.4 pg/day, followed by PFOS (3.9 pg/day) and PFHxS (1.9 pg/day). PFNS was only detected at Slottsparken and the other targeted PFSA compounds were not detected. The PFBS median value was in agreement with the 2018 PFBS median value of 23 pg/day. The median SumPFSA was 25.2 pg/day.

For the carboxylates (PFCA), PFOA was detected at all sites, except Alnabru and Bøler, with median concentrations of 3 pg/day. VEAS had highest PFOA concentration of 18 pg/day PFPA, PFHxA and PFHpA were only detected at the VEAS. PFHxA at VEAS had the highest detectable concentration across all PFAS compounds of 46 pg/day. PFOcDA was detectable at five sites; not at VEAS and Slottsparken, with median value of 3 pg/day.

The neutral PFAS (nPFAS) compounds were not measured in this year's campaign in air, and none of the newPFAS (4:2-, 6:2-, 8:2-FTS and 10:2 FTS) were detected.

The data for the PFAS cannot be converted to estimated air concentrations due to lack of uptake rates for this compound class in the samplers. This hampers the comparison to active air sampling data from Birkenes. However, air measurements at Birkenes station in year 2018 revealed that the perfluorinated carboxylates dominated the pattern of detected PFAS compounds with PFOA>PFHpA>PFNA>PFOS for the annual mean concentrations. In contrast to the findings from our study with passive samplers in 2019, PFBS and PFHxS were below LOD at Birkenes in 2017. The different profiles at the background station at Birkenes in Southern Norway and the urban sites in the Oslo area might suggest different sources, but it may also be a reflection of the different sampling methodologies and that the passive XAD samplers were not optimal for measuring PFAS.

Karásková et al. 2018 concluded that XAD-PAS as passive air samplers seem to be a useful tool in the measurement of PFAS, but there is still variability between those compounds detected by active air and passive samplers. Concerning PUF-PAS samplers, the authors stated that the qualitative determination of PFAS profiles is not appropriate with PUF-PAS samplers due to different sorptive capacities for different classes of PFAS. Karásková et al. 2018 further concluded that given the importance of establishing reliable long-term monitoring for PFAS, passive sampling techniques for these compounds should continue to be investigated and optimized.

2.4.2 Soil

As in the year 2018, PFOS was the dominating compound at all seven sites in 2019. Bøler and Grønmo had highest PFOS concentrations of 5 ng/g dw followed by Alnabru (3 ng/g dw). The PFOS concentrations were in agreement with 2018 data, and soil from Alnabru had much lower concentrations in these two last years compared to the years 2016 and 2017. Other sulfonates such as PFHxS were detected at four out of seven sites, PFHpS at three sites and PFBS only at one site. The other PFSA compounds were not detected

As in 2018, several perfluorinated carboxylates (PFCA) were detected in the soil samples in 2019 with 90-100 % frequency. PFOA dominated at the seven sites. The site Frognerseteren had highest sumPFCA with 8 ng/g dw followed by Bøler with 5 ng/g dw and Grønmo (2.5 ng/g dw).

Median sumPFSA and sumPFCA was 1.9 and 1.0 ng/g dw respectively. Neutral PFAS (nPFAS) compounds were not detected in the soil samples, and for newPFAS, only 10:2 FTS was detected in one soil sample form Alnabru.

2.4.3 Earthworms

As in 2018, PFSA and PFCA were present in many samples of earthworm in 2019. As with soil, PFOS dominated, and Alnabru and Grønmo with 52 and 41 ng/g ww had the highest concentrations. These two samples exceeded the PNECoral (37 ng/g ww) of PFOS for predators such as fieldfare where earthworm is a substantial part of the diet (Herzke et al. 2017). sumPFSA at Alnabru of 65.3 was slightly lower than last year sumPFSA concentration of 89 ng/g ww, and Grønmo had similar sumPFSA concentration as last year. As with soil samples, Frognerseteren had the highest sumPFCA concentration of 34 ng/g ww, and slightly higher than last year (23 ng/g ww), followed by Grønmo with 21 ng/g ww which was higher than last year (13 ng/g ww). Highest concentrations across sites of PFHpA (13.4 ng/g ww), PFOA (6.4 ng/g ww) and PFPA (4.4 ng/g ww) were detected at Frognerseteren. Of the long-chained PFCA, Grønmo had highest concentrations of PFTeA, PFTriA and PFDoA followed by Frognerseteren.

Of nPFAS compounds, PFOSA was the only detectable compound at five sites and highest at Grønmo with 0.21 ng/g ww. Of newPFAS compounds, 6:2 FTS was detected at all sites were highest concentration was found at Alnabru (0.44 ng/g ww). 8:2 FTS was detected at six sites where Grønmo had highest concentration of 0.95 ng/g ww.

The sumPFAS (i.e. sum of all four sub groups) ranged from 14 to 80 ng/g ww compared to 2018 data with the range 13 to 103 ng/g ww. In 2019, Alnabru and Grønmo had the highest sum concentration of 79 and 80 ng/g. This years' concentrations, especially at Alnabru and Frognerseteren, were much lower than the data from 2017 where sumPFAS for these two sites exceeded 500 ng/g ww.

2.4.4 Fieldfare

PFOS dominated in all fieldfare eggs, except the sample from Kjelsås which was dominated by PFDoA followed by PFOS and other long chain carboxylates. As in year 2018, the maximum PFOS concentration was detected in fieldfare eggs at the site Grønmo with 276 ng/g ww (250 ng/g ww in 2018). This is lower than reported reference value for PFOS of 1900 ng/g ww in bird egg (ECCC, 2017) for hatching success. However, the PFOS in the egg samples from Grønmo and Holmen exceeded the PNECoral (37 ng/g ww) for predators where fieldfare is an important food item (Herzke et al. 2017). sumPFSA ranged from 11.8 to 334 ng/g ww with highest sum concentration at Grønmo, and sumPFCA ranged from 9 to 101 ng/g ww with highest sum concentration at Kjelsås.

Highest sumPFAS was detected in eggs from Grønmo, Kjelsås and Holmen with 384, 130 and 110 ng/g ww. The maximum sumPFAS concentration in 2019 and 2018 is much lower than in year 2017 of 1015 ng/g ww at Grønmo.

In accordance with last year, PFOSA was the only compound detected as part of the neutral group, nPFAS. Highest concentration was found at Grønmo with 0.9 ng/g ww. Of the newPFAS group, 8:2 FTS was detected at all sites and 10:2 FTS were detected at four sites. Highest 8:2 FTS concentration was detected at Alnabru 1 (1.6 ng/g ww) and highest 10:2 FTS concentration at Holmen with 13.4 ng/g ww.

2.4.5 Sparrowhawk

The two sparrowhawk eggs from 2019 revealed sumPFAS concentrations of 42 and 365 ng/g ww. PFOS was the dominating compound in both samples, with concentrations of 22 and 153 ng/g ww. Highest sumPFAS value in 2019 is lower than what was found in in 2018 (534 ng/g ww), and comparable with the results from 2017 (246 ng/g ww) and 2016 (383 ng/g ww).

SumPFSA in the two samples from 2019 was 24.6 and 167 ng/g ww, and sumPFCA was 18 and 139 ng/g ww. For the carboxylates (PFCA), PFTriA was the dominating compound followed by and PFTeA and PFDoA.

In the nPFAS group only PFOSA was detected. In the newPFAS group, 6:2 FTS and 10:2 FTS was detected in one and the same sample, and 8:2 FTS in both samples. Highest concentrations were found for 8:2FTS of 48 ng/g ww followed by 10:2 FTS of 11 ng/g ww; both in the same sample with highest sumPFAS concentration.

In a doctoral thesis from an urbanized region of Metro Vancouver, British Columbia Canada, 17 eggs from an avian apex predator, the Cooper's Hawk (Accipiter cooperii), were collected and analysed for PFAS compounds. PFOS was the dominating compound with a median value of 116 ng/g ww and a mean value of 124 ng/g ww (47-227 ng/g ww), (Fremlin, K. 2018), comparable to our findings in 2019.

Of the PFCA compounds, PFTeA and PFDoA had highest concentrations in Copper’s hawk. It was reported that these urban Cooper’s Hawk typically prey upon American Robins (Turdus migratorius), European Starlings (Sturnus vulgaris), and House Sparrows (Passer domestic) which are also year-round residents in Metro Vancouver (Fremlin, K. 2018).

There is limited information with respect to PFAS concentrations in eggs from sparrowhawk. For comparison, in a study from 2012, common kestrel eggs were analysed with respect to PFAS (Nygård and Polder, 2012). They were collected in the time period 2005-2010 with reported sum concentrations on the mean value of 4.5 ng/g ww, but the common kestrel mainly preys on rodents, placing it lower in the food chain than sparrowhawks. A more comparable species is the Merlin, which preys on small birds, and which had 67 ng/g sumPFAS during the same period.

2.4.6 Brown rat

SumPFAS varied from 13 to 399 ng/g ww (Median of 166 ng/g ww) compared to the range 31-129 ng/g ww in 2018 and 16-168 ng/g ww in 2017. As in previous years PFOS was the dominating PFAS in all samples. The highest PFOS concentration measured in this year's monitoring was 272 ng/g ww, higher as found during the last three years of 62.4 ng/g ww in 2018, 116 ng/g ww in 2017 and 188 ng/g ww in 2016.

For PFCA compounds, PFPNA to PFTriA, were detected in all ten samples, and at lower concentration than PFOS. Highest concentration was detected for PFNA of 35.4 ng/g ww.

8:2 FTS was detected in all ten samples with a median value of 0.84 ng/g ww, 10:2 FTS was detected in 70 % of the samples (median value of 3.0 ng/g ww), while 6:2 FTS and 4:2 FTS in 40 and 30 % of the samples at lower concentrations. PFOSA was detected in 90 % of the samples with a median value of 0.4 ng/g ww. The dominating food items for brown rat are not known, but since rats are opportunistic feeder many potential sources and food items are possible within an urban settlement.

2.4.7 Red fox

As for all other biological samples, PFOS was the dominating PFSA compound also in red fox liver with maximum concentration of 35 ng/g ww compared to 22 ng/g ww in 2018. The PFCA compounds were detectable in 90-100 % of the samples for PFNA- PFTeA, maximum value of 15 ng/g ww was detected for PFTriA which was three times higher than detected in year 2018.

PFOSA was detected in 80 % of the samples with a median value of 0.2 ng/g ww. None of the other neutral and newPFAS compounds were detected.

The sumPFAS concentrations ranged from 7 to 71 ng/g ww (median value of 22 ng/g ww) compared to 7 to 31 ng/g ww in 2018. In 2017 the sumPFAS value ranged from 7 to 201 ng/g ww, and in 2016 data from 5 to 37 ng/g ww.

For comparison, in polar fox from Svalbard, PFOS concentrations in liver ranged between 10 and 220 ng/g ww. The high levels in this polar fox species is most probably explained by the partly marine diet (Aas et al., 2014).

2.4.8 Tawny owl

SumPFAS concentrations varied from 9 to 75 ng/g ww in the eleven tawny owl eggs collected from Halden and Aremark. PFOS was the dominating compound ranging from 4 to 35 ng/g ww with a median value of 13 ng/g ww. In this urban terrestrial program, tawny owl eggs were sampled last time in 2017 where PFOS concentrations were in the range of 8 to 61 ng/g ww, and 2 to 50 ng/g in 2016.

Among the carboxylates, PFTriA had highest concentrations with a median value of 3 ng/g ww. None of the lower fluorinated carboxylates below PFNA was detected, and 90-100 % of the samples has detectable concentrations for the series PFNA- PFTeA. Only 10-20 % detection rate was observed for the new PFAS, and PFOA was detected in two samples.

Bustnes et al. reported a median of 9 ng/g ww of PFOS in tawny owl eggs collected in an area around Trondheim in Sør-Trøndelag County, Central Norway, sampled in the years 2001-2009 (Bustnes et al., 2015). In a Swedish study with ten eggs of tawny owl collected in 2014, the median total PFOS was 7.9 ng/g ww (linear PFOS was 7.6 ng/g ww); Eriksson et al, 2016. In this same study from Sweden, the PFTriA dominated the carboxylates with a median value of 1.4 ng/g ww, approximately half the median value of PFTriA in our study of tawny owl in 2019 with 3.0 ng/g ww. The Swedish study also included the species common kestrel and osprey where PFUnA had highest concentrations among the carboxylates.

2.4.9 Summary PFAS

PFAS compounds could be detected in all the investigated matrices. PFOS was the dominating compound in all matrices, except for air where PFBS dominated, see Figure 9 and Table 11. The highest concentrations of PFOS in earthworm and fieldfare eggs exceeded PNEC for predators where these organisms are substantial part of the diet.

This year's data revealed that the livers from brown rat followed by the two sparrowhawk eggs had the highest median value of PFOS. Median sumPFAS concentration was highest in sparrowhawk of 204 ng/g ww, followed by brown rat liver with median sumPFAS value of 166 ng/g ww and fieldfare eggs with median sumPFAS value of 52 ng/g ww.

One sparrowhawk egg and one sample of fieldfare eggs (Kjelsås) had much higher sumPFCA than the other samples, of 139 ng/g ww and 101 ng/g ww, respectively. The main contributors to the sum for both bird eggs were the long chain carboxylates PFDoA-PFTeA, see Table 12, Figure 10. As last year, 8:2 FTS and 10:2 FTS were detected in several samples, and highest concentrations were detected in rat liver samples and the two sparrowhawk eggs, see Table 13, Figure 11.

Table 11: Mean concentrations in with min-max interval below in grey colour of the various perfluorinated sulfonates (PFSA compounds) in Air (pg/day), Soil (ng/dw), Earthworm, Fieldfare, Sparrowhawk, Red fox, Tawny owl and Brown rat. All concentrations in biological samples are given in ng/g ww. <LOD in light grey colour is given for compounds with no detected concentrations.

Compounds	Air pg/day	Soil ng/g dw	Earthworm	Fieldfare	Sparrowhawk	Red fox	Tawny owl	Brown rat
PFBS	16.5 LOD-22.0	<LOD LOD-0.08	1.05 0.59-2.17	<LOD LOD-0.08	<LOD	<LOD	<LOD	<LOD
PFPS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFHxS	1.57 0.21-2.49	0.08 LOD-0.29	2.26 LOD-6.46	0.37 0.16-1.02	2.31 0.36-4.25	0.29 0.12-0.71	0.68 0.03-3.83	0.55 LOD-1.71
PFHpS	<LOD	0.03 LOD-0.06	1.94 LOD-5.30	0.38 0.07-1.65	1.22 0.36-2.08	0.12 0.03-0.22	0.13 LOD-0.38	0.66 LOD-3.16
brPFOS	0.30 LOD-1.51	0.39 LOD-1.16	1.76 LOD-6.90	2.94 LOD-21.6	<LOD	1.28 LOD-5.87	3.98 LOD-20.3	19.2 2.28-51.2
PFOS	3.15 LOD-6.40	1.89 0.15-4.62	**17.7** 3.38-52.4	**49.3** 21.3-276	**87.2** 21.9-153	**17.7** 4.61-34.8	**17.2** 3.75-35.4	**113** 99.9-272
PFNS	<LOD LOD-2.66	<LOD	0.05 LOD-0.17	<LOD LOD-0.45	0.67 0.11-1.23	<LOD	<LOD	<LOD LOD-0.44
PFDcS	<LOD	<LOD	0.17 LOD-0.42	4.42 0.19-33.0	3.82 0.81-6.83	0.11 LOD-0.31	0.44 0.02-1.83	8.50 0.12-27.1

Table 12: Mean concentrations in with min-max interval below in grey colour of the various perfluorinated carboxylates (PFCA compounds) in Air (ng/day), Soil (ng/dw), Earthworm, Fieldfare, Sparrowhawk, Red fox, Tawny owl and Brown rat. All concentrations in biological samples are given in ng/g ww. <LOD in light grey colour is given for compounds with no detected concentrations.

Compounds	Air pg/day	Soil ng/g dw	Earthworm	Fieldfare	Sparrowhawk	Red fox	Tawny owl	Brown rat
PFPA	0.82 LOD-5.26	0.40 LOD-1.54	1.52 LOD-4.36	0.09 LOD-0.79	LOD	0.07 LOD-0.22	LOD	1.25 LOD-4.16
PFHxA	6.58 LOD-45.9	0.47 LOD-1.98	LOD	LOD	LOD	LOD	LOD	<LOD LOD-0.59
PFHpA	0.59 LOD-3.92	0.27 0.09-0.87	2.52 0.35-13.4	LOD	LOD	LOD	LOD	LOD
PFOA	4.54 LOD-18.0	0.77 0.14-2.17	2.29 0.37-6.42	0.91 0.31-2.53	1.05 0.47-1.63	<LOD LOD-0.66	LOD	1.50 LOD-8.67
PFNA	LOD	0.38 0.08-1.01	0.67 0.24-1.87	1.73 0.65-5.03	2.63 1.05-4.21	1.82 0.42-2.92	0.47 0.08-1.56	5.65 0.20-35.4
PFDcA	LOD	0.19 LOD-0.51	0.51 0.17-1.26	3.32 0.79-11.1	2.63 1.06-4.20	1.61 0.24-4.03	0.91 0.19-2.12	6.40 0.87-16.6
PFUnA	LOD	0.15 LOD-0.46	0.66 0.34-1.10	3.56 0.79-11.7	8.90 1.85-16.0	1.74 0.13-8.97	1.49 0.90-3.38	3.66 0.41-9.08
PFDoA	LOD	0.09 LOD-0.27	1.64 0.57-3.35	10.3 7.07-31.6	12.5 3.23-21.7	1.70 0.15-9.63	2.83 LOD-7.35	7.40 0.50-12.3
PFTriA	<LOD	<LOD	2.22 1.08-3.92	7.96 2.28-20.6	**32.4** 5.70-59.1	2.14 0.15-14.7	3.79 1.99-8.97	5.43 0.17-12.6
PFTeA	<LOD	<LOD	2.48 0.78-5.28	7.61 1.64-18.2	17.2 4.13-30.3	0.72 LOD-2.72	2.07 0.82-5.31	4.40 LOD-10.1
PFHxDA	<LOD	<LOD	0.62 0.18-1.13	<LOD	1.20 0.41-1.98	<LOD	<LOD LOD-0.23	<LOD LOD-0.40
PFOcDA	2.77 LOD-4.95	<LOD	0.16 LOD-0.28	<LOD	<LOD	<LOD	<LOD	<LOD

Table 13: Mean concentrations in with min-max interval below in grey colour of the nPFAS and newPFAS compounds in Air (ng/day), Soil (ng/dw), Earthworm, Fieldfare, Sparrowhawk, Red fox, Tawny owl and Brown rat. All concentrations in biological samples are given in ng/g ww. <LOD in light grey colour is given for compounds with no detected concentrations.

Compounds	Air ng/day	Soil ng/g dw	Earthworm	Fieldfare	Sparrowhawk	Red fox	Tawny owl	Brown rat
PFOSA	<LOD	<LOD	0.11 LOD-0.25	0.17 0.03-0.86	0.58 0.09-1.06	0.15 LOD-0.30	<LOD LOD-0.04	0.63 LOD-1.59
4:2 FTS	<LOD	<LOD	<LOD	<LOD LOD-0.06	<LOD	<LOD	<LOD LOD-0.10	0.26 LOD-1.78
6:2 FTS	<LOD	<LOD	0.17 0.05-0.44	<LOD	0.13 LOD-0.24	<LOD	<LOD LOD-0.51	0.27 LOD-2.11
8:2 FTS	<LOD	<LOD	0.36 LOD-0.95	0.62 0.06-1.57	23.9 0.14-47.6	<LOD	<LOD LOD-1.90	1.55 0.15-4.85
10:2 FTS	<LOD	<LOD LOD-1.90	<LOD	2.40 LOD-13.4	5.43 LOD-10.7	<LOD	<LOD LOD-0.70	9.98 LOD-68.7

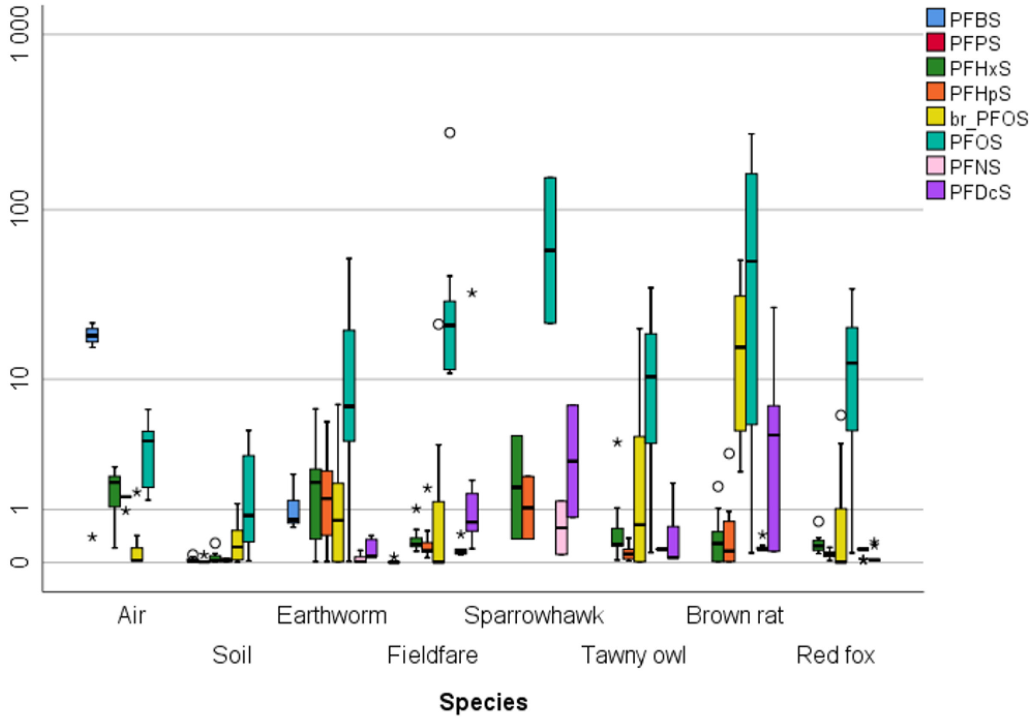

Figure 9: Box plot of PFSA compounds in the different sample types. Concentrations in ng/g ww for biota samples, ng/g dw for soil and pg/day for air. The upper and lower boundaries of the box are representing the 25th and 75th percentile, the horizontal line in the box marks the median. Outliers are plotted as circle (1.5-3 IQR from end of box) or asterisk (>3 IQR from the end of the box). The whiskers represent the minimum and maximum values without outliers.

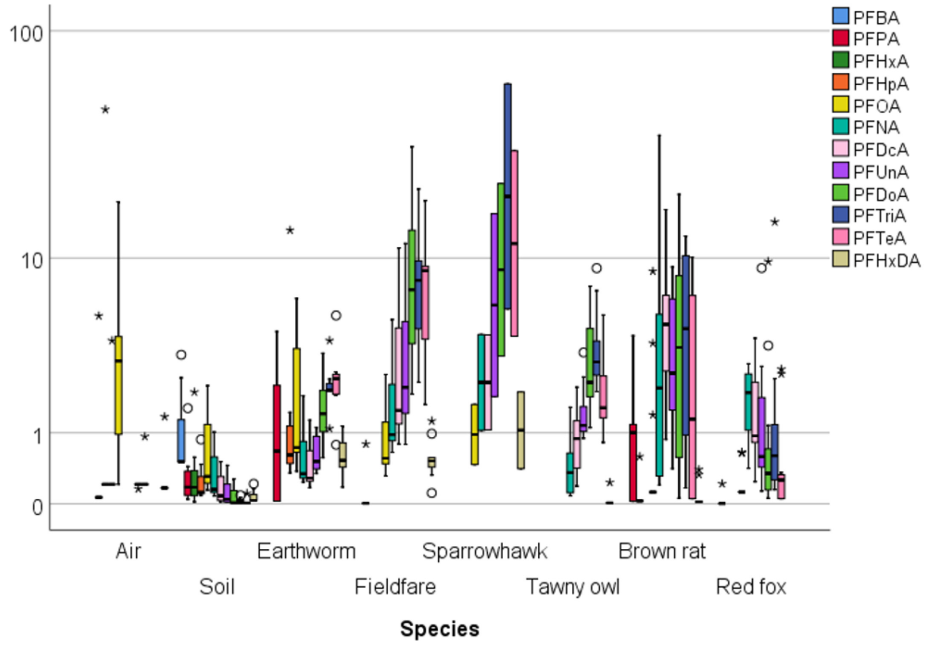

Figure 10: Box plot of PFCA compounds (ng/g ww) in the different species. Soil concentrations in ng/dw. Air concentrations in pg/day. The upper and lower boundaries of the box are representing the 25th and 75th percentile, the horizontal line in the box marks the median. Outliers are plotted as circle (1.5-3 IQR from end of box) or asterisk (>3 IQR from the end of the box). The whiskers represent the minimum and maximum values without outliers.

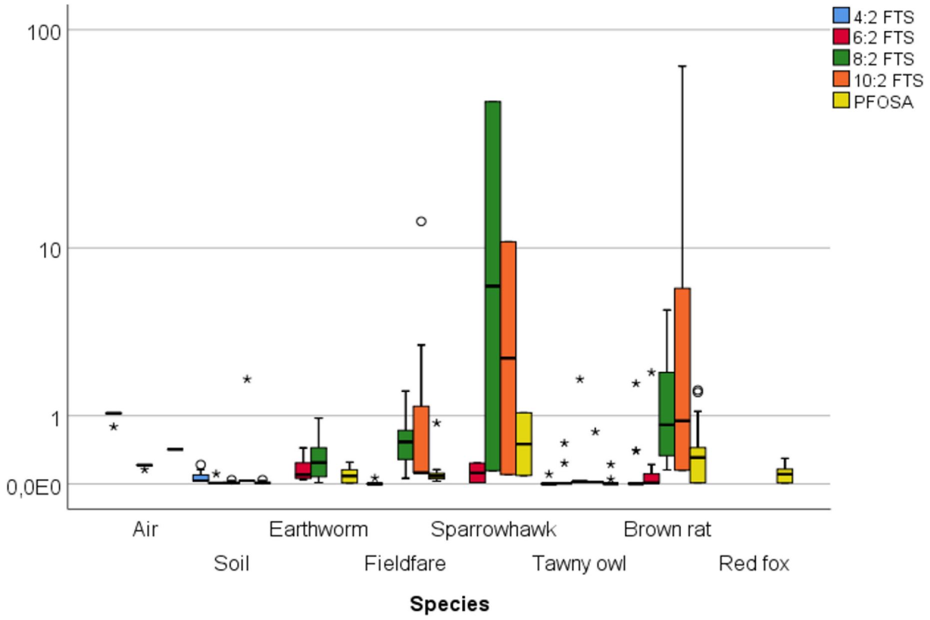

Figure 11: Box plot of fluorotelomer sulfonates (FTS) and PFOSA (ng/g ww) in the different species. Soil concentrations in ng/dw. Air concentrations in pg/day. The upper and lower boundaries of the box are representing the 25th and 75th percentile, the horizontal line in the box marks the median. Outliers are plotted as circle (1.5-3 IQR from end of box) or asterisk (>3 IQR from the end of the box). The whiskers represent the minimum and maximum values without outliers.

2.5 Chlorinated paraffins (CP)

More samples in 2019 were below and close to method LOD compared to the findings from 2018, however the range of data were comparable between the years.

2.5.1 Air

SCCP and MCCP were detected at all air sampling sites. SCCP were detected in the range of 2.1 to 9.5 ng/day where VEAS and Slottsparken had similar and highest levels. The SCCP concentration at Slottsparken was 24 ng/day in 2018 compared to 9 ng/day in 2019. The concentration of SCCP at VEAS in 2018 was 5 ng/day compared to 9 ng/day in 2019.The range of MCCP in 2019 was from <LOD to 4.0 ng/day, and was similar to the MCCP concentrations measured in 2018 (1.2-4.2 ng/day). Alnabru and Kjelsås had highest MCCP concentrations in 2019.

SCCP were higher than MCCP at four stations; Slottsparken, Frognerseteren, VEAS and Kjelsrud. For the other three stations the levels of MCCP were slightly higher than SCCP, except Bøler which revealed 3 ng/day for MCPPS and 2 ng/day for SCCP.

The estimated air concentrations, using an uptake rate of 4 m^3/day according to Li et al. (2012), were 0.5-2.4 ng/m^3 for SCCP and 0.5 ng/m^3 to 1 ng/m^3 for MCCP. Annual mean concentrations of SCCP and MCCP at Birkenes were 0.38 ng/m^3 and 0.12 ng/m^3, in 2017 (Nizzetto et al., 2018). SCCP and MCCP at Birkenes were comparable to the lowest estimated concentrations of SCCP and MCCP, but six times lower than the highest estimated concentrations at Slottsparken and VEAS for SCCP. MCCP at Birkenes were four times lower the lowest MCCP concentration at Slottsparken.

2.5.2 Soil

SCCP concentrations ranged from <LOD to 1218 ng/g dw where Frognerseteren had highest concentration. MCCP ranged from <LOD to 1140 ng/g dw with highest concentration at Bøler. In 2018, SCCP ranged from 364 to 546 ng/g dw and MCCP from 520 to 1129 ng/g dw. The median value of SCCP in 2019 was 508 ng/g dw compared to 482 ng/g dw in 2018. The median value of MCCP in 2019 was 513 ng/g dw compared to 816 ng/g dw in 2018. The maximum concentrations of SCCP and MCCP in 2019 were both below the PNECsoil values[4] of 5950 ng/g dw (5.95 mg/kg dw) and 11900 ng/g dw (11.9 mg/kg dw) for SCCP and MCCP, respectively.

For comparison, chlorinated paraffins were analysed in a large survey of Chinese agricultural soils sampled in 2016 (Aamir et al., 2019). China is the largest producer and consumer of CP, and the SCCP and MCCP concentrations in these agricultural surface soils ranged from 39 to 1609 ng/g (mean value 374 ng/g dw) and 127-1969 ng/g dw (mean value 860 ng/g dw), respectively (Aamir et al., 2019). These findings from Chinese agricultural soils were comparable with the 2018 and 2019 data of soils from the various sites in Oslo.

Other studies have revealed lower concentrations of CP in soils. Halse et al. reported an average of 12 +/- 50 ng/g dw (<0.8-281 ng/g dw) in background soil sampled in 2008 from 32 Norwegian locations (Halse et al., 2015).

In a recent study of soils from Dongguan City, South China, SCCP ranged from 7 to 993 ng/g dw (mean 172) and MCCP from 24 to 2426 ng/g dw (mean 369) (Wu et al., 2020). From the comparison of other reported levels, Wu et al., 2020 concluded that the CP concentrations in soils from Dongguan City were at a medium level and much lower than those from CP production plants, but higher than

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[4] ECHA Chemical Information, https://echa.europa.eu/information-on-chemicals

reported levels from other countries (Wu et al., 2020). Our results of SCCP and MCCP in Oslo revealed comparable levels of SCCP and MCCP to the levels detected in soil from Dongguan City.

2.5.3 Earthworm

In earthworms, SCCP ranged from LOD to 78.8 ng/g ww in 2019 compared to 33.8-64.9 ng/g ww in 2018. MCCP ranged from LOD to 75.9 ng/g ww compared to the range LOD - 134 ng/g ww in 2018. The detectable concentrations of SCCP had low variability among the sites, from 69.7 ng/g ww at Frognerseteren to 78.8 ng/g ww at Slottsparken. Kjelsrud site had highest sum concentration of SCCP and MCCP of 152 ng/g ww.

Thomson (2001) investigated the effects of MCCP on the survival, growth and reproduction of the earthworm. The most sensitive toxicity value for reproduction for earthworms in soil is the chronic (28-day) lowest observed effect concentration (LOEC) of 383 000 ng/g dw, which was clearly above the highest soil samples reported here. This indicates that the present level of CP in soil in Oslo most likely poses no significant risk for earthworms.

2.5.4 Fieldfare

SCCP and MCCP were detected in four out of nine samples. The concentrations of SCCP and MCCP in fieldfare were lower in 2019 compared to 2018. Fieldfare eggs from Bøler revealed very high concentrations of SCCP in 2017 (1280 ng/g ww) and 2018 (4730 ng/g ww) compared to 72 ng/g ww in 2019, also the maximum level of SCCP in fieldfare from 2019. The Alnabru 1 site for fieldfare revealed highest CP concentration with 310 ng/g ww for MCCP. The highest concentrations of SCCP and MCCP in 2019 were below PNECoral[5] values of 5500 ng/g food and 10 000 ng/g food for SCCP and MCCP, respectively. PNECoral values indicate the risk for organisms with fieldfare as important food item, for instance sparrowhawk.

2.5.5 Sparrowhawk eggs

SCCP and MCCP were detectable in one of two sparrowhawk eggs. In the sparrowhawk egg, SCCP and MCCP concentration was 31391 ng/g lw (2009 ng/g ww) and 24703 ng/g lw (1581 ng/g ww), respectively. The concentration of SCCP was higher in 2019 compared to 2018, and the MCCP concentration was in agreement with 2018 findings.

Although muscle and egg samples are not directly comparable, a recent study on muscle samples from peregrine falcons in south-middle Sweden reported 540 and 410 ng/g lipid weight for SCCP and MCCP, respectively (Yuan et al., 2019). The same study (Yuan et al., 2019) reported 550 and 360 ng/g lw of golden eagle (n=10, muscle) for SCCP and MCCP, respectively. SCCP and MCCP were investigated in muscle peregrine falcon in the area of Yangtze River Delta, China; the mean value of SCCP and MCCP were 1300 ng/g lw and 2100 ng/g lw, respectively (Du et al., 2018). Our 2019 results from one egg of sparrowhawk revealed much higher concentrations on a lipid weight basis.

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[5] ECHA Chemical Information, https://echa.europa.eu/information-on-chemicals

2.5.6 *Tawny owl*

SCCP were detected in five and MCCP in seven out of eleven samples. SCCP ranged from LOD to 1063 ng/g ww and MCCP ranged from LOD to 2571 ng/g ww. The concentrations of both SCCP and MCCP were higher in 2019 than in 2017. The highest concentrations for SCCP and MCCP were detected in the same egg with 7350 ng/g lw (1063 ng/g ww) for SCCP and 17783 ng/g lw (2571 ng/g ww) for MCCP.

In a recent study of SCCP and MCCP in marine and terrestrial animals from Scandinavia, the levels of SCCP and MCCP in four eggs of tawny owl and three eggs of common kestrel ranged from 85–88 and 85–87 ng/g lipid, respectively (Yuan et al., 2019), which is much lower than found in our study of tawny owl eggs from 2019.

2.5.7 *Red fox*

SCCP and MCCP were detected in four and three out of ten samples. The range of data for SCCP and MCCP were comparable to the 2018 data. In 2019 SCCP ranged from LOD to 49.5 compared to 12.2-33.9 ng/g ww in 2018. MCCP ranged from LOD to 147 ng/g ww in 2019 and LOD-377 ng/g ww in 2018.

Ten muscle samples of lynx sampled 2012-2016 in Scandinavia revealed 800 and 750 ng/g lipid for SCCP and MCCP, respectively (Yuan et al., 2019). For comparison, the red fox liver samples from Oslo this year were in the range of LOD-2600 ng/g lw and LOD-5764 ng/g lw for SCCP and MCCP, respectively. In the study of Du et al., 2018 of CP in wildlife in the Yangtze river delta (YRD), yellow weasel contained the highest level of SCCP (43 000 ng/g lw) followed by a reptile short-tailed mamushi (22 000 ng/g lw) and peregrine falcon (14 000 ng/g lw), which were much higher than our maximum concentrations from the Oslo area.

2.5.8 *Brown rat*

SCCP and MCCP were detected in 80 and 40% of the samples, respectively. SCCP concentrations (LOD-46 ng/g ww) and MCCP concentrations (LOD- 120 ng/g ww) were lower in 2019 compared to 2018. Yuan et al. 2019 investigated SCCP and MCCP in ten muscle samples of bank vole collected in 2014, and the concentrations were 400 and 370 ng/g lipid for SCCP and MCCP, respectively. Our data from 2019 revealed higher mean value of 1038 and 1484 ng/g lw for SCCP and MCCP, respectively.

SCCP are known to disturb thyroid hormone (TH) homeostasis in rodents (Gong et al, 2018), According to the results from the study of Gong et al., SCCP triggered thyroid disruption mainly through interactions with the constitutive androstane receptor (CAR), a key regulator in xenobiotic-induced thyroid hormone metabolism. It is uncertain if the levels detected in brown rat from Oslo may induce these same effects.

2.5.9 *Summary S/MCCP*

SCCP and MCCP were detected in all sample types. The concentration ranges were in general comparable with findings from 2018, but more samples were below and near method LOD in 2019, see Table 14, Figure 12. As previous year's results, our data from Oslo in 2019 revealed in general higher concentrations compared to other reported data. The lowest estimated air concentrations of SCCP and MCCP at the Oslo locations were comparable to air concentrations at Birkenes in year 2017 with active air samplers. SCCP and MCCP air concentrations at Birkenes were six times lower than the highest estimated air concentrations at Slottsparken and VEAS for SCCP, and MCCP at Birkenes were four times lower the lowest MCCP concentration at Slottsparken. SCCP and MCCP in soil were below PNEC for soil living organisms and none of the levels found in earthworm and fieldfare eggs exceeded the PNECoral for predators where earthworm or fieldfare are important prey (Herzke et al., 2017).

Table 14: Mean concentrations with min-max interval below in grey colour of chlorinated paraffins SCCP and MCCP in Air (pg/day), Soil (ng/dw), Earthworm, Fieldfare, Sparrowhawk, Red fox, Tawny owl and Brown rat. All concentrations in biological samples are given in ng/g ww.

Compounds	Air pg/day	Soil ng/g dw	Earthworm	Fieldfare	Sparrowhawk	Red fox	Tawny owl	Brown rat
SCCP	4904 n=7/7 2060-9464	581 n=6/7 LOD-1218	<LOD n=4/7 LOD-78.8	<LOD n=4/9 LOD-71.7	1016 n=1/2 LOD-2009	<LOD n=4/9 LOD-49.5	191 n=5/11 LOD-1063	35.5 n= 8/10 LOD-45.8
MCCP	2879 n=6/7 LOD-3963	525 n=4/7 LOD-1140	<LOD n=2/7 LOD-75.9	85.8 n=4/9 LOD-310	809 n=1/2 LOD-1581	<LOD n=3/9 LOD-147	474 n=7/11 LOD-2571	<LOD n=4/10 LOD-120

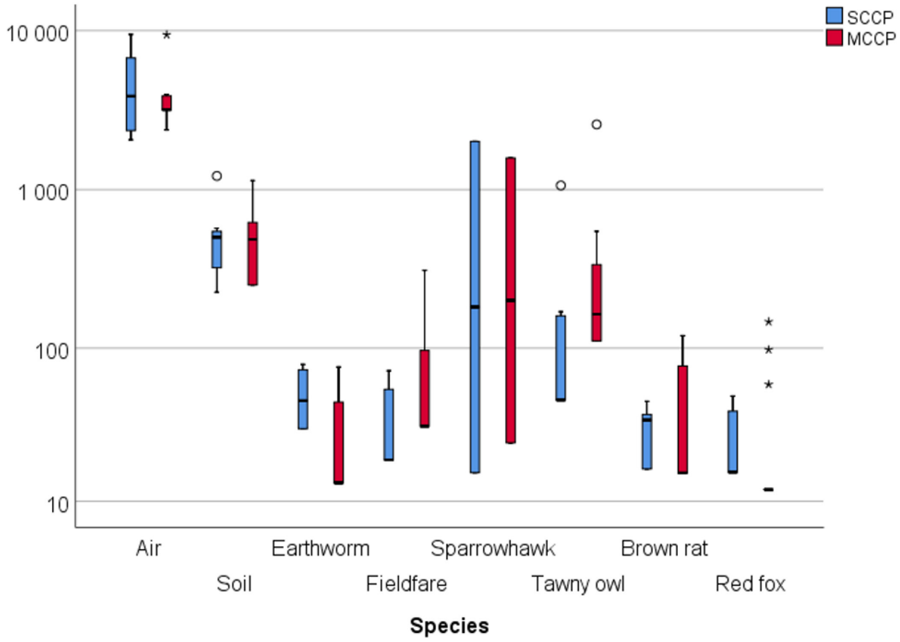

Figure 12: Box plot of SCCP and MCCP. Concentrations in air as pg/day, in soil in ng/dw, species in ng/g ww. The upper and lower boundaries of the box are representing the 25th and 75th percentile, the horizontal line in the box marks the median. Outliers are plotted as circle (1.5-3 IQR from end of box) or asterisk (>3 IQR from the end of the box). The whiskers represent the minimum and maximum values without outliers. Please note only two samples of sparrowhawk.

2.6 Cyclic Siloxanes (cVMS)

The three cyclic volatile methylsiloxanes, D4, D5 and D6, have been found to accumulate in biota (Warner et al. 2010; Kierkegaard et al. 2011; Kierkegaard et al. 2013). They do however bioaccumulate to varying degrees depending on the chemical and organism studied. The EU Member State Committee (MSC) has identified D4, D5 and D6 as substances of very high concern (SVHC), because they are very persistent and very bioaccumulative (vPvB).

All sample concentrations reported for D4-D6 have been blank corrected. Variation observed within the procedural blanks has been used to determine the limit of detection (3 x blank std. dev.) and LOQ (10 x blank std. dev). Co-extracted matrix can have a substantial effect on background variance introduced (Warner et al. 2013), and thus, is ideal to account for variation introduced for the sample matrix investigated to avoid reporting false positive concentrations (Warner et al 2013.). However, due to the numerous sample matrix types investigated within this study, accounting for the variation introduced by each sample matrix was beyond the scope of this study. Thus, the LOQ was used as a conservative limit to ensure concentrations reported were well over blank levels and were not influenced by variation introduced by the co-extracted sample matrix.

2.6.1 Air

All three siloxanes were detected at all seven sites in Oslo. Siloxanes are very volatile, and very high concentrations of all three targeted cVMS oligomers were detected at VEAS. VEAS is the largest wastewater treatment plant in Norway, and the concentrations of D4, D5 and D6 were 150, 1621 and 34 ng/day, respectively. D4 and D6 concentrations were 6 and 8 times higher at VEAS than Slottsparken. The samplers at VEAS were installed directly in the pipe outlet to sample the emissions from the plant. Siloxanes are volatile compounds, and high concentrations are expected in ambient air at wastewater treatment plants.

D5 dominated at all sites, followed by D4 and D6. As previous years Slottsparken had high concentrations of the siloxanes, approximately four times higher of D4 and D5 than the average of the other sites, excluding VEAS.

When excluding VEAS, the range of levels for the siloxanes, and especially for D5 and D6, were in agreement with the results from 2018. Frognerseteren and Grønmo had in general the lowest levels of D4, D5 and D6 in 2019. D4 at Slottsparken had higher concentration with 26 ng/day in 2019 compared to 2018 with 13.3 ng/day. For the other sites, except VEAS, D4 concentrations were lower in 2019 compared to 2018.

The estimated air concentrations in 2019, using an uptake rate of 0.5 m^3/day (Krogseth et al., 2013a), were 9 to 52 ng/m^3 for D4, 11 to 77 ng/m^3 for D5 and 2 to 8 ng/m^3 for D6 (excluding VEAS). This was comparable to the estimated concentrations from 2018 with 20-53 ng/m^3 for D4, 13-69 ng/m^3 for D5 and 2 to 6 ng/m^3 for D6.

The estimated concentrations of D5 and D6 in this study are significantly higher than the concentrations measured at background stations in summer 2017: Zeppelin; 0.08 and 0.03 ng/m^3, and Birkenes; 0.5 and 0.04 ng/m^3 of D5 and D6, respectively (Bohlin-Nizzetto et al 2018). This considerable concentration difference reflects the emission sources in urban areas. Genualdi et al., reported in 2011 in a global review, D5 concentrations ranging from 0.3 (Barrow, Alaska) to 280 ng/m^3 in Paris (Genualdi et al., 2011). The authors suggest that D5 and D6 have elevated concentrations in urban areas, which is most likely due to personal care product use. D4 cannot be compared to background air as the adsorbent used in active air samplers at the background site do not give trustworthy results for D4.

A high D5/D4 ratio has been associated with vicinity to emission source areas. D5 was higher than D4 at most sites this year, where three sites had a ratio from 1 to 1.5, another three sites with ratio at 2, and VEAS with a very high ratio of 10. High ratio at VEAS is expected since VEAS is a wastewater treatment plant and a potential source for emissions of siloxanes.

2.6.2 Soil and earthworm

Only the sites Grønmo and Bøler had detectable concentrations of D4, D5 and D6 in soil. Bøler dominated significantly with D4, D5 and D6 concentrations of 216, 86 and 37 ng/g dw, respectively. At Grønmo, the concentrations were 1.38, 2.45 and 2.75 ng/g dw for D4, D5 and D6, respectively. In 2018, only Grønmo had detectable concentration (3.1 ng/g dw) for D4. Bøler was not included in 2018. For earthworm, none of the compounds were detectable.

2.6.3 Fieldfare

Regarding siloxanes in fieldfare, D5 and D6 were detected above LOQ in five and eight samples, respectively. D4 was only detected in one sample from Alnabru 2 (10.2 ng/g ww). Highest concentration of D5 and D6 was detected at the site Ekeberg with 6.2 and 9.2 ng/g ww.

In 2018, D4 and D5 were below LOQ for all samples. D6 was detected in nine out of ten samples and ranged between <LOQ and 2.8 ng/g ww.

2.6.4 Sparrowhawk

For the two eggs of sparrowhawk, only one egg had detectable concentration of D4 (8.4 ng/g ww) and D5 (16.1 ng/g ww). This is the same egg that had highest concentrations of other contaminants such as CP, PFAS, PBDE, PCB and toxic metals.

In 2018, only D5 with concentration of 76.3 ng/g ww was detected in one egg sample of sparrowhawk. This concentration was higher than the maximum concentration from previous years.

The concentrations in sparrowhawk egg were lower than for herring gull eggs from Oslo 2018 (Ruus et al., 2019), where the highest concentration of D5 was 721 ng/g ww and a mean value of 100 ng/g ww. Glaucous gull eggs from Svalbard showed D4 and D5 concentrations varying between <LOQ and 5.8 for D4, and 3.1 and 40 ng/g ww for D5 in 2016 (Lucia et al., 2016).

2.6.5 Brown rat and red fox

The three siloxanes were detected in 40 to 60 % of the samples. The mean concentrations were comparable and slightly higher than in 2018. As in 2018, highest concentration was detected for D5 of 68.7 ng/g ww (compared to 27.4 ng/g ww in 2018).

Only D4 was detected in one red fox liver sample of 1.05 ng/g ww.

2.6.6 Tawny owl

Siloxanes were detected in some samples of the 11 tawny owl eggs from Halden and Aremark, D4 in four samples, D5 in five samples and D6 in two samples. Highest concentration was detected for D4 of 482 ng/g ww. D5 in the same egg was 34.8 ng/g ww, and D6 was below LOQ. Highest concentration of D5 was 81.8 ng/g ww, and the same egg contained D4 of 10 ng/g ww and D6 of 14.4 ng/g ww. Detection frequencies and concentrations in tawny owl eggs were higher in 2019 compared to 2017, when only D5 was detected in two samples.

2.6.7 Summary cyclic siloxanes

The siloxanes measured in air sampler installed at the pipe outlet at VEAS wastewater plant had very high concentrations of all three siloxanes, and in particular D5 with 1621 ng/day. D4, D5 and D6 were detected at all seven air sampling sites, and cyclic siloxane is the contaminant class with highest concentrations in air samples.

D4, D5, D6 were only sparsely detected in the other samples. Two soil samples had detectable concentrations where one sample from Bøler had highest concentrations. For the biological samples, fieldfare eggs had the highest detection rate (D6), and tawny owl had highest mean and maximum concentrations, detected for D4 and D5, see Figure 13, Table 15.

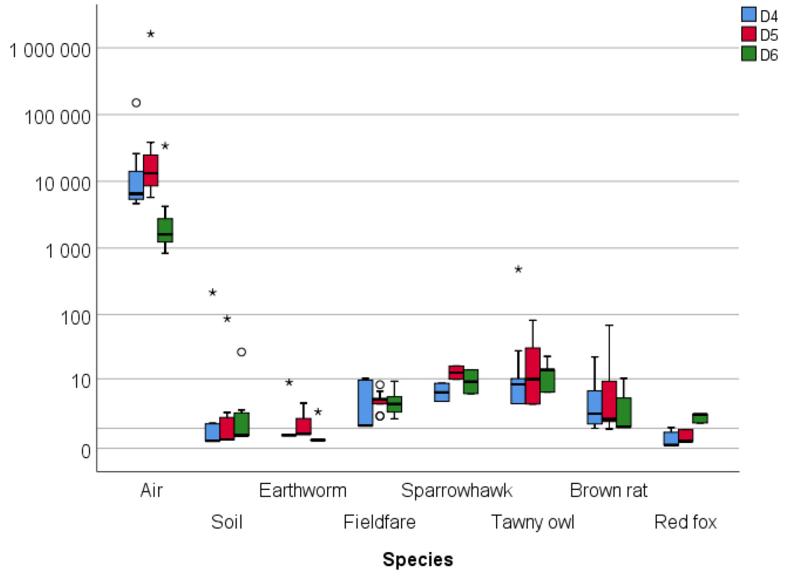

Figure 13: Box plot of D4, D5 and D6. Concentration in air given as pg/day, soil in ng/dw, the other samples in ng/g ww. The upper and lower boundaries of the box are representing the 25th and 75th percentile, the horizontal line in the box marks the median. Outliers are plotted as circle (1.5-3 IQR from end of box) or asterisk (>3 IQR from the end of the box). The whiskers represent the minimum and maximum values without outliers.

Table 15 Mean concentrations with min-max interval below in grey colour of cyclic siloxanes in Air (pg/day), Soil (ng/dw), Earthworm, Fieldfare, Sparrowhawk, Red fox, Tawny owl and Brown rat. All concentrations in biological samples are given in ng/g ww. <LOD in light grey colour is given for compounds with no detected concentrations. The extremely high concentrations for the air sample at VEAS are not included in mean, median, minimum and maximum values.*

Compounds	Air pg/day	Soil ng/g dw	Earthworm	Fieldfare	Sparrowhawk	Red fox	Tawny owl	Brown rat
D4	9281 4647-26047	31.1 LOD-216	<LOD	<LOD LOD-10.1	<LOD LOD-8.42	<LOD LOD-1.05	50.4 LOD-**482**	5.10 LOD-22.4
D5	15132 5744-38354	12.9 LOD-86.4	<LOD	<LOD LOD-7.99	<LOD LOD-16.1	<LOD	21.3 LOD-81.8	9.60 LOD-68.7
D6	1829 836-4222	4.49 LOD-26.8	<LOD	4.12 LOD-9.10	<LOD	<LOD	<LOD LOD-22.9	3.16 LOD-10.2

*Air for VEAS: D4: 150344 pg/day, D5: 1621558 pg/day, D6: 34081 pg/day

2.7 Organic phosphorous flame retardants (OPFR)

This year, OPFR compounds were only analysed for in the seven air samples, one pooled soil sample and one pooled earthworm sample, Table 16.

2.7.1 Air

Many of the target OPFR compounds were detected by PUF-PAS at all sites. SumOPFR varied from 1.6 to 16.6 ng/day compared to 1.04 to 6.82 ng/day in 2018. In 2019, VEAS and Alnabru had highest sumOPFR levels of 16.6 and 15.7 ng/day, followed by Grønmo (sumOPFR of 8.6 ng/day). In 2018, Slottsparken had highest sumOPFR, followed by Alnabru and VEAS.

The compounds TiBP, DBDPE, TnBP, TDCPP and EHDP were detected at all seven sites, and several other compounds were detected in 60 -90 % of the samples. Most average values of the various OPFR compounds were in agreement with the average values from the year 2018. However the component EHDP had higher levels in 2019 where Alnabru dominated with 12 ng/day, followed by VEAS with 9.8 ng/day and Grønmo with 7.5 ng/day. Slottsparken had lowest level of EHDP of 0.81 ng/day.

In 2018 TCPP was the dominating compound at all sites, while in 2019 the compound EHDP dominated at all sites, followed by TCPP; except from site Slottsparken where TCPP dominated. TCPP was also the dominant OPFR compound at Zeppelin in 2018, and EHDP was below LOD.

Generally, few air data of OPFR exists in outdoor air from Norway, however OPFR have been measured at Zeppelin in 2017 and 2018. The dominant OPFR at Zeppelin station in 2018 were TCPP (<LOD-410 pg/m3) and TCEP (<LOD-250 pg/m3) contributing to 60% and 30%, respectively, of sumOPFR in summer and winter time (Bohlin Nizzetto et al., 2019). Conversion to estimated air concentrations is not done for the OPFR in our study from Oslo due to lack of assured uptake rates.

A recent study from the highly industrialized city Bursa in Turkey, measured OPFR in air over 43-75 days using PUF-PAS (Kurt-Karakus et al., 2018). Uptake rates for PUF-PAS were estimated using depuration rates of PCB congeners (3.33-11.2 m^3/day with a mean of 6.21 ± 1.69 m^3/day). Estimated concentrations of sum OPFR in air, using the uptake rates from PCB depuration compounds, (excluding non-detects) ranged from 529 to 19139 pg/m^3 (Kurt-Karakus et al., 2018). The detection frequency was TCPP and TPHP (100%) > TBOEP (88%) > TCEP (85%) > TEHP (78%) > T2iPPP (20%), and concentrations were in the order TBOEP ≫ TCPP > TPHP > TEHP > TCEP. Further, Kurt-Karakas et al. found that the relative contribution to total OPFR decreased for alkylated OPEs and increased for halogenated OPFR in samples going from background to suburban to urban and industrial sites.

Cao et al., found TCIPP, TCEP and TPHP in road dust of one composite road dust sample sampled from main roads of Beijing, China in 2012 (Cao et al., 2014). So far, mostly OPFR in indoor air of buildings and cars have been reported, both are a potential source for outdoor air. TCEP is regulated in the EU and in Norway. In the EU, further information is collected in support of a possible restriction proposal to regulate TCEP, TCPP and TDCP, in flexible polyuretane foam, in child products and furniture and other products.[6]

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[6] https://echa.europa.eu/view-article/-/journal_content/title/echa-weekly-3-april-2019

2.7.2 Soil

For OPFR analyses, a single pooled sample was prepared to represent all seven locations from Oslo. An extreme concentration of TCPP was detected in the pooled soil sample of 49052 ng/g dw. This very high concentration exceeded the PNECsoil value of 1700 ng/g dw for TCPP[7] (Herzke et al., 2017). Since this is a pooled sample consisting of soil from seven different locations, the high concentration can be attributed to one or several sites. When excluding the TCPP concentration, the sum OPFR was 54 ng/g dw. The sumOPFR concentration was 10.6 ng/g dw in 2018, 7.9 ng/g dw in 2017 and 8.6 ng/g dw in 2016.

Next after TCPP, TBEP, TCP and TCEP dominated with 14.4, 13.3 and 7.7 ng/g dw. In 2018, TCEP had highest concentration with 4.2 ng/g dw followed by TCPP of 2.26 ng/g dw. The high level of EHDP in the air samples in 2019 was not reflected in the pooled sample with 1.1 ng/dw.

In the study from the highly industrialized city Bursa in Turkey (Kurt-Karakus et al., 2018), total OPFR in soil ranged from 38 to 468 ng/g dw, compared to 54 ng/g dw in the pooled sample form Oslo in 2019 when excluding the extreme concentration of TCPP.

2.7.3 Earthworms

The SumOPFR of the pooled sample, consisting of earthworms from seven sites, was 11.8 ng/g ww and in agreement with sumOPFR from 2018 (14.4 ng/g ww) and 2017 (11.3 ng/g ww).

The dominating OPFR in 2019 was TCPP and TCP of 5.23 ng/g ww and 3.47 ng/g ww, respectively; compared to TiBP (7.24 ng/g ww) followed by TnBP (3.46 ng/g ww) and TCPP (1.25 ng/g ww) in 2018. In 2017, TCP had the highest concentration of 3.7 ng/g ww followed by TnBP and TCPP, 2.68 and 1.57 ng/g ww respectively.

A recent study (Yang et al., 2018) evaluated the toxicity of ris (2-chloroethyl) phosphate (TCEP) and tricresyl phosphate (TCP) on earthworm (*Eisenia fetida*)**.** Histopathological examination, oxidative stress, DNA damage and gene expression analysis (RT-qPCR) was used to identify the effects and potential mechanism of their toxicity**.** Both TCEP and TCP significantly increased the DNA damage when the concentrations exceeded 1 mg/kg and a dose-response relationship was observed. In addition, TCEP and TCP also changed the acetylcholinesterase (AChE) activity and expression of genes associated with neurotoxic effects in earthworms under exposure to low concentration (0.1 mg/kg). The concentrations of TCEP in the pooled eartworm sample from Oslo in 2019 was below LOD. TCP in earthworm from Oslo in 2019 of 3.5 ng/g ww (0.0035 mg/kg ww) was well below the observed neurotoxic effect of 0.1 mg/kg.

2.7.4 Summary OPFR

OPFR were detected in all air samples at the seven sites in the Oslo area. High levels were detected this year of the compound EHDP, followed by TCPP, TnBP and TPP. EHDP was highest at the site Alnabru, followed by VEAS and Grønmo. TCCP was highest at Slottsparken, followed by Alnabru and VEAS. An extreme concentration of TCPP was detected in the one pooled sample of soil. The sumOPFR excluding TCPP was five times higher than sumOPFR in 2018. TCPP was the dominating compound in the pooled earthworm sample of 5.2 ng/g ww, and the sumOPFR was in agreement with sumOPFR from previous years 2018 and 2017.

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[7] https://echa.europa.eu/brief-profile/-/briefprofile/100.033.766

Table 16: Mean concentrations with min-max interval below in grey colour of organophosphorus compounds (OPFR) in Air (pg/day), Soil (ng/dw), Earthworm (ng/g ww). OPFR were only analysed in one pooled sample of soil and one pooled sample of earthworm. <LOD in light grey colour is given for compounds with no detected concentrations.

Compounds	Air pg/day	Soil ng/g dw	Earthworm
TCEP	302 42-1412	7.7	<LOD
TPrP	<LOD	<LOD	<LOD
TCPP	1281 LOD-3487	49052	5.23
TiBP	242 80-798	<LOD	0.72
BdPhP	<LOD LOD-2.3	<LOD	<LOD
TPP	173 LOD-446	2.0	**0.35**
DBPhP	21.2 5.3-91.5	<LOD	<LOD
TnBP	270 44.8-1188	<LOD	1.39
TDCPP	72.0 12.1-265	9.3	<LOD
TBEP	<LOD LOD-1125	14.4	<LOD
TCP	35.7 LOD-186	13.3	3.47
EHDP	6179 813-11850	1.13	0.60
TXP	<LOD	0.96	<LOD
TEHP	60.7 LOD-164	4.70	<LOD

2.8 Dechloranes and dibromaldrin

The chlorinated flame retardant group dechloranes (Dec-602 to Dec-604, syn- and anti-DP) were analysed in all samples together with dibromoaldrin and the compounds 1,3-Dechlorane Plus monoadduct (1,3-DPMA) and 1,5-Dechlorane Plus monoadduct (1,5DPMA). Dibromoaldrin, Dec-601, Dec-604, 1,3-DPMA and 1,5-DPMA compounds were not detected in any samples. In order to check for the stability of the DPMA compounds, a few test runs were also performed with GPC cleanup instead of acidic cleanup. None of the DPMA compounds were detected. It is recommended to perform more dedicated clean-up and analyses for these DPMA compounds, especially if these contaminants will have increased focus in coming years.

2.8.1 Air

Only the syn- and anti-DP compounds were detected in the air samples. The levels were low compared to OPFR and siloxanes, and more comparable to the levels detected of PBDE and newBrom. Anti-DP was detected at all seven sites with maximum concentration detected at Alnabru (10.7 pg/day) followed by VEAS (6.7 pg/day). Highest sum concentration was detected at Alnabru with 13.5 pg/day followed by VEAS with 8.1 pg/day, Kjelsrud (3.6 pg/day) and Slottsparken (3.1 pg/day).

The concentration ratios of anti-DP to total DP (f_{anti} values) is known to be 0.75 in the commercial mixture (Shoeib et al., 2014). At the Oslo sites where both isomers were detected, the f_{anti} values varied from 0.69 at Slottsparken to 0.83 at VEAS.

2.8.2 Soil

Anti-DP had also highest concentration in soil, detected in 70 % of the samples, where Alnabru and Bøler had highest concentrations of 1.59 and 1.41 ng/g dw. Syn-DP was detected in 60 % of the samples with similar concentrations of 0.33- 0.47 ng/g dw. Dec-602 was detected three of seven samples.

2.8.3 Earthworm

Only Dec-602 was detected in two samples (0.02 ng/g ww), and syn-DP in four out of seven samples. Syn-DP had highest concentrations varying from 0.18 to 0.22 ng/g ww detected at VEAS, Alnabru, Grønmo and Bøler in increasing order.

In 2018, also few compounds were detected above LOD in earthworms, only Dec-602 (0.02 ng/g ww) in one sample from Alnabru, and syn-DP (0.18 ng/g ww) and anti-DP (0.55 ng/g ww) in one sample from Frognerseteren.

2.8.4 Fieldfare

Several dechloranes were detectable in fieldfare eggs. In agreement with data from 2018, Dec-602 was detected in all nine samples and dec-603 in 90 % of the samples. As in 2018, Dec-603 dominated, but with lower concentrations than in 2018; 0.87 ng/g at Holmen and 0.5 ng/g ww at two Alnabru sites. Maximum concentration in 2018 of dec-603 was 2.23 ng/g ww at the site Alnabru 3.

Next after dec-603, anti-DP was detected in six samples and syn-DP in four samples. SumDP varied from 0.29 to 1.61 ng/g ww where Holmen and Alnabru 1 and 2 dominated, compared to 2018 where sumDP varied from 0.08 to 2.72 ng/g ww.

2.8.5 Sparrowhawk

In the two sparrowhawk eggs, Dec-602, Dec-603 and anti-DP were detected in both samples, and in agreement with 2018 data. Syn-DP was detected in one sample.
The two sum values were 1.41 and 5.52 ng/g ww, compared to the range 1.51 to 8.50 ng/g ww in 2018. Maximum concentration in 2019 was detected for anti-DP of 1.78 ng/g ww compared to 4.62 ng/g ww of Dec-603 in 2018.

A study from China (Chen et al., 2013) studied the levels of syn- and anti-DP in various terrestrial birds. Syn- and anti-DP in muscle of eleven Eurasian sparrowhawk ranged from 6 to 230 ng/g lw (median 21) and 20-1090 ng/g lw (median 80) in muscle, respectively. Chen et al. 2013 also suggested that the dechlorane plus (DP) burdens in terrestrial raptors could be driven by the accumulation of the anti-DP isomer, and that factors other than lipid solubility such as hepatic binding protein could be important in determining tissue deposition. In another study, Li et al. (2019) concluded that selective enrichment of anti-DP was observed in hens and their eggs. In addition, stereo-selective excretion of syn-DP was dominant in bioaccumulation of DP in chicken.

A recent North American study (Liu et al., 2019) of peregrine falcon eggs (n=15) reported these concentrations of Dec-602 (23.3-247 ng/g lw), Dec-603 (21.9-145 ng/g lw), anti-DP (3.4-170 ng/g lw) and syn-DP (1.2- 52.6 ng/g lw).

Lipid normalised concentrations of dechloranes in the two sparrowhawk eggs from Oslo in 2019 were lower than in the North American study; Dec-602 (10.0 and 27.6 ng/g lw), Dec-603 (8.62 and 19.1 ng/g lw), syn-DP (14.3 ng/g lw) and anti-DP (4.34 and 27.8 ng/g lw).

A study of peregrine falcon eggs collected from Canada and Spain showed a distinct difference in the dechlorane levels (Dechlorane Plus (DP), Dec 602, Dec 603, and Dec 604) in the two countries, with a mean of 1.78 ng/g lw in Spanish samples compared to 36.4 ng/g lw in Canadian samples, suggesting larger use of the chemical in North America (Guerra et al., 2011).

2.8.6 Red fox

Of the dechlorane compounds, only Dec-602 was detected in the ten red fox liver samples. Dec-602 was as last year detected in all ten samples. The concentrations in 2019 (0.01 to 0.06 ng/g ww) were lower than in 2018 (0.02 to 0.8 ng/g ww).

Boyles et al. (2017) reported sum dechloranes (including anti- and syn-DP, Dec-602, 603, and 604) in 44 bobcat livers in the range of 1.8 to 120 ng/g lw (median 28.7 ng/g lw). In this study, from midwestern US, bobcat samples were predominated by Dec-603 (34.1% in average), followed by Dec-604 (25.8%) anti-DP (15.7%).

In another study (Boyles et al., 2017b), dechlorane analogues were detected in 38% of raccoon samples and ranged from 0.15 to 50.5 ng/g lw (median = 2.32). In these raccoon samples Dec-603 dominated, followed by Dec-602, as in the study with bobcats. In the present study of red fox livers from Oslo 2019, the Dec-602 concentrations were much lower and varied from 0.31 to 1.71 ng/g lw. Higher concentrations were detected in 2018 in red fox from Oslo; sum concentrations of 3.1 to 28.6 ng/g lw (median 3.1 ng/g lw). 2017 sum data in red fox liver from Oslo was 4.9 to 158 ng/g lw (median of 7.5 ng/g lw).

2.8.7 Tawny owl

The same type of dechloranes detected in fieldfare and sparrowhawk eggs were also detected in tawny owl eggs from Halden and Aremark; Dec-602 in 90 % of the samples, Dec-603 in 55 % of the samples, syn-DP in 36 % of the samples and anti-DP in 64 % of the samples. Anti-DP had highest concentrations (0.14-1.57 ng/g ww) followed by syn-DP, Dec-602 and Dec-603.

In a study from Doñana Natural Space and surrounding areas, located in south-western Spain several bird eggs were collected that had failed to hatch during three sampling campaigns in 2010, 2011 and 2012 (Barón et al., 2014). In one species, barn owl, Dec-603, syn-DP and anti-DP mean values were 1.81, 3.07 and 2.38 ng/g lw in (Barón et al., 2014). In the tawny owl eggs from Halden and Aremark in 2019, the mean levels for Dec-603, syn-DP and anti-DP were 0.76, 2.14 and 4.99 ng/g lw, respectively.

2.8.8 Brown rat

In the ten brown rat liver samples, anti-DP detected in 80 % of the samples dominated with a mean value of 0.46 ng/g ww. Syn-DP was detected in 70 % of the samples with a mean value of 0.12 ng/g ww. Dec-602 was detected in three samples (mean value 0.02 ng/g ww) and Dec-603 in one sample, 0.02 ng/g ww. Maximum levels of syn- and anti-DP was detected in the same liver sample of 0.23 and 2.40 ng/g ww.

Sprague–Dawley rats were consecutively exposed to commercial dechlorane (DP 25) by gavage feeding for 90 days at different doses (0, 1, 10, and 100 mg kg−1 d−1) to investigate the accumulation pattern of syn-DP and anti-DP in liver, muscle, and serum of rats (Li et al., 2013). Li et al. found that DP preferentially accumulated in the liver, and there was no significant stereoselectivity of anti-DP or syn-DP in the low DP exposure groups, but f_{anti} was reduced significantly (0.26 to 0.30) in the high dosage groups where syn-DP dominated. Further, there was no observable-effect in histopathology and death during the experiment, although the mRNA expression levels of some genes in the low dosage group decreased significantly and enzyme activity of CYP 2B2 increased (Li et al., 2013). The f_{anti} values for the rat liver samples from Oslo varied between 0.60 and 0.91.

2.8.9 Summary dechloranes

Dechloranes were detected in all samples, but at relatively low levels compared to other pollutant classes (see Figure 14, Table 17).

All four dechlorane compounds Dec-602, Dec-603, syn-DP and anti-DP were detected in bird eggs, where Dec-602 and Dec-603 had highest detection frequencies. In fox liver, only Dec-602 was detected and in low concentration. In rat liver, syn- and anti-DP dominated. Anti-DP concentrations dominated in most samples, except earthworm where only syn-DP and Dec-602 were detected.

Although no studies to date are known to show effects of dechloranes on birds, a study where mice were orally exposed to environmentally relevant doses of Dec 602 (1 and 10 µg/kg body weight per day) for 7 consecutive days, revealed effects on immune function in mice (Feng et. al, 2016). Another study of DP revealed no effects on pipping success up to 500 ng/g egg (Crump et al., 2011).

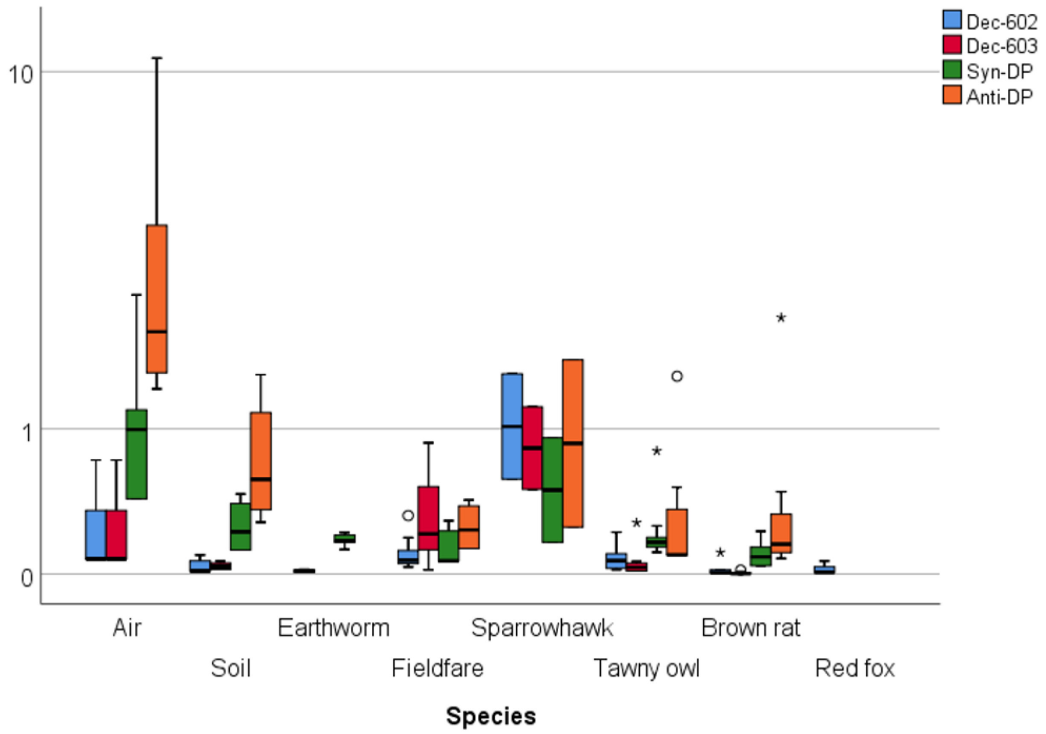

Figure 14: Box plot for dechloranes, concentrations in pg/day for air, ng/g dw for soil and ng/g ww for biota. The upper and lower boundaries of the box are representing the 25th and 75th percentile, the horizontal line in the box marks the median. Outliers are plotted as circle (1.5-3 IQR from end of box) or asterisk (>3 IQR from the end of the box). The whiskers represent the minimum and maximum values without outliers.

Table 17: Mean concentrations with min-max interval below in grey colour of dechlorane compounds in all samples. All concentrations for biota are given in ng/g ww. <LOD in light grey colour is given for compounds with no detected concentrations.

Compounds	Air pg/day	Soil ng/g dw	Earthworm	Fieldfare	Sparrowhawk	Red fox	Tawny owl	Brown rat
DBA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Dec-602	<LOD	<LOD LOD- 0.09	<LOD LOD- 0.02	0.11 0.03-0.32	1.09 0.57-1.60	0.03 0.01-0.06	0.10 LOD-0.22	0.02 LOD-0.11
Dec-603	<LOD	<LOD	<LOD	0.34 LOD-0.87	0.86 0.50-1.22	<LOD	0.06 LOD-0.28	<LOD LOD-0.02
Dec-604	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Dec-601	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Syn-DP	1.09 0.49-2.79	0.30 LOD-0.47	<LOD LOD- 0.22	<LOD LOD-0.29	0.50 LOD-0.92	<LOD	0.17 LOD-0.80	0.12 LOD-0.23
Anti-DP	3.84 1.42-10.7	0.80 LOD-1.59	<LOD	0.27 LOD-0.42	1.02 0.25-1.78	<LOD	0.39 LOD-1.57	0.46 LOD-2.40
1,3-DPMA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
1,5-DPMA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

2.9 Phenolic compounds and alkyl ethoxilates

Phenolic compound (bis-A, bis-S, bis-F, TBBPA, octyl- and nonylphenols) were not analysed in air samples, and these compounds were only sporadically detected in the other samples, and none were detected in the soil samples. For brown rat,only three pooled samples of rat liver were analysed.

2.9.1 Earthworms

Only four samples of earthworm from Slottsparken, Alnabru, Bøler and Kjelsrud were analysed due to lack of material. Bis-A was detected in two of the samples, 24.4 and 22.7 ng/g ww, at Slottsparken and Alnabru. Bis- S and Bis-F were detected in one sample from Slottsparken, 2.8 and 1.2 ng/g ww. The rest of the compounds were below LOD.

2.9.2 Fieldfare

Bis-A was detected in two egg samples, Alnabru 2 (24.2 ng/g ww) and Ekeberg (9.2 ng/g ww). Bis-F was detected in three samples. Alnabru 1 and 2, and Bøler of 4.2, 4.3 and 3.9 ng/g ww. The rest of the compounds were below LOD.

2.9.3 Sparrowhawk

In the two egg samples of sparrowhawk, only Bis-S, Bis-F and 2,4 Bis-F were detected in one sample of 1.7, 5.7 and 4.5 ng/g ww. The rest of the compounds were below LOD.

2.9.4 Red fox

In red fox liver bis-A was detected in one sample (17.6 ng/g ww), and 2,4-bis F in one sample of 22.1 ng/g ww. The rest of the compounds were below LOD.

2.9.5 Brown rats

Three pooled samples of brown rat liver were analysed. Bis-A was detected in all three samples, 30.4, 70.1 and 345 ng/g ww. 4-t-octylphenol was detected in one sample of 8.7 ng/g ww.

2.9.6 Tawny owl

Bis-A was detected in five out of eleven tawny owl egg samples at more or less same concentrations from 7.3 to 8.6 ng/g ww. Bis-F together with 2,4-Bis-F and 2,2-Bis-F were detected in one and the same sample with 33.6, 26.0 and 0.6 ng/g ww, respectively.

2.9.7 Summary phenols

First and foremost, Bis-A was detected in some samples, and with highest concentrations in brown rat liver, see Table 18. As last year, highest concentrations were detected in brown rat liver. Highest concentration in rat liver in 2019 was 345 ng/g ww compared to 124 ng/g ww in 2018 of Bis-A.

A NOAEL value has been reported from rat studies of 5 mg/kg-bw/day for bis-A (US EPA, 2010). Based on this NOAEL value one would expect that effects in rats from Oslo area is negligible.

Table 18: Mean concentrations with min-max interval below in grey colour of phenolic compounds in Soil, Earthworm, Fieldfare eggs, Sparrowhawk eggs, Red fox liver and Brown rat liver (three pooled samples). All concentrations are given in ng/g ww. <LOD in light grey colour is given for compounds with no detected concentrations.

Compounds	Soil	Earthworm	Fieldfare	Sparrowhawk	Red fox	Tawny owl	Brown rat
4,4-Bis-A	<LOD	<LOD LOD-24.4	<LOD LOD-24.0	<LOD	<LOD LOD -17.6	<LOD LOD-8.6	149 30.4-345
2,4- Bis-A	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
4,4-Bis-S	<LOD	<LOD LOD-2.8	<LOD	<LOD LOD-1.70	<LOD	<LOD	<LOD
2,4- Bis-F	<LOD	<LOD	<LOD	<LOD	<LOD LOD -22.1	<LOD	<LOD
4,4-Bis-F	<LOD	<LOD	<LOD LOD-4.33	<LOD LOD-5.69	<LOD	<LOD LOD -33.6	<LOD
2,4- Bis-F	<LOD	<LOD	<LOD	<LOD LOD-4.48	<LOD	<LOD LOD -26.0	<LOD
2,2- Bis-F	<LOD	<LOD LOD-1.19	<LOD	<LOD	<LOD	<LOD LOD -0.61	<LOD
TBBPA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	LOD
4-t-Octylphenol	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD LOD -8.72
4-octylphenol	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Nonylphenol	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

2.10 UV compounds

Pooled samples were used for analyses, one sample for soil, one sample for earthworm and three samples for the other species. Fieldfare samples were not analysed due to lack of material.

In 2019, fewer compounds were detected in the pooled samples compared to 2018, except in the rat liver samples. The compound OC was not detected in 2019, in contrast to the results from 2018. In general, lower concentrations were detected in 2019 compared to 2018 results. Highest number of detected UV compounds were found in brown rat liver (see Table 19) with concentrations in the range of <LOD to 0.60 ng/g ww.

Table 19: Mean concentrations with min-max interval below in grey colour of UV compounds in pooled samples of Soil (one sample), Earthworm (one sample), Sparrowhawk egg (three samples), Red fox liver (three samples), Tawny owl egg (three samples) and Brown rat liver (three samples). All biota concentrations are given in ng/g ww and soil in ng/g dw. <LOD in light grey colour is given for compounds with no detected concentrations.

Compounds	Soil	Earthworm	Sparrowhawk	Red fox	Tawny owl	Brown rat
BP3	<LOD	0.47	<LOD	<LOD	<LOD	0.17 LOD-0.41
EHMC-Z	<LOD	0.03	<LOD	<LOD LOD-0.03	<LOD	<LOD LOD-0.03
EHMC-E	<LOD	<LOD	<LOD	<LOD	0.23 LOD-0.57	<LOD
OC	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
UV-327	0.10	<LOD	0.31 0.09-0.53	<LOD	0.07 LOD-0.20	<LOD LOD-0.07
UV-328	0.89	<LOD	0.43 LOD-0.76	<LOD	0.18 LOD-0.48	0.28 LOD-0.60
UV-329	<LOD	<LOD	0.23 0.12-0.33	<LOD	<LOD	<LOD LOD-0.13

2.11 Biocides

Biocides (rodenticides) were only analysed for in red fox and rat liver samples i.e. species that were more likely to be exposed to these substances through their diet. Five biocides were selected for analyses in these samples (Bromadiolone, Brodifacoum, Flocumafen, Difenacoum and Difethialone).

2.11.1 Red fox

As in 2017 and 2018, bromadiolone and brodifacoum were the dominating compounds. Bromadiolone were detected in all ten red fox liver samples and ranged from 4.3 to 1923 ng/g ww compared to < LOD to 3473 ng/g ww in 2018. The 2019 data revealed no sample above 2000 ng/g ww (see Figure 15, The upper and lower boundaries of the box are representing the 25th and 75th percentile, the horizontal line in the box marks the median. Outliers are plotted as circle (1.5-3 IQR from end of box) or asterisk (>3 IQR from the end of the box). The whiskers represent the minimum and maximum values without outliers.
Table 20), with mean value of 764 ng/g ww (median 774 ng/g ww); slightly higher mean value than in 2018, and much lower compared to the mean value of 1800 ng/g ww (median of 996 ng/g ww) in 2017.

Brodifacoum is a highly lethal 4-hydroxycoumarin vitamin K antagonist anticoagulant poison. In recent years, it has become one of the world's most widely used biocide. It is typically used as a rodenticide, but is also toxic to all mammals. Brodifacoum was detected in eight out of ten samples and ranged from <LOD to 182 ng/g ww (median of 34.6 ng/g ww) compared to 2018 data ranging from <LOD to 818 ng/ww with a median of 55 ng/g ww. Flocumafen was detected in two samples. As in 2018, flocumafen was not detected, and difenacoum was detected in two samples, in agreement with last years' results.

Bromadiolone persists very long in the liver, up to 270 days (Giraudoux et al., 2006). In a study from Sweden (Nordström et al., 2012), bromadiolone was found in the range <LOQ to 1100 ng/g ww in red fox livers (n=10), and a Finnish study (Koivisto et al., 2016), revealed mean and maximum concentration of bromadiolone in fox livers (n=11) of 209 and 911 ng/g ww, respectively. Our red fox

liver samples from Oslo in 2019 revealed higher mean and maximum concentrations than detected in the two studies from Sweden and Finland.

A study from Spain (Sánchez-Barbudo et al., 2012) reported a bromadiolone mean concentration of 150 ng/g ww with maximum concentration of 12300 ng/g ww in red fox livers. Berny et al. (1997) described liver concentrations ranging from 800 to 6900 ng/g ww (median of 1500 ng/g) in confirmed bromadiolone-poisoned foxes.

A hepatic toxicity threshold of 200 ng/g ww for anticoagulant rodenticides (AC) has formerly been considered to represent a lethal hazard for birds and mammals (Berny et al 1997; Fourel et al., 2018). Bromadiolone exceeded this threshold in six red fox liver samples.

2.11.2 Brown rats

In rats, bromadiolone was found in 90% of the samples. The concentrations of bromadiolone in rats were <LOD-512 ng/g ww, compared to <LOD-205 ng/g ww (mean 154 ng/g ww) in 2018. Brodifacoum was detected in two samples (13.3 and 101 ng/g ww), Flocumafen (133 ng/g ww) in one and the same sample with highest Bromadiolone concentration, and Difethialone in one sample (24 ng/g ww). Bromadiolone exceeded the hepatic toxicity threshold of 200 ng/g ww in two samples.

2.11.3 Summary biocides

As previous years have revealed, bromadiolone dominated both in red fox and brown rat liver. Still, the levels of rat poisons were much higher in the red fox than in the target species; the rats, see Figure 15, The upper and lower boundaries of the box are representing the 25th and 75th percentile, the horizontal line in the box marks the median. Outliers are plotted as circle (1.5-3 IQR from end of box) or asterisk (>3 IQR from the end of the box). The whiskers represent the minimum and maximum values without outliers.
Table 20. A possible explanation for this may be the fact that in our study all the rats sampled were taken by clap-traps, not in traps baited with poison. So maybe poisoned rats are an easy prey for the fox, as sick animals are a much easier prey than healthy ones.

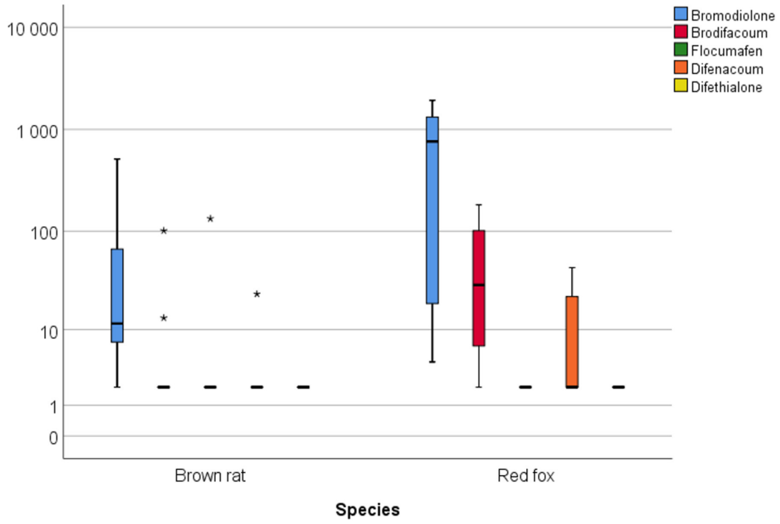

Figure 15: Box plot of rodenticides in liver samples of brown rat and red fox. Concentrations in ng/g ww. The upper and lower boundaries of the box are representing the 25th and 75th percentile, the horizontal line in the box marks the median. Outliers are plotted as circle (1.5-3 IQR from end of box) or asterisk (>3 IQR from the end of the box). The whiskers represent the minimum and maximum values without outliers.

Table 20: Mean concentrations with min-max interval below in grey colour of biocides in red fox liver and brown rat liver. All concentrations are given in ng/g ww. <LOD in light grey colour is given for compounds with no detected concentrations.

Compounds	Red fox	Brown rat
Bromadiolone	764 4.30-1923	117 LOD-512
Brodifacoum	57.5 LOD-182	12.1 LOD-101
Flocumafen	<LOD	13.5 LOD-133
Difenacoum	7.5 LOD-43.4	2.5 LOD-23.5
Difethialone	<LOD	<LOD
Sum Biocides	828 13.2-1982	103 LOD-508

2.12 Benzothiazoles

Benzothiazoles BZT and MBZT were investigated in one soil sample, one earthworm sample and one fieldfare egg sample from Kjelsås, a site near an artificial turf arena which may be a source for these contaminants due to rubber from recirculated car tires.

Both components were below laboratory blanks. Benzothiazole was < 30 ng/g and Mercaptobenzotiazol was < 3 ng/g for all samples. If excluded the influence of laboratory blanks, there were a small increase in concentrations from soil to earthworm to fieldfare eggs for MBZT. A re-investigation with a larger number of samples and extra care to avoid contamination is recommended in order to get more reliable results.

Compounds	Soil Kjelsås	Earthworm Kjelsås	Fieldfare egg Kjelsås
Benzothiazole BZT	<30	<30	<30
Mercaptobenzothiazole MBZT	<3	<3	<3

3 Compound classes across air, soil and species

In the following chapter we will only give a short summary of similarities and the dissimilarities in the load of the major compound classes across matrices. Each compound class has been discussed in the previous chapters across species, including box and whiskers plot. In this chapter we will summarize the dominating compound classes across environmental matrices using sum values and median sum concentrations. For air, soil and earthworm, we have chosen to report sum values per site since at least soil and earthworm samples are closely site related, and possibly air too. Birds and mammals move and migrate over larger distances in the Oslo area and median or mean sum values are more relevant for these species. The overview will first and foremost be given in form of graphical information in figures. Individual data can be found in the Annex 3.

3.1 Air

Air concentrations from passive samplers (PAS) given in pg/day (or ng/day) cannot be directly compared to concentrations in other environmental matrices, but spatial distribution and comparison of contaminant pattern in soil and earthworms can be performed. More importantly, comparison across sites for the air data has revealed that there are areas in Oslo that have higher concentrations than other places in Oslo for some of the pollutant groups.

The total load of pollutants in air from the Oslo sites can be a combination of local and more distant sources. However, a dominance of urban sources are most likely since the levels from the PAS in Oslo are elevated, compared to data from background stations such as Zeppelin (Svalbard) and Birkenes. This indicates the existence of a number of point sources/emissions caused by human activities in Oslo.

As in previous year's results, the emerging pollutants cyclic siloxanes (cVMS), chlorinated paraffins (CP) and OPFR were observed at highest concentrations in the air samples at the seven locations. cVMS were measured at highest concentrations (pg/day), followed by SCCP and OPFR. The very volatile siloxanes constituted between 40 to 98 % of the sum concentrations of all measured pollutants at the various sites. cVMS constituted 98% of the sum concentrations at VEAS, 80 % of the sum at Slottsparken and Bøler, 60 % of the sum at Frognerseteren and Kjelsrud, 50 % of the sum at Grønmo and 40 % at Alnabru.

In the special case of VEAS, the extreme high concentration of cVMS constituted 98 % of the sum concentration. This year, compared to 2018, the PUF and XAD-2 samplers for the various type of contaminants were placed more directly in the plume from the outlet of the pipe at VEAS, and higher concentrations were expected in 2019. However, due to mishandling of the samplers at VEAS, we cannot neglect possible contamination from indoor air. The repeated air sampling in 2020 at VEAS will confirm or refute the 2019 results.

In 2018, Slottsparken dominated with highest sum concentrations of the majority of the compound classes, but in 2019 both Alnabru and VEAS together with Slottsparken also dominated the results.

Slottsparken had highest sum concentrations of PCB and newBFR, in addition PFSA together with Grønmo. Alnabru had highest for PBDE and dechloranes, and VEAS had highest concentrations for the more volatile groups, see overview below and Table 21. The results from this year and previous years revealed that central city and industry areas in Oslo act as emission sources contributing with emissions to the total load in air of several pollutants.

Overview of locations with highest sum concentrations in air for the various compound classes:
PCB: Slottsparken > Alnabru
PBDE: Alnabru >> other locations
NewBFR: Slottsparken > Alnabru
Dechloranes (Dec): Alnabru > VEAS
PFSA: Grønmo ~ Slottsparken> Frognerseteren~ Kjelsrud
PFCA: VEAS >> Kjelsrud >Grønmo
OPFR: VEAS ~ Alnabru >Grønmo
CP: VEAS ~ Slottsparken >>Kjelsrud> Alnabru
cVMS: VEAS >>> Slottsparken > Kjelsrud

Table 21: Sum concentrations (pg/day) of the various pollutant groups in air at the seven sites in the Oslo area. <LOD concentrations were not included in the sum concentrations.

Site	PCB	PBDE	newBFR	Dec	PFSA	PFCA	OPFR	CP	cVMS
Slottsparken	**483**	1.57	**59.6**	3.17	**31.1**	2.21	5359	**11536**	**68623**
Frognerseteren	36.4	0.72	6.97	1.49	26.4	5.55	6297	4266	14371
Grønmo	26.2	0.83	2.01	1.74	**31.6**	7.15	8605	5060	11295
Alnabru	**126**	**141**	**14.5**	**13.5**	18.9	3.69	**15655**	7832	16807
VEAS	46.2	1.62	12.1	**8.07**	0.21	**73.1**	**16577**	**12144**	**1805984**
Bøler	40.0	1.56	6.19	1.42	17.3	3.26	1579	5024	21148
Kjelsrud	60.2	1.32	11.6	3.64	25.0	9.21	6989	8616	25203

3.2 Soil

In soil, as last years, the main contributors to the overall pollution were besides metals (where Pb was the major toxic metal), chlorinated paraffins (CP) and OPFR, see Table 22.

Frognerseteren revealed highest Pb and SumToxicMetal concentrations. After metals, and as last year, CP were the dominating organic pollutant class. PCB and PBDE played only a small role of the overall contamination at the various sites. The levels of PFSA and PFCA were comparable to 2018 data, and much lower than in 2017.

Overview of locations with highest sum concentrations in soil for the various compound classes:

Toxic metals:	Frognerseteren > Slottsparken
PCB:	Bøler > Slottsparken~Grønmo~Frognerseteren
PBDE:	Alnabru > Bøler
Dechloranes	Grønmo ~ Bøler
PFSA:	Bøler ~ Grønmo
PFCA:	Frognerseteren > Bøler
CP:	Frognerseteren > Bøler
cVMS:	Bøler >> Grønmo

Table 22: Sum concentrations (ng/g dw) of the various pollutant groups in soil at the seven sites in the Oslo area. <LOD concentrations were not included in the sum. OPFR is not included due to only one pooled sample. NewBFR and Phenols are not included due to most data <LOD.

Site	Toxic Metals	PCB	PBDE	Dechl.	PFSA	PFCA	CP	cVMS
Slottsparken	63829	3.46	0.65	0.43	0.55	0.91	1021	<LOD
Frognerseteren	**102257**	3.06	0.61	1.40	1.84	**8.14**	**1910**	<LOD
Grønmo	43057	3.12	1.29	**2.07**	**5.15**	2.64	1131	6.58
Alnabru	35837	1.70	**4.24**	1.08	3.19	0.97	522	<LOD
VEAS	21087	0.09	0.82	<LOD	0.15	0.34	458	<LOD
Bøler	29952	**9.16**	2.19	1.96	**5.24**	4.88	1634	**329**
Kjelsrud	35298	1.40	0.98	<LOD	0.61	1.04	<LOD[1]	<LOD

[1]: High LOD values for SCCP and MCCP

When comparing air and soil data, Slottsparken and Alnabru dominated the air concentrations, while for soil, the site Grønmo also revealed high concentrations of both CP and PCB. cVMS compounds dominate air samples, but these volatile compounds do not dominate soil samples, and are not detected in some soil samples, except from the Bøler site with 329 ng/g dw, where concentration of D4 was 216 ng/g dw.

3.3 Earthworms

Sum concentrations for earthworms (Table 23) revealed some similarities to sum concentrations of soil samples, and in agreement with 2018 data for earthworms. As for soil, Frognerseteren had highest sum of toxic metals in earthworms, due to high Pb concentration. Also as for soil, sumPFCA was highest at Frognerseteren, followed by Grønmo. The levels of PFCA can be related to the use of skiwax containing PFCA, but this is not certain. Alnabru had highest sumPFAS in agreement with the data from 2018. In agreement with soil data, CP were the dominating organic pollutant class.

Overview of locations with highest sum concentrations in earthworms for the various compound classes:

Toxic metals:	Frognerseteren >> Bøler
PCB:	Slottsparken > Grønmo~Alnabru
PBDE:	VEAS >Frognerseteren
Dechloranes	Frognerseteren ~VEAS~Grønmo
PFSA:	Alnabru > Grønmo
PFCA:	Frognerseteren> Grønmo
CP:	Kjelsrud > Slottsparken

*Table 23**:** Sum concentrations (ng/g ww) of the various pollutant groups in earthworms at the seven sites in the Oslo area. <LOD concentrations were not included in the sum. OPFR is not included due to only one pooled sample. NewBFR and Phenols are not included due to most data below LOD.*

Site	Toxic Metals	PCB	PBDE	Dec	PFSA	PFCA	CP
Slottsparken	5960	**3.61**	0.32	<LOD	14.0	18.7	78.8
Frognerseteren	**62986**	0.36	0.61	0.237	12.9	**34.4**	69.7
Grønmo	5490	2.59	0.03	0.216	57.0	21.1	70.1
Alnabru	3449	2.46	0.05	0.179	**65.2**	12.5	50.3
VEAS	4449	0.45	**1.92**	0.219	8.4	4.68	<LOD
Bøler	6662	0.23	<LOD	<LOD	6.10	7.03	<LOD
Kjelsrud	2588	1.13	0.04	<LOD	11.1	8.52	**152**

3.4 Pollutant loads across species and inter-species comparisons

In general, direct comparison of the pollutant concentrations detected in the investigated species is difficult, since different tissue types were sampled (whole earthworm, eggs and liver samples). As a result, only general conclusions can be drawn. There are major differences between the concentrations and patterns of accumulation of organic pollutants, and metals between the species involved in this study. Levels of organic pollutants, especially PCB and CP, are much higher in the top predators (eggs of sparrowhawk) than in the other species. On the other hand, metals were much higher in earthworms than in any other species, and much higher than the organic pollutant groups. PFAS, which primarily binds to proteins, behaves differently in biota compared to the “classic” organic pollutants such as PCB, however some PFAS have been shown to bioaccumulate like PCB.

Figure 16 shows the median sum concentrations of common groups of organic pollutants measured in the various species. Note that only two sparrowhawk eggs were available in 2019. Biocides were only measured in red fox and brown rat livers, and not included. OPFR were not included since only measured in earthworm (in addition to soil and air samples).

Figure 17 shows the box and whiskers plot of the sum concentrations of the same organic pollutant classes.

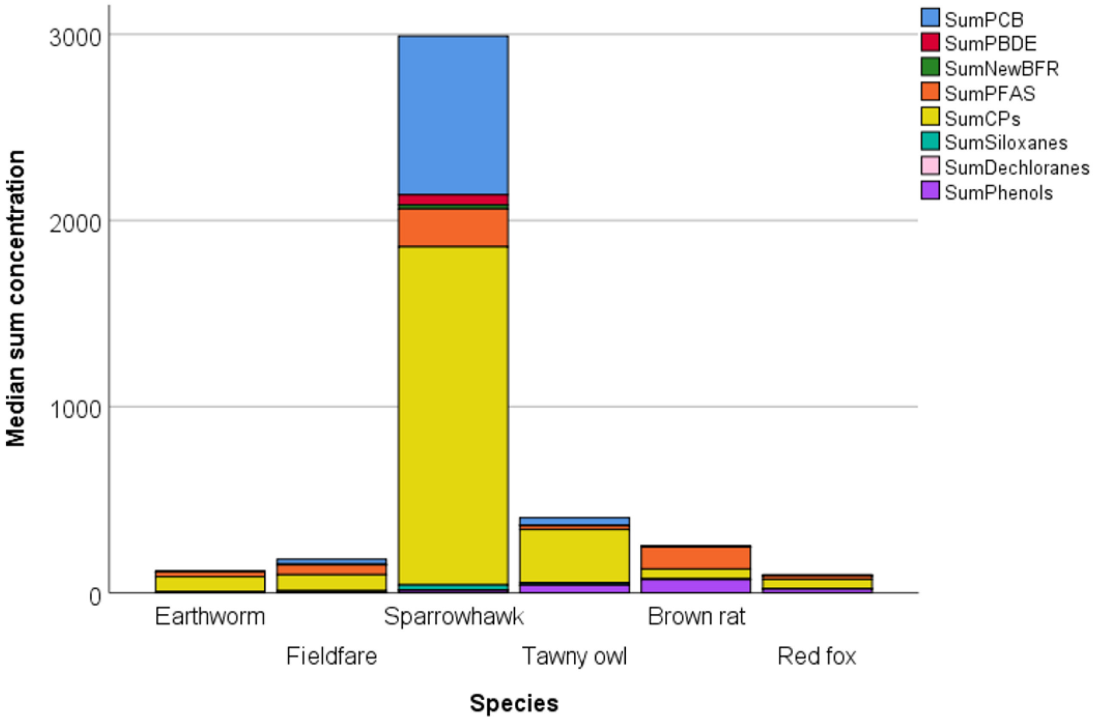

Figure 16: Organic pollutant groups in the various biota samples given by Median Sum concentrations (ng/g ww). Figure below shows percentage contribution of organic pollutant groups in the samples.

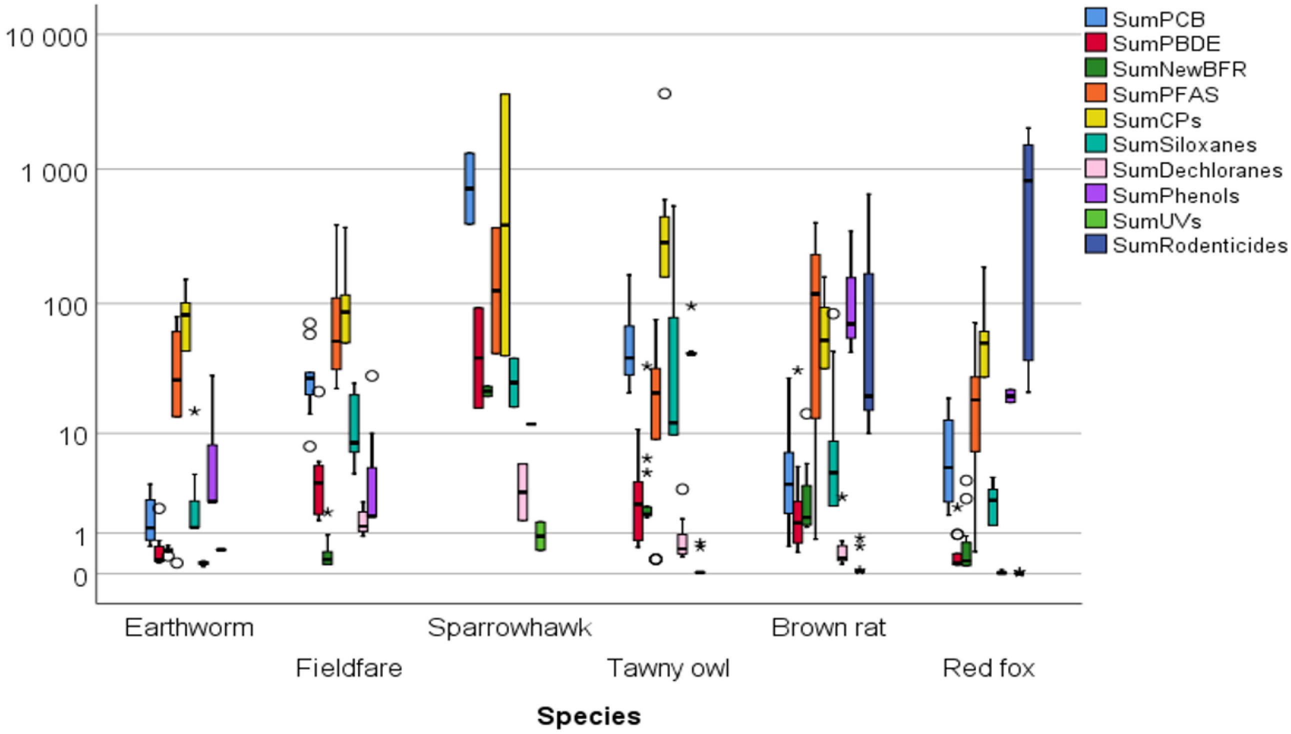

Figure 17: Box plot of the sum concentrations of the most dominating organic pollutant groups in the various biological samples. Concentrations are given in ng/g ww. The upper and lower boundaries of the box are representing the 25th and 75th percentile, the horizontal line in the box marks the median. Outliers are plotted as circle (1.5-3 IQR from end of box) or asterisk (>3 IQR from the end of the box). The whiskers represent the minimum and maximum values without outliers.

4 Bioaccumulation and biomagnification

As part of the sampling campaign, the following species representing a terrestrial food chain were sampled: Soil, earthworms, fieldfare eggs and sparrowhawk eggs. In our case, we use fieldfare eggs as representatives of fieldfare chicks, which are potential prey items of sparrowhawks, along with adult fieldfares. In addition, stable isotopes were determined as supporting parameters on all biological samples within this study. Using this information, trophic magnification factors (TMFs) were estimated to determine the bioaccumulation potential of a chemical within the food web. TMFs are increasingly used to quantify biomagnification and represent the average diet-to-consumer transfer of a chemical through food webs. They have been suggested as a reliable tool for bioaccumulation assessment of chemicals that have been in commerce long enough to be quantitatively measured in environmental samples. TMFs differ from biomagnification factors, which apply to individual species and can be highly variable between predator-prey combinations. The TMF is calculated from the slope of a regression between the chemical concentration and trophic level of organisms in the food web. The trophic level can be determined from stable nitrogen (N) isotope ratios (δ15N) (Borgå et al. 2012). The general scientific consensus is that chemicals are considered bioaccumulative if they exhibit a TMF > 1.

4.1 Results from stable nitrogen and carbon isotope analyses

$\delta^{15}N$ values can be used to estimate the relative trophic positions of an organism. Terrestrial food chains are in general very short, and biomagnification is generally assumed to be positively linked to food chain length such that the longer the food chain is, the higher the pollutant concentrations will be at the top of the food chain. Thus, despite bioaccumulation capabilities of some pollutants, top predators in the terrestrial food webs may be at lower risk for experiencing secondary poisoning than top predators in marine food webs, which are typically long. The strength of the relationship between tissue concentrations and trophic position is however also influenced by the properties of the chemicals, the types of tissue analysed, sampling period and location, and feeding habits of the species. In general, more lipophilic chemicals show stronger relationships between measured tissue concentrations and trophic position.

Table 24: $\delta^{15}N$ in the different sample types from the Oslo area.

Species	N	Mean	Median	Minimum	Maximum
Soil	7	1.07	0.94	-1.30	3.00
Earthworm	7	3.98	3.19	1.98	6.62
Fieldfare	9	7.04	7.02	5.88	7.81
Sparrowhawk	2	7.50	7.50	7.26	7.75
Brown rat	10	7.40	7.54	6.38	8.44
Red fox	10	8.21	8.28	6.85	9.71
Tawny owl	11	8.00	8.05	5.33	9.37

According to the measured $\delta^{15}N$ data, the organisms included in this monitoring cover different trophic levels. Earthworms showed the lowest $\delta^{15}N$ which is consistent with the fact that it holds the lowest tropic position among the different organisms/species in this study, while red foxes had highest mean value. Many of the other species had quite similar values.

Figure 18 shows the $\delta^{15}N$ signature of the investigated species. Differences between soil and earthworms to the other species are quite considerable, with moderate $\delta^{15}N$ enrichment further up the food web.

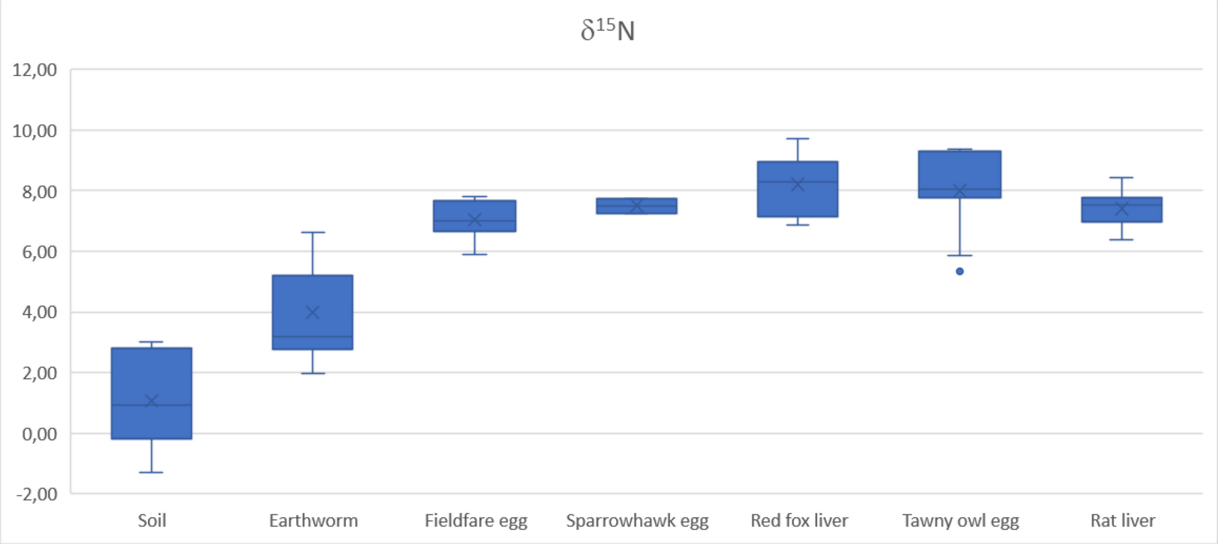

Figure 18: Box and whiskers plot of $\delta^{15}N$ (‰) values in all species analysed.

Nitrogen in the protein of consumers is generally enriched in $\delta^{15}N$ by 3–5‰ relative to prey nitrogen (i.e. $\delta^{15}N$ = 3–5‰). This nitrogen heavy isotope enrichment appears to be caused by isotopic fractionation occurring with transamination during protein catabolism (Doucett et al., 1999). This increase allows determination of an animal's trophic level (TL) in a food web (DeNiro and Epstein, 1978; Post, 2002).

In this present study from Oslo region, the red fox and tawny owl were characterized by the highest mean $\delta^{15}N$ values of 8.21 and 8.00, followed by sparrowhawk (7.50) and brown rat liver (7.40), fieldfare (7.04) and earthworms (3.98). The $\delta^{15}N$ values in 2019 were slightly lower than in 2018, where soil showed largest difference between years with a mean $\delta^{15}N$ value of 1.07 in 2019 compared to 2.6 in 2018. Tawny owl had the same mean $\delta^{15}N$ value as in 2017 when this species was last sampled.

Similar to the data from previous years, the two sparrowhawk eggs had relatively low levels of $\delta^{15}N$, and may indicate that the fractionation rate in this species or its prey species is different than expected. However, it might more likely be caused by the fact that the prey of the sparrowhawk is almost dominated by terrestrial prey. The fieldfare is considered to be a secondary consumer, feeding on insects, earthworms, berries and seeds. Since some insect species can be carnivorous also, they might reside on an equally high TL as the prey of sparrowhawk and thus causing elevated $\delta^{15}N$ values. Tillberg et al., found for example a difference in $\delta^{15}N$ of 6.0 ‰ among some ant colonies suggesting that estimates of trophic position in a single species can span up to two trophic levels (Tillberg et al., 2006).

$\delta^{13}C$ values provide information regarding the source of dietary carbon, e.g. whether and to what extent an organism feeds on marine or freshwater organisms or aquatic or terrestrial organisms. For example, samples from marine locations are expected to show a less negative $\delta^{13}C$ value than samples from terrestrial locations**.** However, direct comparison of the data presented in this report should be taken with care, since different tissues were analysed for the different species in the study (eggs, liver, whole individuals). Different tissues may have different $\delta^{13}C$ turnover rates and may reflect the dietary exposure differently and in an optimal study design only data from the same tissue type should be compared (optimally muscle tissue due to slow turnover rates).

The $\delta^{13}C$ levels found in the two sparrowhawk eggs were -25.8 and -24.4 (mean value -25.1) compared to the interval -27.6 to -24.9 with a mean of -25.9 in 2018. In 2017, $\delta^{13}C$ ranged from -26.2 to -24.5 with a mean value of -25.5. For comparison with the marine food chain, a range of $\delta^{13}C$ values between different gull species of -17 to -25 have been reported previously (Gebbink and Letcher 2012; Gebbink et al. 2011). Of the organisms, tawny owl and fieldfare eggs revealed lowest $\delta^{13}C$ concentrations (mean values), which was in accordance with 2017 and 2018 data, respectively.

Table 25: $\delta^{13}C$ levels in the different sample types.

Species	N	Mean	Median	Minimum	Maximum
Soil	7	-28.08	-28.17	-29.03	-27.09
Earthworm	7	-26.38	-26.22	-27.71	-25.12
Fieldfare	9	-26.37	-26.37	-27.00	-25.91
Sparrowhawk	2	-25.12	-25.12	-25.81	-24.42
Brown rat	10	-24.55	-24.65	-25.14	-24.02
Red fox	10	-24.53	-24.54	-25.56	-23.51
Tawny owl	11	-26.93	-26.81	-28.40	-25.61

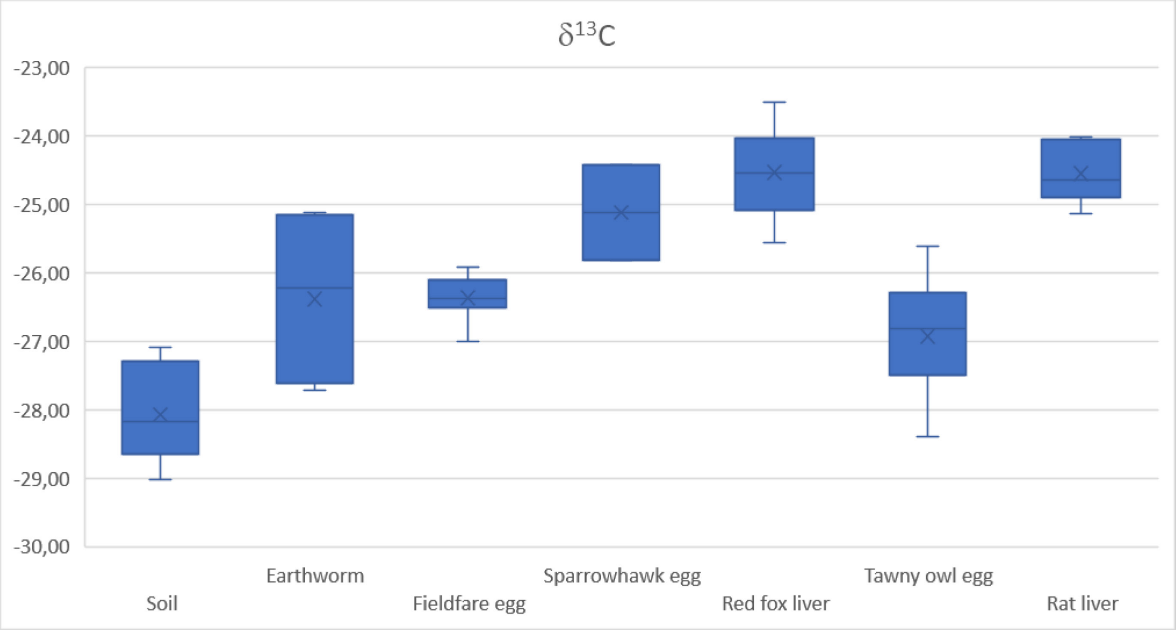

Figure 19: Box and whiskers plot of $\delta^{13}C$ values in the different species analysed.

$\delta^{34}S$ values provide information regarding the foraging ecology of certain species. Marine sulfate generally has higher $\delta^{34}S$ values than terrestrial materials or waters (Michener and Schell 1994) and sulfur isotope analyses have been used extensively in wetlands and fisheries studies to determine the amount of marine derived nutrients in estuarine systems (Hesslein et al. 1991; Kwak and Zedler 1997; MacAvoy et al. 2000). Using this method, Lott et al., managed to develop four foraging groups of raptors: Coastal bird-eaters (CB), coastal generalists (CG), inland bird-eaters (IB), and inland generalists (IG) (Lott et al., 2003).

Figure 20 illustrates the four foraging groups from Lott et al., 2003. Based on the δ^{34}S values from 2020 (Figure 21), sparrowhawk seem to belong to the bird eater category, tawny owls belong to the generalist's category and fieldfare to the inland generalists.

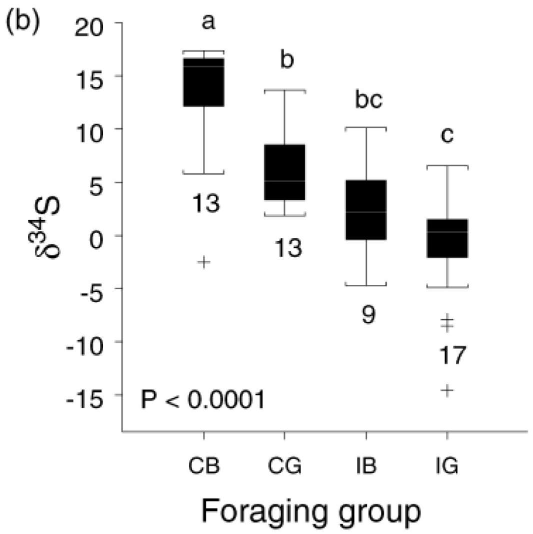

Fig. 2 Box plot showing the central 50% (*boxes*) and range (*lines*) of **a** δD_{f-p} and **b** δ^{34}S for four foraging groups of raptors: coastal bird-eaters (*CB*), coastal generalists (*CG*), inland bird-eaters (*IB*), and inland generalists (*IG*). Letters above boxes indicate group membership and numbers below boxes indicate sample size. + An outlier value

Figure 20: Boxplot illustrating δ^{34}S relationships in respect to foraging strategies in raptors, taken from (Lott et al., 2003).

Table 26: δ^{34}S levels in the different sample types.

Species	N	Mean	Median	Minimum	Maximum
Soil	7	11.04	11.72	2.27	16.09
Earthworm	7	-4.65	-3.00	-18.56	1.72
Fieldfare	9	-4.06	-3.54	-9.42	0.36
Sparrowhawk	2	0.52	0.52	-0.61	1.65
Brown rat	10	1.32	1.42	-1.91	5.77
Red fox	10	3.33	3.22	2.19	4.55
Tawny owl	11	2.12	2.02	0.53	5.10

As last year in 2018, earthworm and fieldfare eggs at VEAS had both the lowest δ^{34} S values.

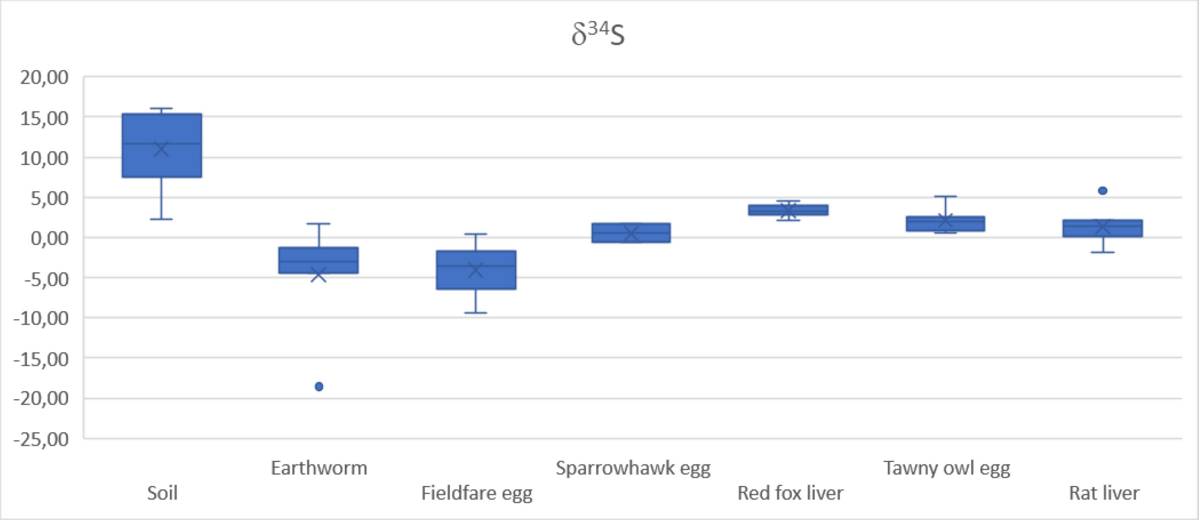

Figure 21: Box and whiskers plot of δ^{34} S values in the urban terrestrial environment in the Oslo area.

Fieldfare as a terrestrial omnivore (seeds, berries, earthworms and insects), shows a distinction to the sparrowhawk and other species, overlapping earthworm data. δ^{34} S levels are not enriched in the foodchain and stay stable within the same location, allowing comparison of foraging habits.

When relating all samples against δ^{13}C and δ^{15}N, the following graph is achieved, with soil samples in the lowest left corner followed by earthworm, fieldfare, tawny owl, sparrowhawk, brown rat and red fox. There are some overlap, but rather distinct clustering. Note that sparrowhawk data are only for two eggs. Tawny owl eggs and red fox liver data revealed a quite broad spread of data.

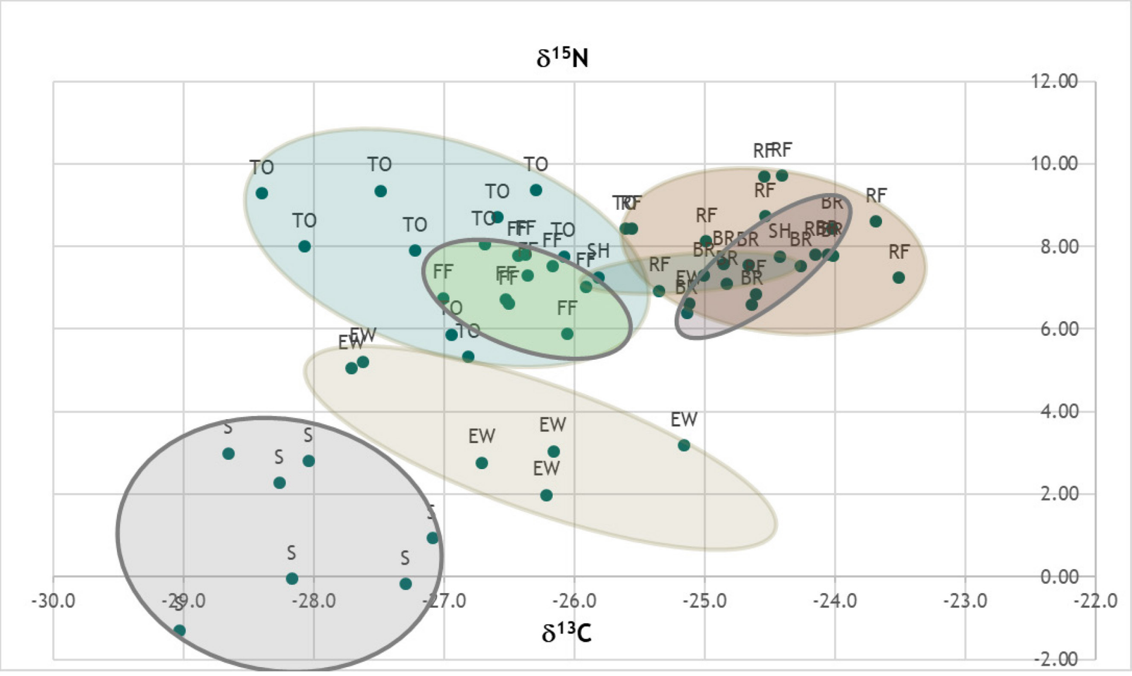

Figure 22: Relationship between the dietary descriptors $\delta^{15}N$ and $\delta^{13}C$ in soil and biota samples from urban terrestrial environment in Oslo, 2019; soil (S), earthworm (EW), fieldfare (FF), sparrowhawk (SH), red fox (RF), brown rat (BR), tawny owl (TO).

4.2 Estimation of biomagnification by calculation of TMF values

The selected species in this study represent species from the 2nd trophic level (earthworms), 2nd to 3rd (fieldfare) and the 3rd and 4th trophic level (brown rat, red fox and sparrowhawk). To assess the biomagnification of each chemical we correlated the lipid-corrected (except for the case of PFAS compounds, which are wet weight) log concentrations of the different pollutants in the different species of the food web with $\delta^{15}N$, i.e. information on the relative trophic position of the organisms. Within the frame of this study, we applied a foodchain approach earthworm (EW) – fieldfare (FF)–sparrowhawk (SH) to estimate the TMF.

$TL_{EW} = 2 * (\delta^{15}N_{EW} / \delta^{15}N_{EWmean})$

$TL_{FF} = 3 + (\delta^{15}N_{FF} - (\delta^{15}N_{EWmean} + 2.4))/3.8$

$TL_{SH} = 4 + (\delta^{15}N_{SH} - (\delta^{15}N_{EWmean} + 2.4))/3.8$

Trophic magnification factors (TMFs) were calculated as the power of 10 of the slope (b) of the linear regression between log concentration and the samples TL.

$\text{Log [compound]} = a + b\text{TL}$

$\text{TMF} = 10^b$

The here estimated TMFs must be treated with caution since the recommended tissue type (muscle) could not be used which is the basis for the TL equation for birds. Instead egg samples were available which are characterized by a much shorter turnover rate and thus reflect the short term exposure rather than the long term one.

With the use of a foodchain approach with data from 2014 to 2019 for earthworm, fieldfare and sparrowhawk eggs, the following results and calculated TMFs were obtained, see Table 27.

In the calculations, lipid weight concentrations for hydrophobic compounds, and wet weight basis for PFAS compounds, for the year 2014 to 2019 were used. Concentrations below LOD are included, and replaced by the formula; LOD* n/N. In addition, data from background/reference areas from year 2014 were included in the calculations.

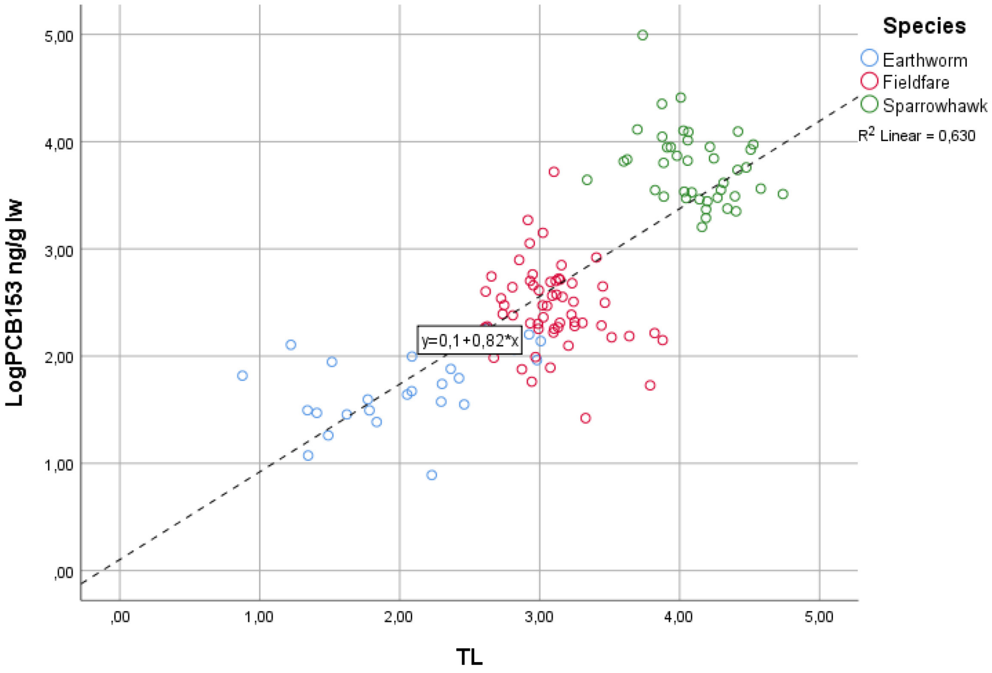

Figure 23: Relationship between trophic level (TL) and Log PCB153 based on data from the years 2014 to 2019.

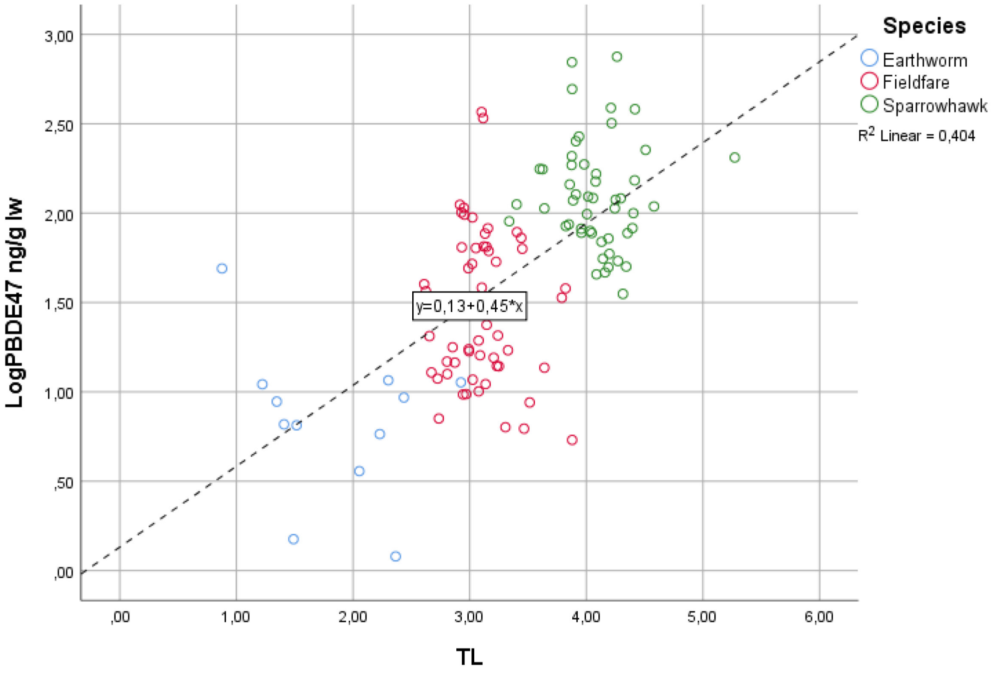

Figure 24: Relationship between trophic level (TL) and Log BDE47 for the 2014-2019 dataset.

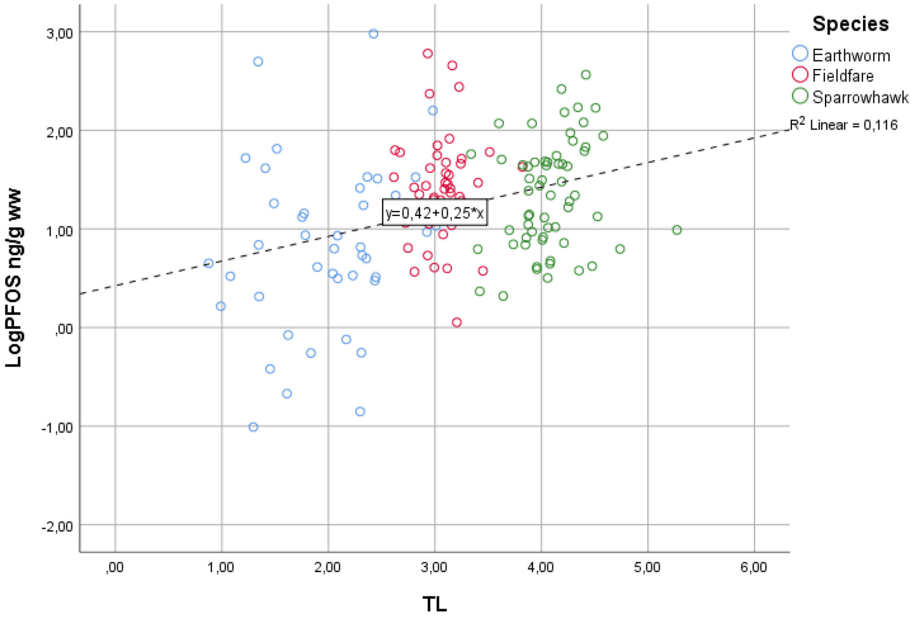

Figure 25: Relationship between trophic level (TL) and LogPFOS for the 2014-2019 dataset

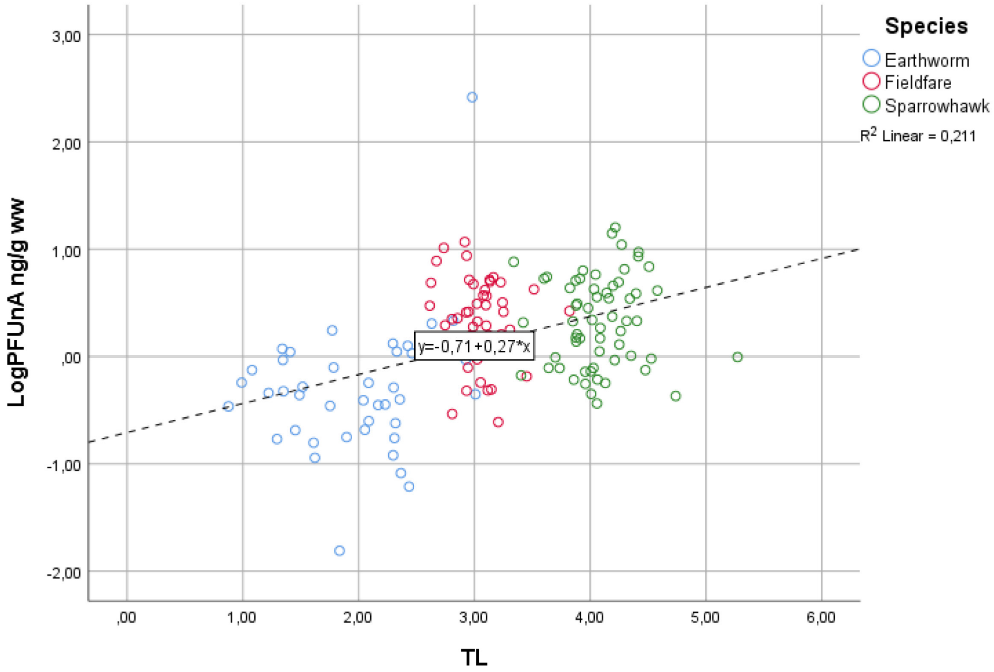

Figure 26: Relationship between trophic level (TL) and Log PFUnA for the 2014-2019 dataset, concentrations in ng/g ww.

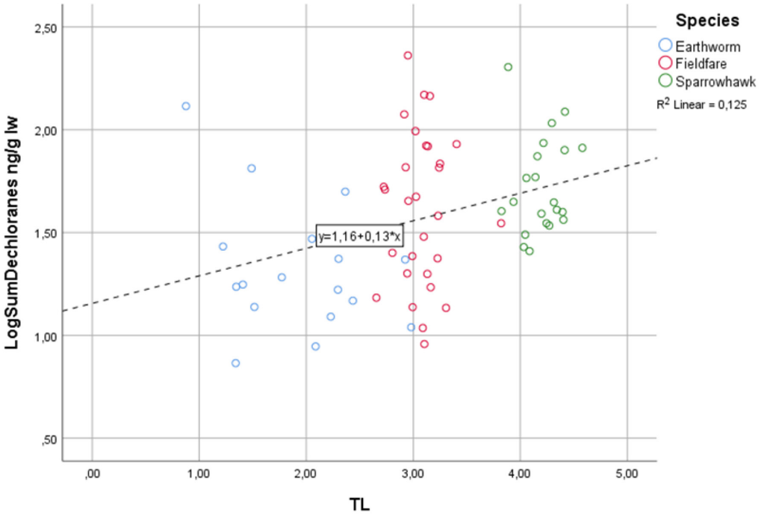

Figure 27: Relationship between trophic level (TL) and Log SumDechloranes for the 2014-2019 dataset, concentrations in ng/g lw.

*Table 27: Calculated TMF values of selected organic pollutants based on the 2014-2019 data for earthworm, fieldfare and sparrowhawk. P is based on the Spearman rank correlation between the log value of the compound (lw = lipid weight, ww = wet weight), NS = not significant, ** = P<0,01.*

Compounds	TMF	R	P
PCB153 lw	6.61	0.778	**
PCB138 lw	5.49	0.782	**
PBDE47 lw	2.82	0.631	**
PFUnA ww	1.86	0.444	**
PFTeA ww	1.74	0.393	**
PFTriA ww	1.55	0.393	**
PFOS ww	1.78	0.314	**
PFDoA ww	1.78	0.352	**
PFHxS ww	0.57	-0.252	**
D5 lw	1.02	0.081	NS
SumPBDE lw	2.75	0.660	**
SumPCB lw	5.75	0.772	**
SumPFAS ww	1.44	0.251	**
Sum Dechloranes lw	1.35	0.384	**

TMFs >1 indicate biomagnification of these compounds in the terrestrial foodchain.

In respect to these criteria, PCB153, BDE47, PFOS, PFUnA and PFTriA bioaccumulated in the observed food-chain based on the 2014-2019 data. PFOA, PFHxS, SCCP, MCCP, syn-DP and anti-DP did not biomagnify in this food chain. For these substances, either no clear trend or a decrease with trophic levels was observed.

Loi et al. (2011) reported TMF values of 1.3 and 1.74 for PFOS and PFUnA, respectively, in a subtropical food web in Hong Kong. However, a study of a terrestrial food chain lichen-caribou-wolf (Müller et al. 2011) revealed higher TMF values for PFOS (2.3-2.6) and PFUnA (2.2-2.9), and the authors concluded that the biomagnification process was mainly dependent on the fluorinated chain and not on the functional group of PFCAs and PFSAs.

Several of the single dechlorane compounds had few detectable concentrations in earthworms, sum concentrations of dechloranes were therefore applied to generate TMF. The sum concentrations of dechloranes revealed a TMF of 1.35. The compound dec-602 with few detectable concentrations in earthworm indicated an increase in the foodchain (data not shown here), while syn-DP, anti—DP and the sum of these two isomers, revealed TMF below 1, indicating trophic dilution. Published data on TMFs of dechloranes show no clear conclusion on the biomagnification of dechloranes, and TMF's from terrestrial food webs or foodchains are scarce. A recent study of terrestrial food web composed of terrestrial insects (beetles, grasshoppers, crickets, mole-crickets, butterflies, moths, mantises, and dragonflies) and lizards, revealed a TMF 1.7 of the sum of syn- and anti-DP (Liu et al. 2020). However, trophic dilution for DP was observed in the aquatic food web of the same study (Liu et al., 2020).

5 Changes over time of pollution loads

Data acquired for organic compound classes over the past five years of this project (2013/2014 – 2019) for birds and mammals were used to assess potential changes in levels over time. No statistical trend analysis was performed due to insufficient data material.

Data from air, soil and earthworm were not included because the sampling sites in Oslo for these matrixes have been changed since this monitoring program was started. Calculation of mean or median values were therefore less relevant for air, soil and earthworm than for birds and mammals that are moving over lager areas, although locations samples of red foxes have changed from year to year, and tawny owl egg samples did not come from the Oslo area in 2019.

We have graphically displayed the median sum concentrations of the most dominating organic pollutant groups for birds and mammals over the years (see Figure 28). Median sum was chosen due to some extreme concentrations in single samples from year to year which have high influence on the mean values. Note that tawny owl eggs were not available in 2018, and brown rat liver absent in 2014 and only two samples of sparrowhawk eggs were available in year 2019.

The general overview is that the PFAS, PCB and CP dominated the organic pollutant loads in the samples during the years 2014 to 2019. For sparrowhawk eggs, the PCB where the dominating organic pollutant class, followed by PFAS and CP. In fieldfare egg, the PFAS group had highest median sum concentrations, followed by PCB and CP. In red fox and brown rat liver, PFAS and CP revealed highest levels, especially the last years.

CP in sparrowhawk and tawny owl eggs revealed high fluctuations of median sum values over the years. It is uncertain if the high median sumCP concentration in tawny owl eggs from 2019 are due to different sampling locations in 2019 compared to 2017 and previous years. Especially CP in sparrowhawk revealed a large increase in median sumCP the last two years. It was one sample in year 2018 and one sample of two eggs in year 2019 with very high levels of CP. The two samples in 2018 and 2019 with very high CP concentrations were not from the same location. It is known that some sparrowhawks might stay in Norway during winter, but many will migrate to south-western Europe in the fall. We do not know if this large increase in concentration of CP is attributed to accumulated levels in Oslo area or due to accumulated levels from sources further south in Europe by the same birds as the previous years; or if it can be explained by different birds migrating to Norway in spring.

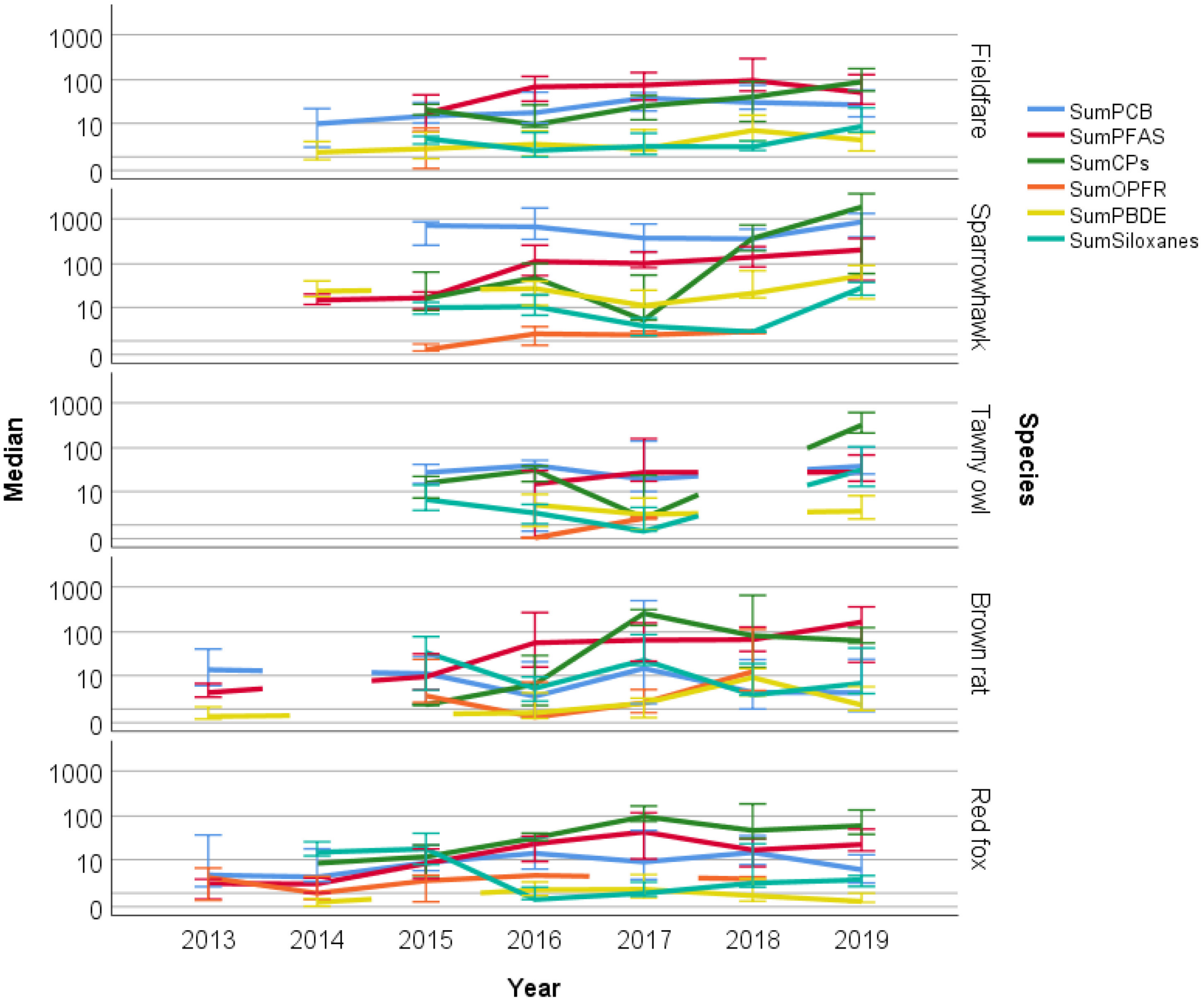

Figure 28: Changes over years of groups of organic pollutants in different biological sample types with Median value of sum concentrations including 95 % confidence interval. Concentrations are given in ng/g ww.

6 Conclusion and Recommendations

This report presents the findings from the sixth year of the urban terrestrial programme.

The median of sum concentrations of the various pollutant group in the investigated species was in agreement with the preceding years and as follows[1,2,3]:

- Air : cVMS >> CP > OPFR >>PCB
- Soil : ToxicMetals (~OPFR) >>CP > Phenols
- Earthworm : ToxicMetals >> CP >PFAS ~ Phenols
- Fieldfare egg : PFAS ~CP > ToxicMetals ~PCB
- Sparrowhawk egg : CP > PCB > PFAS > ToxicMetals
- Tawny owl : CP > ToxicMetals > PCB >PFAS
- Red fox liver : Biocides > ToxicMetals > CP >PFAS
- Brown rat liver : ToxicMetals >>PFAS> Phenols> CP

[1] TCPP extreme high concentration in one pooled soil sample; OPFR group
[2] SumToxicMetals is the sum of Hg, Cd, Pb and As.
[3] Only two sparrowhawk eggs in 2019

An estimation of the trophic magnification was carried out for the foodchain:
earthworm - fieldfare – sparrowhawk

In order to assess the bioaccumulation potential, trophic magnification factors (TMF) were calculated. The TMF calculations revealed that the typical hydrophobic and well known POPs such as PCB and PBDE, had TMF well above 1, and a high potential for magnification in the food chain earthworm-fieldfare-sparrowhawk investigated in this study. These findings are in agreement with published literature on freshwater- and marine food webs (Ruus et al., 2017; Munoz et al., 2017; Zhou et al., 2016; Walters et al, 2011). TMF for PFOS, PFUnA, PFTRiA and sum of dechloranes were also above 1, but the data were more scattered and had a less clear linear relationship.

The following findings and recommendations should be followed up in future campaigns:

- Although lower PFOS-levels were detected in 2019 and 2018 than in 2017, fieldfare from the locality Grønmo (former landfill) had the highest concentrations of PFOS of all samples. Earthworm from both Grønmo and Alnabru had higher PFOS-concentration than the other sites.

- In order to better understand if other PFAS are present than the ones targeted by this study, we suggest the measurement of extractable organic fluorine (EOF) in some samples and locations with high PFAS-concentrations. This additional data would give valuable information on the presence of other PFAS compounds emitted to the urban environment.

- Fieldfare from Kjelsås (near an artificial turf arena) revealed for the fourth year a high concentration of Pb. Soil and earthworm from Frognerseteren had the highest Pb-concentrations of all samples.

- Potential sources for Pb at Frognerseteren should be investigated.

- One pooled soil-sample comprising the seven soil-samples, had very high concentration of the OPFR-compound TCPP. We recommend to analyse TCPP in the respective seven soil-samples to investigate if this high concentration is attributed to one polluted site or not.

- Biocide concentrations were comparable to the results from 2018, and still higher in red fox liver than in rat liver, and may indicate secondary poisoning of some of the red foxes.

- We suggest to include measurements of biocides in raptor-samples as we in this study observed an increased risk of secondary poisoning of top predators.

- cVMS, SCCP/MCCP, OPFR and PCB play an important role as air pollutants in Oslo. Campaigns to better clarify spatial variations of air pollutants in the city centre is needed, and continuous monitoring similar to that at Birkenes and Zeppelin is recommended (Monitoring of environmental contaminants in air and precipitation, annual report 2018; Bohlin-Nizzetto et al., 2019) .

- Sampling should be improved in the future with use of traps for red fox and badger to be able to catch animals closer to the city, and over a larger area.

- We propose to investigate pollutant-load in relevant scavenger insects and/or insects living on organic material in soil.

By keeping and building on this monitoring scheme, we can expect to follow pollutant-levels over time in the Oslo-region and establish temporal and spatial trends, and in addition identify hotspots where mitigation and management measures can be implemented.

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Appendix 1

Introduction & methods

Introduction

Background and objectives

The main objective of this monitoring study was to investigate the concentrations of selected organic and inorganic pollutants and their bioaccumulation potential and possible adverse effects in species living in a terrestrial and urban ecosystem. The urban sites in or in the near vicinity of Oslo were identified for sampling. The results from this study will feed into the evaluation of potential environmental hazards and ongoing regulatory work, at both national- and international level. The project had the following key goals:

- Report concentrations of chosen environmental pollutants in several trophic levels of the terrestrial food chain
- Evaluate the bioaccumulation potential of pollutants in the terrestrial food chain
- Evaluate the total exposure in terrestrial animals
- Evaluate how land-living species are exposed to a variety of pollutants
- Evaluate trends in various pollutants over time

Investigated samples

Sparrowhawk (*Accipiter nisus*).
The sparrowhawk is a small bird of prey with a widespread distribution in Norway. It feeds mainly on birds of small to medium size, and thrushes (*Turdidae*) are preferred prey (Haftorn 1971, Hagen 1952). It commonly occurs close to human habitations, where it can breed in different types of forest patches. Most of the population migrates to south-western Europe during winter, but some individuals stay, and often feed on small garden birds during winter (Haftorn 1971). The sparrowhawk is on top of a terrestrial food-chain (invertebrates-small birds-sparrowhawk) and is therefore subjected to bioaccumulation of persistent organic pollutants (POPs). The sparrowhawk is a protected species in Norway, so the collection of eggs for analysis was carried out under a special license issued by the Norwegian Environment Agency. The species nests in stick-nests in forests or forest patches and lays 4-6 eggs. It has been documented that the sparrowhawk is one of the species most affected by environmental pollutants in Europe after World War II (Bennington 1971, Bennington 1974, Burgers et al. 1986, Cooke 1979, Newton et al. 1986, Ratcliffe 1960), and also in Norway (Bühler & Norheim 1981, Frøslie et al. 1986, Holt & Sakshaug 1968, Nygård et al. 2006, Nygård & Polder 2012). Estimated trophic level 4.

Tawny owl (*Strix aluco*)
The tawny owl is a medium sized owl, nesting at Østlandet, Vestlandet and in Trøndelag in Norway. Its habitat is connected to forest borders in cultivated areas, parks and old gardens. It is nesting in hollow trees, also in cities. In absence of hollow trees, it can nest in nestboxes. The Tawny owl lays 3-4 eggs, early in spring (March, April). Voles and other rodents contribute with almost 75% to its diet, with birds as an additional prey. Frogs, squirrel and other small owl species have been observed as prey too. The adult birds are mostly stationary, reflecting local pollution in its eggs. The Tawny owl is a protected species and only one egg from each nest was taken, under permission from the Norwegian Environment Agency. Estimated trophic level 3.

Fieldfare (*Turdus pilaris*)

The fieldfare is a member of the thrush family and is a common breeding bird in Eurasia. It is a migratory species; birds that breed in the northern regions migrate to the south and south-west in the winter. The majority of the birds that breed in Norway spend the winter months in south-west Europe (Bakken et al. 2006). It is omnivorous, with its diet mainly consisting of invertebrates during spring and summer, especially earthworms. The diet changes more to berries, grain and seeds during autumn and winter (Haftorn 1971). Estimated trophic level 3.

Earthworms (*Lumbricidae*)

Earthworms are animals commonly living in soil feeding on live and dead organic matter. Its digestive system runs through the length of its body. It conducts respiration through its skin. An earthworm has a double transport system composed of coelomic fluid that moves within the fluid-filled coelom and a simple, closed blood circulatory system. Earthworms are hermaphrodites, having both male and female sexual organs. Earthworms form the base of many food chains. They are preyed upon by many species of birds (e.g. starlings, thrushes, gulls, crows), mammals (e.g. bears, badgers, foxes, hedgehogs), and invertebrates (e.g. ground beetles, snails). They are found almost anywhere in soil that contains some moisture (Macdonald 1983). Lumbricus terrestris was the most common species. Estimated trophic level 2 (Hui et al. 2012).

Red fox (*Vulpes vulpes*)

The red fox is the most abundant carnivore in Europe and is widespread. It is found over most of the world. It inhabits most of Norway, from the mountains, through the forests and the agricultural landscape and is also found in the cities. It primarily feeds on rodents, but it is a generalist predator feeding on everything from small ungulate calves, hares, game-birds and other birds, reptiles and invertebrates, to human offal. Estimated trophic level 3-4.

Brown rat (*Rattus norvegicus*)

The brown rat is one of the most common rats in Europe. This rodent can become up to 25 cm long. The brown rat can be found wherever humans are living, particularly in urban areas. It is a true omnivore, feeding on everything from bird eggs to earthworms and human waste. The brown rat breeds throughout the whole year, producing up to 5 litters a year. Estimated trophic level: 3-4.

Soil

Soil samples were taken from the surface layer (0-20 cm), combining three subsamples to one combined sample per location. The locations for soil samples were the same locations as for the earthworm samplings to make direct comparisons possible.

Air

Two types of PAS adsorbents were used at all sites: i) polyurethane foam (PUF), and ii) polystyrene-divinylbenzene copolymeric resin (XAD). The PAS were deployed over a period of three months (late June/early July to October 2018) giving time-weighted mean concentration over that time period. The two types of PAS were chosen to collect a wide spectrum of volatile and semi-volatile pollutants; i) PUF disks were used to collect semi-volatile non-polar pollutants (i.e. PCB, PBDE, nBFR, CP, and OPFR), and ii) XAD was used to collect more volatile and more polar pollutants (i.e. siloxanes and PFAS). While XAD is considered a pure gas-phase sampler, the PUF-PAS can also sample particle-associated compounds to some extent although with lower accuracy. Some particle-associated compounds (e.g. BDE-209) are collected by the PUF-PAS, but the results should be considered as less certain due to the uncertainties of the uptake in the sampler (which is not designed to sample particles, but gases) (Bohlin et al., 2014; Melymuk et al., 2016). The PUF disk and the XAD are placed in metal containers specially designed for each sampler type to control the uptake of chemicals. The use of PAS for volatile-semivolatile organic pollutants is considered as a good sampling strategy for screening at several sites simultaneously (Melymuk et al., 2016). It is important to highlight that the

PAS are designed as complementary tools to active air samplers and that the PAS provide semi-quantitative levels which should be treated with caution in further analyses. The data from PAS can be compared between sampling sites when normalized to ng/day or further converted to estimated concentrations in air (pg/m3). Conversion to estimated concentrations is done using class-specific uptake rates obtained from calibration studies (Bohlin et al. 2014; Melymuk et al., 2016). The estimated concentrations in air can then be compared with data from active air samplers in previous studies. However, a direct comparison to data from active samplers used at monitoring stations (for example Zeppelin and Birkenes stations) should be done with caution as the accumulation in PAS and the applied uptake rates introduce factors of uncertainty.

For the targeted pollutants in this study there are published uptake rates from calibration studies for PCB, PBDE, cVMS and CP, but not for PFAS, OPFR and dechloranes (Bohlin et al., 2014; Krogseth et al., 2013; Li et al., 2012). For PCB and CP, an uptake rate of 4 m^3/day is used in this study (Harner et al., 2006; Bohlin et al., 2014; Li et al., 2012). For PBDE an uptake rate of 2 m^3/day is used (Bohlin et al., 2014) and for siloxanes an uptake rate of 0.5 m^3/day was used (Krogseth et al 2013a). Data from the PAS in this study are presented as ng/day for all targeted pollutants and as estimated air concentrations (pg/m^3 or ng/m^3) for the pollutants with uptake rates as mentioned above, without including physical-chemical properties for the specific compounds and ambient temperature for the specific site in the sampling period. Due to the uncertainty of uptake rates, it is first recommended to make a relative comparison of levels (ng/day) across sites for the various pollutant groups in this present study.

Investigated pollutants

In this study a total of 132 compounds were investigated. These included metals, seven PCB, PFAS, PBDE, new BFR, three siloxanes (D4, D5 and D6), chlorinated paraffins (SCCP and MCCP), organic phosphorous compounds (OPFR), UV compounds, biocides and phenolic compounds, together with the stable isotopes $\delta^{15}N$, $\delta^{13}C$ and $\delta^{34}S$. OPFR and UV compounds were measured in a selection of pooled samples, representing the species covered within the project. An overview over the analysed compounds is given in Table 28.

Table 28: Overview over analysed compounds.

Parameters	Abbreviation	CAS number
Metals		
Chromium	Cr	7440-47-3
Nickel	Ni	7440-02-0
Copper	Cu	7440-50-8
Zinc	Zn	7440-66-6
Arsenic	As	7440-38-2
Silver	Ag	7440-22-4
Cadmium	Cd	7440-43-9
Lead	Pb	7439-92-1
Total-Mercury	Hg	7440-02-0
Polychlorinated biphenyls (PCB)		
2,4,4'-Trichlorobiphenyl 28	PCB-28	7012-37-5
2,2',5,5'-Tetrachlorobiphenyl 52	PCB-52	35693-99-3
2,2',4,5,5'-Pentachlorobiphenyl 101	PCB-101	37680-73-2
2,3',4,4',5-Pentachlorobiphenyl 118	PCB-118	31508-00-6
2,2',3,4,4',5'-Hexachlorobiphenyl 138	PCB-138	35065-28-2
2,2',4,4',5,5'-Hexachlorobiphenyl 153	PCB-153	35065-27-1
2,2',3,4,4',5,5'-Heptachlorobiphenyl 180	PCB-180	35065-29-3
Per- and polyfluorinated alkyl substances (PFAS)		
PFCA (perfluorinated carboxylate acids)		
Perfluorinated butanoic acid	PFBA	307-24-4
Perfluorinated hexanoic acid	PFHxA	375-85-9
Perfluorinated heptanoic acid	PFHpA	335-67-1
Perfluorinated octanoic acid	PFOA	375-95-1
Perfluorinated nonanoic acid	PFNA	335-76-2
Perfluorinated decanoic acid	PFDcA	2058-94-8
Perfluorinated undecanoic acid	PFUnA	307-55-1
Perfluorinated dodecanoic acid	PFDoA	72629-94-8
Perfluorinated tridecanoic acid	PFTriA	376-06-7
Perfluorinated tetradecanoic acid	PFTeA	67905-19-5
Perfluorinated hexadecanoic acid	PFHxDA	16517-11-6
Perfluorinated octadecanoic acid	PFOcDA	375-73-5
PFSA (Perfluorinated sulfonates)		
Perfluorinated butane sulfonate	PFBS	
Perfluorinated pentane sulfonate	PFPS	2706-91-4
Perfluorinated hexane sulfonate	PFHxS	355-46-4
Perfluorinated heptane sulfonate	PFHpS	375-92-8
Perfluorinated octane sulfonate (linear)	PFOS	2795-39-3
Perfluorinated octane sulfonate (branched)	brPFOS	
Perfluorinated nonane sulfonate	PFNS	17202-41-4
Perfluorinated decane sulfonate	PFDcS	67906-42-7
Perfluoroundecane sulfonate	PFUnS	
Perfluorododecane sulfonate	PFDoS	
Perfluorotridecane sulfonate	PFTrS	

Perfluorotetradecane sulfonate	PFTS	
nPFAS (polyfluorinated neutral compounds)		
Perfluorooctane sulfonamide	PFOSA	754-91-6
N-Methyl perfluorooctane sulphonamide	meFOSA	31506-32-8
N-Ethyl perfluorooctane sulfonamide	etFOSA	4151-50-2
N-Methyl perfluorooctane sulfonamidoethanol	meFOSE	24448-09-7
N-Ethyl perfluorooctane sulfonamidoethanol	etFOSE	1691-99-2
6:2-Fluorotelomer alcohol	6:2 FTOH	647-42-7
8:2-Fluorotelomer alcohol	8:2 FTOH	678-39-7
10:2-Fluorotelomer alcohol	10:2 FTOH	865-86-1
12:2-Fluorotelomer alcohol	12:2 FTOH	39239-77-5
newPFAS		
6:2 Fluorotelomersulfonate	6:2 FTS	27619-97-2
8:2 Fluorotelomersulfonate	8:2 FTS	481071-78-7
10:2 Fluorotelomersulfonate	10:2 FTS	120226-60-0
12:2 Fluorotelomersulfonate	12:2 FTS	149246-64-0
Polybrominated diphenylethers (PBDE)		
2,2',4,4'-Tetrabromodiphenylether 47	BDE-47	5436-43-1
2,2',4,4',5-Pentabromodiphenylether 99	BDE-99	60348-60-9
2,2',4,4',6-Pentabromodiphenylether 100	BDE-100	189084-64-8
3,3',4,4',5-Pentabromodiphenylether 126	BDE-126	366791-32-4
2,2',4,4',5,5'-Hexabromodiphenylether 153	BDE-153	68631-49-2
2,2',4,4',5,6'-Hexabromodiphenylether 154	BDE-154	207122-15-4
2,2',3,3',4,5',6-Heptabromodiphenylether 175	BDE-175	446255-22-7
2,2',3,4,4',5',6-Heptabromodiphenylether 183	BDE-183	207122-16-5
2,3,3',4,4',5,6- Heptabromodiphenylether 190	BDE-190	189084-68-2
2,2',3,3',4,4',5,6'-Octabromodiphenylether196	BDE-196	446255-38-5
2,2',3,3',5,5'6,6'-Octabromodiphenylether 202	BDE-202	67797-09-5
2,2',3,3',4,4',5,5',6-Nonabromdiphenylether 206	BDE-206	63936-56-1
2,2',3,3'4,4',5,6,6'-Nonabromodiphenylether 207	BDE-207	437701-79-6
Decabromodiphenylether 209	BDE-209	1163-19-5
New BFR		
Decabromodiphenyl ethane	DBDPE	84852-53-9
2,4,6-tribromophenyl ether)	ATE (TBP-AE)	3278-89-5
α-1,2-Dibromo-4-(1,2-di-bromo-ethyl)cyclohexane	α-TBECH	3322-93-8
β-1,2-Dibromo-4-(1,2-di-bromo-ethyl)cyclohexane	β-TBECH	
γ/δ- 1,2-Dibromo-4-(1,2-di-bromo-ethyl)cyclohexane	γ/δ-TBECH	
2-bromoallyl 2,4,6-tribromophenyl ether	BATE	99717-56-3
1,2,3,4,5 Pentabromobenzene	PBBZ	608-90-2
Pentabromotoluene	PBT	87-83-2
Pentabromoethylbenzene	PBEB	85-22-3
Hexabromobenzene	HBB	87-82-1
2,3-dibromopropyl 2,4,6-tribromophenyl ether	DPTE	35109-60-5
2-Ethylhexyl 2,3,4,5-tetrabromobenzoate	EHTBB	183658-27-7
1,2-Bis(2,4,6-tribromophenoxy)ethane	BTBPE	37853-59-1
2,3,4,5-tetrabromophthalate	TBPH (BEH /TBP)	26040-51-7
Dechloranes and dibromo-aldrin		
Dechlorane plus syn	syn-DP	135821-03-3
Dechlorane plus anti	anti-DP	135821-74-8
Dechlorane 601	Dec-601	3560-90-2
Dechlorane 602	Dec-602	31107-44-5
Dechlorane 603	Dec-603	13560-92-4
Dechlorane 604	Dec-604	34571-16-9
Dibromo-aldrin	DBA	20389-65-5
1,5-Dechlorane Plus monoadduct	1,5-DPMA	Not available
1,3-Dechlorane Plus monoadduct	1,3-DPMA	Not available
Cyclic volatile methyl siloxanes	D4	556-67-2
	D5	541-02-6
	D6	540-97-6
Chlorinated paraffins		
Short-chain chlorinated paraffins (C10-C13)	SCCP	85535-84-8

Medium-chain chlorinated paraffins (C14-C17)	MCCP	85535-85-9
Organic phosphorous flame retardants (OPFR)		
Tri(2-chloroethyl)phosphate	TCEP	115-96-8
Tris(2-chloroisopropyl) phosphate	TCPP/TCIPP	13674-84-5
Tris(1,3-dichloro-2-propyl)phosphate	TDCPP/TDCIPP	13674-87-8
Tris(2-butoxyethyl) phosphate	TBEP/TBOEP	78-51-3
2-etylhexyldiphenyl phosphate	EHDP/EHDPP	1241-94-7
Tricresyl phosphate	TCP	1330-78-5
Tri-n-butylphosphate	TBP/ TnBP	126-73-8
Tri-iso-butylphosphate	TBP/TiBP	126-71-6
Triethyl phosphate	TEP	78-40-0
Tripropyl phosphate	TPrP/TPP	513-08-6
Triisobutyl phosphate	TiBP	126-71-6
Butyl diphenyl phosphate	BdPhP	2752-95-6
Triphenyl phosphate	TPP/TPhP	115-86-6
Dibutylphenyl phosphate	DBPhP	2528-36-1
Trixylylphosphate	TXP	25155-23-1
Tris(4-isopropylphenyl)phosphate	TIPPP/T4IPP	26967-76-0
Tris(4-Tert-butylphenyl)phosphate	TTBPP	78-33-1
Tris(2-ethylhexyl)phosphate	TEHP	78-42-2
UV compounds		
Octocrylene	OC	6197-30-4
Benzophenone-3	BP3	131-57-7
Ethylhexylmethoxycinnamate	EHMC	5466-77-3
UV-327	UV-327	3864-99-1
UV-328	UV-328	25973-55-1
UV-329	UV-329	3147-75-9
Biocides (Rodenticides)		
Bromadiolon		28772-56-7
Brodifacoum		56073-10-0
Flocumafen		90035-08-8
Difenacoum		56073-07-5
Difethialone		104653-34-1
Phenols		
4,4 Bisphenol A	Bis-A	80-05-7
2,4- Bisphenol A	2,4-Bis-A	837-08-1
4,4 Bisphenol S	Bis-S	80-09-1
2,4 Bisphenol S	2,4-Bis-A	5397-34-2
4,4 Bisphenol F	Bis-F	620-92-8
2,4 Bisphenol F	2,4-Bis-F	2467-03-0
2,2 Bisphenol F	2,2-Bis-F	2467-02-9
4-n-Nonylphenol	4n-nonyl	104-40-5
4-n-Octylphenol	4n-octyl	1806-26-4
4-t-Octylphenol	4t-octyl	140-66-9
Tetrabromobisphenol A	TBBPA	79-94-7
Benzothiazoles		95-16-9
Benzothiazole	BZT	95-16-9
Mercaptobenzothiazole	mBZT	149-30-4

Metals including Hg

Because of their high degree of toxicity, even at low concentrations, mercury (Hg), lead (Pb) cadmium (Cd) and arsenic (As) are considered priority metals that are of environmental and public health concern (Tchounwou et al. 2012; AMAP, 2009). This group is therefore of main focus in this report and defined as the group ‘toxic metals’. These metallic elements are considered systemic toxicants that are known to induce multiple organ damage, even at lower levels of exposure. Best studied is the uptake of metals from soil to invertebrates (Heikens et al. 2001). The impact these metals have on humans and animals is well known, and all four metals are considered as environmentally hazardous compounds (Latif et al. 2013). Recently, there has been an increased use of silver as nanoparticles. Nanotechnology makes it possible to combine silver (Ag) with other materials, such as different polymers. As a result, Ag now can be found in a variety of new products, which again lead to alteration of emission sources and patterns. Adsorbed Ag may have long residence time in the organism (Rungby 1990). Arsenic is also known as a toxic metalloid (Klaassen 2008). Among the different metals determined in the present work, Hg, Pb and Cd have a potential to bioaccumulate (Connell et al. 1984; Latif et al. 2013). However, Hg (as methyl-mercury (MeHg)) is the only metal with high bioaccumulation potential through food-chains.

Polychlorinated biphenyls (PCB)
Polychlorinated biphenyls (PCB) have been used in a variety of industrial applications since the 1930s. PCB were used in Norway until the 1980s, in cooling agents and insulation fluids, as plasticizers, lubricant oils, hydraulic fluids and sealants among others. Use of PCB was banned in Norway in 1980. They are known to degrade very slowly in the environment, are toxic, may bioaccumulate and undergo long-range environmental transport (Gai, et al. 2014). As a result, PCB are recognized as persistent organic pollutants (POPs) and are regulated under the Stockholm Convention and the convention on long-range transboundary air pollution (CLRTAP). They are widely distributed in the environment and can be found in air, water, sediments and biota. Most PCB are poorly water soluble, but dissolve efficiently in lipid-rich parts of organisms (hydrophobic and lipophilic). They can affect the reproduction success, impair immune response and may cause defects in the genetic material. PCB can be metabolized in organisms and form metabolites causing hormonal disturbances. This study includes the group of PCB found to be dominating in most environmental matrices, the non-dioxin like PCB, the so-called PCB7 group.

Polybrominated diphenylethers (PBDE)
Polybrominated diphenylethers (PBDE) is a group of additive flame retardants with a wide variety of uses in plastics/ polymers/composites, textiles, furniture, housings of computers and TVs, wires and cables, pipes and carpets, adhesives, sealants, coatings and inks. There are three commercial PBDE products, technical or commercial penta-, octa- and deca-BDE. These are all technical mixtures containing different PBDE congeners. Tetra-, penta-, hexa- and heptaBDE congeners were listed in the Stockholm Convention and CLRTAP in 2009, due to being persistent, bioaccumulative, and toxic chemicals that can undergo long-range environmental transport (Darnerud, 2003; Law et al., 2014). As a result, the commercial penta- and octa-PBDE mixtures were globally banned. The use of commercial decaBDE was banned in Norway in 2008. In the same year a restriction on the use of commercial decaBDE in electrical and electronic products entered into force in the EU. A restriction on the manufacture, use and placing on the market of decaBDE in EU enter into force in 2019. In North-America voluntary agreements with the industry have led to reduced use of decaBDE. Globally, commercial deca-BDE is still widely used and remains a high production volume chemical. However, an agreement for including decaBDE in the Stockholm Convention as a POP was settled in May, 2017.

The tetra- and pentaBDE congeners BDE 47 and 99, which were the main components of commercial pentaBDE mixtures, are among the most studied PBDE. The early documentation of congeners of the technical mixtures penta- and octa-BDE detected in the Arctic was one of the main reasons to ban production, import, export, sales and use of products with more 0.1 % (by weight) of penta-, octa- and deca-BDE in Norway. The regulation and banning of the PBDE, and most probably better waste handling, have resulted in a decrease of most BDEs, except BDE 209, the main component of commercial deca-BDE, over time (AMAP 2009; Helgason et al. 2009). Spatial trends of PBDE in arctic seabirds and marine mammals indicate that Western Europe and eastern North America are important source regions of these compounds via long-range atmospheric transport and ocean currents. The tetra- to hexa-BDEs biomagnify in arctic food webs while results for the fully brominated PBDE congener, BDE 209 or deca-BDE, are more ambiguous. Several lines of evidence show that also BDE-209 bioaccumulates, at least in some species. The available bioaccumulation data largely reflects species and tissue differences in uptake, metabolism and elimination, as well as differences in exposure and also analytical challenges in measuring BDE-209 correctly. Moreover, in the environment and biota, BDE-209 can debrominate to lower PBDE congeners that are more persistent, bioaccumulative and toxic. PBDE concentrations are often lower in terrestrial organisms compared to marine top predators (de Wit et al. 2010 and references herein).

New brominated flame retardants (New BFR)

As a result of the regulation of the penta- and octa-BDEs and more recently also deca-BDE, new non-PBDE BFRs have been introduced into the market as replacement FRs. For example, firemaster 550 (containing BEHTBP) is a replacement product for penta-BDE (Venier and Hites, 2008) that was introduced to the market in 2003 (Stapleton et al., 2008). Saytex 8010 (Albemarle) and Firemaster 2100 (Chemtura), which are common trade names for decabromodiphenyl ethane (DBDPE), are replacement products for deca-BDE that were introduced into the market in the mid-1980s (Umweltbundesamt, 2001).

Per- and polyfluorinated alkyl substances (PFAS)

Per- and polyfluorinated alkyl substances (PFAS) have been widely used in many industrial and commercial applications. The chemical and thermal stability of a perfluoroalkyl moiety, caused by a very strong C-F bond, in addition to its hydrophobic and lipophobic nature, lead to highly useful and enduring properties in surfactants and polymers. Polymer applications include textile stain and water repellents, grease-proof, food-contact paper and other food contact materials used for cooking. Surfactant applications that take advantage of the unparalleled aqueous surface tension–lowering properties include processing aids for fluoropolymer manufacture, coatings, and aqueous film–forming foams (AFFFs) used to extinguish fires involving highly flammable liquids. Numerous additional applications have been described, including floor polish, ski waxes, and water-proof coatings of textile fibers (Buck et al 2011). Since they are so persistent and hardly degrade in the environment, and due to their widespread use, PFAS have been detected worldwide in the environment, wildlife, and humans. Scientific studies focus on how these substances are transported in the environment, and to what extent and how humans and wildlife are exposed and their potential toxic effects (Butt et al. 2010; Jahnke et al. 2007; Kannan et al. 2005; Stock et al. 2007; Taniyasu et al. 2003; Trier et al. 2011). Studies have revealed the potential for atmospheric long-range transport of PFAS (Ahrens et al, 2011; AMAP Assessment 2015). Toxic effects on biological organisms and humans where for example discussed by Gai et al. (2014), Hagenaars et al. (2008), Halldorsson et al. (2012), Newsted et al. (2005), and Whitworth et al. (2012). Polyfluorinated acids are structurally similar to natural long-chain fatty acids and may displace them in biochemical processes and at receptors, such as PPARα and the liver-fatty acid binding protein (L-FABP). Perfluoroalkanoates, particularly PFOA, PFNA and PFDA, but not PFHxA, are highly potent peroxisome proliferators in rodent livers and affect mitochondrial, microsomal, and cytosolic enzymes and proteins involved in lipid metabolism. Beach et al. (2006) reported an increased mortality for birds (mallards *Anas platyrhynchos* and northern bobwhite quail *Colinus virginianus*) and a reduced reproduction success have been observed. PFOA and other PFAS are suspected to be endocrine disruptors and exposure during pregnancy has induced both early and later life adverse health outcomes in rodents. Associations between PFOA exposures and human health effects have been reported. PFOS, its salts and PFOSF are recognized as POPs, and are listed in the Stockholm Convention and CLRTAP. However globally, the production and use of PFOS, its salts and PFOSF is still allowed for certain applications. In Norway, PFOS and PFOA are banned, and the C9-C14 PFCAs and PFHxS[8] are on the Norway's Priority List of Hazardous substances as well as being included in the candidate list of substances of very high concern for Authorization in ECHA.

New PFAS

In addition to the well known PFAS, more than 5000 PFAS are on the global market for intentional uses, and the chemical identities of many are yet unknown (Wang et al., 2017). Emissions and leakage to the environment are unavoidable, and sooner or later, environmental concentrations will be reported. For example, in a recent study (MacInnis et al 2017) perfluoro-4-ethylcyclohexane-sulfonate (PFECHS) was detected for the first time in an atmospherically derived sample, and a

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[8] https://echa.europa.eu/documents/10162/40a82ea7-dcd2-5e6f-9bff-6504c7a226c5

potential source was attributed to aircraft hydraulic system leakage. Also, Pan reported the occurrence and bioaccumulation of hexafluoropropylene oxide trimer acid in surface water and fish (Pan et al., 2017). Gebbink et al. 2017, published findings of the PFOA replacement chemical GenX at all downstream river sampling sites with the highest concentration (812 ng/L) at the first sampling location downstream from a production plant in the Netherlands, proving the necessity of measuring for a broad range of emerging PFAS.

Cyclic volatile methyl siloxanes, (cVMS)
There are concerns about the properties and environmental fate of the three most common cVMS; D4, D5, and D6 (Wang et al., 2013). These compounds are used in large volumes in personal care products and technical applications and are released to the environment either through volatilization to air or through wastewater effluents. Once emitted to water, they can sorb to particles and sediments or be taken up by aquatic biota. They are persistent in the environment, can undergo long-range atmospheric transport, and can have high concentrations in aquatic biota, but often lower in the terrestrial environment. There is still limited knowledge on their toxicity, but D4 has been shown to display endrocrine disrupting effects. D4 and D5 are listed on Norway's priority list with the aim to stop emissions of these substances within 2020. The European Commission has published its Regulation to restrict the use of octamethylcyclotetrasiloxane (D4) and decamethylcyclopentasiloxane (D5) in wash-off cosmetic products in a concentration equal to or greater than 0.1% by weight.

Chlorinated paraffins (CP)
CP have been produced since the 1930s and the world production of CP was 300,000 tonnes in 2009. CP are used in coolants and lubricants in metal manufacturing industry and as plasticizers and flame-retardant additives in plastic, sealants, rubber and leather (KEMI, 2013, WHO 1996). The non-flammability of CP, particularly at high chlorine contents, relies on their ability to release hydrochloric acid at elevated temperatures, thereby inhibiting the radical reactions in flames (WHO, 1996).

There exist some data on SCCP and MCCP detected in Norwegian environment and other parts of the world, including Arctic. Air monitoring at Zeppelin observatory, Svalbard, reports air concentrations of sum S/MCCP around 300 pg/m3. In air collected at Bear Island (Norway), concentrations were 1.8 to 10.6 ng/m^3 (Borgen et al. 2003). In a screening study (Harju et al., 2013), SCCP and MCCP were detected in Norwegian Arctic biota. Levels of SCCP were found to dominate compared to MCCP in polar bear and seal plasma, kittiwake eggs, cod liver and polar cod. However, the opposite trend was observed for glaucous gull plasma and eider duck eggs where MCCP were found at higher concentrations. The data indicated that SCCP and MCCP biomagnified in Arctic food webs with TMF > 1. A recent subtropical marine food web study also indicated that SCCP and MCCP biomagnified with trophic magnification factors for ∑SCCP and ∑MCCP were 4.29 and 4.79 (Zeng et al 2017). In a Canadian freshwater study in Lake Ontaio and Lake Michigan , SCCP and MCCP were found to biomagnify between prey and predators from both lakes with highest values observed for Diporeia-sculpin (Lake Ontario, C15Cl9 = 43; Lake Michigan, C10Cl5 = 26). Trophic magnification factors for the invertebrates−forage fish−lake trout food webs from the same study ranged from 0.41 to 2.4 for SCCP and from 0.06 to 0.36 for MCCP (Houde et al., 2008). SCCP and MCCP have been found in sediments from landfills in Norway at levels of up to 19,400 and 11,400 ng/g ww with peak levels associated with waste deposition from mechanical and shipping industries (Borgen et al., 2003). CP have been detected in biota samples collected in Norway, SCCP ranged from 14 to 130 ng/g wet weight (ww) in mussels and were also detected in moss samples (3–100 ng/g ww), revealing the potential transportation of SCCP in the atmosphere (Borgen et al., 2003). In fish livers collected from samples in the North and Baltic Seas, SCCP and MCCP ranged from 19 to 286 and <10 to 260 ng/g ww (Geiss et al. 2010; Reth et al. 2006). In a recent study (Yuan & de Wit, 2018), SCCP and MCCP were measured in Swedish terrestrial birds and animals; SCCP and MCCP concentrations in starling were 360 and 310 ng/g lw, respectively; in peregrine falcon SCCP and MCCP were 580 and 410 ng/g lw. Bank vole had 420 and 30 ng/g and lynx had 820 and 750 ng/g lw for SCCP and MCCP, respectively. SCCP was included in the POPs Regulation (EC) 850/2004 by the amendment (EU) 2015/2030 in 2015. So far MCCP are not globally regulated, however, SCCP has recently been included in the Stockholm Convention, and a global regulation will be effectuated within November 2019.

Organophosphorous flame retardants (OPFR)
The global use of phosphorous containing flame retardants in 2001 was 186 000 tonnes (Marklund et al., 2005). Arylphosphate is used as a flame retardant, but also as a softener in PVC and ABS. They are also used as flame retardants in hydraulic oils and lubricants. Some PFRs are known to be very toxic. PFRs can be either inorganic or organic, and the organic PFRs can be divided into non-halogen PFRs and halogenated PFRs. In the halogenated PFRs chlorine is the most common halogen (Hallanger et al., 2015). In this study both halogenated and non-halogen organic PFRs are included. The chlorinated OPFR compounds are thought to be sufficiently stable for short- and medium-range atmospheric transportation (Regnery and Püttmann, 2009), and observations of PFRs in the marine environment (Bollmann et al., 2012) and in remote areas (Aston et al., 1996; Regnery and Püttmann, 2009, 2010), such as glacier-ice in the Arctic and particulate organic matter in Antarctic (Ciccioli et al., 1994; Hermanson et al., 2005) suggests that some PFRs are subject to long-range transport (Möller et al., 2012).

Dechloranes
Under the common term dechloranes we find different dechlorane structures and the closely related dibromoaldrine (DBALD). All of them are used as flame retardants or are impurities of DP and are polycyclic and highly chlorinated (or partly brominated) compounds. As the production of these compounds start with hexachlorocyclopentadiene (HCCP) they are chemically closely related to Mirex and a lot of other pesticides.

There is a growing international interest in dechlorane related compounds with an increasing number of scientific papers and reports on this compound group. A review study in 2011 on Dechlorane Plus (DP) summarized the available information as following: Dechlorane Plus (DP) is a high production volume and very persistent compound. DP is a global pollutant and has recently been detected along a pole-to-pole transect of the Atlantic Ocean. There seems to be one production site in North America and at least one in China. Beside DP there are other closely related compounds in the environment. These DP analogues have also been detected globally. Modelling data are in agreement with available environmental data, proposing DP and analogues to be persistent, bioaccumulative, and long-range transported (Sverko et al., 2011). A recent Norwegian screening study from the Oslo area reported detectable concentrations of syn- and anti-DP in rat liver samples, in influent, effluent and sludge from Vestfjorden Wastewater Treatment Plant (Veas) and in indoor house dust samples (Schlabach et al., 2017a).

In a screening study of Arctic biota samples Dec-602 was found in detectable concentrations in glaucous gull, kittiwake and polar bear. Syn- and anti-DP were only detected in ringed seal and polar bear samples (Schlabach et al., 2017b).

This year, also 1,3- and 1,5-DP-monoadducts (DPMA) were included. These compounds are positional isomers, and are thought to arise from the incomplete reaction of DP, or impurities in the DP starting material during its manufacture (Tomy et al., 2013).

In May 2019, Norway submitted a proposal to include Dechlorane Plus and its syn- and anti- isomers in Annexes A, B and/or C to the Stockholm Convention on Persistent Organic Pollutants (POPs)[9].

Alkylphenols and bisphenols

Nonyl- and octylphenols are used in manufacturing antioxidants, lubricating oil additives, laundry and dish detergents, emulsifiers, and solubilizers. Nonylphenol has attracted attention due to its prevalence in the environment and due to its ability to act with estrogen-like activity. Nonyl- and octylphenols are also precursors of the degradation products alkylphenol ethoxylates.

Waste water treatment plants are recipients from relevant sources such as roads, industries etc. of nonyl- and octylphenols besides degradation in the environment (Loyo-Rosales et al., 2007). Nonylphenol is rated harmful and corrosive, as well as harmful for the aquatic ecosystem (Preuss et al., 2006).

Bisphenol A (Bis-A) is an industrial chemical with high production volumes used in the production of polycarbonate plastics and epoxy resins. Due to its versatile use, Bis-A is a pollutant found in all ecosystems worldwide (Fromme et al. 2002). Especially the endocrine disrupting capability is of concern. Following opinions of scientists, public and regulators, manufacturers have begun to remove bisphenol A from their products with a gradual shift to using bisphenol analogues in their products. In these days two of the analogues – bisphenol S (Bis-S) and bisphenol F (Bis-F) have been mostly used as bisphenol A replacements. Bis-S is used in a variety of applications, for example as a developer in a thermal paper, even in the products marketed as “BPA-free paper”(Liao et al., 2012). Bis-S is also used as a wash fastening agent in cleaning products, an electroplating solvent and constituent of phenolic resins (Clark, 2000). Bis-F is used to make epoxy resins and coatings such as tanks and pipe linings, industrial floors, adhesives, coatings and electrical varnishes (Fiege et al., 2000). The brominated version, tetrabromobisphenol A, is used as one of the major brominated flame-retardants.

The restrictions for the use of Bisphenol A by the polymer industry triggered its replacement with bisphenol S (Bis-S) in thermal paper and other products. Bisphenol F (Bis-F) and bisphenol B (Bis-B) can replace Bis-A in the production of epoxy resin and polycarbonate. They have been detected in canned foods and soft drinks. In addition to these analogues, bisphenol AF (Bis-AF) has broad application in the manufacture of phenolic resins or fluoroelastomers. Annual production is assumed to be in the range of 5 to 300 tons in the USA (Yang et al. 2014). Unfortunately, those new bisphenol compounds could have similar deleterious effects as Bis-A. Recent studies have indeed demonstrated possible estrogenic activity similar to that of Bis-A (Rosenmai et al. 2014).

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[9] Available from: http://chm.pops.int/TheConvention/POPsReviewCommittee/Meetings/POPRC15/Overview/tabid/8052/Default.aspx

UV compounds

Concern over our contribution to the loads of environmental pollutants originating from our use of personal care products is continuously growing. Due to their continuous release via wastewater effluent, personal care products have been termed pseudo-persistent (Barceló & Petrovic, 2007) irrespective of their PBT characteristics. The increase in public awareness over the dangers of over-exposure to sunlight has lead to an increase in products available to protect us. The first reported environmental occurrence of an organic UV filter was over 30 years ago when benzophenone was determined in the Baltic Sea (Ehrhardt et al., 1982), although personal care products were not identified as the source. UV filters and UV stabilizers all absorb UV light and in general can be loosely divided into 2 categories; UV filters used in personal care products to protect hair and cutaneous membranes from sun damage, and UV stabilizers used in technical products such as plastics and paints to protect polymers and pigments against photodegradation, and to prevent discolouring. Many of the compounds are used for both purposes and frequently used in combination to extend the UV range protection provided. It is widely reported that UV filters and stabilizers used in personal care products enter the aquatic environment indirectly via sewage effluent discharges and directly from water sports activities causing them to wash directly from skin surfaces into receiving waters (Langford et al., 2015). UV filter occurrence can be season- and weather dependent, higher concentrations were detected in wastewater influents in summer than in winter (Tsui et al., 2014) and receiving waters have demonstrated the same patterns of distribution with higher concentrations in hot weather than in cold (Langford and Thomas, 2008).

Benzotriazoles

Orthohydroxy benzotriazole UV stabilizers are heterocyclic compounds with a hydroxyphenyl group attached to the benzotriazole structure. This class of UV stabilizers has a broad range of physico-chemical properties enabling them to absorb or scatter UV light as well as reflect it, making them very useful for UV protection. The ozone layer is efficient at removing UV radiation below 280 nm so benzotriazoles have been developed to absorb the full spectrum of UV light from 280 nm to 400 nm.

Bioaccumulation has been observed in the marine environment in Japan for this group of UV stabilizers (Nakata et al., 2009). UV-320 (2-(3,5-di-t-butyl-2-hydroxyphenylbenzotriazole) for example is considered to be a PBT compound and has been banned from manufacture or use in Japan. Filter-feeding and sediment-dwelling organisms contained some of the high concentrations indicating sorption to particulates is a likely sink for some benzotraizole UV stabilizers. UV 328 was found in breastmilk of women in Korea by Lee et al. 2015, emphasising human exposure of these chemicals.

BP3 (Benzophenone-3)

Benzophenones have a high stability in UV light and absorb UV light in the UVA and UVB range. Benzophenones interact with the estrogen and androgen receptor and induce vitellogenin in male fathead minnow (*Pimephales promelas*), although *in vitro* BP-3 was up to 100,000 times less potent than estradiol. BP-3 demonstrated some limited agonistic activity at the androgen receptor, but significant anti-estrogenic activity in vitro. Androgen receptor antagonist activity using yeast cells possessing the androgen receptor was equally as potent as flutamide. It is possible that the estrogenic activity may have resulted from demethylation of BP-3 to the 4-hydroxy metabolite, which is a more potent estrogen receptor agonist than the BP-3 (Kunz and Fent, 2006).

ODPABA (2-ethylhexyl-4-dimethylaminobenzoate)

ODPABA absorbs UV light only in the UVB range. ODPABA has a half-life of 39 hours in seawater and the presence of organic matter may inhibit photolysis (Sakkas et al., 2003).

EHMC (Ethylhexylmethoxycinnamate)

EHMC is the most commonly used UV filter in sun lotions and is used in over 90% of those available in Europe. It has demonstrated multiple hormone activities in fish with gene expression profiling showing antiestrogenic activity compared to estrogenic/antiandrogenic activity using VTG induction (Christen et al., 2011; Fent et al., 2008). EHMC is lipophilic and accumulates in biota showing a tendency to bioaccumulate through different trophic levels (Fent et al., 2010).

OC (Octocrylene)

OC absorbs light in the UVB range and short wavelength UVA light also, and is frequently used to protect other UV filters from photodegradation in the UVB range. OC was one of the main UV filters detected during the Screening 2013, found in treated wastewater, sludge, sediments and cod liver, indicating bioavailability, but no biomagnification (Thomas, 2014).

Biocides

Rodenticides are classed as biocides, and in Europe they are regulated by the EU Biocidal Products Regulation (EU) no 528/2012. The first-generation rodenticides were introduced for pest control in the 1940s, but after some rodents developed resistance to these compounds, second-generation anticoagulant rodenticides (SGARs) were developed and introduced in the 1970s. The SGAR group includes brodifacoum, bromadiolone, difenacoum, difethialone, and flocoumafen. They act as vitamin K antagonists and interfere with the synthesis of blood clotting agents in vertebrates making them vulnerable to haemorrhage (Stone *et al.* 2003; Vandenbroucke 2008).

Compared to the first generation of rodenticides such as warfarin, SGARs are more likely to have effects on non-target species due to their extremely slow elimination rate from the target species and their higher vertebrate liver toxicity. They are likely to accumulate in non-target species which consume either bait or poisoned prey. Exposed rodents for example, can survive for several days after consumption of SGARs and continue to consume bait which in turn increases their body burden allowing an even greater exposure potential to non-target predators. SGARs are considered high potency anticoagulants and the substances are retained in the liver for 6-12 months after exposure, compared to up to one month for warfarin, a first-generation rodenticide (Eason *et al.* 2002).

Exposure can occur indirectly as a result of avian and mammalian predators consuming exposed target or non-target rodent species (secondary poisoning), or directly through consumption of the baits (primary poisoning). The use of SGARs has been extensive in Norway and Europe. As a result of the risk assessment of the SGARs under the Biocidal Products Regulation (EU 528/2012), several risk mitigation measures have been implemented in Norway and other European countries. Limited data are available on the occurrence of SGAR residues in non-target species in Norway (Langford et al., 2013). However, monitoring data show that SGARs are found in non-target animals throughout Europe (Laakso et al. 2010; Elmeros et al. 2015). The environmental occurrence of brodifacoum was investigated in New Zealand (Ogilvie 1997). Aerial application of brodifacoum was used on a small island to eradicate rats. After an aerial application of cereal-based bait, no residues were detected in water or soil, or in the beetles found on the bait although it is possible that the sampling campaign was not extensive enough. However, residues were detected in one anthropod (*Gymnoplectron* spp), and in the livers of one owl (*Ninox novaeseelandiae*) and one parakeet (*Cyanoramphus novaezelandiae*). Clearly, it is difficult to draw conclusions from such a small study, but it does highlight the potential of exposure. The occurrence of residues in the anthropods raise concerns about insectivore exposure whereas other studies have all focused on carnivorous species such as raptors and vultures.

In a previous study of Norwegian raptors (Langford et al, 2013), brodifacoum, bromadiolone, difenacoum and flocoumafen were detected in golden eagle (*Aquila chrysaetos*) and eagle owl (*Bubo bubo*) livers at a total SGAR concentration of between 11 and 255 ng/g in approximately 70% of the golden eagles and 50% of the eagle owls examined. In the absence of specific golden eagle and eagle owl toxicity thresholds for SGARs, a level of >100 ng/g was used as a potential lethal range, accepting that poisoning may occur below this level. Thirty percent of the golden eagle and eagle owl livers contained total SGAR residue levels above this threshold.

A recent publication (Fourel et al., 2018) stated that liver samples of red fox from France had higher concentrations of trans compared to the cis isomer of bromadiolone. The cis-isomer were rarely found in the red fox samples and the authors concluded that the cis-isomer would not persist in the food chain. Further, they recommended that monitoring of rodenticides should differentiate diastereoisomers in non-target species.

Benzothiazoles

Benzothiazoles are high-production volume chemicals that are used as complexing and anticorrosive agents for metals, act as vulcanizing accelerators for rubber materials, and possess anti-freezing/anti-icing properties (Asheim et al., 2019). Car tires are an important source to the spread of benzothiazoles (BTHs) in the urban areas. (Asheim et al., 2019). Mercapto-benzothiazole is the main vulcanization accelerator used while benzothiazole (and 2 hydroxy benzothiazoleare common breakdown products of vulcanizing agents and antioxidants added to the rubber materials during manufacturing (Asheim et al., 2019)

This year, a few samples were screened for benzothiazole and mercaptobenzothiazole. These few samples were collected from the site Kjelsås which is near an artificial turf arena where rubber for car tires most probable have been used. The samples were one soil samples, one earthworm sample and egg from fieldfare.

Stable isotopes

Stable isotopes of carbon and nitrogen can be used to define the trophic position of an organism as well as assess the carbon sources in the diet of the organism (Peterson and Fry, 1987). The isotope ratio of carbon results in a unique signature, which is propagated upwards to the predators (DeNiro and Epstein 1978). The differentiation between terrestrial and marine diet is possible as well (Hobson and Sealy 1991). Predators feeding mostly on marine organisms will show a higher accumulation of ^{13}C than predators from the terrestrial food chain. The comparison of carbon signatures of organisms from the same food chain will also give the possibility to identify their diet. The enrichment of the heavier ^{15}N-isotope in relation to the lighter ^{14}N-isotope in the predators, compared to the prey, is used to define the relative position in a food chain of an organism. Subsequently, the correlation between concentrations of pollutants relative to their trophic concentration can be used to estimate biomagnification (Kidd et al. 1995).

Quality assurance

NINA, NIVA and NILU are certified to both ISO 9001 and 14001. The laboratories of NILU and NIVA are furthermore accredited according to ISO 17025. In addition, the "Guidelines for field work in connection with environmental monitoring" were followed (JAMP; OSPAR, 2009). Moreover, special precautions were taken to prevent contamination of samples during field work. Sample collection manuals tested and adapted to special conditions to avoid materials which may contain PFAS, siloxanes and BFRs during sampling, handling and storage, were followed. Sampling materials such as bags, containers, knives, scalpels, gloves etc. were pre-cleaned or for disposable use. In addition, emphasis was placed on the use of disposable gloves, disposable knives and as little processing of the samples as practical and general cleanliness. For the same compound group, samples were dissected and prepared in the same laboratory which minimized sample handling, shipment, repeated freezing and thawing, etc. This was done to ensure minimum variation in sample quality in all steps and at the same time improve comparability of results. Fieldblanks for air samples were continuously included. These are transported and stored together with the exposed samples and give information about any contamination during sampling or storage.

Sample preparation and analysis

Preparation of bird eggs and measurement of eggshell thickness

Length (L) and breadth (B) of eggs were measured with a vernier calliper to the nearest 0.1 mm. The eggs were weighed before emptying (W_b). A hole was drilled at the equator, and the contents were transferred to a glass container and sealed with sheets of aluminium foil. The egg volume was calculated by using the formula (Hoyt, 1979):

$V = 0.51 * L * B^2$

The dried eggshells were measured (length (mm), breadth (mm) and weight (W_s) (in mg)) in order to calculate the eggshell index, which is a measure of eggshell quality (Ratcliffe, 1970). In addition, the shell thickness was measured using a special calliper (Starrett model 1010).

The shell index was calculated according to following equation:

$SI = W_s$ (mg)/L x B.

Chemical analysis

Due to the differing physicochemical properties of the pollutants of interest, several sample preparations methods were applied. Lipophilic compounds such as PBDE and PCB were analyzed together. PFAS and metals required a dedicated sample preparation each.

PBDE, CP, DDT group, pesticides and PCB. All biological samples were prepared in a similar manner. Briefly, 0.5-1 gram of sample were mixed and homogenized with a 20 fold amount of dry Na_2SO_4. Prior to extraction, the samples were added a mixture of several different isotope labelled compounds for quantification purposes. The samples were extracted with organic solvents and concentrated under nitrogen flow, followed by a clean-up procedure using concentrated sulphuric acid and a silica column to remove lipids and other interferences prior to analysis.
The compounds were quantified on GC-HRMS (Waters Autospec) and/or BG-QToF (Agilent 7200B).
Air and soil: Soxhlet extraction in acetone/hexane (1:1, v:v) were used for all samples prior to GC/MS analysis. Soil: Solvent acetone: hexane, Cu-treatment in order to remove sulphur. The extract was evaporated and treated 2-4 times with 3-4 mL of concentrated sulphuric acid. Following by

adsorption chromatography (silica). Air: The extract was evaporated and treated 2-4 times with 3-4 mL of concentrated sulphuric acid. Following by adsorption chromatography (silica).

PFAS. Ionic and new PFAS: Air and soil samples were extracted with methanol whilst biological tissues were extracted with acetonitrile (ACN), subsequently evaporated to 1 ml and treated with emulsive clean-up prior to analyses with UPLC/MS/MS in ESI(-) mode. Neutral PFAS: Samples were homogenized and 2 g aliquots taken. Internal standards were added and the samples were shaken and sonicated for 1 hour with ACN (5 mL) and then centrifuged. The solvent was decanted off and the procedure was repeated and the two extracts were combined. Water was “salted out” with the addition of 1 g of NaCl and the ACN extract was finally centrifuged with a 0.2 um nylon Spin-X filter (Costar).UPLC-HighRes MS analysis: Neutral PFAS analytes were separated on a Acquity BEH C8 column (100 x 2 mm x 1.7 µm) with water and MeOH (both containing 0,2 % NH_4OH) using a gradient elution program over a period of 10 minutes with a flow rate of 0.5 ml/min. Analytes were ionized with ESI in negative mode and ions measured with a TOF mass spectrometer.

Metals. All biological samples were prepared in a similar manner. The samples were digested by microwave-assisted mineralization using an UltraClave. About 0.5-0.75 grams of sample were weighed in TFM tubes and 5 ml of diluted supra pure nitric acid was added. The samples were submitted to a four-step program with 220°C as maximum temperature. After digestion, the samples were split in two aliquots, where concentrated HCl were added to the aliquot used for Hg determination. Metals were analysed applying an ICP-MS.

Siloxanes. All operations were performed inside a clean cabinet to avoid contamination by siloxanes from the lab air. In addition, operators retained from using cosmetics or personal care products on the day of sample processing. Soil extraction: One gram of soil was extracted overnight using a biphasic mixture of acetonitrile and hexane (1:1) using a slightly modified method previously published by Sparham et al. (2008; 2011). Hexane fraction was collected and analyzed by Concurrent solvent recondensation large volume injection gas chromatography mass spectrometry (CSR-LVI-GC/MS) using a modified method previously published by Companioni-Damas et al., 2012. Biota extraction: One gram of homogenized egg, liver, or whole body worm was extracted using a biphasic mixture of acetonitrile and hexane (3:1). Extraction mixture was sonicated for 15 minutes followed by vigorous mixing on a horizontal mixer for one hour. Resulting hexane phase was collected and analysed using CSR-LVI-GC/MS. Air samples: Air samples were spiked with ISTD (C13 labeled siloxanes), extracted with hexane and, after addition of RSTD, the extracts were injected to GC-MS without further work-up or concentration.

Dechloranes. Prior to extraction, the samples were added a mixture of isotope labelled PCB and dechloranes for quantification purposes. The soil and biota-samples were extracted with organic solvents and concentrated under nitrogen flow, followed by a clean-up procedure using concentrated sulphuric acid and a silica column to remove lipids and other interferences prior to analysis. Prior to analysis, all samples were concentrated to ~150 µL sample volume. The extracts were injected into an Agilent 7890N GC system coupled to an Agilent 7200 QToF mass spectrometer operated in electron capture negative ionization mode (GC-ECNI-HRMS) and PCB-153 and the dechlorane compounds were quantified based on the use of internal standards.

OPFR. Samples of 1-2g was homogenized and internal standards were added to samples (d12-TCEP, d18-TCPP, d15-TDCPP, d15-TPP, d27-TnBP and d51-TEHP). Samples were extracted by ultrasonication and evaporated to near dryness. Cleanup of the samples was done using solid phase extraction. The sample was eluted using acetonitrile, and the eluate was evaporated to 100-200uL and recovery standard (2,4-TXP-d27) and 50uL of 0.2% formic acid in cleaned deionized water were added. Analysis was carried out on a UPLC/MSMS (TSQ Vantage, Thermo Scientific inc). Multiple reaction monitoring (MRM) of the M+H+ was used using Argon as collisions gas for the monitoring of two product ions for each analyte. Air and soil: The PUF-PAS used for air sampling were spiked with internal standard and extracted using Soxhlet with a solvent mix of Acetone/n-Hexane (1:1, v:v). Extract was concentrated and cleanup was performed using solid phase extraction as for biota and soil samples. Soil samples was added internal standard and extracted by ultra-sonication using acetonitrile. The extract was concentrated and diluted with purified water and cleanup was performed using solid phase extraction using acetonitrile as eluent. Cleaned extract was concentrated, transferred to analytical glass and added recovery standard and 50uL 0.2% formic acid in cleaned deionized water.

Biocides. Coumachlor was used as an internal standard for all samples.
Zinc chloride (200 µl) was added to rat livers (0.3-0.4 g), fox livers (0.6-0.8 g), worms (1 g) or soil (1 g). These were then extracted with 2.5 ml acetonitrile by vortex. Samples were centrifuged before extracts were analysed by LC-HRMS (liquid chromatography high-resolution mass spectrometry). Rodenticides were separated on a C8 column with a gradient elution of 0.01% formic acid in 75:25 methanol:acetonitrile and 0.01% formic acid in water. CIS-, and TRANS-, isomers were identified by retention time as per Fourel et al (2018). [Sci. Tot. Env. (622-623) pp 924-929]

UV compounds. Chrysene-d_{12} and benzophenone-d_{10} was used as internal standards.
Liver, worms (1.7 g) and soil (0.6-1.6 g) were extracted with iso-hexane/isopropanol (50/50) by ultrasonication for 1 hour. Samples were centrifuged and the solvent decanted. This extraction was repeated, and the extracts combined. The iso-hexane fraction was isolated by the addition of 0.5% NaCl and evaporated to approximately 1 ml before solvent exchange to cyclohexane. Different clean up methods were used for each matrix in response to differing interferences.

Phenolic compounds. Soil samples were extracted with accelerated solvent extraction and further cleaned with SPE. Egg samples were extracted using ultrasonic assisted liquid extraction, cleaned on a Florisil column and with dSPE (C18). Remaining interferences were removed with SPE. Biological samples were extracted with acetonitrile and water. Separation of the organic fraction including analytes was induced by the addition of salts. Fat was removed by liquid-liquid extraction with hexane and remaining interferences were removed with SPE. All samples were analyzed with the use the Agilent 1290 UHPLC coupled to Agilent 6550 HR-QTOF equipped with Agilent Dual Jet Stream electrospray source operating in a negative mode.

Benzothiazoles:
All manipulations were performed inside a clean cabinet to avoid contamination from the lab air. Soil extraction: One gram of soil was extracted overnight using a biphasic mixture of acetonitrile and hexane (1:1) using a slightly modified method previously published by Sparham et al. (2008; 2011). Biota extraction: One gram of homogenized egg and whole body worm was extracted using a biphasic mixture of acetonitrile and hexane (3:1). Extraction mixture was sonicated for 15 minutes followed by vigorous mixing on a horizontal mixer for one hour. One procedural blanks was prepared per each sample. Hexane extract was separated and stored in the freezer prior to analysis.
200uL subsample was transferred to a LC vial and internal standard (10uL of 0.1ng/uL of 3,7-Dimethyl PFOA in methanol) was added. Samples were evaporated in a gentle stream of nitrogen and re-dissolved in methanol. Instrumental analysis was done on UPLC-MS-MS TSQ Vantage (Thermo Scientific) with Waters Acquity UPLC HSS column, C18 1.7µm 2.1x100mm, gradient mobile phase water-methanol with 0.2M Ammonium Acetate at 0.3-0.5 mL/min. SRM transitions used were 136→65 and 136→109 for Benzothiazole(positive ions) and 166→58, 166→134for Mercaptobenzothiazole(negative ions). LOQ was calculated based on values in the blank samples.

Quality control. All chemical analyses followed international requirements for quality assurance and control (QA/QC), e.g. recommendations of the Arctic Monitoring and Assessment Programme (AMAP) and the requirements in the European quality norm EN 17049. The QA/QC of the sample preparation and analysis was assured through the use of mass labelled internal standards for the BFR (^{13}C DBDPE), PCB (^{13}C PCB) and PFAS (^{13}C PFAS). Quality of sample preparation and analysis was achieved through the use of certified reference materials and laboratory blanks. For each batch of samples, one standard reference material (SRM; EDF2525 for PCB and PBDE and PERFOOD intercal 2012 for PFAS) and one blank sample was prepared. The limits of detection (LOD) were calculated for each sample, using the accepted standard method, i.e. the average of blanks plus 3 times the standard deviation for blanks, for LOD.

CP (SCCP and MCCP) have higher uncertainties than the traditional POPs. It is not possible to separate the single compounds of SCCP and MCCP, and quantification is based on isomer groups. The applied internal standards are also difficult to characterise. There are no certified reference materials available for CP, and the opportunities for proficiency testing are few, and these tests contain too few participants to be regarded as significant. In addition, there are no standardized analytical methods for CP, but there are several different analytical approaches, and several different quantification approaches in use, which again provide different quantitative results. Furthermore, in contrast to other regulated POPs like PCB, which shows decreasing concentrations in most products of daily use, the use of CP has increased again in a lot of different industrial, household products and consumer goods. All samples are treated solely with tested and validated methods. However, samples cannot be sampled, stored, extracted and prepared for analysis without any physical contact to a lot of different materials and instruments. This trend causes a raising number of blank samples exceeding the acceptance level, which in consequence raises the limit of detection for samples analyzed in parallel with those blank samples.

For siloxanes the greatest risk in the analysis is background contamination, as these chemicals (D4, D5 and D6) are applied in e.g. skin care products. Therefore, all sample preparation was performed within a clean cabinet (equipped with HEPA- and activated carbon filter) to avoid contamination from sources within the indoor environment and to allow trace analysis of these compounds in matrices from pristine environment (Krogseth et al. 2013b; Warner et al. 2013). Samples were analysed in groups with 3 procedural blanks with every extraction batch to account for background response and analytical variation. Variation observed within the procedural blanks has been used to determine the limit of detection (3 x blank std. dev.) and LOQ (10 x blank std. dev). LOQ was used as a conservative limit to ensure concentrations reported were well over blank levels and were not influenced by variation introduced by the co-extracted sample matrix. Field blanks were prepared for siloxane analyses by packing 2 or 3 grams of XAD resin in filter bags of polypropylene/cellulose, which were thereafter cleaned by ultrasonic treatment in hexane for 30 min followed by additional treatment with dichloromethane. After ultrasonic treatment, the field blanks were dried in a clean cabinet to avoid contamination. After drying, the field blanks were placed within solvent washed polypropylene /cellulose filter bags and put into sealed polypropylene containers and sent for sampling purposes. Several field-blanks were stored at NILU's laboratories and analysed to determine reference concentrations before sampling. The field blanks sent for sampling purposes were exposed and handled in the field during sampling and during preparation of samples.

Stable isotopes and other supporting information. Stable isotopes were analysed by the Institute for Energy Technology (IFE), Kjeller, Norway. Lipids were determined using a gravimetric method. All data are listed in the Appendix 3.

Biomagnification

Like in the urban terrestrial study from 2018 (Herzke et et al., 2019) and previous years, a TMF on the basis of trophic levels was estimated. The trophic level (TL) was calculated for each species per individual relative to the species representing the lowest position, assuming a 3.8 ‰ increase of δ^{15} per full trophic level (Hallanger et al., 2011). Earthworm was used as a base level and defined as inhabiting TL 2.

Based on their known food-choice and their position in their food chain, their trophic levels (TL) would be as follows *a priori*: Earthworms = 2, red fox = 3, tawny owl = 3, fieldfare = 3, and sparrowhawk = 4.

For earthworms we modified the TL value by multiplying it with the ratio between the sample $\delta^{15}\mathrm{N}_{\mathrm{sample}}$ and the mean $\delta^{15}\mathrm{N}$ value for earthworms.

For birds the trophic enrichment of δ^{15} changes with an isotopic enrichment factor of 2.4‰ causing a modification of the equation for TL calculations as follows (Hallanger et al., 2011):

$\mathrm{TL}_{\mathrm{fieldfare}} = 3 + (\delta^{15}\mathrm{N}_{\mathrm{fieldfare}} - (\delta^{15}\mathrm{N}_{\mathrm{earthworm}} + 2.4))/3.8$

$\mathrm{TL}_{\mathrm{sparrowhawk}} = 4 + (\delta^{15}\mathrm{N}_{\mathrm{sparrowhawk}} - (\delta^{15}\mathrm{N}_{\mathrm{earthworm}} + 2.4))/3.8$

For further data assessment of the biomagnification, all hydrophobic pollutants such as PCB and PBDE data were lipid normalized. PFAS are not lipophilic compounds (Kelly, 2009), and we calculations were performed on wet weight basis. Trophic magnification factors (TMFs) were calculated as the power of 10 of the slope (b) of the linear regression between log concentration and the samples TL.

$\mathrm{Log}\,[\mathrm{compound}] = a + b\mathrm{TL}$

$\mathrm{TMF} = 10^{b}$

In addition a comparison of $\delta^{15}\mathrm{N}$ levels in each species was done.

The here estimated TMFs must be treated with caution since the recommended tissue type (muscle) could not be used. Instead liver and egg samples were available which are characterized by a much shorter turnover rate and thus reflect the short term exposure rather than the long term one.

Statistical methods

Statistics were performed using SPSS statistics, ver. 25 (® IBM). We tested differences between groups by using the non-parametric Mann-Whitney test. This test is conservative, as it does not require any assumptions of the distribution of the values (Zar, 1984).

In many of the sample groups, the values of measurement were below the detection limit (LOD). However, if some, but not all samples of a certain species and type were below LOD, the following calculation (Voorspoels et al., 2002) was made to substitute LOD with an expected concentration value (C_{exp}), using the total number of analysed samples of same type (N_{tot}), and the number of samples with concentration levels above LOD (N_{above}):

$$C_{exp} = LOD^* \, N_{above}/N_{tot}.$$

In such cases, <LOD has been substituted with C_{exp} in the calculations of mean and median, and in box and whiskers plots. Where mean values are below LOD, LOD is specified in the tables.

Appendix 2

GPS coordinates for sampling locations year 2019

GPS coordinates for sampling locations year 2019

ID	**Location**	**UTM-zone**	**Latitude**	**Longitude**
Air				
19/2294	Slottsparken/Dronningparken	32V	59.9166	10.7263
19/2295	Frognerseteren	32V	59.983611	10.69083
19/2296	Grønmo	32V	59.8397	10.8523
19/2297	Alnabru	32V	59.9169	10.8327
19/2465	VEAS (pipe outlet)	32V	59.79340	10.49707
19/2298	Bøler	32V	59.880294	10.851834
19/2299	Stokstad (Kjelsrud)	32V	59.94	10.8758
Soil				
19/1771	Slottsparken	32V	59.916876	10.723989
19/1772	Frognerseteren	32V	59.97695	10.68054
19/1773	Grønmo	32V	59.84078	10.8551
19/1774	Alnabru	32V	59.914174	10.829139
19/1775	VEAS	32V	59.799631	10.487164
19/1776	Bøler	32V	59.88029	10.85130
19/1777	Kjelsrud	32V	59.9400	10.8758
Earthworm				
19/1763	Slottsparken	32V	59.916876	10.723989
19/1764	Frognerseteren	32V	59.97695	10.68054
19/1765	Grønmo	32V	59.84078	10.8551
19/1766	Alnabru	32V	59.914174	10.829139
19/1767	VEAS	32V	59.799631	10.487164
19/1768	Bøler	32V	59.88029	10.85130
19/1769	Kjelsrud	32V	59.9400	10.8758
Fieldfare				
19/1712	Holmen (7328/7329)	32V	59.9528076	10.6820476
19/1713	Grønmo (7315)	32V	59.840759	10.854873
19/1714	Arnestad (7330/7331)	32V	59.8028092	10.4870622
19/1715	Alnabru 1 (7320/7321)	32V	59.91528	10.83139
19/1716	Alnabru 2 (7322/7323)	32V	59.9159272	10.8317809
19/1717	Alnabru 3 (7324/7325)	32V	59.9161527	10.8318537
19/1718	Bøler (7318/7319)	32V	59.8800017	10.8527189
19/1719	Kjelsås (7326/7327)	32V	59.963904	10.788082
19/1720	Ekeberg (7316/7317)	32V	59.891432	10.771185
Red fox				
19/1809	Hellerudmyra, Oslo	32V	60.00834	10.46559
19/1810	Hellerudmyra, Oslo	32V	60.00834	10.46559
19/1811	Hellerudmyra, Oslo	32V	60.00834	10.46559
19/1812	Hellerudmyra, Oslo	32V	60.00834	10.46559
19/1813	Hellerudmyra, Oslo	32V	60.00834	10.46559

19/1814	Hellerudmyra, Oslo	32V	60.00834	10.46559
19/1815	Hellerudmyra, Oslo	32V	60.00834	10.46559
19/1816	Hellerudmyra, Oslo	32V	60.00834	10.46559
19/1817	Hellerudmyra, Oslo	32V	60.00834	10.46559
19/1818	Hellerudmyra, Oslo	32V	60.00834	10.46559
Brown rats				
19/1822	7594+7595 Female (Slemmestad)	32V	59.815	10.46723
19/1823	7596 Female (Slemmestad)	32V	59.815	10.46723
19/1824	7597 Female(Smestad)	32V	59.93745	10.68556
19/1825	7599 Female (Bærum)	32V	59.92214	10.60458
19/1826	7613 Female (Furuset)	32V	59.93354	10.87152
19/1827	7608 Male (Sandvika)	32V	59.89713	10.54565
19/1828	7600 Male (Trosterud)	32V	59.92695	10.86558
19/1829	7601+7602 Male (Slemmestad)	32V	59.815 59.92876	10.46723 10.71865
19/1830	7598+7606 Male (Fagerborg)	32V	59.92804	10.73239
19/1831	7609+7611 Male (Furuset)	32V	59.93354	10.87152
Sparrow hawk	Confidential for species protection	Confidential for species protection	Confidential for species protection	Confidential for species protection
Tawny owl	Confidential for species protection	Confidential for species protection	Confidential for species protection	Confidential for species protection

Appendix 3

Concentrations of pollutants in individual samples

All biological samples are given in ng/g ww, air samples in pg/day and soil in ng/g dw.

Isotopes

NILU-Sample number:	Sample type:	$\delta^{13}C_{VPDB}$	$\delta^{15}N_{AIR}$	W% C	W% N	C/N	$\delta^{34}S_{VCDT}$	W% S
19/1771	Soil	-28,04	2,81	5,68	0,42	13,59	7,55	0,06
19/1772	Soil	-27,09	0,94	14,37	0,91	15,71	11,72	0,09
19/1773	Soil	-27,29	-0,18	8,13	0,42	19,25	16,09	0,06
19/1774	Soil	-29,03	-1,30	2,19	0,23	9,72	15,35	0,02
19/1775	Soil	-28,26	2,27	4,66	0,43	10,80	14,46	0,05
19/1776	Soil	-28,17	-0,04	28,21	1,65	17,13	2,27	0,18
19/1777	Soil	-28,65	3,00	4,32	0,40	10,87	9,86	0,06
19/1763	Earthworm	-25,12	6,62	35,39	7,94	4,46	-2,77	0,58
19/1764	Earthworm	-26,16	3,05	45,70	9,71	4,70	-1,29	0,82
19/1765	Earthworm	-25,16	3,19	49,25	10,88	4,53	-3,00	0,96
19/1766	Earthworm	-26,71	2,77	46,36	10,33	4,49	-4,39	0,94
19/1767	Earthworm	-27,71	5,05	48,49	9,91	4,89	-18,56	1,05
19/1768	Earthworm	-26,22	1,98	47,08	9,73	4,84	1,72	1,12
19/1769	Earthworm	-27,62	5,21	46,11	9,75	4,73	-4,26	0,94
19/1712	Fieldfare egg	-27,00	6,75	52,28	8,13	6,43	-4,44	0,73
19/1713	Fieldfare egg	-26,43	7,79	50,78	9,14	5,56	-3,33	0,86
19/1714	Fieldfare egg	-26,52	6,71	49,07	9,11	5,38	-9,42	0,96
19/1715	Fieldfare egg	-25,91	7,02	50,44	9,57	5,27	-7,81	0,94
19/1716	Fieldfare egg	-26,05	5,88	51,38	8,68	5,92	-5,02	0,90

NILU-Sample number:	Sample type:	$\delta^{13}C_{VPDB}$	$\delta^{15}N_{AIR}$	W% C	W% N	C/N	$\delta^{34}S_{VCDT}$	W% S
19/1717	Fieldfare egg	-26,37	7,81	53,18	8,29	6,41	-3,54	0,93
19/1718	Fieldfare egg	-26,36	7,30	50,87	8,04	6,33	-2,61	0,76
19/1719	Fieldfare egg	-26,50	6,61	49,07	8,66	5,67	0,36	0,98
19/1720	Fieldfare egg	-26,16	7,52	45,69	9,05	5,05	-0,74	0,91
19/1721	Sparrowhawk egg	-25,81	7,26	51,05	7,60	6,71	1,65	0,69
19/1722	Sparrowhawk egg	-24,42	7,75	52,27	9,17	5,70	-0,61	0,73
19/1809	Red fox liver	-24,41	9,71	46,71	10,52	4,44	4,55	1,21
19/1810	Red fox liver	-24,54	9,68	46,70	11,14	4,19	4,45	1,32
19/1811	Red fox liver	-24,15	7,80	45,65	11,02	4,14	2,71	1,30
19/1812	Red fox liver	-24,61	6,85	45,33	11,88	3,81	2,86	1,17
19/1813	Red fox liver	-25,56	8,43	45,68	9,88	4,62	3,89	0,98
19/1814	Red fox liver	-23,51	7,24	44,18	12,14	3,64	3,16	1,11
19/1815	Red fox liver	-24,54	8,73	46,08	10,66	4,32	2,91	1,12
19/1816	Red fox liver	-24,99	8,13	45,67	10,25	4,46	2,19	1,03
19/1817	Red fox liver	-23,68	8,61	45,73	9,57	4,78	3,35	0,99
19/1818	Red fox liver	-25,35	6,93	44,62	6,48	6,89	3,29	0,73
19/1723	Tawny owl egg	-27,49	9,35	57,46	7,74	7,43	0,75	0,83
19/1724	Tawny owl egg	-28,40	9,29	61,77	5,71	10,83	1,23	0,71
19/1725	Tawny owl egg	-26,59	8,70	54,55	8,78	6,21	1,92	0,90
19/1726	Tawny owl egg	-26,08	7,76	50,93	9,61	5,30	2,02	1,03
19/1727	Tawny owl egg	-25,61	8,42	52,40	8,87	5,91	0,53	0,96
19/1728	Tawny owl egg	-26,29	9,37	55,72	6,98	7,98	0,90	0,85

NILU-Sample number:	Sample type:	$\delta^{13}C_{VPDB}$	$\delta^{15}N_{AIR}$	W% C	W% N	C/N	$\delta^{34}S_{VCDT}$	W% S
19/1729	Tawny owl egg	-28,07	8,01	63,09	5,35	11,79	2,07	0,42
19/1730	Tawny owl egg	-27,22	7,89	54,90	8,04	6,83	2,60	0,75
19/1731	Tawny owl egg	-26,69	8,05	54,45	8,08	6,74	2,06	0,83
19/1732	Tawny owl egg	-26,94	5,87	52,21	6,94	7,52	4,18	0,69
19/1801	Tawny owl egg	-26,81	5,33	52,97	7,88	6,72	5,10	0,66
19/1822	Rat liver	-24,83	7,10	47,39	11,12	4,26	1,50	0,97
19/1823	Rat liver	-24,64	6,60	47,71	10,62	4,49	1,71	0,86
19/1824	Rat liver	-24,02	8,44	48,48	12,33	3,93	2,06	0,98
19/1825	Rat liver	-25,14	6,38	50,20	11,01	4,56	2,05	0,97
19/1826	Rat liver	-24,26	7,54	46,78	10,76	4,35	1,26	0,95
19/1827	Rat liver	-24,02	7,77	45,75	10,64	4,30	-1,91	0,80
19/1828	Rat liver	-25,01	7,29	46,45	8,94	5,20	0,56	0,97
19/1829	Rat liver	-24,06	7,81	47,81	10,14	4,72	1,34	0,82
19/1830	Rat liver	-24,66	7,54	46,79	10,48	4,47	5,77	0,99
19/1831	Rat liver	-24,86	7,57	36,94	8,40	4,40	-1,18	0,92

Metals

NILU-Sample number:	Sample type:	Cr	Ni	Cu	Zn	As	Ag	Cd	Pb	Hg
19/1771	Soil	63906	31513	29048	107443	7921	273	254	55433	221
19/1772	Soil	23470	4045	8302	27866	3696	400	574	97915	72,7
19/1773	Soil	31166	10223	15728	88042	4023	250	332	38610	92,0
19/1774	Soil	73911	37028	27957	160599	6472	136,3	269	29058	38,6
19/1775	Soil	115865	64387	24841	60871	5236	107,8	234	15578	39,0
19/1776	Soil	7924	3588	8872	29608	832	120,6	224	28780	115,4
19/1777	Soil	55869	28518	36632	107869	4692	206,0	258	30246	101,7
19/1763	Earthworm	3792	2062	3574	133265	1181	38,5	910	3567	302
19/1764	Earthworm	916	392	1882	94853	555	165,5	3993	58261	177
19/1765	Earthworm	154	144	1728	170843	825	26,3	3344	1116	205,1
19/1766	Earthworm	835	573	3024	223746	436	15,5	2226	678	109,2
19/1767	Earthworm	1608	1248	3523	176295	1255	36,1	2358	604	233
19/1768	Earthworm	1194	722	1538	123722	158	42,3	2115	4272	117
19/1769	Earthworm	5451	2445	3612	191570	620	31,0	943	928	97
19/1712	Fieldfare egg	6,05	5,07	826	5388	3,01	0,62	0,13	6,86	11,8
19/1713	Fieldfare egg	76,0	32,3	817	11154	2,65	4,69	0,29	18,6	9,82
19/1714	Fieldfare egg	20,8	11,1	433	29056	3,65	0,31	0,58	30,4	9,61
19/1715	Fieldfare egg	80,9	32,8	343	10503	1,84	0,31	0,29	8,91	11,2
19/1716	Fieldfare egg	2,38	3,26	598	5990	3,32	0,11	0,59	8,18	12,0
19/1717	Fieldfare egg	282	182	475	12100	2,33	0,36	0,58	15,1	13,1

NILU-Sample number:	Sample type:	Cr	Ni	Cu	Zn	As	Ag	Cd	Pb	Hg
19/1718	Fieldfare egg	22,2	3,59	534	6595	4,21	0,43	0,21	15,27	6,54
19/1719	Fieldfare egg	21,0	11,29	643	5248	5,26	0,44	0,16	50,9	9,24
19/1720	Fieldfare egg	10,6	4,44	609	19107	4,39	0,71	0,36	42,33	10,43
19/1721	Sparrowhawk egg	7,7	2,67	2106	4212	0,95	0,89	0,10	4,31	98,6
19/1722	Sparrowhawk egg	13,13	3,37	1017	17516	1,04	0,21	0,14	12,23	185
19/1809	Red fox liver	80	25,6	10335	40754	22,00	1,95	26	47,3	30,5
19/1810	Red fox liver	105,4	47,5	9920	49908	14,03	0,95	28,9	44,2	47
19/1811	Red fox liver	485,0	177,1	17243	43568	7,69	3,30	311	278	136,4
19/1812	Red fox liver	421	138,7	15553	45222	4,72	29,38	181	3000836	267
19/1813	Red fox liver	122	41,0	8454	27328	3,21	7,47	50,4	760,2	61,3
19/1814	Red fox liver	649	323,3	21867	43815	10,6	5,91	153,9	13496	80
19/1815	Red fox liver	362	156,4	11333	47010	1,96	1,10	97	202,6	47,5
19/1816	Red fox liver	2878,1	1434,5	12307	35694	7,18	2,74	271	312,9	56
19/1817	Red fox liver	110,9	33,3	17715	42540	4,24	1,84	107	354,7	143
19/1818	Red fox liver	762,4	327,3	9786	24683	40,5	3,47	352,4	111	20
19/1723	Tawny owl egg	2,05	1,41	1706	14149	0,85	1,40	0,12	3,83	64,83
19/1724	Tawny owl egg	37,11	17,34	2547	16803	0,94	8,24	0,26	5,57	65,28
19/1725	Tawny owl egg	70,62	11,53	3188	13267	0,35	2,34	0,20	6,22	43,65
19/1726	Tawny owl egg	63,53	24,17	1969	14485	1,16	1,30	0,11	2,04	35,28
19/1727	Tawny owl egg	3,18	1,17	1056	9063	9,87	0,47	0,11	4,05	39,34
19/1728	Tawny owl egg	1,69	1,94	1207	10757	6,68	1,05	0,10	10,31	37,04
19/1729	Tawny owl egg	116,81	43,04	3985	31100	0,99	1,89	0,37	4,71	33,26

NILU-Sample number:	Sample type:	Cr	Ni	Cu	Zn	As	Ag	Cd	Pb	Hg
19/1730	Tawny owl egg	129,80	24,95	2874	19150	1,32	2,09	0,34	4,98	24,29
19/1731	Tawny owl egg	6,01	3,31	988	9802	0,60	0,46	0,10	1,30	32,43
19/1732	Tawny owl egg	1,88	2,31	3113	9660	1,00	1,47	0,29	2,80	47,21
19/1801	Tawny owl egg	3,22	1,25	750	10701	0,68	0,75	0,10	2,34	55,74
19/1822	Rat liver	151	47	4086	25664	14176	0,94	27,1	37	6
19/1823	Rat liver	77	39	6336	29149	2880	1,46	106,21	239,8	3,89
19/1824	Rat liver	684	280	3523	23271	1338	0,89	16,4	381	5,36
19/1825	Rat liver	546	234,8	3449	25227	9986	7,85	22,4	24	7,92
19/1826	Rat liver	842	364	4723	35705	2318	2,45	307,0	59,7	8,04
19/1827	Rat liver	114,4	39,6	3884	21685	6904	1,78	427,1	57,1	22,53
19/1828	Rat liver	60	31	3133	21914	763	0,57	43	555,4	1,1
19/1829	Rat liver	3019,0	129,0	4719	28417	1626	0,25	12,8	46	1,23
19/1830	Rat liver	173,6	51,6	7096	28910	1484	2,02	11,4	496,3	13,2
19/1831	Rat liver	157,0	69,2	4901,5	34326,6	998,2	13,4	137,2	98,3	14,3

PCB

NILU-Sample number:	Sample type:	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180
19/2294	Air	39,9	135	148	32,4	46,3	67,1	14,0
19/2295	Air	6,2	10,5	8,4	2,6	3,2	4,6	0,9
19/2296	Air	5,2	7,4	5,5	1,6	2,4	3,3	0,8
19/2297	Air	48,0	36,6	18,4	6,7	6,8	8,2	1,7
19/2465	Air	11,5	15,9	9,0	2,5	2,6	4,0	0,7
19/2298	Air	4,8	11,9	9,4	3,9	4,2	4,9	0,9
19/2299	Air	11,7	21,2	12,9	3,6	4,1	5,6	1,2
19/1771	Soil	0,09	0,14	0,56	0,51	0,83	0,92	0,42
19/1772	Soil	0,09	0,08	0,257	0,350	0,900	0,918	0,462
19/1773	Soil	0,16	0,15	0,37	0,40	0,79	0,82	0,43
19/1774	Soil	<0,08	0,11	0,177	0,191	0,483	0,522	0,21
19/1775	Soil	<0,08	0,09	<0,133	<0,191	<0,333	<0,346	<0,074
19/1776	Soil	0,10	0,17	0,909	1,410	2,720	2,670	1,190
19/1777	Soil	<0,07	0,10	0,189	0,169	0,340	0,392	0,205
19/1763	Earthworm	0,288	0,19	0,53	0,25	0,78	1,24	0,33
19/1764	Earthworm	0,255	0,11	<0,08	<0,115	<0,200	<0,207	<0,072
19/1765	Earthworm	0,597	0,68	0,47	0,12	0,24	0,40	0,09
19/1766	Earthworm	0,295	0,11	0,19	0,147	0,51	1,02	0,19
19/1767	Earthworm	0,371	0,076	<0,080	<0,115	<0,200	<0,207	<0,045
19/1768	Earthworm	0,159	0,072	<0,080	<0,115	<0,200	<0,207	<0,045

NILU-Sample number:	Sample type:	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180
19/1769	Earthworm	0,145	0,068	0,103	<0,115	0,268	0,418	0,132
19/1712	Fieldfare egg	<0,045	0,43	6,45	4,51	17,1	24,2	6,04
19/1713	Fieldfare egg	0,12	1,67	4,30	1,69	6,27	9,26	3,79
19/1714	Fieldfare egg	<0,045	0,33	1,00	0,81	1,75	2,81	1,04
19/1715	Fieldfare egg	0,05	0,43	1,60	0,62	5,40	9,11	4,36
19/1716	Fieldfare egg	0,05	0,32	2,20	0,92	7,72	13,2	5,59
19/1717	Fieldfare egg	<0,05	0,23	1,73	0,59	8,93	13,3	5,08
19/1718	Fieldfare egg	<0,045	0,25	1,09	0,66	3,52	6,31	2,43
19/1719	Fieldfare egg	<0,045	1,74	16,9	11,3	17,2	19,5	4,24
19/1720	Fieldfare egg	<0,045	0,32	1,82	0,97	5,35	8,11	3,65
19/1721	Sparrowhawk egg	0,18	0,45	3,00	10,1	65,4	195	118
19/1722	Sparrowhawk egg	1,75	2,03	20,9	129	250	572	337
19/1809	Red fox liver	<0,023	0,033	<0,040	<0,057	0,49	1,03	1,38
19/1810	Red fox liver	<0,024	<0,029	<0,04	0,09	0,43	1,22	1,43
19/1811	Red fox liver	<0,023	0,018	<0,040	<0,057	0,11	0,67	1,59
19/1812	Red fox liver	<0,023	0,019	<0,040	0,43	2,49	6,98	9,06
19/1813	Red fox liver	<0,023	0,018	<0,040	0,12	0,29	3,80	8,53
19/1814	Red fox liver	<0,023	0,017	<0,04	<0,06	0,16	1,37	8,16
19/1815	Red fox liver	<0,023	0,017	<0,040	<0,057	0,36	1,68	5,90
19/1816	Red fox liver	<0,023	0,019	<0,040	<0,057	<0,10	0,41	1,80
19/1817	Red fox liver	<0,023	0,017	<0,040	<0,057	0,28	3,35	9,41
19/1818	Red fox liver	<0,023	0,020	<0,04	<0,06	<0,10	0,28	1,31

NILU-Sample number:	Sample type:	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180
19/1723	Tawny owl egg	0,104	<0,033	0,258	3,400	9,130	21,80	16,8
19/1724	Tawny owl egg	0,131	<0,033	0,321	4,450	12,40	28,20	19,5
19/1725	Tawny owl egg	0,073	<0,033	0,182	2,540	6,840	15,90	11,7
19/1726	Tawny owl egg	0,094	0,058	0,207	1,640	5,410	14,50	8,77
19/1727	Tawny owl egg	2,160	0,410	1,250	9,170	24,80	43,30	23,1
19/1728	Tawny owl egg	4,270	0,943	2,550	13,90	39,30	67,50	34,4
19/1729	Tawny owl egg	0,191	<0,033	0,445	3,850	12,70	34,10	19,2
19/1730	Tawny owl egg	0,058	<0,033	0,105	0,952	3,400	9,940	6,49
19/1731	Tawny owl egg	0,069	0,052	0,164	1,300	4,690	12,60	8,11
19/1732	Tawny owl egg	0,08	0,07	0,18	1,90	6,27	19,4	10,9
19/1801	Tawny owl egg	0,06	0,06	0,12	1,22	4,02	12,6	7,70
19/1822	Rat liver	0,03	0,02	0,04	0,13	0,68	0,59	0,31
19/1823	Rat liver	<0,02	0,02	<0,04	0,07	0,21	0,21	0,24
19/1824	Rat liver	0,06	0,02	<0,04	0,06	0,90	1,21	0,95
19/1825	Rat liver	<0,02	0,02	<0,04	<0,06	0,15	0,18	0,17
19/1826	Rat liver	<0,02	0,02	<0,04	0,09	0,91	1,92	2,62
19/1827	Rat liver	<0,02	0,02	<0,04	0,07	1,00	1,53	1,05
19/1828	Rat liver	<0,02	0,02	0,07	0,47	6,39	8,51	8,78
19/1829	Rat liver	<0,02	0,03	0,05	0,18	1,26	1,19	0,80
19/1830	Rat liver	0,08	0,02	0,05	0,67	2,87	2,23	1,00
19/1831	Rat liver	<0,02	0,02	<0,04	0,41	10,30	10,40	5,96

PBDE

NILU-Sample number:	Sample type:	BDE47	BDE99	BDE 100	BDE 126	BDE 153	BDE 154	BDE 175/183	BDE 191	BDE 196	BDE 202	BDE 206	BDE 207	BDE 209
19/2294	Air	1,15	0,33	0,09	<0,01	<0,11	<0,06	<0,06	<0,05	<0,08	<0,11	<2,16	<0,94	<10,53
19/2295	Air	0,49	0,18	<0,05	<0,01	<0,07	<0,05	<0,06	<0,04	<0,08	<0,11	<2,16	<0,94	<10,53
19/2296	Air	0,49	0,27	0,06	<0,01	<0,09	<0,06	<0,06	<0,05	<0,08	<0,11	<2,16	<0,94	<10,53
19/2297	Air	1,60	1,14	0,22	<0,01	0,16	0,11	0,28	<0,05	<0,08	<0,17	3,46	1,83	133
19/2465	Air	1,29	0,25	0,08	<0,02	<0,06	<0,04	<0,06	<0,04	<0,08	<0,10	<2,11	<0,92	<10,31
19/2298	Air	0,60	0,23	0,09	0,05	0,19	0,18	0,17	0,05	<0,08	<0,11	<2,16	<0,94	<10,53
19/2299	Air	0,84	0,41	0,08	<0,01	<0,06	<0,04	<0,06	<0,04	<0,08	<0,11	<2,16	<0,94	<10,53
19/1771	Soil	<0,15	0,06	0,02	<0,01	<0,07	<0,05	<0,04	<0,07	<0,09	<0,12	<0,13	<0,12	0,54
19/1772	Soil	<0,15	0,11	0,03	<0,03	<0,06	<0,04	<0,03	<0,04	<0,08	<0,10	<0,10	<0,09	<0,52
19/1773	Soil	<0,15	0,10	0,03	<0,01	<0,03	<0,02	<0,02	<0,02	<0,09	<0,12	<0,07	<0,06	1,17
19/1774	Soil	<0,15	<0,05	<0,02	<0,01	<0,05	<0,04	<0,02	<0,04	<0,09	<0,12	<0,10	<0,09	4,24
19/1775	Soil	<0,15	<0,05	<0,02	<0,01	<0,04	<0,03	<0,02	<0,04	<0,07	<0,09	<0,06	<0,04	0,82
19/1776	Soil	0,36	0,25	0,09	<0,02	<0,04	<0,03	<0,02	<0,03	<0,09	<0,11	<0,12	<0,11	1,49
19/1777	Soil	<0,13	0,05	<0,02	<0,01	<0,04	<0,03	<0,01	<0,02	<0,03	<0,04	<0,06	<0,06	0,94
19/1763	Earthworm	<0,088	<0,028	<0,014	<0,004	<0,011	<0,01	<0,01	<0,01	<0,01	<0,02	<0,04	<0,03	0,321
19/1764	Earthworm	<0,088	<0,028	<0,014	<0,004	<0,011	<0,01	<0,01	<0,01	<0,02	<0,03	<0,04	<0,03	0,614
19/1765	Earthworm	<0,088	0,031	<0,014	<0,002	<0,011	<0,01	<0,01	<0,01	<0,01	<0,02	<0,04	<0,03	<0,31
19/1766	Earthworm	<0,088	0,039	0,015	<0,003	<0,011	<0,01	<0,01	<0,01	<0,02	<0,02	<0,04	<0,03	<0,31
19/1767	Earthworm	<0,088	<0,028	<0,014	<0,005	<0,011	<0,01	<0,01	<0,01	<0,01	<0,02	0,15	<0,03	1,77
19/1768	Earthworm	<0,088	<0,028	<0,014	<0,002	<0,011	<0,01	<0,01	<0,01	<0,01	<0,02	<0,04	<0,03	<0,31

NILU-Sample number:	Sample type:	BDE47	BDE99	BDE 100	BDE 126	BDE 153	BDE 154	BDE 175/183	BDE 191	BDE 196	BDE 202	BDE 206	BDE 207	BDE 209
19/1769	Earthworm	<0,088	0,037	<0,014	<0,002	<0,011	<0,01	<0,01	<0,01	<0,01	<0,02	<0,04	<0,03	<0,31
19/1712	Fieldfare egg	5,19	8,58	3,76	<0,01	1,02	1,11	0,26	<0,07	0,55	0,49	<0,06	<0,05	0,35
19/1713	Fieldfare egg	2,03	1,67	0,92	<0,01	0,26	0,24	0,10	<0,04	<0,05	<0,06	<0,05	<0,05	<0,31
19/1714	Fieldfare egg	0,47	0,49	0,24	<0,01	0,07	0,08	<0,02	<0,02	<0,03	<0,04	<0,06	<0,05	<0,31
19/1715	Fieldfare egg	0,46	0,70	0,30	<0,01	0,21	0,12	0,12	<0,04	<0,04	<0,05	0,07	0,21	0,51
19/1716	Fieldfare egg	0,45	0,50	0,25	<0,01	0,22	0,10	0,13	<0,02	<0,04	<0,04	<0,05	<0,04	<0,31
19/1717	Fieldfare egg	0,39	0,55	0,27	<0,01	0,15	0,12	0,10	<0,04	<0,03	<0,04	<0,04	<0,04	<0,31
19/1718	Fieldfare egg	1,17	2,73	1,27	<0,01	0,38	<0,02	0,07	<0,04	<0,04	<0,04	<0,04	<0,03	<0,31
19/1719	Fieldfare egg	1,17	1,38	0,60	<0,01	0,25	0,14	0,05	<0,02	<0,05	<0,06	<0,04	<0,03	<0,31
19/1720	Fieldfare egg	0,95	1,57	0,70	<0,01	0,30	0,26	0,20	<0,05	<0,07	<0,08	<0,05	<0,04	<0,31
19/1721	Sparrowhawk egg	2,630	6,420	2,130	0,006	2,580	0,831	0,577	<0,027	0,182	0,381	<0,04	0,066	<0,31
19/1722	Sparrowhawk egg	20,400	33,100	13,200	<0,069	15,100	6,95	1,88	<0,036	0,273	0,566	<0,035	0,115	0,741
19/1809	Red fox liver	0,110	0,018	0,026	0,009	0,049	0,023	0,0384	0,0455	0,0893	0,16	0,223	0,272	0,555
19/1810	Red fox liver	0,028	0,027	0,016	<0,001	0,005	<0,001	<0,001	<0,001	<0,001	0,004	<0,004	<0,003	<0,031

NILU-Sample number:	Sample type:	BDE47	BDE99	BDE 100	BDE 126	BDE 153	BDE 154	BDE 175/183	BDE 191	BDE 196	BDE 202	BDE 206	BDE 207	BDE 209
19/1811	Red fox liver	<0,044	<0,025	<0,018	<0,025	<0,042	<0,0265	<0,0122	<0,0217	<0,117	<0,132	<0,089	<0,074	2,01
19/1812	Red fox liver	0,148	<0,053	<0,097	<0,015	0,119	<0,0274	0,0312	<0,0168	<0,0349	<0,051	<0,036	<0,030	0,251
19/1813	Red fox liver	0,061	<0,020	0,009	<0,006	0,089	<0,0161	<0,0201	<0,0334	<0,0147	<0,069	<0,019	<0,017	0,213
19/1814	Red fox liver	<0,044	<0,014	0,007	<0,004	0,027	<0,0126	0,0102	<0,00685	<0,0128	0,0158	0,0427	0,0456	0,376
19/1815	Red fox liver	0,044	<0,014	0,010	<0,004	0,035	<0,0106	<0,0111	<0,0102	0,0149	<0,026	<0,019	<0,017	<0,344
19/1816	Red fox liver	<0,044	<0,014	0,007	<0,006	<0,038	<0,027	<0,0249	<0,0413	0,0619	0,0764	<0,049	<0,044	0,891
19/1817	Red fox liver	<0,044	<0,025	<0,022	<0,014	0,043	<0,0373	<0,0392	<0,0213	<0,0356	<0,044	<0,100	<0,090	<0,925
19/1818	Red fox liver	0,048	0,022	0,025	<0,010	<0,027	<0,0399	0,0256	<0,0351	<0,0846	<0,104	<0,077	<0,067	0,439
19/1723	Tawny owl egg	0,24	0,72	0,17	<0,02	0,46	0,10	0,15	<0,07	<0,05	<0,05	<0,08	0,15	0,84
19/1724	Tawny owl egg	0,35	0,99	<0,07	<0,01	0,66	0,12	0,18	<0,02	<0,03	0,11	0,10	0,14	1,25
19/1725	Tawny owl egg	0,18	0,50	0,14	<0,02	0,33	0,07	<0,05	<0,09	<0,04	<0,04	<0,05	<0,05	0,51
19/1726	Tawny owl egg	0,21	0,56	0,20	<0,01	0,44	0,10	0,14	<0,04	<0,03	<0,03	<0,05	<0,05	1,81
19/1727	Tawny owl egg	1,00	1,14	0,65	<0,04	1,55	0,20	<0,15	<0,28	<0,15	<0,16	<0,35	<0,30	<0,48
19/1728	Tawny owl egg	1,69	1,87	1,11	<0,04	2,29	0,27	0,69	<0,23	<0,26	<0,27	<0,54	<0,47	-1,01
19/1729	Tawny owl egg	0,49	1,55	0,50	<0,05	1,04	0,30	0,32	<0,25	<0,29	<0,31	<0,31	<0,27	2,22

NILU-Sample number:	Sample type:	BDE47	BDE99	BDE 100	BDE 126	BDE 153	BDE 154	BDE 175/183	BDE 191	BDE 196	BDE 202	BDE 206	BDE 207	BDE 209
19/1730	Tawny owl egg	0,15	0,33	0,14	<0,02	0,32	0,06	0,06	<0,05	<0,08	<0,08	<0,10	<0,09	0,49
19/1731	Tawny owl egg	0,20	0,40	0,17	<0,02	0,30	0,10	<0,07	<0,12	<0,17	<0,19	<0,38	<0,34	<0,48
19/1732	Tawny owl egg	0,25	0,34	0,13	<0,04	0,22	<0,08	<0,08	<0,15	<0,16	<0,17	<0,24	<0,21	0,53
19/1801	Tawny owl egg	0,17	0,24	<0,01	<0,01	<0,03	0,04	<0,04	<0,07	<0,06	<0,06	<0,07	<0,06	0,63
19/1822	Rat liver	*0,13*	0,04	0,03	<0,01	<0,04	<0,02	<0,02	<0,05	<0,07	<0,07	<0,22	2,05	28,5
19/1823	Rat liver	0,06	0,03	0,02	<0,01	<0,04	<0,03	<0,04	<0,07	<0,11	<0,11	<0,22	0,79	2,3
19/1824	Rat liver	0,08	0,02	0,01	<0,01	<0,05	<0,03	<0,03	<0,05	<0,04	<0,04	<0,07	<0,06	<0,2
19/1825	Rat liver	0,07	0,04	0,03	<0,02	<0,03	<0,02	<0,02	<0,03	<0,04	<0,04	<0,07	<0,06	1,0
19/1826	Rat liver	0,08	0,05	0,03	<0,01	<0,03	<0,02	<0,02	<0,03	<0,05	<0,05	<0,09	<0,07	1,0
19/1827	Rat liver	<0,04	<0,01	<0,01	<0,01	<0,04	<0,02	<0,02	<0,03	<0,06	<0,06	<0,13	<0,11	<0,2
19/1828	Rat liver	<0,04	<0,03	0,03	<0,01	0,15	<0,02	<0,03	<0,05	<0,08	<0,09	<0,20	<0,17	1,5
19/1829	Rat liver	0,15	0,06	0,04	<0,04	0,09	<0,02	<0,03	<0,05	<0,06	<0,06	0,08	0,45	4,1
19/1830	Rat liver	0,08	<0,02	0,02	<0,01	<0,03	<0,02	<0,02	<0,04	<0,05	0,06	0,07	<0,06	0,7
19/1831	Rat liver	0,07	0,02	0,01	<0,01	0,25	<0,02	<0,02	<0,04	<0,07	<0,08	<0,11	<0,09	<0,6

PFSA (perfluorosulfonates)

NILU-Sample number:	Sample type:	PFBS	PFPS	PFHxS	PFHpS	brPFOS	PFOS	PFNS	PFDcS	PFUnDS	PFDoDS
19/2294	Air	22,00	<0,11	2,15	<1,37	<0,11	4,24	2,66	<3,16	<5,26	<5,26
19/2295	Air	18,43	<0,11	2,49	<1,37	0,42	4,91	<1,26	<3,16	<5,26	<5,26
19/2296	Air	21,70	<0,11	1,85	<1,37	1,51	6,40	<1,26	<3,16	<5,26	<5,26
19/2297	Air	18,31	<0,11	0,63	<1,37	<0,11	<1,89	<1,26	<3,16	<5,26	<5,26
19/2465	Air	<0,53	<0,11	0,21	<0,84	<0,11	<1,26	<1,26	<3,16	<5,26	<5,15
19/2298	Air	15,67	<0,11	1,63	<1,37	<0,11	<1,47	<1,26	3,16	<5,26	<5,26
19/2299	Air	19,06	<0,11	2,03	<1,37	<0,11	3,91	<1,26	<3,16	<5,26	<5,26
19/1771	Soil	<0,07	<0,07	<0,03	<0,03	0,06	0,49	<0,03	<0,07	<0,35	<0,35
19/1772	Soil	<0,08	<0,08	0,04	0,06	0,48	1,25	<0,03	<0,08	<0,40	<0,40
19/1773	Soil	<0,07	<0,07	0,13	0,05	1,16	3,82	<0,03	<0,07	<0,36	<0,36
19/1774	Soil	0,08	<0,07	0,29	0,05	0,38	2,39	<0,03	<0,07	<0,34	<0,34
19/1775	Soil	<0,07	<0,07	<0,03	<0,03	<0,01	0,15	<0,03	<0,07	<0,34	<0,34
19/1776	Soil	<0,11	<0,11	0,06	<0,04	0,56	4,62	<0,04	<0,11	<0,54	<0,54
19/1777	Soil	<0,06	<0,06	<0,02	<0,02	0,09	0,52	<0,02	<0,06	<0,31	<0,31
19/1763	Earthworm	0,69	<0,05	1,51	2,46	<0,02	9,30	<0,02	<0,05	<0,25	<0,25
19/1764	Earthworm	1,47	<0,05	2,24	1,01	1,11	6,89	0,15	<0,05	<0,25	<0,25
19/1765	Earthworm	0,66	<0,05	2,50	5,30	6,90	41,3	<0,02	0,42	<0,25	<0,25
19/1766	Earthworm	1,06	<0,05	6,46	2,17	2,76	52,4	<0,02	0,41	<0,25	<0,25
19/1767	Earthworm	2,17	<0,05	2,30	<0,02	0,58	3,38	<0,02	<0,05	<0,25	<0,25
19/1768	Earthworm	0,59	<0,05	<0,02	1,03	<0,02	4,48	<0,02	<0,05	<0,25	<0,25

NILU-Sample number:	Sample type:	PFBS	PFPS	PFHxS	PFHpS	brPFOS	PFOS	PFNS	PFDcS	PFUnDS	PFDoDS
19/1769	Earthworm	0,75	<0,05	0,82	1,62	0,91	6,54	0,17	0,30	<0,25	<0,25
19/1712	Fieldfare egg	<0,050	<0,050	0,54	0,52	3,7	41	0,12	0,86	<0,25	<0,25
19/1713	Fieldfare egg	<0,050	<0,050	1,02	1,65	21,6	276	0,45	33,0	<0,25	<0,25
19/1714	Fieldfare egg	<0,050	<0,050	0,23	0,07	1,22	11,3	0,19	0,19	<0,25	<0,25
19/1715	Fieldfare egg	<0,050	<0,050	0,16	0,10	<0,02	14,9	0,15	1,93	<0,25	<0,25
19/1716	Fieldfare egg	<0,050	<0,050	0,27	0,17	<0,02	11,5	0,11	0,51	<0,25	<0,25
19/1717	Fieldfare egg	<0,050	<0,050	0,38	0,15	<0,02	21,3	0,10	0,70	<0,25	<0,25
19/1718	Fieldfare egg	0,08	<0,050	0,32	0,28	<0,02	29,5	0,12	1,47	<0,25	<0,25
19/1719	Fieldfare egg	<0,050	<0,050	0,23	0,30	<0,02	27,4	<0,19	0,68	<0,25	<0,25
19/1720	Fieldfare egg	<0,050	<0,050	0,19	0,15	<0,02	10,9	<0,19	0,37	<0,25	<0,25
19/1721	Sparrowhawk egg	<0,050	<0,050	0,36	0,36	<0,02	21,9	0,11	0,81	<0,25	<0,25
19/1722	Sparrowhawk egg	<0,050	<0,050	4,25	2,08	<0,02	153	1,23	6,83	<0,25	<0,25
19/1809	Red fox liver	<0,050	<0,050	0,17	0,22	<0,02	22,5	<0,19	0,18	<0,25	<0,25
19/1810	Red fox liver	<0,050	<0,050	0,25	0,11	<0,02	14,7	<0,19	0,10	<0,25	<0,25
19/1811	Red fox liver	<0,050	<0,050	0,22	0,08	1,02	10,3	<0,19	0,06	<0,25	<0,25
19/1812	Red fox liver	<0,050	<0,050	0,71	0,15	5,87	20,6	<0,19	0,25	<0,25	<0,25
19/1813	Red fox liver	<0,050	<0,050	0,26	0,11	2,12	9,3	<0,19	<0,05	<0,25	<0,25
19/1814	Red fox liver	<0,050	<0,050	0,33	0,19	<0,02	28,1	<0,19	0,31	<0,25	<0,25
19/1815	Red fox liver	<0,050	<0,050	0,17	0,06	<0,02	20,2	<0,19	0,07	<0,25	<0,25
19/1816	Red fox liver	<0,050	<0,050	0,38	0,12	<0,02	12,6	<0,19	<0,05	<0,25	<0,25
19/1817	Red fox liver	<0,050	<0,050	0,23	0,14	3,74	34,8	<0,19	<0,05	<0,25	<0,25
19/1818	Red fox liver	<0,050	<0,050	0,12	0,03	<0,02	4,61	<0,19	<0,05	<0,25	<0,25

NILU-Sample number:	Sample type:	PFBS	PFPS	PFHxS	PFHpS	brPFOS	PFOS	PFNS	PFDcS	PFUnDS	PFDoDS
19/1723	Tawny owl egg	<0,050	<0,050	0,24	0,09	7,51	12,6	<0,19	0,07	<0,25	<0,25
19/1724	Tawny owl egg	<0,050	<0,050	0,71	0,38	20,3	32,3	<0,19	0,67	<0,25	<0,25
19/1725	Tawny owl egg	<0,050	<0,050	0,25	0,14	<0,02	18,9	<0,19	0,10	<0,25	<0,25
19/1726	Tawny owl egg	<0,050	<0,050	0,43	<0,02	<0,02	9,36	<0,19	0,23	<0,25	<0,25
19/1727	Tawny owl egg	<0,050	<0,050	0,10	0,17	2,98	17,0	<0,19	1,08	<0,25	<0,25
19/1728	Tawny owl egg	<0,050	<0,050	0,27	0,21	6,18	33,5	<0,19	1,83	<0,25	<0,25
19/1729	Tawny owl egg	<0,050	<0,050	1,05	0,22	4,19	35,4	<0,19	0,60	<0,25	<0,25
19/1730	Tawny owl egg	<0,050	<0,050	0,30	0,07	<0,02	10,7	<0,19	0,09	<0,25	<0,25
19/1731	Tawny owl egg	<0,050	<0,050	0,27	<0,02	1,19	10,1	<0,19	0,14	<0,25	<0,25
19/1732	Tawny owl egg	<0,050	<0,050	3,83	0,12	0,80	5,73	<0,19	0,04	<0,25	<0,25
19/1801	Tawny owl egg	<0,050	<0,050	0,03	0,03	0,50	3,75	<0,19	0,02	<0,25	<0,25
19/1822	Rat liver	<0,050	<0,050	1,04	0,95	31,6	161	0,44	27,1	<0,25	<0,25
19/1823	Rat liver	<0,050	<0,050	0,23	0,05	4,61	30,1	<0,19	8,91	<0,25	<0,25
19/1824	Rat liver	<0,050	<0,050	0,41	<0,02	2,28	5,08	<0,19	0,12	<0,25	<0,25
19/1825	Rat liver	<0,050	<0,050	0,35	0,22	7,85	102	0,25	2,79	<0,25	<0,25
19/1826	Rat liver	<0,050	<0,050	0,28	0,16	10,1	172	<0,19	5,10	<0,25	<0,25
19/1827	Rat liver	<0,050	<0,050	1,71	3,16	51,2	234	<0,19	0,97	<0,25	<0,25
19/1828	Rat liver	<0,050	<0,050	0,50	0,71	31,7	97,9	<0,19	6,77	<0,25	<0,25
19/1829	Rat liver	<0,050	<0,050	0,84	0,44	24,2	50,4	<0,19	23,2	<0,25	<0,25
19/1830	Rat liver	<0,050	<0,050	<0,02	0,03	3,26	5,66	0,22	5,74	<0,25	<0,25
19/1831	Rat liver	<0,050	<0,050	0,14	0,87	25,2	272	<0,19	4,30	<0,25	<0,25

PFCA (perfluorocarboxylates)

NILU-Sample number:	Sample type:	PFBA	PFPA	PFHxA	PFHpA	PFOA	PFNA	PFDcA	PFUnA	PFDoA	PFTriA	PFTeA	PFHxDA	PFOcDA
19/2294	Air	<0,32	<0,53	<0,21	<0,21	2,21	<1,37	<1,16	<0,21	<0,21	<0,32	<1,37	<0,32	<1,26
19/2295	Air	<0,32	<0,53	<0,21	<0,21	3,03	<1,37	<1,16	<0,21	<0,21	<0,32	<1,37	<0,32	2,52
19/2296	Air	<0,32	<0,53	<0,21	<0,21	3,97	<1,37	<1,16	<0,21	<0,21	<0,32	<1,37	<0,32	3,17
19/2297	Air	<0,32	<0,53	<0,21	<0,21	<0,21	<1,37	<1,16	<0,21	<0,21	<0,32	<1,37	<0,32	3,69
19/2465	Air	<0,31	5,26	45,9	3,92	18,0	<1,03	<1,13	<0,21	<0,93	<0,31	<1,34	<1,34	<1,24
19/2298	Air	<0,32	<0,53	<0,21	<0,21	<0,21	<1,37	<1,16	<0,21	<0,21	<0,32	<1,37	<0,32	3,26
19/2299	Air	<0,32	<0,53	<0,21	<0,21	4,26	<1,37	<1,16	<0,21	<0,21	<0,32	<1,37	<0,32	4,95
19/1771	Soil	<2,14	0,13	0,15	0,11	0,29	0,15	0,08	<0,03	<0,03	<0,06	<0,07	<0,14	<0,17
19/1772	Soil	<2,42	1,54	1,98	0,87	2,17	0,72	0,39	0,30	0,17	<0,06	<0,08	<0,16	<0,19
19/1773	Soil	<2,17	0,16	0,20	0,16	1,20	0,45	0,22	0,13	0,10	<0,06	<0,07	<0,14	<0,17
19/1774	Soil	<2,09	0,31	0,21	0,10	0,16	0,10	0,05	0,03	<0,03	<0,05	<0,07	<0,14	<0,16
19/1775	Soil	<2,04	<0,07	<0,03	0,09	0,14	0,08	<0,03	0,03	<0,03	<0,05	<0,07	<0,13	<0,16
19/1776	Soil	<3,28	0,44	0,58	0,47	1,13	1,01	0,51	0,46	0,27	<0,09	<0,11	<0,22	<0,26
19/1777	Soil	<1,89	0,19	0,15	0,12	0,31	0,13	0,08	0,06	<0,02	<0,05	<0,06	<0,12	<0,15
19/1763	Earthworm	<1,52	1,13	<0,02	1,44	4,25	1,87	1,26	0,93	2,40	2,05	2,39	0,70	0,23
19/1764	Earthworm	<1,52	4,36	<0,02	13,4	6,42	0,85	0,64	0,93	1,68	2,38	2,45	0,94	0,28
19/1765	Earthworm	<1,52	0,71	<0,02	0,87	2,94	0,82	0,72	1,10	3,35	3,92	5,28	1,13	0,21
19/1766	Earthworm	<1,52	3,73	<0,02	0,61	0,62	0,25	0,29	0,46	1,41	1,99	2,62	0,49	<0,12
19/1767	Earthworm	<1,52	<0,05	<0,02	0,51	0,69	0,34	0,17	0,36	0,57	1,08	0,78	0,18	<0,12
19/1768	Earthworm	<1,52	<0,05	<0,02	0,35	0,37	0,24	0,22	0,34	1,06	2,01	1,88	0,37	0,19

NILU-Sample number:	Sample type:	PFBA	PFPA	PFHxA	PFHpA	PFOA	PFNA	PFDcA	PFUnA	PFDoA	PFTriA	PFTeA	PFHxDA	PFOcDA
19/1769	Earthworm	<1,52	0,63	<0,02	0,45	0,73	0,33	0,28	0,51	0,99	2,10	1,96	0,53	<0,12
19/1712	Fieldfare egg	<0,050	<0,050	<0,41	<1,72	2,53	2,99	4,56	5,18	13,4	9,82	8,73	0,52	<0,31
19/1713	Fieldfare egg	<0,050	<0,050	<0,41	<1,72	1,22	2,21	6,12	4,92	15,6	8,31	10,0	0,50	<0,31
19/1714	Fieldfare egg	<0,050	<0,050	<0,41	<1,72	0,80	0,66	0,79	0,79	1,92	2,28	1,64	<0,14	<0,31
19/1715	Fieldfare egg	<0,050	<0,050	<0,41	<1,72	0,31	0,65	1,49	2,12	7,07	7,85	8,85	1,25	<0,31
19/1716	Fieldfare egg	<0,050	<0,050	<0,41	<1,72	0,48	0,85	1,18	1,34	2,82	3,51	3,01	0,57	<0,31
19/1717	Fieldfare egg	<0,050	0,79	<0,41	<1,72	0,56	0,96	1,25	1,61	3,77	4,52	3,99	0,32	<0,31
19/1718	Fieldfare egg	<0,050	<0,050	<0,41	<1,72	0,45	1,31	2,24	3,01	11,57	9,71	9,17	0,53	<0,31
19/1719	Fieldfare egg	<0,050	<0,050	<0,41	<1,72	1,31	5,03	**11,1**	**11,7**	**31,6**	**20,6**	**18,2**	0,98	<0,31
19/1720	Fieldfare egg	<0,050	<0,050	<0,41	<1,72	0,54	0,92	1,08	1,42	4,91	5,10	4,86	0,43	<0,31
19/1721	Sparrowhawk egg	<0,050	<0,050	<0,41	<1,72	0,47	1,05	1,06	1,85	3,23	5,70	4,13	0,41	<0,31
19/1722	Sparrowhawk egg	<0,050	<0,050	<0,41	<1,72	1,63	4,21	4,20	15,96	21,75	59,10	30,3	1,98	<0,31
19/1809	Red fox liver	<0,050	<0,050	<0,41	<1,72	<0,57	1,05	0,85	0,42	0,20	0,25	0,16	<0,14	<0,31
19/1810	Red fox liver	<0,050	<0,050	<0,41	<1,72	<0,57	1,03	0,82	0,43	0,19	0,15	<0,08	<0,14	<0,31
19/1811	Red fox liver	<0,050	<0,050	<0,41	<1,72	<0,57	1,39	0,77	0,48	0,35	0,55	0,29	<0,14	<0,31
19/1812	Red fox liver	<0,050	<0,050	<0,41	<1,72	0,65	2,92	4,03	8,97	9,63	14,7	2,72	<0,14	<0,31
19/1813	Red fox liver	<0,050	<0,050	<0,41	<1,72	<0,57	1,72	1,04	0,64	0,45	0,44	0,13	<0,14	<0,31
19/1814	Red fox liver	<0,050	<0,050	<0,41	<1,72	0,65	2,61	3,78	1,82	3,68	2,39	2,55	<0,14	<0,31
19/1815	Red fox liver	<0,050	<0,050	<0,41	<1,72	<0,57	2,32	1,49	1,12	0,71	0,85	0,26	<0,14	<0,31
19/1816	Red fox liver	<0,050	<0,050	<0,41	<1,72	<0,57	2,22	0,83	0,53	0,45	0,65	0,30	<0,14	<0,31
19/1817	Red fox liver	<0,050	0,22	<0,41	<1,72	0,66	2,55	2,28	2,83	1,15	1,17	0,36	<0,14	<0,31
19/1818	Red fox liver	<0,050	<0,050	<0,41	<1,72	<0,57	0,42	0,24	0,13	0,15	0,26	0,33	<0,14	<0,31

NILU-Sample number:	Sample type:	PFBA	PFPA	PFHxA	PFHpA	PFOA	PFNA	PFDcA	PFUnA	PFDoA	PFTriA	PFTeA	PFHxDA	PFOcDA
19/1723	Tawny owl egg	<0,050	<0,050	<0,41	<1,72	<0,57	0,75	0,95	0,98	1,59	1,99	1,11	<0,14	<0,31
19/1724	Tawny owl egg	<0,050	<0,050	<0,41	<1,72	<0,57	1,56	2,12	2,45	4,54	7,00	3,07	<0,14	<0,31
19/1725	Tawny owl egg	<0,050	<0,050	<0,41	<1,72	<0,57	0,62	0,89	1,08	1,84	2,99	1,37	<0,14	<0,31
19/1726	Tawny owl egg	<0,050	<0,050	<0,41	<1,72	<0,57	0,10	0,37	0,94	2,00	2,41	1,33	<0,14	<0,31
19/1727	Tawny owl egg	<0,050	<0,050	<0,41	<1,72	<0,57	0,36	1,02	1,27	3,02	2,60	1,85	<0,14	<0,31
19/1728	Tawny owl egg	<0,050	<0,050	<0,41	<1,72	<0,57	0,65	1,76	1,93	5,02	4,23	2,91	<0,14	<0,31
19/1729	Tawny owl egg	<0,050	<0,050	<0,41	<1,72	<0,57	0,63	1,50	3,38	7,35	8,97	5,31	0,23	<0,31
19/1730	Tawny owl egg	<0,050	<0,050	<0,41	<1,72	<0,57	0,14	0,46	1,12	2,16	3,59	2,10	<0,14	<0,31
19/1731	Tawny owl egg	<0,050	<0,050	<0,41	<1,72	<0,57	0,11	0,48	1,15	2,38	2,80	1,55	<0,14	<0,31
19/1732	Tawny owl egg	<0,050	<0,050	<0,41	<1,72	<0,57	0,08	0,28	1,16	1,10	3,06	1,29	<0,14	<0,31
19/1801	Tawny owl egg	<0,050	<0,050	<0,41	<1,72	<0,57	0,12	0,19	0,90	LOD	2,04	0,82	<0,14	<0,31
19/1822	Rat liver	<0,050	1,18	0,59	<1,72	<0,57	5,36	16,64	9,08	19,46	8,12	6,59	<0,14	<0,31
19/1823	Rat liver	<0,050	4,16	<0,41	<1,72	<0,57	0,22	2,65	2,24	5,80	3,54	3,21	<0,14	<0,31
19/1824	Rat liver	<0,050	<0,050	<0,41	<1,72	<0,57	0,20	1,19	0,75	1,00	0,44	0,24	<0,14	<0,31
19/1825	Rat liver	<0,050	2,64	<0,41	<1,72	<0,57	1,71	6,28	2,95	10,0	5,74	7,52	<0,14	<0,31
19/1826	Rat liver	<0,050	<0,050	<0,41	<1,72	<0,57	0,31	3,97	3,59	7,78	10,2	10,1	0,40	<0,31
19/1827	Rat liver	<0,050	1,17	<0,41	<1,72	8,67	35,4	16,2	8,01	14,9	12,6	7,67	0,33	<0,31
19/1828	Rat liver	<0,050	1,08	<0,41	<1,72	3,79	6,60	6,64	1,71	3,60	1,38	1,29	<0,14	<0,31
19/1829	Rat liver	<0,050	1,15	<0,41	<1,72	1,38	2,54	3,82	1,50	2,62	0,96	0,64	<0,14	<0,31
19/1830	Rat liver	<0,050	1,00	<0,41	<1,72	<0,57	0,55	0,87	0,41	0,57	0,17	<0,08	<0,14	<0,31
19/1831	Rat liver	<0,050	<0,050	<0,41	<1,72	<0,57	3,68	5,68	6,38	8,25	11,1	6,63	<0,14	<0,31

nPFAS

NILU-Sample number:	Sample type:	PFOSA	meFOSA	etFOSA	meFOSEA	meFOSE	etFOSE	6:2 FTOH	8:2 FTOH	10:2 FTOH
19/2294	Air	<0,42	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
19/2295	Air	<0,42	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
19/2296	Air	<0,42	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
19/2297	Air	<0,42	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
19/2465	Air	<0,42	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
19/2298	Air	<0,42	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
19/2299	Air	<0,42	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
19/1771	Soil	<0,03	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1772	Soil	<0,03	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1773	Soil	<0,03	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1774	Soil	<0,03	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1775	Soil	<0,03	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1776	Soil	<0,04	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1777	Soil	<0,02	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1766	Earthworm	<0,02	<0,3	<0,3	<5,0	<5,0	<5,0	<2,0	<2,0	<2,0
19/1768	Earthworm	0,09	<0,3	<0,3	<5,0	<5,0	<5,0	<2,0	<2,0	<2,0
19/1769	Earthworm	0,25	<0,3	<0,3	<5,0	<5,0	<5,0	<2,0	<2,0	<2,0
19/1766	Earthworm	0,08	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
19/1767	Earthworm	<0,02	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
19/1768	Earthworm	0,10	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

NILU-Sample number:	Sample type:	PFOSA	meFOSA	etFOSA	meFOSEA	meFOSE	etFOSE	6:2 FTOH	8:2 FTOH	10:2 FTOH
19/1769	Earthworm	0,21	<0,3	<0,3	<5,0	<5,0	<5,0	<2,0	<2,0	<2,0
19/1712	Fieldfare egg	0,16	<0,3	<0,3	<5,0	<5,0	<5,0	<2,0	<2,0	<2,0
19/1713	Fieldfare egg	0,86	<0,3	<0,3	<5,0	<5,0	<5,0	<2,0	<2,0	<2,0
19/1714	Fieldfare egg	0,09	<0,3	<0,3	<5,0	<5,0	<5,0	<2,0	<2,0	<2,0
19/1715	Fieldfare egg	0,08	<0,3	<0,3	<5,0	<5,0	<5,0	<2,0	<2,0	<2,0
19/1716	Fieldfare egg	0,05	<0,3	<0,3	<5,0	<5,0	<5,0	<2,0	<2,0	<2,0
19/1717	Fieldfare egg	0,08	<0,3	<0,3	<5,0	<5,0	<5,0	<2,0	<2,0	<2,0
19/1718	Fieldfare egg	0,12	<0,3	<0,3	<5,0	<5,0	<5,0	<2,0	<2,0	<2,0
19/1719	Fieldfare egg	0,04	<0,3	<0,3	<5,0	<5,0	<5,0	<2,0	<2,0	<2,0
19/1720	Fieldfare egg	0,03	<0,3	<0,3	<5,0	<5,0	<5,0	<2,0	<2,0	<2,0
19/1721	Sparrowhawk egg	0,09	<0,3	<0,3	<5,0	<5,0	<5,0	<2,0	<2,0	<2,0
19/1722	Sparrowhawk egg	1,06	<0,3	<0,3	<5,0	<5,0	<5,0	<2,0	<2,0	<2,0
19/1809	Red fox liver	0,30	<0,3	<0,3	<5,0	<5,0	<5,0	<2,0	<2,0	<2,0
19/1810	Red fox liver	0,10	<0,3	<0,3	<5,0	<5,0	<5,0	<2,0	<2,0	<2,0
19/1811	Red fox liver	0,09	<0,3	<0,3	<5,0	<5,0	<5,0	<2,0	<2,0	<2,0
19/1812	Red fox liver	0,16	<0,3	<0,3	<5,0	<5,0	<5,0	<2,0	<2,0	<2,0
19/1813	Red fox liver	0,29	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1814	Red fox liver	0,16	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1815	Red fox liver	<0,02	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1816	Red fox liver	<0,02	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1817	Red fox liver	0,25	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1818	Red fox liver	0,16	<0,3	<0,3	<5	<5	<5	<2	<2	<2

NILU-Sample number:	Sample type:	PFOSA	meFOSA	etFOSA	meFOSEA	meFOSE	etFOSE	6:2 FTOH	8:2 FTOH	10:2 FTOH
19/1723	Tawny owl egg	<0,02	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1724	Tawny owl egg	0.05	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1725	Tawny owl egg	<0,02	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1726	Tawny owl egg	<0,02	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1727	Tawny owl egg	<0,02	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1728	Tawny owl egg	0,22	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1729	Tawny owl egg	<0,02	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1730	Tawny owl egg	<0,02	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1731	Tawny owl egg	<0,02	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1732	Tawny owl egg	<0,02	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1801	Tawny owl egg	<0,02	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1822	Rat liver	1,59	<0,3	<0,3	<5,0	<5	<5	<2	<2	<2
19/1823	Rat liver	0,24	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1824	Rat liver	0,28	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1825	Rat liver	1,54	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1826	Rat liver	0,43	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1827	Rat liver	0,31	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1828	Rat liver	<0,02	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1829	Rat liver	1,09	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1830	Rat liver	0,31	<0,3	<0,3	<5	<5	<5	<2	<2	<2
19/1831	Rat liver	0,45	<0,3	<0,3	<5	<5	<5	<2	<2	<2

Fluorotelomer sulfonates (New PFAS)

NILU-Sample number:	Sample type:	8:2 FTS	4:2FTS	6:2FTS	10:2 FTS
19/1771	Soil	<0,21	<1,05	<0,53	<0,3
19/1772	Soil	<0,21	<1,05	<0,53	<0,3
19/1773	Soil	<0,21	<1,05	<0,53	<0,3
19/1774	Soil	<0,21	<1,05	<0,53	1,90
19/1775	Soil	<0,21	<0,21	<0,52	<0,3
19/1776	Soil	<0,21	<1,05	<0,53	<0,3
19/1777	Soil	<0,21	<1,05	<0,53	<0,3
19/1766	Earthworm	<0,03	<0,14	<0,07	<0,3
19/1768	Earthworm	<0,03	<0,16	<0,08	<0,3
19/1769	Earthworm	<0,03	<0,14	<0,07	<0,3
19/1712	Fieldfare egg	<0,03	<0,14	<0,07	13,4
19/1714	Fieldfare egg	<0,03	<0,13	<0,07	<0,30
19/1715	Fieldfare egg	<0,04	<0,22	<0,11	3,10
19/1716	Fieldfare egg	<0,02	<0,12	<0,06	1,2
19/1717	Fieldfare egg	0,33	<0,10	0,07	0,90
19/1718	Fieldfare egg	0,16	<0,10	0,05	<0,30
19/1719	Fieldfare egg	0,95	<0,10	0,12	<0,30
19/1720	Fieldfare egg	0,47	<0,10	0,44	<0,30
19/1721	Sparrowhawk egg	0,14	<0,10	0,10	<0,30
19/1722	Sparrowhawk egg	<0,02	<0,10	0,05	10,7

NILU-Sample number:	Sample type:	8:2 FTS	4:2FTS	6:2FTS	10:2 FTS
19/1809	Red fox liver	0,42	<0,10	0,37	<0,3
19/1810	Red fox liver	1,19	<0,01	<0,04	<0,3
19/1811	Red fox liver	0,73	0,06	<0,04	<0,3
19/1812	Red fox liver	0,06	<0,01	<0,04	<0,3
19/1813	Red fox liver	1,57	<0,01	<0,04	<0,3
19/1814	Red fox liver	0,53	<0,01	<0,04	<0,3
19/1815	Red fox liver	0,66	<0,01	<0,04	<0,3
19/1816	Red fox liver	0,32	<0,01	<0,04	<0,3
19/1817	Red fox liver	0,21	<0,01	<0,04	<0,3
19/1818	Red fox liver	0,28	<0,01	<0,04	<0,3
19/1723	Tawny owl egg	0,14	<0,01	<0,04	<0,3
19/1725	Tawny owl egg	47,6	<0,01	0,24	<0,30
19/1726	Tawny owl egg	<0,38	<0,01	<0,04	<0,3
19/1727	Tawny owl egg	<0,38	<0,01	<0,04	<0,3
19/1728	Tawny owl egg	<0,38	<0,01	<0,04	0,7
19/1729	Tawny owl egg	<0,38	<0,01	<0,04	<0,3
19/1730	Tawny owl egg	<0,38	<0,01	<0,04	<0,3
19/1731	Tawny owl egg	<0,38	<0,01	<0,04	<0,3
19/1732	Tawny owl egg	<0,38	<0,01	<0,04	<0,3
19/1801	Tawny owl egg	<0,38	<0,01	<0,04	<0,3
19/1822	Rat liver	<0,38	<0,01	<0,04	68,7
19/1823	Rat liver	<0,38	<0,01	<0,04	10,2

NILU-Sample number:	Sample type:	8:2 FTS	4:2FTS	6:2FTS	10:2 FTS
19/1824	Rat liver	<0,38	<0,01	<0,04	<0,30
19/1825	Rat liver	<0,38	<0,01	<0,04	7,20
19/1826	Rat liver	<0,38	0,10	<0,04	6,30
19/1827	Rat liver	<0,38	<0,01	<0,04	1,20
19/1828	Rat liver	<0,38	<0,01	0,24	<0,30
19/1829	Rat liver	1,90	<0,01	0,51	0,90
19/1830	Rat liver	<0,38	<0,01	<0,04	<0,30
19/1831	Rat liver	<0,38	<0,01	<0,04	4,7

Chlorinated paraffins (CP)

NILU-Sample number:	Sample type:	SCCP	MCCP
19/2294	Air	9410	2126
19/2295	Air	2525	<2032
19/2296	Air	2060	3000
19/2297	Air	3869	3963
19/2465	Air	9464	2680
19/2298	Air	2192	2832
19/2299	Air	4809	3807
19/1771	Soil	508	513
19/1772	Soil	1218	692
19/1773	Soil	572	559
19/1774	Soil	522	<452
19/1775	Soil	458	<452
19/1776	Soil	495	1140
19/1777	Soil	<339	<452
19/1763	Earthworm	78.8	<40.1
19/1764	Earthworm	69.7	<40.1
19/1765	Earthworm	70.1	<40.1
19/1766	Earthworm	<68.6	50.3
19/1767	Earthworm	<68.6	<40.1
19/1768	Earthworm	<68.6	<40.1

NILU-Sample number:	Sample type:	SCCP	MCCP
19/1769	Earthworm	75.6	75.9
19/1712	Fieldfare egg	50.7	<79.0
19/1713	Fieldfare egg	<47.6	<79.0
19/1714	Fieldfare egg	<47.6	<79.0
19/1715	Fieldfare egg	58.9	310
19/1716	Fieldfare egg	<47.6	<79.0
19/1717	Fieldfare egg	<47.6	96.6
19/1718	Fieldfare egg	71.7	106
19/1719	Fieldfare egg	54.6	<79.0
19/1720	Fieldfare egg	<47.6	83.9
19/1721	Sparrowhawk egg	<47	<74
19/1722	Sparrowhawk egg	2009	1581
19/1809	Red fox liver	43.9	<56.2
19/1810	Red fox liver	n.a.	n.a.
19/1811	Red fox liver	<36.8	<56.2
19/1812	Red fox liver	38.2	<56.2
19/1813	Red fox liver	<36.8	<56.2
19/1814	Red fox liver	<36.8	58.7
19/1815	Red fox liver	43.7	<56.2
19/1816	Red fox liver	<36.8	98
19/1817	Red fox liver	<36.8	147
19/1818	Red fox liver	49.5	<56.2

NILU-Sample number:	Sample type:	SCCP	MCCP
19/1723	Tawny owl egg	160	371
19/1724	Tawny owl egg	1063	2571
19/1725	Tawny owl egg	<140	<238
19/1726	Tawny owl egg	170	<238
19/1727	Tawny owl egg	<140	252
19/1728	Tawny owl egg	170	<238
19/1729	Tawny owl egg	<140	547
19/1730	Tawny owl egg	<140	242
19/1731	Tawny owl egg	<140	<238
19/1732	Tawny owl egg	157	286
19/1801	Tawny owl egg	<140	337
19/1822	Rat liver	<33.2	90.2
19/1823	Rat liver	37.2	<54.6
19/1824	Rat liver	45.8	<54.6
19/1825	Rat liver	33.0	<54.6
19/1826	Rat liver	37.9	<54.6
19/1827	Rat liver	34.7	<54.6
19/1828	Rat liver	<33.2	76.9
19/1829	Rat liver	37.7	120
19/1830	Rat liver	36.8	<54.6
19/1831	Rat liver	38.5	86.6

Siloxanes (cVMS)

NILU-Sample number:	Sample type:	D4	D5	D6
19/2294	Air	26047	38354	4222
19/2295	Air	6507	6824	1039
19/2296	Air	4715	5744	836
19/2297	Air	4647	10695	1465
19/2465	Air	150344	1621558	34081
19/2298	Air	6122	13220	1806
19/2299	Air	7647	15952	1604
19/1771	Soil	<0,58	<0,72	<1,13
19/1772	Soil	<1,29	<1,45	<1,27
19/1773	Soil	1,38	2,45	2,75
19/1774	Soil	<0,56	<0,70	<2,06
19/1775	Soil	<0,55	<0,69	<1,08
19/1776	Soil	216	86	27
19/1777	Soil	<0,51	<0,63	<1,00
19/1763	Earthworm	<3,09	<1,5	<2,26
19/1764	Earthworm	<3,09	<1,5	<2,26
19/1766	Earthworm	<3,09	<1,5	<2,26
19/1767	Earthworm	<3,09	<3,75	<2,26
19/1768	Earthworm	<8,75	<3,75	<2,53
19/1769	Earthworm	<3,09	<1,5	<2,26

NILU-Sample number:	Sample type:	D4	D5	D6
19/1712	Fieldfare egg	<3,58	<3,65	2,25
19/1713	Fieldfare egg	<3,58	4,41	2,5
19/1714	Fieldfare egg	<3,58	<1,63	<2
19/1715	Fieldfare egg	<3,58	<1,63	2,86
19/1716	Fieldfare egg	10,1	7,99	4,94
19/1717	Fieldfare egg	<3,58	4,56	3,96
19/1718	Fieldfare egg	<3,58	<3,65	3,62
19/1719	Fieldfare egg	<9,54	4,59	6,06
19/1720	Fieldfare egg	<9,55	6,17	9,1
19/1721	Sparrowhawk egg	<8,1	<9,84	<8,48
19/1722	Sparrowhawk egg	8,42	16,1	<14,04
19/1809	Red fox liver	<0,3	<0,5	<2,2
19/1810	Red fox liver	<0,7	<0,5	<2,2
19/1811	Red fox liver	<0,7	<0,9	<2,2
19/1812	Red fox liver	<0,3	<0,5	<1,4
19/1813	Red fox liver	<0,3	<0,5	<1,4
19/1814	Red fox liver	<0,3	<0,5	<1,4
19/1815	Red fox liver	<0,3	<0,9	<2,2
19/1816	Red fox liver	1,1	<0,9	<2,2
19/1817	Red fox liver	<0,3	<0,9	<2,2
19/1818	Red fox liver	<0,3	<0,5	<2,2
19/1723	Tawny owl egg	**482**	34,8	<14,04

NILU-Sample number:	Sample type:	D4	D5	D6
19/1724	Tawny owl egg	28,0	27,5	22,9
19/1725	Tawny owl egg	<8,1	<9,84	<14,04
19/1726	Tawny owl egg	<4,58	<5,99	<8,48
19/1727	Tawny owl egg	<8,1	56,3	<14,04
19/1728	Tawny owl egg	10,0	81,8	14,4
19/1729	Tawny owl egg	10,2	16,2	<14,04
19/1730	Tawny owl egg	<4,58	<5,99	<8,48
19/1731	Tawny owl egg	<4,58	<5,99	<8,48
19/1732	Tawny owl egg	<4,58	<5,99	<8,48
19/1801	Tawny owl egg	8,2	<5,99	<8,48
19/1822	Rat liver	<1,32	2,09	<2,75
19/1823	Rat liver	6,29	<1,52	<2,75
19/1824	Rat liver	9,5	68,7	5,5
19/1825	Rat liver	22,4	11,1	10,2
19/1826	Rat liver	2,32	<1,52	<2,75
19/1827	Rat liver	<1,32	<0,71	<2,75
19/1828	Rat liver	<1,32	<1,52	4,65
19/1829	Rat liver	2,31	2	<2,75
19/1830	Rat liver	4,99	9,09	4,69
19/1831	Rat liver	<0,51	<0,71	<2,75

OPFR

NILU-Sample number:	Sample type:	TCEP	TPrP	TCPP	TiBP	BdPhP	TPP	DBPhP	TnBP	TDCPP	TBEP	TCP	EHDP	TXP	TEHP
19/2294	Air	303	<2,1	3487	271	<1,1	169	8,77	183,8	35,7	<294,7	14,8	813	<3,7	73,6
19/2295	Air	<59	<2,1	<261	80	<1,1	63	5,29	44,8	12,1	<294,7	<2,4	6066	<3,7	26,5
19/2296	Air	<59	<2,1	757	80	<1,1	110	7,49	53,3	28,6	<294,7	19,0	7490	<3,7	59,5
19/2297	Air	162	<2,1	2490	211	<1,1	235	14,5	218,9	123,6	<294,7	186,5	11850	<3,7	163,9
19/2465	Air	1417	<2,1	3191	798	2,3	446	91,5	1188,3	264,7	1125	7,3	9830	<3,6	45,0
19/2298	Air	<59	<2,1	<261	136	<1,1	<33	8,45	97,5	15,4	<294,7	<2,4	1322	<3,7	<13,7
19/2299	Air	133	<2,1	1145	121	<1,1	155	12,2	106,3	24,1	<294,7	18,9	5884	<3,7	44,6
19/1802	Soil	7,7	<0,2	49052	<0,10	<0,10	2,0	<0,1	<0,1	9,3	14,4	13,3	1,1	1,0	4,7
19/1803	Earthworm	<0,4	<0,01	5,23	0,72	<0,01	0,35	<0,01	1,39	<0,2	<0,1	3,47	0,60	<0,05	<0,2

NewBrom

NILU-Sample number:	Sample type:	ATE (TBP-AE)	a-TBECH	b-TBECH	g/d-TBECH	BATE	PBT	PBEB	PBBZ	HBB	DPTE	EHTBB	BTBPE	TBPH (BEH /TBP)	DBDPE
19/2294	Air	<0,2	30,8	17,5	1,0	<0,1	2,1	<0,1	6,9	1,1	0,2	<0,1	<0,5	<0,6	<94,2
19/2295	Air	<0,2	4,2	2,3	<0,1	<0,1	0,4	<0,1	<1,8	<0,7	0,1	<0,1	<0,5	<0,6	<94,2
19/2296	Air	<0,2	1,2	0,6	0,2	<0,1	<0,3	<0,1	<1,8	<0,7	0,1	<0,1	<0,5	<0,6	<94,2
19/2297	Air	<0,2	4,7	2,5	0,1	<0,1	5,0	<0,1	<1,8	<0,7	0,3	<0,1	1,9	<0,6	<94,2
19/2465	Air	<0,2	2,9	<0,2	<0,1	<0,1	6,8	<0,1	<1,8	<1,7	0,5	0,3	<0,5	1,6	<92,3
19/2298	Air	<0,2	1,9	1,0	0,1	<0,1	0,3	<0,1	<1,8	<0,7	<0,1	0,2	<0,5	2,9	<94,2
19/2299	Air	<0,2	5,5	3,1	<0,1	<0,1	0,6	<0,1	<1,8	<0,7	<0,1	<0,1	<0,5	2,4	<94,2
19/1771	Soil	<0,06	<0,22	<0,15	<0,08	<0,04	<0,07	<0,04	<0,57	<0,23	<0,02	<0,02	<0,15	<0,18	<29,8
19/1772	Soil	<0,06	<0,24	<0,17	<0,09	<0,04	<0,07	<0,04	<0,57	0,26	<0,02	<0,02	<0,15	<0,18	<29,8
19/1773	Soil	<0,06	<0,13	<0,09	<0,05	<0,04	<0,07	<0,04	<0,57	<0,23	<0,02	<0,02	0,20	<0,18	<29,8
19/1774	Soil	<0,06	<0,11	<0,08	<0,04	<0,04	<0,07	<0,04	<0,57	<0,23	<0,02	<0,02	<0,15	<0,18	<29,8
19/1775	Soil	<0,06	<0,13	<0,09	<0,05	<0,04	<0,07	<0,04	<0,57	<0,23	<0,02	<0,02	<0,15	<0,18	<29,8
19/1776	Soil	<0,06	<0,09	<0,06	<0,03	<0,04	<0,07	<0,04	<0,57	<0,23	<0,02	<0,02	<0,15	<0,18	<29,8
19/1777	Soil	<0,05	<0,11	<0,08	<0,04	<0,03	<0,06	<0,04	<0,50	<0,21	<0,02	<0,02	<0,13	<0,16	<26,3
19/1763	Earthworm	<0,04	<0,13	<0,09	<0,06	<0,02	<0,04	<0,03	<0,34	<0,14	<0,01	<0,06	<0,09	<0,11	<17,9
19/1764	Earthworm	<0,04	<0,07	<0,05	<0,03	<0,02	<0,04	<0,03	<0,34	<0,14	<0,01	<0,05	<0,09	<0,11	<17,9
19/1765	Earthworm	<0,04	<0,09	<0,06	<0,04	<0,02	<0,04	<0,03	<0,34	0,16	<0,01	<0,06	<0,09	<0,11	<17,9
19/1766	Earthworm	<0,04	<0,06	<0,04	<0,02	<0,02	<0,04	<0,03	<0,34	<0,14	<0,01	<0,06	<0,09	<0,11	<17,9
19/1767	Earthworm	<0,04	<0,04	<0,03	<0,02	<0,02	<0,04	<0,03	<0,34	<0,14	<0,01	<0,07	<0,09	<0,11	<17,9
19/1768	Earthworm	<0,04	<0,04	<0,03	<0,02	<0,02	<0,04	<0,03	<0,34	<0,14	<0,01	<0,02	<0,09	<0,11	<17,9

NILU-Sample number:	Sample type:	ATE (TBP-AE)	a-TBECH	b-TBECH	g/d-TBECH	BATE	PBT	PBEB	PBBZ	HBB	DPTE	EHTBB	BTBPE	TBPH (BEH /TBP)	DBDPE
19/1769	Earthworm	0,04	<0,04	<0,03	<0,02	<0,02	<0,04	<0,03	<0,34	<0,14	<0,01	<0,03	<0,09	<0,11	<17,9
19/1712	Fieldfare egg	<0,04	<0,06	<0,04	<0,02	<0,02	<0,04	<0,03	<0,34	<0,14	<0,01	<0,09	<0,09	<0,11	<17,9
19/1713	Fieldfare egg	<0,04	<0,06	<0,04	<0,02	<0,02	<0,04	<0,03	<0,34	<0,14	<0,01	<0,08	<0,09	<0,11	<17,9
19/1714	Fieldfare egg	<0,04	<0,04	<0,03	<0,02	<0,02	<0,04	<0,03	<0,34	0,16	0,03	<0,05	<0,09	<0,11	<17,9
19/1715	Fieldfare egg	<0,04	<0,05	<0,04	<0,02	<0,02	<0,04	<0,03	<0,34	<0,14	<0,01	<0,08	<0,09	<0,11	<17,9
19/1716	Fieldfare egg	<0,04	<0,04	<0,03	<0,02	<0,02	<0,04	<0,03	<0,34	<0,14	0,03	<0,06	<0,09	<0,11	<17,9
19/1717	Fieldfare egg	<0,04	<0,04	<0,03	<0,02	<0,02	<0,04	<0,03	<0,34	<0,14	<0,01	<0,14	<0,09	<0,11	<17,9
19/1718	Fieldfare egg	0,14	0,20	0,10	0,17	0,15	0,13	0,12	<0,34	0,25	0,07	0,39	0,14	<0,11	<17,9
19/1719	Fieldfare egg	0,07	0,07	0,06	0,06	0,06	0,06	0,05	<0,34	0,22	0,03	0,16	0,09	<0,11	<17,9
19/1720	Fieldfare egg	0,04	<0,04	<0,03	<0,02	<0,04	<0,04	0,03	<0,34	0,17	0,02	0,10	<0,09	<0,11	<17,9
19/1721	Sparrowhawk egg	0,064	0,124	0,133	0,174	0,151	0,171	0,143	<0,34	0,299	0,129	0,156	0,124	0,13	<17,9
19/1722	Sparrowhawk egg	<0,0353	0,157	0,174	0,0978	<0,02	0,236	0,103	<0,34	0,61	0,131	<0,055	0,107	<0,108	21,8
19/1809	Red fox liver	<0,02	<0,02	<0,02	<0,01	<0,01	<0,02	<0,01	<0,17	<0,07	<0,01	<0,20	<0,04	<0,05	<8,95
19/1810	Red fox liver	<0,04	<0,21	<0,16	<0,09	<0,03	<0,03	<0,02	<0,17	0,07	<0,02	<0,10	<0,04	<0,17	<8,95
19/1811	Red fox liver	0,20	0,17	0,17	0,12	0,17	0,13	0,12	0,18	0,18	0,11	<1,06	<0,10	<1,40	<8,95
19/1812	Red fox liver	<0,02	<0,02	<0,02	<0,01	<0,01	<0,02	<0,01	<0,17	<0,07	<0,01	<0,50	<0,04	<0,05	<8,95
19/1813	Red fox liver	0,03	0,04	0,04	0,03	0,03	0,03	0,03	<0,17	0,08	0,02	<0,05	0,04	<0,05	<8,95
19/1814	Red fox liver	0,03	0,02	0,03	0,02	0,02	<0,02	<0,01	<0,17	<0,07	<0,02	<0,06	<0,04	<0,05	<8,95
19/1815	Red fox liver	<0,02	<0,02	<0,02	<0,01	<0,01	<0,02	<0,01	<0,17	0,07	0,01	<0,04	<0,04	<0,05	<8,95
19/1816	Red fox liver	0,16	0,15	0,15	0,13	0,19	0,14	0,13	0,20	0,20	0,09	<0,11	<0,08	<1,12	<8,95

NILU-Sample number:	Sample type:	ATE (TBP-AE)	a-TBECH	b-TBECH	g/d-TBECH	BATE	PBT	PBEB	PBBZ	HBB	DPTE	EHTBB	BTBPE	TBPH (BEH /TBP)	DBDPE
19/1817	Red fox liver	<0,02	<0,02	<0,03	<0,01	<0,01	<0,02	<0,01	<0,17	<0,07	<0,01	<0,60	<0,04	<0,05	<8,95
19/1818	Red fox liver	<0,02	<0,02	<0,02	<0,01	<0,01	<0,02	<0,01	<0,17	<0,07	<0,01	<0,07	<0,04	<0,09	<8,95
19/1723	Tawny owl egg	0,12	0,08	0,08	0,05	0,05	0,06	0,04	<0,3	0,18	0,05	<0,19	0,09	0,22	<17,90
19/1724	Tawny owl egg	<0,04	0,18	0,13	0,08	0,08	0,15	0,10	<0,3	0,47	0,07	0,21	0,41	2,15	29,40
19/1725	Tawny owl egg	0,05	0,05	0,05	0,02	0,04	0,06	0,04	<0,3	0,27	0,04	0,15	0,10	0,15	<17,90
19/1726	Tawny owl egg	<0,04	<0,04	<0,03	0,03	0,03	<0,04	0,03	<0,3	0,16	0,03	0,12	<0,09	0,22	<17,90
19/1727	Tawny owl egg	<0,04	<0,04	<0,03	<0,02	<0,02	<0,04	<0,03	<0,3	0,15	<0,01	<0,02	<0,09	<0,11	<17,90
19/1728	Tawny owl egg	0,25	0,20	0,26	0,18	0,20	0,19	0,18	<0,3	0,36	0,22	0,46	0,23	0,42	<17,90
19/1729	Tawny owl egg	<0,11	<0,82	<0,62	<0,39	<0,17	<0,04	<0,03	<0,3	<0,31	<0,10	<0,87	0,19	<1,09	<17,90
19/1730	Tawny owl egg	<0,04	<0,05	<0,04	<0,02	<0,02	<0,04	<0,03	<0,3	<0,14	<0,01	<0,18	0,09	<0,11	<17,90
19/1731	Tawny owl egg	<0,04	<0,08	<0,06	<0,03	<0,02	<0,04	<0,03	<0,3	<0,15	<0,01	<0,03	0,09	<0,11	<17,90
19/1732	Tawny owl egg	<0,04	<0,10	<0,07	<0,04	<0,02	<0,04	<0,03	<0,3	<0,14	<0,01	<0,09	0,09	<0,11	<17,90
19/1801	Tawny owl egg	<0,04	<0,16	<0,11	<0,06	<0,02	<0,04	<0,03	<0,3	<0,14	<0,02	<0,04	0,09	<0,11	<17,90
19/1822	Rat liver	<0,06	<0,62	<0,43	<0,13	<0,03	<0,02	<0,01	<0,17	0,08	<0,02	<0,13	<0,04	<0,12	<8,95
19/1823	Rat liver	<0,06	<0,47	<0,32	<0,10	<0,03	<0,02	<0,01	<0,17	0,08	<0,01	<0,09	<0,04	<0,094	<8,95
19/1824	Rat liver	<0,07	<0,41	<0,28	<0,09	<0,02	<0,02	<0,01	<0,17	0,08	<0,01	<0,26	<0,04	<0,23	<8,95
19/1825	Rat liver	<0,05	<0,59	<0,41	<0,13	<0,03	<0,02	<0,01	<0,17	0,08	<0,02	<1,44	<0,04	2,16	<8,95
19/1826	Rat liver	<0,04	<0,34	<0,23	<0,07	<0,02	<0,02	<0,01	<0,17	0,09	<0,02	<0,73	<0,04	<0,27	<8,95
19/1827	Rat liver	<0,05	<0,40	<0,28	<0,09	<0,02	<0,02	<0,01	<0,17	0,08	<0,01	<0,21	<0,04	<0,122	<8,95
19/1828	Rat liver	<0,06	<0,51	<0,35	<0,11	<0,03	<0,02	<0,01	<0,17	0,10	<0,04	<1,39	<0,04	<0,272	<8,95
19/1829	Rat liver	<0,04	<0,41	<0,28	<0,09	<0,02	<0,02	<0,01	<0,17	0,08	<0,04	<2,58	<0,04	<0,67	<8,95

NILU-Sample number:	Sample type:	ATE (TBP-AE)	a-TBECH	b-TBECH	g/d-TBECH	BATE	PBT	PBEB	PBBZ	HBB	DPTE	EHTBB	BTBPE	TBPH (BEH /TBP)	DBDPE
19/1830	Rat liver	<0,04	<0,46	<0,32	<0,10	<0,03	<0,02	<0,01	<0,17	0,10	<0	<0,30	<0,04	<0,25	<8,95
19/1831	Rat liver	<0,04	<0,43	<0,30	<0,09	<0,02	<0,02	<0,01	<0,17	0,11	<0,02	<0,41	<0,04	<0,254	13,5

Dechloranes and dibromoaldrin

NILU-Sample number:	Sample type:	DBA	Dec-602	Dec-603	Dec-604	Dec-601	syn-DP	anti-DP	1,3-DPMA	1,5-DPMA
19/2294	Air	<0,7	<0,1	<0,1	<2,0	<0,3	1,0	2,2	<0,7	<1,4
19/2295	Air	<0,7	<0,1	<0,1	<2,0	<0,3	<0,9	1,5	<0,7	<1,4
19/2296	Air	<0,7	<0,1	<0,1	<2,0	<0,3	<0,9	1,7	<0,7	<1,4
19/2297	Air	<0,7	<0,7	<0,7	<2,0	<2,0	2,8	10,7	<0,7	<1,4
19/2465	Air	<0,7	<0,7	<0,7	<1,9	<1,9	1,4	6,7	<0,6	<1,3
19/2298	Air	<0,7	<0,1	<0,1	<2,0	<0,3	<0,9	1,4	<0,7	<1,4
19/2299	Air	<0,7	<0,1	<0,1	<2,0	<0,3	1,0	2,6	<0,7	<1,4
19/1771	Soil	<0,23	<0,05	<0,06	<1,15	<0,34	<0,27	0,43	<0,21	<0,43
19/1772	Soil	<0,23	0,05	<0,05	<0,84	<0,26	0,42	0,94	<0,21	<0,43
19/1773	Soil	<0,23	0,09	<0,04	<0,74	<0,22	0,38	1,59	<0,21	<0,43
19/1774	Soil	<0,23	<0,04	<0,06	<0,96	<0,31	0,33	0,73	<0,21	<0,43
19/1775	Soil	<0,23	<0,03	<0,04	<0,80	<0,24	<0,27	<0,36	<0,21	<0,43
19/1776	Soil	<0,23	0,08	<0,05	<0,87	<0,28	0,47	1,41	<0,21	<0,43
19/1777	Soil	<0,23	<0,04	<0,05	<0,91	<0,27	<0,27	<0,36	<0,21	<0,43
19/1763	Earthworm	<0,137	<0,018	<0,03	<0,38	<0,12	<0,16	<0,22	<0,13	<0,26

NILU-Sample number:	Sample type:	DBA	Dec-602	Dec-603	Dec-604	Dec-601	syn-DP	anti-DP	1,3-DPMA	1,5-DPMA
19/1764	Earthworm	<0,137	<0,014	<0,02	<0,38	<0,09	<0,16	<0,22	<0,13	<0,26
19/1765	Earthworm	<0,137	0,023	<0,02	<0,38	<0,09	0,21	<0,22	<0,13	<0,26
19/1766	Earthworm	<0,137	0,023	<0,02	<0,38	<0,09	0,19	<0,22	<0,13	<0,26
19/1767	Earthworm	<0,137	<0,013	<0,02	<0,38	<0,08	0,18	<0,22	<0,13	<0,26
19/1768	Earthworm	<0,137	<0,015	<0,02	<0,38	<0,09	0,22	<0,22	<0,13	<0,26
19/1769	Earthworm	<0,137	<0,015	<0,02	<0,38	<0,09	<0,16	<0,22	<0,13	<0,26
19/1712	Fieldfare egg	<0,137	0,068	0,87	<0,62	<0,15	0,29	0,384	<0,125	<0,257
19/1713	Fieldfare egg	<0,137	0,0571	<0,023	<0,50	<0,13	<0,16	<0,216	<0,125	<0,257
19/1714	Fieldfare egg	<0,137	0,034	0,211	<0,47	<0,12	<0,16	<0,216	<0,125	<0,257
19/1715	Fieldfare egg	<0,137	0,119	0,517	<0,51	<0,13	0,17	0,422	<0,125	<0,257
19/1716	Fieldfare egg	<0,137	0,322	0,544	<0,40	<0,09	0,26	0,424	<0,125	<0,257
19/1717	Fieldfare egg	<0,137	0,19	0,113	<0,399	<0,09	<0,16	0,234	<0,125	<0,257
19/1718	Fieldfare egg	<0,137	0,0483	0,123	<0,63	<0,146	<0,16	<0,216	<0,125	<0,257
19/1719	Fieldfare egg	<0,137	0,0803	0,193	<0,56	<0,125	<0,164	0,223	<0,125	<0,257
19/1720	Fieldfare egg	<0,137	0,0514	0,499	<0,52	<0,12	0,229	0,316	<0,125	<0,257
19/1721	Sparrowhawk egg	<0,137	0,573	0,499	<0,38	<0,08	<0,164	0,251	<0,125	<0,257
19/1722	Sparrowhawk egg	<0,137	1,600	1,220	<0,38	<0,06	0,917	1,780	<0,125	<0,257
19/1809	Red fox liver	<0,069	0,009	<0,008	<0,188	<0,039	<0,082	<0,108	<0,062	<0,129
19/1810	Red fox liver	<0,069	0,008	<0,007	<0,188	<0,036	<0,082	<0,108	<0,062	<0,129
19/1811	Red fox liver	<0,069	0,025	<0,007	<0,188	<0,030	<0,082	<0,108	<0,062	<0,129
19/1812	Red fox liver	<0,069	0,035	<0,007	<0,188	<0,034	<0,082	<0,108	<0,062	<0,129
19/1813	Red fox liver	<0,069	0,065	<0,008	<0,188	<0,041	<0,082	<0,108	<0,062	<0,129

NILU-Sample number:	Sample type:	DBA	Dec-602	Dec-603	Dec-604	Dec-601	syn-DP	anti-DP	1,3-DPMA	1,5-DPMA
19/1814	Red fox liver	<0,069	0,026	<0,008	<0,188	<0,038	<0,082	<0,108	<0,062	<0,129
19/1815	Red fox liver	<0,069	0,015	<0,008	<0,188	<0,041	<0,082	<0,108	<0,062	<0,129
19/1816	Red fox liver	<0,069	0,052	<0,008	<0,188	<0,038	<0,082	<0,108	<0,062	<0,129
19/1817	Red fox liver	<0,069	0,036	<0,007	<0,188	<0,035	<0,082	<0,108	<0,062	<0,129
19/1818	Red fox liver	<0,069	0,015	<0,008	<0,188	<0,041	<0,082	<0,108	<0,062	<0,129
19/1723	Tawny owl egg	<0,14	0,10	0,06	<0,38	<0,14	<0,20	0,36	<0,13	<0,26
19/1724	Tawny owl egg	<0,14	<0,03	<0,04	<0,56	<0,22	0,80	1,57	<0,16	<0,34
19/1725	Tawny owl egg	<0,14	0,07	0,06	<0,38	<0,14	<0,16	0,23	<0,13	<0,26
19/1726	Tawny owl egg	<0,14	0,06	0,05	<0,38	<0,13	<0,16	0,24	<0,13	<0,26
19/1727	Tawny owl egg	<0,14	0,13	<0,02	<0,38	<0,10	0,26	0,50	<0,13	<0,26
19/1728	Tawny owl egg	<0,14	0,21	<0,03	<0,42	<0,16	0,22	0,51	<0,13	<0,26
19/1729	Tawny owl egg	<0,14	0,22	0,28	<0,38	<0,11	0,19	0,37	<0,13	<0,26
19/1730	Tawny owl egg	<0,14	0,07	0,06	<0,38	<0,07	<0,16	<0,22	<0,13	<0,26
19/1731	Tawny owl egg	<0,14	0,06	0,05	<0,38	<0,10	<0,16	<0,22	<0,13	<0,26
19/1732	Tawny owl egg	<0,14	0,11	<0,02	<0,38	<0,12	<0,16	<0,22	<0,13	<0,26
19/1801	Tawny owl egg	<0,14	0,07	<0,03	<0,38	<0,14	<0,16	<0,22	<0,13	<0,26
19/1822	Rat liver	<0,07	<0,01	<0,01	<0,19	<0,05	0,09	0,20	<0,06	<0,13
19/1823	Rat liver	<0,07	<0,01	<0,01	<0,19	<0,05	0,13	0,48	<0,06	<0,13
19/1824	Rat liver	<0,07	<0,01	0,02	<0,19	<0,03	<0,08	<0,11	<0,06	<0,13
19/1825	Rat liver	<0,07	<0,01	<0,01	<0,19	<0,04	<0,08	0,15	<0,06	<0,13
19/1826	Rat liver	<0,07	0,02	<0,01	<0,19	<0,03	0,14	0,33	<0,06	<0,13
19/1827	Rat liver	<0,07	<0,01	<0,01	<0,19	<0,04	<0,08	<0,11	<0,06	<0,13

NILU-Sample number:	Sample type:	DBA	Dec-602	Dec-603	Dec-604	Dec-601	syn-DP	anti-DP	1,3-DPMA	1,5-DPMA
19/1828	Rat liver	<0,07	0,02	<0,01	<0,19	<0,04	0,17	0,43	<0,06	<0,13
19/1829	Rat liver	<0,07	<0,01	<0,01	<0,19	<0,03	0,23	2,40	<0,06	<0,13
19/1830	Rat liver	<0,07	<0,01	<0,01	<0,19	<0,03	0,09	0,13	<0,06	<0,13
19/1831	Rat liver	<0,07	0,11	<0,01	<0,19	<0,04	0,17	0,25	<0,06	<0,13

UV compounds

NILU-Sample number:	Sample type:	BP3	EHMC-Z	EHMC-E	OC	UV-327	UV-328	UV-329
19/1802	Soil	<0,300	<0,030	<0,200	<2,000	0,104	0,891	<0,10
19/1803	Earthworm	0,474	0,033	<0,300	<2,500	<0,100	<0,200	<0,20
19/1721	Sparrowhawk egg	<0,2	<0,05	<0,4	<2	0,09	<0,2	0,33
19/1722	Sparrowhawk egg	<0,2	<0,05	<0,4	<2	0,53	0,76	0,12
19/1819	Red fox liver	<0,150	<0,020	<0,200	<2,000	<0,03	<0,100	<0,100
19/1820	Red fox liver	<0,150	0,030	<0,200	<2,000	<0,03	<0,100	<0,100
19/1821	Red fox liver	<0,150	0,022	<0,200	<2,000	<0,03	<0,100	<0,100
19/1804	Tawny owl egg	<0,150	<0,080	0,570	<1,200	<0,030	<0,100	<0,100
19/1805	Tawny owl egg	<0,150	<0,080	<0,200	<1,200	0,195	0,480	<0,100
19/1806	Tawny owl egg	<0,150	<0,080	<0,200	<1,200	<0,030	<0,100	<0,100
19/1832	Rat liver	<0,150	<0,026	<0,200	<2,000	<0,05	<0,10	<0,1
19/1833	Rat liver	0,41	<0,020	<0,200	<2,000	<0,05	0,17	<0,100
19/1834	Rat liver	<0,150	0,025	<0,200	<2,000	0,07	0,60	0,13

Biocides

NILU-Sample number:	Sample type:	Bromadiolone	Brodifacoum	Flocumafen	Difenacoum	Difethialone
19/1809	Red fox liver	905	7	<2	43,4	<2
19/1810	Red fox liver	1323	182	<2	<2	<2
19/1811	Red fox liver	1608	101	<2	<5	<2
19/1812	Red fox liver	642	54	<2	<2	<2
19/1813	Red fox liver	95	141,3	<2	<2	<2
19/1814	Red fox liver	1923	59	<2	<30	<2
19/1815	Red fox liver	13,2	<2,00	<2	<2	<2
19/1816	Red fox liver	1107	<2,0	<2	22,1	<2
19/1817	Red fox liver	4	15,6	<2	<2	<2
19/1818	Red fox liver	18,8	12	<2	<2	<2
19/1822	Rat liver	8,9	<2,0	<2,0	<2,0	<2,0
19/1823	Rat liver	66,5	13,3	<2,0	<2,0	<2,0
19/1824	Rat liver	512	<2,0	133	<2,0	<2,0
19/1825	Rat liver	<2,0	<2,0	<2,0	<2,0	<2,0
19/1826	Rat liver	3	<2,0	<2,0	<2,0	<2,0
19/1827	Rat liver	14,6	<2,0	<2,0	<2,0	<2,0
19/1828	Rat liver	38	101,1	<2,0	24	<2,0
19/1829	Rat liver	9,2	<2,0	<2,0	<2,0	<2,0
19/1830	Rat liver	508	<2,0	<2,0	<2,0	<2,0
19/1831	Rat liver	7,3	2,0	2,0	2,0	2,0

Phenols

NILU-Sample number:	Sample type:	4,4-bis-A	2,4-bis-A	4,4-bis-S	2,4-bis-S	4,4-bis-F	2,4-bis-F	2,2-bis-F	TBBPA	4-t-octyl-phenol	4-octyl-phenol	4-nonyl-phenol
19/1771	Soil	<36,0	<2,0	<6,0	<3,0	<12,0	11,6	<2,0	<35,0	<35,0	<8,0	<13,0
19/1772	Soil	<36,0	<2,0	<6,0	<3,0	<12,0	<11,0	<2,0	<35,0	<35,0	<8,0	<13,0
19/1773	Soil	<36,0	<2,0	<6,0	<3,0	<12,0	<11,0	<2,0	<35,0	<35,0	<8,0	<13,0
19/1774	Soil	<36,0	<2,0	<6,0	<3,0	<12,0	<11,0	<2,0	<35,0	<35,0	<8,0	<13,0
19/1775	Soil	<36,0	<2,0	<6,0	<3,0	<12,0	<11,0	<2,0	<35,0	<35,0	<8,0	<13,1
19/1776	Soil	<36,0	<2,0	<6,0	<3,0	<12,0	<11,0	<2,0	<35,0	<35,0	<8,0	<13,0
19/1777	Soil	<36,0	<2,0	<6,0	<3,0	<12,0	<11,0	<2,0	<35,0	<35,0	<8,0	<13,0
19/1763	Earthworm	24,4	<2,0	2,8	<1,0	<10,0	<15,0	**1,2**	<4,0	<7,0	<6,0	<7,5
19/1766	Earthworm	22,7	<2,0	<2,0	<1,0	<10,0	<15,0	<1,0	<4,0	<7,0	<6,0	<7,5
19/1768	Earthworm	<17,0	<2,0	<2,0	<1,0	<10,0	<15,0	<1,0	<4,0	<7,0	<6,0	<7,5
19/1769	Earthworm	<17,0	<2,0	<2,0	<1,0	<10,0	<15,0	<1,0	<4,0	<7,0	<6,0	<7,5
19/1712	Fieldfare egg	<8,0	<2,0	<1,0	<0,5	<3,5	<5,5	<0,5	<4,5	<5,0	<3,5	<4,0
19/1714	Fieldfare egg	<8,0	<2,0	<1,0	<0,5	<3,5	<5,5	<0,5	<4,5	<5,0	<3,5	<4,0
19/1715	Fieldfare egg	<8,0	<2,0	<1,0	<0,5	4,2	<5,5	<0,5	<4,5	<5,0	<3,5	<4,0
19/1716	Fieldfare egg	24,0	<2,0	<1,0	<0,5	4,3	<5,5	<0,5	<4,5	<5,0	<3,5	<4,0
19/1717	Fieldfare egg	<8,0	<2,0	<1,0	<0,5	<3,5	<5,5	<0,5	<4,5	<5,0	<3,5	<4,0
19/1718	Fieldfare egg	<8,0	<2,0	<1,0	<0,5	3,9	<5,5	<0,5	<4,5	<5,0	<3,5	<4,0
19/1719	Fieldfare egg	<8,0	<2,0	<1,0	<0,5	<3,5	<5,5	<0,5	<4,5	<5,0	<3,5	<4,0
19/1720	Fieldfare egg	9,2	<2,0	<1,0	<0,5	<3,5	<5,5	<0,5	<4,5	<5,0	<3,5	<4,0
19/1721	Sparrowhawk egg	<10,5	<1,5	1,7	<1,0	5,7	4,5	<0,5	<3,5	<8,0	<3,5	<5,5

NILU-Sample number:	Sample type:	4,4-bis-A	2,4-bis-A	4,4-bis-S	2,4-bis-S	4,4-bis-F	2,4-bis-F	2,2-bis-F	TBBPA	4-t-octyl-phenol	4-octyl-phenol	4-nonyl-phenol
19/1722	Sparrowhawk egg	<10,5	<1,5	<1,0	<1,0	<5,0	<4,0	<0,5	<3,5	<8,0	<3,5	<5,5
19/1809	Red fox liver	<14,0	<2,0	<1,5	<0,5	<8,0	<12,0	<0,5	<3,5	<6,0	<5,0	<6,0
19/1810	Red fox liver	<14,0	<2,0	<1,5	<0,5	<8,0	<12,0	<0,5	<3,5	<6,0	<5,0	<6,0
19/1811	Red fox liver	<14,0	<2,0	<1,5	<0,5	<8,0	<12,0	<0,5	<3,5	<6,0	<5,0	<6,0
19/1812	Red fox liver	<14,0	<2,0	<1,5	<0,5	<8,0	<12,0	<0,5	<3,5	<6,0	<5,0	<6,0
19/1813	Red fox liver	<14,0	<2,0	<1,5	<0,5	<8,0	<12,0	<0,5	<3,5	<6,0	<5,0	<6,0
19/1814	Red fox liver	17,6	<2,0	<1,5	<0,5	<8,0	<12,0	<0,5	<3,5	<6,0	<5,0	<6,0
19/1815	Red fox liver	<14,0	<2,0	<1,5	<0,5	<8,0	<12,0	<0,5	<3,5	<6,0	<5,0	<6,0
19/1816	Red fox liver	<14,0	<2,0	<1,5	<0,5	<8,0	<12,0	<0,5	<3,5	<6,0	<5,0	<6,0
19/1817	Red fox liver	<14,0	<2,0	<1,5	<0,5	<8,0	<12,0	<0,5	<3,5	<6,0	<5,0	<6,0
19/1818	Red fox liver	<14,0	<2,0	<1,5	<0,5	<8,0	22,1	<0,5	<3,5	<6,0	<5,0	<6,0
19/1723	Tawny owl egg	<7,0	<1,5	<1,5	<0,5	<4,0	<2,5	<0,5	<2,0	<12,0	<4,0	<6,0
19/1724	Tawny owl egg	<7,0	<1,5	<1,5	<0,5	<4,0	<2,5	<0,5	<2,0	<12,0	<4,0	<6,0
19/1725	Tawny owl egg	<7,0	<1,5	<1,5	<0,5	<4,0	<2,5	<0,5	<2,0	<12,0	<4,0	<6,0
19/1726	Tawny owl egg	8,6	<1,5	<1,5	<0,5	<4,0	<3,1	<0,5	<2,0	<12,0	<4,0	<6,0
19/1727	Tawny owl egg	<7,0	<1,5	<1,5	<0,5	<4,0	<2,5	<0,5	<2,0	<12,0	<4,0	<6,0
19/1728	Tawny owl egg	7,8	<1,5	<1,5	<0,5	33,6	26,0	**0,6**	<2,0	<12,0	<4,0	<6,0
19/1729	Tawny owl egg	8,3	<1,5	<1,5	<0,5	<4,0	<2,5	<0,5	<2,0	<12,0	<4,0	<6,0
19/1730	Tawny owl egg	7,3	<1,5	<1,5	<0,5	<4,0	<2,5	<0,5	<2,5	<12,0	<4,0	<6,0
19/1731	Tawny owl egg	<7,0	<1,5	<1,5	<0,5	<4,0	<2,5	<0,5	<2,0	<12,0	<4,0	<6,0
19/1732	Tawny owl egg	8,0	<1,5	<1,5	<0,5	<4,0	<2,5	<0,5	<2,0	<12,0	<4,0	<6,0

NILU-Sample number:	Sample type:	4,4-bis-A	2,4-bis-A	4,4-bis-S	2,4-bis-S	4,4-bis-F	2,4-bis-F	2,2-bis-F	TBBPA	4-t-octyl-phenol	4-octyl-phenol	4-nonyl-phenol
19/1801	Tawny owl egg	<7,0	<1,5	<1,5	<0,5	<4,0	<2,5	<0,5	<2,1	<12,0	<4,0	<6,0
19/1832	Rat liver	345,0	<2,00	<1,50	<0,50	<8,00	<12,00	<0,50	<3,50	<6,0	<5,0	<6,0
19/1833	Rat liver	70,1	<2,00	<1,50	<0,50	<8,00	<12,00	<0,50	<3,50	<6,0	<5,0	<6,0
19/1834	Rat liver	30,4	<2,00	<3,68	<0,50	<8,00	<12,00	<0,50	<3,50	8,7	<5,0	<6,0

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