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Miljøgifter i terrestrisk og bynært miljø 2017
Environmental pollutants in the terrestrial and urban environment 2017

Summary - sammendrag

Abiotic and biotic samples from the terrestrial and urban environment were analysed for inorganic and various organic contaminants in the Oslo area. The species analysed were earthworms, fieldfare, sparrowhawk, brown rat, tawny owl, red fox and badger. Air and soil samples were also included in the study to increase the understanding on sources and uptake of pollutants. A foodchain approach was used, in order to detect trophic magnification of the different compounds.

Prøver fra det urbane terrestriske miljøet i Oslo-området ble analysert for flere organiske og uorganiske miljøgifter. De utvalgte artene var meitemark, gråtrost, spurvehauk, rotte, kattugle, rødrev og grevling. 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.

4 emneord

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Odd Rygh

Summary

On behalf of the Norwegian Environment Agency, the Norwegian Institute for Air Research (NILU) in collaboration with Norwegian Institute for Nature Research (NINA) and Norwegian Institute for Water Research (NIVA) analysed air, soil and biological samples from the terrestrial and urban environment for various inorganic and organic contaminants in 2017. The purpose of this report is to provide an updated assessment of pollution present within the terrestrial urban environment in Norway to evaluate potential environmental hazards caused by a densely populated urban area, and to provide information to ongoing regulatory work at both national and international level.

The project had the following key goals:

- Report concentrations of the chosen environmental pollutants in several trophic levels of a terrestrial food web
- Compare the concentration of the various pollutants across samples and species
- Evaluate potential trophic magnification of the different compounds. with a foodchain approach
- Evaluate how land-living species are exposed to a variety of pollutants

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

A broad cocktail of pollutants, consisting both of persistent organic pollutants, organic phenolic pollutants, biocides, pesticides, UV compounds, emerging and legacy PFAS, siloxanes, chlorinated paraffins, organic phosphorous flame retardants and metals (see Table 2, page 36) were measured in air, soil and biota samples. Comparison across samples and species were performed in addition to biomagnification from lower to higher trophic levels.

The average of sum concentrations of the dominant contaminant group for each matrix in the investigated species in 2017 was as follows (on a wet weight basis): Note that pesticides were only measured in sparrowhawk eggs. SumToxicMetals below is the sum of Hg, Cd, Pb and As.

- Air : SumSiloxanes >> SumCPs >SumOPFRs>>SumPCBs
- Soil : SumToxicMetals > SumCPs > SumPFAS
- Earthworms : SumToxicMetals >> SumPFAS >SumCPs
- Fieldfare : SumPFAS~SumCP> SumPhenols ~ SumToxicMetals > SumPCB
- Sparrowhawk: (Sum Pesticides) > SumPCBs > SumToxicMetals~SumPFAS
- Tawny owl : SumPhenols ~ SumPFAS ~ SumPCB> SumCPs> SumToxicMetals
- Red fox : SumBiocides > SumToxicMetals > SumCPs>SumPFAS~SumPCB
- Brown rat : SumToxicMetals > SumBiocides> SumCPs ~ SumPCB > SumPFAS
- Badger : SumToxicMetals > SumBiocides> SumPFAS> SumCPs

Contaminant data revealed larger variability both in levels and composition between the various locations for soil, earthworm and partly fieldfare, than for birds of higher trophic levels and mammalian species.

Below follows a short summary for each compound class investigated.

Metals; concentrations were highest in soil. Of the biological matrices analysed, earthworms, brown rat and badger livers contained the highest amounts of the heavy and toxic metals Hg, Cd, Pb and As. Earthworms from Frognerseteren had Pb concentration of 33770 ng/g ww, more than 30 times higher than the other sites. As in 2016, fieldfare egg from one sampling

site Kjelsås had Pb concentration of 206 ng/g ww, more than 20 times higher than the other sites. A general threshold for adverse physiological effects is set at 400 ng/g ww in bird blood. Direct comparison between bird egg and bird blood concentrations are not recommended, but this year's concentration in egg was below this threshold. Approximately 400 ng/g ww was detected in 2016 in fieldfare egg from Kjelsås. The predicted-no-effect-concentration of Pb for predator birds (for instance sparrowhawk) is set to 3400 ng/g in food (for instance fieldfare).

PCBs; data across all species and media revealed that sparrowhawk had the highest average concentrations of sumPCB of 460 ng/g ww followed by brown rat, red fox, fieldfare and tawny owl (228, 39, 36 and 34 ng/g ww). One sparrowhawk sample had a SumPCB value of 1300 ng/g ww. Although this concentration is lower than a general reported NOEL value for wild birds of 4000 ng/g for PCB, potential effects cannot be excluded due to different sensitivity among bird species. PCB 153 dominated in almost all sample types, with the exception of fox where PCB 180 dominated, and air where PCB 52 and 101 dominated. The air concentrations of PCBs at the urban sites were 5-50 times higher than those measured at background air monitoring stations in Norway suggesting the urban area to be a source for PCBs. One site had ten times higher air concentrations than the other indicating this to be a hotspot for PCBs in Oslo.

PBDEs; The levels of PBDEs were lower in all environmental samples compared to PCB and PFAS. However, one sparrowhawk egg sample contained a SumPBDE of 100 ng/g ww where PBDE47, 99, 100 and 153 were the main contributors to the sum. This sum concentration is ten times lower than a threshold level for reduction of reproduction performance in osprey of 1000 ng/g ww. The same egg sample with highest sumPBDE had highest SumPCB value. For sparrowhawk egg samples PBDE 100 had the highest concentrations, approximately the double of the concentration of 47, 99 and 153. Sparrowhawk had the highest average sumPBDEs followed by fieldfare and tawny owl. The passive air sampler could detected a few BDE-congeners (i.e. 47 and 99) in urban air. The estimated air concentrations were up to 100 times higher than those measured at background air monitoring sites suggesting the urban area to be a source for PBDEs. Especially high concentrations of PBDEs in air were observed at Alnabru.

PFAS; The dominating PFAS compound was PFOS in all environmental samples and earthworm had the highest PFOS and average sumPFAS concentrations due to two samples from Alnabru and Fornebu with PFOS concentration of 499 and 159 ng/g ww, respectively. A recent study has revealed a LC50 of PFOS of approximately 540 mg/kg in earthworm (*Eisenia fetida*), 1000-fold higher than our highest PFOS concentration. The sample from Fornebu also contained high concentrations of the long-chained carboxylates PFUnA and PFTriA, 261 and 159 ng/g ww, respectively. The next highest average SumPFAS was measured in fieldfare. In agreement with what was found in 2016, fieldfare egg sample from Grønmo had very high sum of the branched and linear PFOS concentrations of 918 ng/g ww, which was 15 times more than the average sum of all other fieldfare samples. This PFOS concentration in fieldfare egg is lower than a recommended threshold value for PFOS of 1900 ng/g ww in bird egg.

New PFAS; only the compound PFECHS was found in detectable and small amounts in sparrowhawk eggs, fox liver, badger liver. Highest concentration was found in fox liver of 5 ng/g ww.

SCCP/MCCP: The chlorinated paraffins were found in most samples, but in lesser extent in sparrowhawk and tawny owl eggs. Highest concentrations were detected in soil, air, fieldfare, brown rat and fox liver. One fieldfare sample from Bøler had a very high sum concentration of

SCCP and MCCP of 1420 ng/g ww where SCCP dominated with 1280 ng/g ww. It is not known if these concentrations may pose a risk to fieldfare. The estimated concentrations of CPs in air were not significantly higher, except SCCP at two sites, than those observed at background air monitoring sites in Norway.

Cyclic siloxanes: Air samples had high levels of the compounds D4, D5 and D6 and not unexpected due to their high volatility. D5 was the dominating oligomer in the air samples and the estimated concentrations of D5 in the air were about ten times higher than those in background air. The highest SumSiloxane concentration was found at Slottsparken with 36 ng/day. The mean sum levels in the samples, except air, varied from <LOD to 38 ng/g ww where brown rat had highest concentrations. The levels of D4, D5 and D6 in earthworms and fieldfare eggs as prey are not high enough to pose any risk for predators.

OPFR: As with siloxanes, air samples had high loads of OPFR and ranged from 0.6 to 3.5 ng/day. TCPP was the dominating compound, and as with siloxanes, the site Slottsparken had the highest concentration of TCPP and sumOPFR. For biological samples, the one pooled earthworm sample had highest sumOPFR of 11 ng/g ww followed by soil, also pooled samples, with 8 ng/g dw. The compound TCP had highest concentration in earthworm (3.7 ng/g ww) which is not expected to give adverse effects.

New BFR: This contaminant class was hardly found in any of the samples, only small amounts in the sparrowhawk eggs where DBDPE was most prevailing with detection in 6 of 10 samples with max concentration of 4 ng/g ww. We have not been able to relate these levels to any known toxic effect of DBDPE.

Dechloranes; were found in many of the samples, but at relatively low levels to the other dominating contaminants. Dechlorane plus anti and syn was the dominating congeners in air, soil and earthworm samples; but to some extent in the liver samples and especially in the bird eggs also the compounds Dechlorane 602 and 603 were detected. Of all dechlorane compounds, anti dechlorane plus (anti-DP) was detected in highest concentrations in fox and rat livers with maximum concentration of 6 and 9 ng/g ww. Highest average sumDechloranes was found in soil of 2 ng/g dw. The levels were in general lower than found in other studies and we have not been able to relate these levels to any effect of dechloranes.

Pesticides: were only analysed in sparrowhawk eggs and average SumPesticides was 893 ng/g ww where ppDDE clearly dominated the sum with an average of 874 ng/g ww. This concentration is comparable with a reported PNEC of 870 ng/g ww associated with 20% eggshell thinning in osprey.

UV compounds were not detectable in the pooled samples of bird eggs, but detected in soil, earthworm and liver samples. EHMC was detected in soil, earthworm and liver samples. Highest concentration was found in badger liver with 7 ng/g ww. Effect levels for this compound is not found for terrestrial ecosystems.

Biocides; were measured in fox, badger and rat livers and two of four compounds, Bromadiolone and Brodifacoum were found in high amounts and especially Bromadiolone with up to 4412 ng/ww in fox liver. Compared to studies from Sweden and Finland, the concentrations of bromadiolone in red fox liver from Oslo were higher. Compared to a study measuring bromadiolene concentrations in confirmed poisoned foxes, the levels in red fox liver samples from Oslo area were higher.

Phenols; were first and foremost detected in the bird eggs and the highest levels of phenols were surprisingly found in tawny owl eggs. When excluding semi-quantitative compounds the mean sumPhenols was 57 ng/g ww. None reported effect concentrations have been found for birds. None of the phenols were detected in soil, earthworm, red fox or badger, and only Bisphenol A was detected in one sample of brown rat.

Bioaccumulation calculations through the use of TMF and data from all years, revealed as previous years that the typical hydrophobic and well known POPs such as PCBs, PBDEs had TMF well above 1, and high potential for magnification in the food chain earthworm-fieldfare-sparrowhawk. TMF for PFOS and PFUnA were slightly above 1 and indicated a moderate trophic magnification. The chlorinated paraffins, SCCP and MCCP, did not reveal potential for magnification in this particular terrestrial food chain, but other previous studies have indicated the potential for biomagnification in marine and freshwater food webs.

Sammendrag

På oppdrag fra Miljødirektoratet for året 2017 analyserte NILU (Norsk institutt for luftforskning), 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. Formålet med studien var å gi en oppdatert vurdering av forurensningssituasjonen og potensiell risiko for artene i bynære områder. Resultatene vil også kunne brukes i forbindelse med nasjonale og internasjonale reguleringer av stoffene.

Prosjektet hadde følgende delmål:
- Rapportere konsentrasjoner av de utvalgte miljøgifter på flere nivå av en terrestrisk næringskjede og næringsnett.
- Sammenstille og vurdere fordeling av miljøgiftklassene på tvers av prøver og arter
- Vurdere biomagnifiseringspotensialet av forurensninger ved bruk av næringskjedetilnærming
- Vurdere hvordan terrestriske arter er utsatt for en rekke miljøgifter

Denne rapporten presenterer funnene fra det femte året av det urbane terrestriske programmet.

Et stort spekter av kjemiske stoffer ble analysert; persistente organiske miljøgifter, bisfenoler, biocider, pesticider, UV forbindelser, regulerte og nye PFAS stoffer, siloksaner, klorerte paraffiner, organiske fosforflammehemmere og metaller (se Tabell 2, side 36) i de ulike prøvene. For hver stoffgruppe ble forurensingsnivået sammenlignet på tvers av arter og prøver. Resultatene har gitt en omfattende oversikt over både regulerte og mange andre nye kjemikalier som kan utøve risiko i et komplekst bymiljø.

De mest dominerende miljøgiftgruppene i 2017 prøvene er angitt som gjennomsnitt av sum konsentrasjoner i de ulike miljøprøvene (på våtvektbasis). SumToxicMetals er summen av konsentrasjonen av Hg, Cd, Pb og As.

- Luft	:	SumSiloxanes >> SumCPs >SumOPFRs>>SumPCBs
- Jord	:	SumToxicMetals > SumCPs > SumPFAS
- Meitemark	:	SumToxicMetals >> SumPFAS >SumCPs
- Gråtrost	:	SumPFAS~SumCP> SumPhenols ~ SumToxicMetals > SumPCB
- Spurvehauk	:	(Sum Pesticides) > SumPCBs > SumToxicMetals~SumPFAS
- Kattugle	:	SumPhenols ~ SumPFAS ~ SumPCB> SumCPs> SumToxicMetals
- Rødrev	:	SumBiocides > SumToxicMetals > SumCPs>SumPFAS~SumPCB
- Brunrotte	:	SumToxicMetals > SumBiocides> SumCPs ~ SumPCB > SumPFAS
- Grevling	:	SumToxicMetals > SumBiocides> SumPFAS> SumCPs

Miljøgiftdata viste større variabilitet, både i nivåer og sammensetning, mellom de forskjellige lokalitetene for jord, meitemark og delvis gråtrost, enn for spurvehauk og kattugle og andre arter som rødrev, brunrotte og grevling.

Nedenfor følger en kort oppsummering for hver komponentgruppe som ble analysert i prøvene.

Metaller; konsentrasjonene var høyest i jord. Av de biologiske prøvene inneholdt meitemark brunrotte og grevling de høyeste konsentrasjoner av tungmetallene Hg, Cd, Pb og As. Meitemark fra Frognerseteren hadde Pb-konsentrasjon på 33770 ng/g ww, mer enn 30 ganger høyere enn de andre områdene. Som i 2016, gråtrostegg fra et reir ved Kjelsås hadde en Pb-konsentrasjon på 206 ng/g ww, mer enn 20 ganger høyere enn de andre lokalitetene. En generell terskelverdi for fysiologisk skadevirkning er satt til ca. 400 ng/g ww i fugleblod. Konsentrasjon i fugleblod er ikke direkte sammenlignbart med fugleegg, men ingen gråtrostegg hadde konsentrasjon opp mot denne terskelverdien i 2017. I 2016 ble det målt opp mot 400 ng/g i gråtrostegg fra Kjelsås. Predikert ikke-effekt konsentrasjon (PNEC) for Pb i rovfugl (f.eks. spurvehauk) er satt til 3400 ng/g i byttedyr (f.eks. gråtrost).

PCB; Data på tvers av alle arter og medier viste at spurvehauken hadde den høyeste gjennomsnittlige konsentrasjonen av sumPCB på 460 ng/g ww, etterfulgt av brunrotte, rødrev, gråtrost og kattugle (228, 41, 36 og 34 ng/g ww). En spurvehaukprøve hadde en SumPCB-verdi på 1300 ng/g ww. Selv om denne konsentrasjonen er lavere enn en generell NOEL verdi for fugl på 4000 ng/g, så kan en ikke neglisjere at effekter kan oppstå siden sensitiviteten kan være ulik mellom fuglearter. PCB 153 dominerte i nesten alle prøvetyper, med unntak av lever fra rødrev hvor PCB 180 dominerte, og luft hvor de mer flyktige PCB 52 og 101 dominerte. Luftkonsentrasjonen av PCB i Osloområdet var 5-50 ganger høyere enn nivåer målt på bakgrunnsstasjoner, som indikerer at byområdet er en kilde til PCB. En lokalitet hadde 10 ganger høyere konsentrasjoner enn de andre lokalitetene.

PBDE; Nivåene av PBDEer var lavere i alle miljøprøver sammenlignet med PCB og PFAS. Men, en eggprøve fra spurvehauk inneholdt en SumPBDE på 100 ng/g ww hvor PBDE47, 99, 100 og 153 ga størst bidrag til summen. Sumkonsentrasjon hos spurvehauk er ti ganger lavere enn en terskelverdi for reproduksjonseffekter hos fiskeørn på 1000 ng/g ww. Samme eggprøve hadde også høyeste SumPCB-verdi. I spurvehauk dominerte PBDE 100, med omtrent den dobbelte av konsentrasjonen av 47, 99 og 153. Spurvehauk hadde høyeste gjennomsnittlige sumPBDE etterfulgt av gråtrost og kattugle. De passive luftprøvetakerne detekterte noen få BDE kongenere (BDE47 og 99) i bylufta. De estimerte luftkonsentrasjonene var opp til 100 ganger høyere enn konsentrasjoner fra bakgrunnsstasjoner, som indikerer at byområdet er en kilde til PBDE. Spesielt høye konsentrasjoner av PBDE i luft ble observert på Alnabru.

PFAS; Den dominerende PFAS-forbindelsen var PFOS i alle miljøprøver og meitemark hadde den høyeste PFOS og gjennomsnittlige sumPFAS konsentrasjonen på grunn av to prøver fra Alnabru og Fornebu med PFOS konsentrasjon på henholdsvis 499 og 159 ng/g ww. Et studie har rapportert en LC50 verdi på ca. 540 mg/kg i mark (*Eisenia fetida*), over 1000 ganger høyere enn våre høyeste målte PFOS konsentrasjoner. Prøven fra Fornebu inneholdt også høye konsentrasjoner av henholdsvis de langkjedede karboksylatene PFUnA og PFTriA, 261 og 159 ng/g ww. Den neste høyeste gjennomsnittlige SumPFAS ble målt i gråtrost. I samsvar med 2016 data, så viste også 2017 data svært høy sum av de forgrenede og lineære PFOS-konsentrasjonene på 918 ng/g ww for gråtrostegg fra Grønmo, som var 15 ganger mer enn gjennomsnittet av alle andre gråtrostprøver. Denne PFOS konsentrasjonen i gråtrost er lavere enn en foreslått toksisk referanseverdi av PFOS på 1900 ng/g ww i fugleegg.

Nye PFAS; Bare PFECHS ble funnet i detekterbare og små mengder i spurvehaukegg, lever fra rev og grevling. Høyeste konsentrasjon ble funnet i lever fra rødrev på 5 ng/g ww.

SCCP/MCCP; De klorerte parafinene ble funnet i de fleste prøver, men i mindre grad i spurvehauk- og kattugleegg. De høyeste konsentrasjonene ble funnet i jord, luft

(ng/sampler), gråtrost, og lever fra rotte og rødrev. En gråtrostprøve fra Bøler hadde en meget høy sumkonsentrasjon av SCCP og MCCP på 1420 ng/g ww hvor SCCP dominerte med 1280 ng/g ww. Det er ikke kjent om disse konsentrasjonene kan utgjøre en risiko for gråtrost. De estimerte luftkonsentrasjonene av klorparaffiner var ikke signifikant høyere, bortsett fra SCCP ved to lokaliteter, enn det som har vært observert ved bakgrunnsstasjoner i Norge.

Sykliske siloksaner; Luftprøvene hadde høye nivåer av forbindelsene D4, D5 og D6 og ikke uventet på grunn av høy flyktighet av disse forbindelsene. D5 var den dominerende i luftprøver og de estimerte konsentrasjoner av D5 i luften var omtrent ti ganger høyere enn i bakgrunnsområder. Den høyeste SumSiloksan-konsentrasjonen ble funnet på Slottsparken med 36 ng/dag. De gjennomsnittlige Sumnivåene i prøvene, unntatt luft, varierte fra <LOD til 38 ng/g ww hvor brunrotte hadde høyeste konsentrasjoner. Nivåene av D4, D5 og D6 i meitemark og gråtrostegg som byttedyr er ikke høye nok til å utgjøre noen risiko for rovdyr.

OPFR: Som for siloksanene så viste også OPFR høye nivåer i luft fra 0.6 til 3.5 ng/dag. TCPP dominerte, og som med siloksaner hadde Slottsparken den høyeste konsentrasjonen av TCPP og sumOPFR. Samleprøven av meitemark hadde høyeste sumOPFR konsentrasjon på 11 ng/g ww etterfulgt av jord, også kun en samleprøve, med 8 ng/g dw. Forbindelsen TCP hadde høyeste konsentrasjon i meitemark (3.7 ng/g ww), som ikke er forventet å gi skadelige effekter.

Nye BFR: Denne gruppen ble nesten ikke funnet i noen av prøvene, bare små mengder i spurvehaukeggene hvor DBDPE dominerte med deteksjon i 6 av 10 prøver med maksimum konsentrasjon på 4 ng/g ww. Rapporterte effektkonsentrasjoner er ikke funnet for denne forbindelsen.

Dekloraner; ble funnet i mange av prøvene, men i relativt lave nivåer sammenlignet med de andre dominerende miljøgiftklasser. Dekloran pluss anti og syn var de dominerende forbindelser i luft-, jord- og meitemarkprøvene, men forbindelsene Dekloran 602 og 603 ble også funnet i de andre prøvene og dominerte i fugleeggene. Anti-DP ble funnet i høyeste konsentrasjoner og dominerte i lever fra rotte og rødrev med maksimumskonsentrasjoner på hhv 6 og 9 ng/g ww. Høyeste gjennomsnittlige sumDekloran ble funnet i jord på 2 ng/g tørrvekt. Konsentrasjonene var generelt lavere enn det som er rapportert fra andre studier, og vi har ikke kunnet relatere til skadelige effekter.

Pesticider; ble kun analysert i spurvehaukegg og gjennomsnittlig SumPesticider var 893 ng/g ww hvor ppDDE fullstendig dominerte summen med et gjennomsnitt på 874 ng/g ww. Denne konsentrasjonen er sammenlignbar med en rapportert PNEC på 870 ng/g ww assosiert med 20% eggskallfortynning hos fiskeørn.

UV-forbindelser; ble kun analysert i samleprøver og ikke påvist i prøver av fugleegg, men funnet i jord, meitemark og leverprøver. EHMC ble påvist i jord, meitemark og leverprøver. Høyeste konsentrasjon ble funnet i grevlinglever med 7 ng/g ww. Data med effektkonsentrasjon er ikke funnet.

Biocider; ble målt i lever fra rødrev, grevling og rotte. To av fire forbindelser, Bromadiolon og Brodifacoum, funnet i høye mengder og spesielt Bromadiolone med opptil 4412 ng/g ww i lever fra rødrev. Sammenlignet med studier av bromadiolon i rødrev fra Sverige og Finland så var de målte konsentrasjonene av bromadiolon i rødrev fra Oslo området høyere. Bromadiolon i enkelte rødrevprøver fra Oslo var også høyere enn konsentrasjoner fra et studie med bekreftet bromadiolon-forgiftet rødrev.

Fenoler; Ingen komponenter ble detektert i jord, meitemark, rødrev og grevling. Komponenter ble først og fremst funnet i fugleeggene av gråtrost, spurvehauk og kattugle. Kattugle hadde overraskende høyest sum konsentrasjoner (57 ng/g ww). Om disse konsentrasjonen har skadelige effekter er ikke kjent. Kun en prøve fra rotte hadde detekterte mengder av Bisfenol A.

Bioakkumulasjonsberegninger ved bruk av trofisk magnifiseringsfaktor (TMF) og data fra alle år, avslørte som tidligere år at de typiske hydrofobe og velkjente POPene, som PCB og PBDE, hadde TMF godt over 1 og høyt potensial for magnifisering i næringskjeden meitemark-gråtrost-spurvehauk. TMF for PFOS og PFUnA var litt over 1 og indikerer en moderat trofisk magnifisering. De klorerte paraffiner, SCCP og MCCP viste ikke potensial for magnifisering, heller det motsatte med høyeste konsentrasjon ved lavere trofiske nivåer.

Abbreviations

BAF	Bioaccumulation factor
BSAF	Biota-soil accumulation factor
BFR	brominated flame retardants
CA	concentration addition
CI	confidence interval
dw	dry weight
EI	electron impact ionization
ESI	electrospray ionization
EAC	ecotoxicological assessment criteria
EQS	environmental quality standard
ww	wet weight
GC-HRMS	gas chromatography – high resolution mass spectrometry
GC-MS	gas chromatography – mass spectrometry
ICP MS	inductive coupled plasma – mass spectrometry
LC-MS	liquid chromatography – mass spectrometry
LOD	limit of detection
lw	lipid weight
LOEL	lowest observed effect level
MEC	measured environmental concentration
M-W U	Mann–Whitney *U* test
MCCP	medium-chain chlorinated paraffins
N	detected/measured samples
NCI	negative chemical ionization
NOEC	no observed effect concentration
NOAEL	no observed adverse level
NOEL	no observed effect level
NP-detector	nitrogen-phosphorous detector
PBDE	polybrominated diphenylethers
PCA	principal component analysis
PCB	polychlorinated biphenyls
PCI	positive chemical ionization
PEC	predicted environmental concentration
PFAS	perfluorinated alkylated substances
PNEC	predicted no effect concentration
$PNEC_{pred}$	predicted no effect concentration for predator
PSA	primary/secondary amine phase
SCCP	short-chain chlorinated paraffins
SSD	species sensitivity distribution
SIR	selective ion reaction
SPE	solid phase extraction
STU	sum toxic unit
TL	Trophic level
TMF	Trophic magnification factor
UHPLC	ultra high pressure liquid chromatography

Content

Attachments:

Appendix 1: Concentrations of pollutants in individual samples 2017

Appendix 2: GPS coordinates for sampling locations 2017

Appendix 3: Eggshell data in sparrowhawks from the Oslo area 2017

1. Introduction

1.1 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 were chosen in or in the near vicinity of Oslo. 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

1.2 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 & Bogan 1978, 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 in the samples. Estimated trophic level 2 (Hui et al. 2012). Sampling sites for earthworm were Alnabru, Slottsparken, Fornebu, VEAS, and Frognerseteren.

European Badger (*Meles meles*)
The European badger is a predator and is the second largest member of the family Mustelidae, next to the wolverine. It can be up to 80 cm in length and up to 16 kg during the autumn when it has plenty of food. The most important food item is earthworm, but it is an opportunistic feeder. The badger can be found in Østlandet and Sørlandet and up to Trøndelag in Norway, and also detected in southern part of Nordland county. It is not an uncommon inhabitor in more populated areas and cities. Estimated trophic level: 3

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 (0-10 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

For the second time in the urban terrestrial program, air samples were collected using passive air samplers (PAS) at the five locations chosen for soil- and earthworm sampling (Alnabru, Slottsparken, Fornebu, VEAS, and Frognerseteren). 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 (June to September 2017) giving time-weighted average concentrations over that time period.

1.3 Investigated pollutants

In this study a total of 150 compounds were investigated. These included 11 metals, 7 PCBs, 16 PFAS, 14 PBDEs, three siloxanes (D4, D5 and D6), chlorinated paraffins, organic phosphorous compounds (OPFRs), UV compounds, biocides and phenolic compounds, together with the stable isotopes $\delta^{15}N$, $\delta^{13}C$ and $\delta^{34}S$. Some pesticides (DDT and its breakdown products, HCB and HCH isomers) were analysed in sparrowhawk egg samples. 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 1

Table 1: 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 substances (PFAS)		
PFCA (perfluorinated carboxylate acids)		
Perfluorinated butanoic acid	**PFBA**	
Perfluorinated hexanoic acid	PFHxA	307-24-4
Perfluorinated heptanoic acid	PFHpA	375-85-9
Perfluorinated octanoic acid	PFOA	335-67-1
Perfluorinated nonanoic acid	PFNA	375-95-1
Perfluorinated decanoic acid	PFDcA	335-76-2
Perfluorinated undecanoic acid	PFUnA	2058-94-8

Perfluorinated dodecanoic acid	PFDoA	307-55-1
Perfluorinated tridecanoic acid	PFTriA	72629-94-8
Perfluorinated tetradecanoic acid	PFTeA	376-06-7
Perfluorinated hexadecanoic acid	PFHxDA	67905-19-5
Perfluorinated octadecanoic acid	PFOcDA	16517-11-6
PFSA (Perfluorinated sulfonates)		375-73-5
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	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)		
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
Perfluorooctane sulfonamide	PFOSA	754-91-6
New PFAS		
6:2 Fluortelomersulphonate	6:2 FTS	27619-97-2
8:2 Fluortelomersulphonate	8:2 FTS	481071-78-7
10:2 Fluortelomersulphonate	10:2 FTS	
2,3,3,3-Tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy)propanoic acid	HFPO-DA	13252-13-6
Potassium 1,1,2,2- tetrafluoro-2- (perfluorohexyloxy) ethane sulfonate	F53	754925-54-7
Potassium 2-(6-chloro1,1,2,2,3,3,4,4,5,5,6,6-dodecafluorohexyloxy)- 1,1,2,2-tetrafluoroethane sulfonate	F53B	73606-19-6
Monochlorinated PFOS	Cl-PFOS	777011-38-8
Monochlorinated PFOA	Cl-PFOA	335-63-7
Monochlorinated PFHxS	Cl-PFHxS	
Sodium Dodecafluoro-3H- 4,8-dioxanonanoate	NaDONA	958445-44-8
Cyclohexanesulfonic acid	PFECHS	67584-42-3
PAPS		
6:2 Fluorotelomer phosphate monoester	6:2 monoPAP	57678-01-0
8:2 Fluorotelomer phosphate monoester	8:2 monoPAP	57678-03-2
6:2 Fluorotelomer phosphate diester	6:2 diPAP	57677-95-9
8:2 Fluorotelomer phosphate diester	8:2 diPAP	678-41-1
Polybrominated diphenylethers (PBDE) and other FRs		
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
ß-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
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		
Dechlorane plus	DP	13560-89-9
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
Cyclic Siloxanes	D4	556-67-2
	D5	541-02-6
	D6	540-97-6
Chlorinated paraffins	SCCP (C10-C13)	85535-84-8
	MCCP (C14-C17)	85535-85-9
Phosphorus organic 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		
Octocrylen	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
Biocids		
Bromadiolon		28772-56-7
Brodifacoum		56073-10-0
Flocumafen		90035-08-8
Difenacoum		56073-07-5
Phenols		
Bisphenol A	Bis-A	80-05-7
Bisphenol S	Bis-S	80-09-1

Bisphenol F	Bis-F	1333-16-0
Hexafluorobisphenol A	Bis-AF	1478-61-1
Bisphenol BP	Bis-BP	1844-01-5
Bisphenol B	Bis-B	77-40-7
Bisphenol Z	Bis-Z	843-55-0
Bisphenol AP	Bis-AP	1571-75-1
Bisphenol E	Bis-E	2081-08-5
Bisphenol FL	Bis-FL	3236-71-3
BIsphenol P	Bis-P	2167-51-3
Bisphenol M	Bis-M	13595-25-0
Bisphenol G	Bis-G	127-54-8
Bisphenol TMC	Bis-TMC	129188-99-4
Nonylphenol		104-40-5
Octylphenol		1806-26-4
Tetrabromobisphenol A	TBBPA	79-94-7
Ethoxylates		
Octylphenol MonoEthoxylate	OPEO	51437-89-9
Nonylphenol MonoEthoxylate	NPEO	104-35-8
Octylphenol DiEthoxylate	OPEO2	
Nonylphenol DiEthoxylate	NPEO2	
Pesticides		
HCB		118-74-1
α-HCH		319-84-6
β-HCH		319-85-7
γ-HCH		58-89-9
o,p-DDT		789-02-6
p,p'-DDT		50-29-3
o,p-DDE		3424-82-6
p,p'-DDE		72-55-9

1.3.1 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 significance (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.

1.3.2 Polychlorinated biphenyls (PCB)

Polychlorinated biphenyls (PCBs) have been used in a variety of industrial applications since the 1930s. PCBs 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 PCBs 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,

PCBs are recognized as persistent organic pollutants and are regulated under the Stockholm Convention. They are widely distributed in the environment and can be found in air, water, sediments and biota. Most PCBs 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. PCBs can be metabolized in organisms and form metabolites causing hormonal disturbances. This study includes the group of PCBs found to be dominating in most environmental samples, the non-dioxin like PCBs, the so-called PCB7 group.

1.3.3 Polybrominated diphenylethers (PBDE)

Polybrominated diphenylethers (PBDEs) 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 decabromodiphenyl ether. These are all technical mixtures containing different PBDE congeners. Tetra-, penta-, hexa- and heptaBDE congeners were listed in the Stockholm Convention in 2009, due to being persistent, bioaccumulative, and are 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 and listed in the Stockholm Convention. 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 persistent organic pollutant 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 PBDEs. 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 PBDEs, and most probably better waste handling, have resulted in a decrease of most BDEs, except BDE 209, the main component of commercial decaBDE, over time (AMAP 2009; Helgason et al. 2009). Spatial trends of PBDEs 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 hexaBDEs biomagnify in arctic food webs while results for the fully brominated PBDE congener, BDE 209 or decaBDE, 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. 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 octaBDEs and more recently decaBDE, new non-PBDE BFRs have been introduced into the market. Firemaster 550 (containing BEHTBP) is a

replacement product for PentaBDE (Venier and Hites, 2008) and 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) is a replacement for the DecaBDE and was introduced into the market in the mid-1980s (Umweltbundesamt, 2001).

1.3.4 Per- and polyfluorinated alkyl substances (PFAS)

Per- and polyfluorinated alkylated substances (PFASs) have been widely used in many industrial and commercial applications. The chemical and thermal stability of a perfluoroalkyl moiety, which is caused by the 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, PFASs 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; de Wit et al. 2012). 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 listed in the Stockholm Convention and are recognized as persistent organic pollutants. 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[1] 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 PFASs

In addition, more than 3000 PFASs 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-

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

ethylcyclohexanesulfonate (PFECHS) was detected for the first time in an atmospherically derived sample, and a 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.

1.3.5 Cyclic volatile methyl siloxanes, (cVMS)

There are concerns about the properties and environmental fate of the three most common cyclic siloxanes 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.

1.3.6 Chlorinated paraffins (CPs)

CPs have been produced since the 1930s and the world production of chloroparaffins was 300,000 tonnes in 2009. Chloroparaffins 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 CPs, 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. 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 SCCPs were found to dominate compared to MCCPs 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 MCCPs were found at higher concentrations. The data indicated that SCCP and MMCP biomagnified in Arctic food webs with TMF > 1. A recent subtropical marine food web study also indicated tha SCCP and MCCP biomagnified with trophic magnification factors for ∑SCCPs and ∑MCCPs were 4.29 and 4.79 (Zeng et al 2017). In a Canadian freshwater study in Lake Ontaio and Lake Michigan , SCCPs and MCCPs 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 SCCPs and from 0.06 to 0.36 for MCCPs (Houde et al., 2008). SCCPs and MCCPs 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). CPs have been detected in biota samples collected in Norway, SCCPs 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 SCCPs in the atmosphere (Borgen et al., 2003). In fish livers collected from samples in the North and Baltic Seas, SCCPs and MCCPs 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 MCCPs are not globally regulated, however, SCCP has recently been included in the Stockholm Convention, and a global regulation will be effectuated within November 2019.

1.3.7 Organophosphorous flame retardants (PFR)

The global use of phosphorous containing flame retardants in 2001 was 186000 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).

1.3.8 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 contaminant 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).

1.3.9 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 one of the main sources 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).

1.3.10 UV compounds

Concern over our contribution to the loads of environmental contaminants originating from our use of personal care products is continuing to grow. 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).

1.3.11 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 1 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.

1.3.12 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).

2. Methods

2.1 Sampling

The main objective of the project was to assess the presence of the targeted contaminants in a terrestrial urban environment in Norway, and to assess the bioaccumulation potential of the contaminants. A variety of locations were chosen for sampling of air, soil, earthworms and, when possible, fieldfare eggs, reflecting the different area uses in an urban setting: Alnabru, an industrialised site; Slottsparken, an urban park surrounded by traffic; Frognerseteren, a popular skiing area, also used for international competitions; Fornebu, an area with a former national airport, and VEAS, Norway's largest sewage treatment plant. The different species included in the study were selected to represent different trophic levels, from primary consumers (earthworm) via secondary consumers (fieldfare and badger) to a top predator (sparrowhawk). In addition, two omnivore generalists representing a truly urban environment, the red fox and the brown rat, were chosen. The tawny owl is also top predator, feeding primarily on small rodents. Sparrowhawk and tawny owl eggs 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 2. All samples were sampled and handled according the guidelines given in OSPAR/ JAMP, 2009.

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

Sample type	No. of samples	Location	Date	Sampling strategy
Air	5	Oslo	2017	Passive air samples
Soil	5	Oslo	2017	Pool of individual samples
Earthworms (*Lumbricidae*)	5	Oslo	2017	Pool of individual samples
Fieldfare (*Turdus pilaris*)	10	Oslo	2017	Pool of 2 eggs from same nest
Sparrowhawk (*Accipiter nisus*)	10	Oslo	2017	Fresh eggs
Brown rat (*Rattus norvegicus*)	9	Oslo	2017	Pool of 2 individual samples for 6 samples
Tawny owl (*Strix aluco*)	7	Oslo	2017	Addled eggs
Red fox (*Vulpes vulpes*)	10	Oslo	2017	Individual liver samples
Badger (Melis melis)	3	Oslo	2017	Individual liver samples

Air

Air concentrations were measured using two types of passive air samplers (PAS) at five locations; Fornebu, VEAS, Alnabru, Slottsparken, and Frognerseteren, the same sites as for soil and worms. The PAS were prepared, deployed and retrieved by NILU personnel. Each sampler type was exposed for three months (June-September 2017) according to standard routines in the guidance document for the Global Monitoring Plan, GMP (UNEP, 2015). Field blanks for air samples were continuously included. These were transported and stored together with the exposed samples and give information about any contamination during sampling or storage.

The two types of PAS were chosen to collect a wide spectrum of volatile and semi-volatile contaminants; i) PUF disks were used to collect semi-volatile non-polar contaminants (i.e. PCBs, PBDEs, nBFRs, CPs, and OPFRs), and ii) XAD was used to collect more volatile and more polar contaminants (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 contaminants 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 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 PCBs, PBDEs, cVMS and CPs but not for PFAS, OPFRs and dechloranes (Bohlin et al., 2014; Krogseth et al., 2013; Li et al., 2012). For PCBs and CPs, an uptake rate of 4 m3/day is used in this study (Harner et al., 2006; Bohlin et al., 2014; Li et al., 2012). For PBDEs an uptake rate of 2 m3/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 passive air samplers in this study are presented as ng/day for all targeted pollutants and as estimated air concentrations (pg/m3) for the pollutants with uptake rates. 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. For comparison to air concentrations from active air samplers the estimated air concentrations are used.

	Deployed 2017	Retrieved 2017	Number of exposure days
Alnabru	June 27	September 20	85
Frognerseteren (Holmenkollen)	June 23	September 20	89
Slottsparken (Dronningparken)	June 23	September 20	89
Fornebu	June 27	September 20	85
VEAS	June 23	September 20	89

Figure 1. ***Air samples (PUF and XAD) at one sampling site***

Soil

Soil samples were collected at the same five locations as air samples (Figure 2). The upper layer of 0-10 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, Fornebu, VEAS).

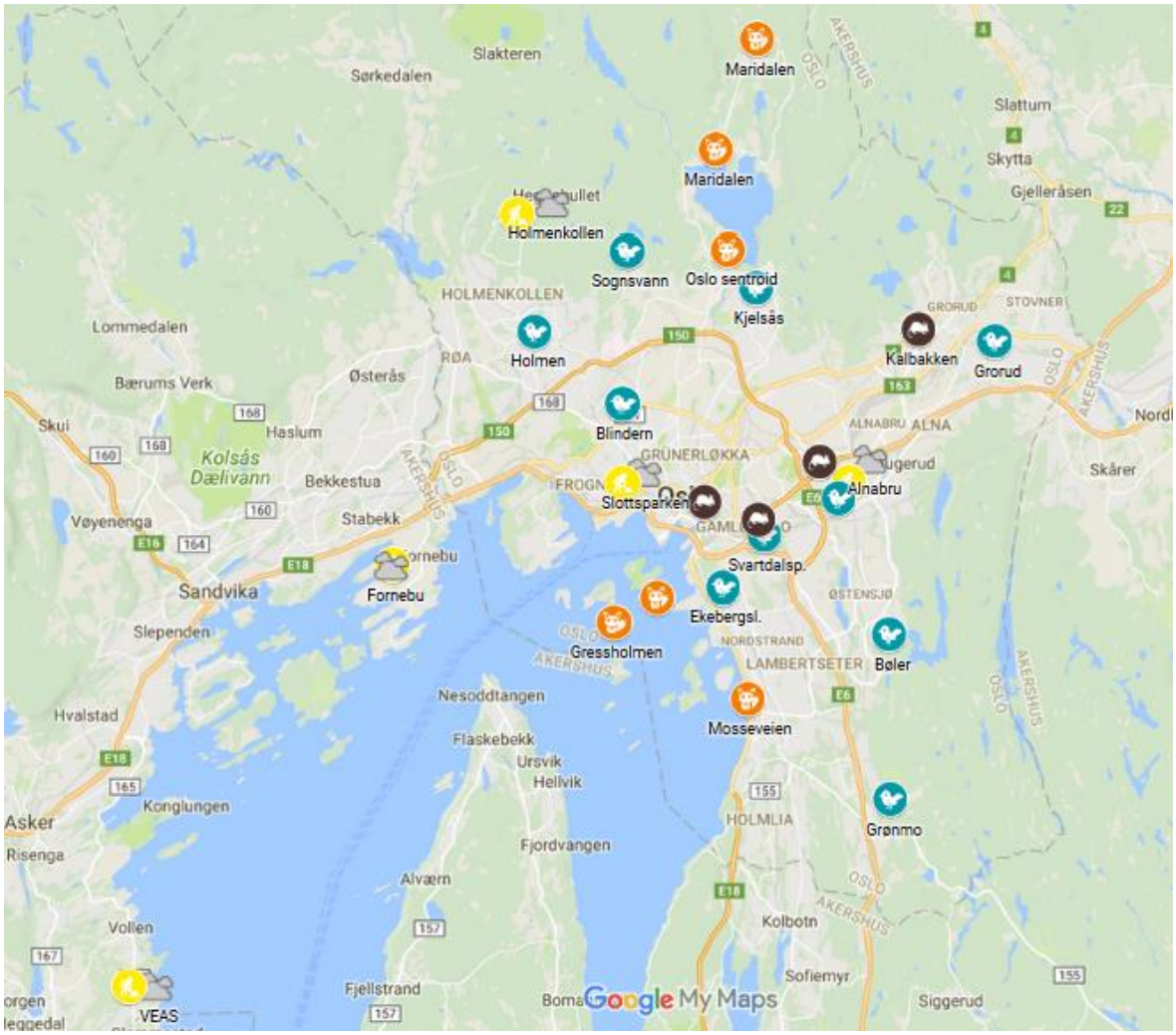


Figure 2: Locations for soil& earthworms (yellow icon), air samples (grey icon), fieldfare (blue-green icon), rat (brown icon) and red fox (orange icon).

Earthworms (*Lumbricidae*)

Earthworms were collected at the same five locations in Oslo as the soil samples to allow a direct comparison (Figure 2). All pooled samples consisted of up to 10 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.

Figure 3: Habitat (left), soil profile (middle) and waste (isolation cables) in the ground (right) of the soil and worm sampling-site at Alnabru.

Fieldfare *(Turdus pilaris)*
Two fieldfare eggs were collected from each out of ten nests in the Oslo area, 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).

Sparrowhawk *(Accipiter nisus)*
Sparrowhawk eggs were collected at different locations in the Oslo area (N=10). 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.

Tawny owl *(Strix aluco)*
Tawny owl eggs were collected 20th of April in Ås and Vestby district. These eggs were addled eggs and collected at the time of ringing of the chicks, and later handled by the same method as the fieldfare and sparrowhawk eggs at NINA.

Brown rat *(Rattus norvegicus)*
Brown rats were caught using clap-traps (no rat poison involved). Three samples were individual samples and six samples were pooled together for analyses, 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 four liver samples of female rats and three liver samples of male rats and two mixed samples from Oslo. The bodyweight of the rats ranged between 52 g and 299 g.

Red fox *(Vulpes vulpes)*
Red foxes for the urban pollution measurements were collected in the greater area of Oslo. Some of the foxes were shot by local hunters on assignment from NINA, while others were foxes delivered to the Veterinary institute in Oslo. Among the sampled foxes, there were six males and four females. Their age was estimated to vary between one and four years. Their sex was determined by inspection of the gonads, while the age was determined by examining the incremental layer-structure in their teeth (Morris, 1972).

Badger
Only three liver samples of badger was available for the project. One of the badgers was obtained as shot, one was hit by a car, and the third was found dead near the metro at Stovner. All three were adult males.

Dissection of liver samples from red fox, rat and badger was carried out at the laboratories of NINA, applying the siloxane relevant precautions, while the livers from the Veterinary institute were sampled in their laboratory. The samples were wrapped in aluminium foil and thereafter put into sealed polyethylene bags before being frozen at – 21°C

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). 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.

2.2 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 data for shell thickness can be found in the Appendix.

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 PBDEs and PCBs were analyzed together. PFAS and metals required a dedicated sample preparation each.

PBDEs, CPs, DDTs, pesticides and PCBs. All biological samples were prepared in a similar manner. Briefly, 3-4 grams of sample were mixed and homogenized with a 20 fold amount of dry Na_2SO_4. The homogenate was extracted using a mixture of Acetone/ Cyclohexane (1/1 v/v). The organic extract was evaporated and treated 2-4 times with 3-4 mL of concentrated sulfuric acid to remove the lipids. Extracts were measured using GC/HRMS. 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 sulfuric acid. Following by adsorption chromatography (silica). Air: The extract was evaporated and treated 2-4 times with 3-4 mL of concentrated sulfuric 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, 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 MeCN (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 MeCN 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 % NH4OH) 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^{o}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 was added to sample (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 SFC-MS (super critical fluid chromatography – mass spectrometry). Rodenticides were separated on a C18 column with methanol (0.1% formic acid) as both the make-up and the mobile phase, using a gradient elution.

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.

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 labeled internal standards for the BFRs (^{13}C DBDPE), PCBs (^{13}C PCBs) 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 10 samples, one standard reference material (SRM; NIST 1945 for PCBs and PBDEs and PERFOOD intercal 2012 for PFAS) and one blank sample was prepared. 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. The data were used to calculate limits of quantification (average blank response + 3 times standard deviation of response). To ensure accuracy of measured results, a random sample from each matrix was selected for duplicate analysis. 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.

2.3 Biomagnification

Like in the urban terrestrial study from 2016, (Herzke et al., 2017), 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, badger = 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 $\delta^{15}N_{sample}$ and the average $\delta^{15}N$ 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):

$$TL_{fieldfare} = 2 + (\delta^{15}N_{fieldfare} - (\delta^{15}N_{earthworm} + 2.4))/3.8$$

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

For further data assessment of the biomagnification, all sumPCB and sumPBDE data were lipid normalized. PFAS are not lipophilic compounds (Kelly, 2009), however we performed calculations for SumPFAS both on lipid weight basis and wet weight basis for comparisons. 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.

Log [compound] = a + *b*TL

$TMF = 10^b$

In addition a comparison of $\delta^{15}N$ 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.

2.4 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 calculation of mean values, and the number of detected (n) over measured samples (N) are given in the tables.

3. Results

In total, 150 single compounds were analysed in this study. Some of the compounds such as pesticides were only measured in sparrowhawk, metals were not measured in air samples and biocides only in liver samples of fox, rat and badger. Some compound classes such as OPFR and UV compounds were only analysed in one or three pooled samples of the various environmental samples.

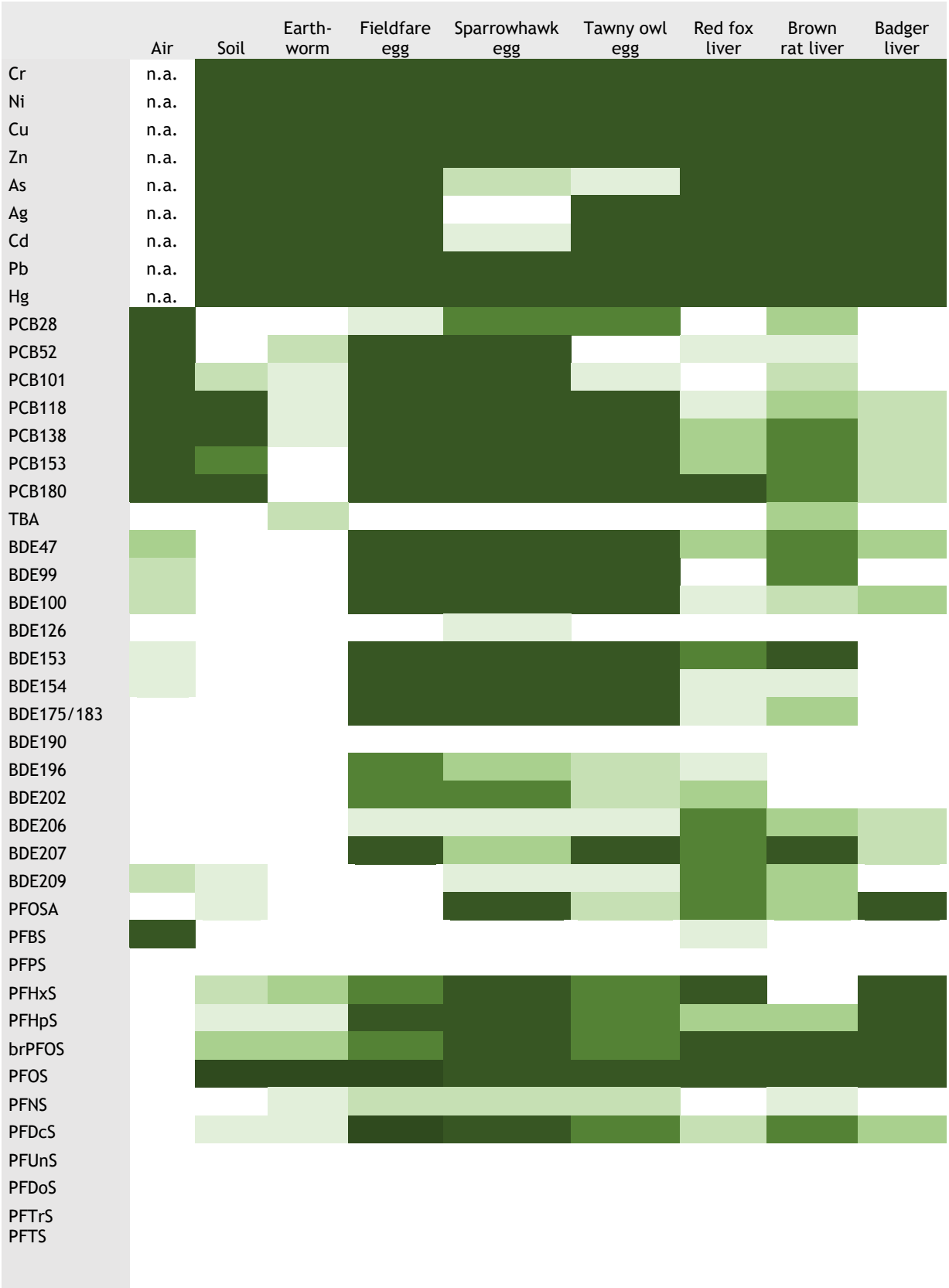
Table 3 gives the percentage detection of the various compounds in the different environmental samples. As can be seen, metals were detected in almost all samples which is also the case with PCBs, perfluorinated sulfonates (PFSA) and carboxylates (PFCA).

In the chapters below, we mainly discuss the sum for each group of contaminants investigated. Single compounds/congeners are only discussed in special cases. Detected concentrations are summarized in the tables below (mean, median, maximum and minimum) and individual data can be found in the Appendix. The number of cases (n/N) in all tables denotes the number of detectable/measured samples.

In general, the largest number of substances and the highest concentrations of halogenated organic pollutants were found in sparrowhawk eggs. PCB and PBDE levels were highest in this species, while PFAS levels were highest in earthworms followed by fieldfare, badger and sparrowhawk. Toxic metals were found in highest concentrations in earthworm, followed by brown rat and badger. Highest sum concentrations of siloxanes and CPs were highest in soil and brown rats, UV compounds in badger and earthworms, and biocides were highest in red fox. Phenols were highest in tawny owl, while OPFRs were highest in earthworms.

Table 3: The ratio of detected samples for each chemical in the various samples types. Bisphenols marked with grey colours indicate semi-quantitative results. Colour codes give the percentage detection, no colour is zero detection:

90-100 % 70-89 % 50-69 % 30-49 % 10-29 % 0 %




Air
Soil
Earth-worm
Fieldfare egg
Sparrowhawk egg
Tawny owl egg
Red fox liver
Brown rat liver
Badger liver
PFBA
PFHxA
PFHpA
PFOA
PFNA
PFDcA
PFUnA
PFDoA
PFTriA
PFTeA
PFHxDA
PFOcDA
6:2FTS
8:2 FTS
10:2FTS
meFOSA
etFOSA
meFOSEA
meFOSE
etFOSE
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8:2 FTOH
10:2 FTOH
12:2 FTOH
HFPO-DA
Cl-PFOA
Cl-PFHxS
Cl-PFOS
NaDONA
PFECHS
F53
F53B
SCCP
MCCP
D4
D5
D6
TEP
TCEP
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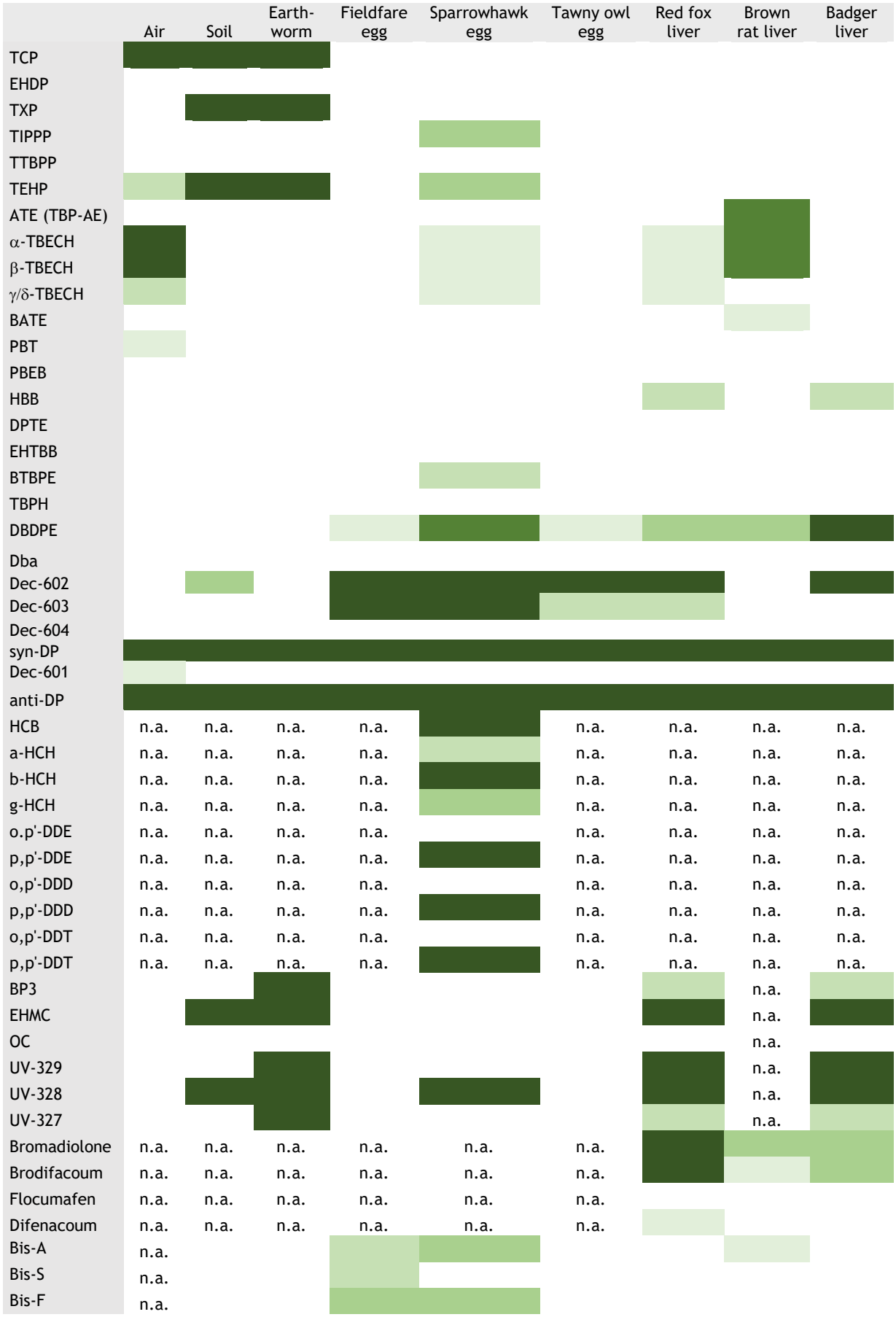
BdPhP
TPP
DBPhP
TnBP
TDCPP
TBEP



	Air	Soil	Earth-worm	Fieldfare egg	Sparrowhawk egg	Tawny owl egg	Red fox liver	Brown rat liver	Badger liver
TCP									
EHDP									
TXP									
TIPPP									
TTBPP									
TEHP									
ATE (TBP-AE)									
α-TBECH									
β-TBECH									
γ/δ-TBECH									
BATE									
PBT									
PBEB									
HBB									
DPTE									
EHTBB									
BTBPE									
TBPH									
DBDPE									
Dba									
Dec-602									
Dec-603									
Dec-604									
syn-DP									
Dec-601									
anti-DP									
HCB	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.	n.a.
a-HCH	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.	n.a.
b-HCH	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.	n.a.
g-HCH	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.	n.a.
o.p'-DDE	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.	n.a.
p,p'-DDE	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.	n.a.
o,p'-DDD	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.	n.a.
p,p'-DDD	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.	n.a.
o,p'-DDT	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.	n.a.
p,p'-DDT	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.	n.a.
BP3								n.a.	
EHMC								n.a.	
OC								n.a.	
UV-329								n.a.	
UV-328								n.a.	
UV-327								n.a.	
Bromadiolone	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
Brodifacoum	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
Flocumafen	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
Difenacoum	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
Bis-A	n.a.								
Bis-S	n.a.								
Bis-F	n.a.								

	Air	Soil	Earth-worm	Fieldfare egg	Sparrowhawk egg	Tawny owl egg	Red fox liver	Brown rat liver	Badger liver
4-t-octylphenol									
4-nonylphenol									
Bis-FL	n.a.								
Bis-BP	n.a.								
Bis-TMC	n.a.								
Bis-P	n.a.								
Bis-M	n.a.								
Bis-Z	n.a.								
Bis-AF	n.a.								
Bis-AP	n.a.								
2.2-bis-F	n.a.								
Bis-E	n.a.								
Bis-B	n.a.								
dodekylefenol	n.a.								
TBBPA	n.a.								

3.1 PCBs

3.1.1 Air

Of the targeted seven indicator PCBs, all were detected at all five sites. PCB 28, 52, 101 and 118 were the dominating congeners. The highest levels were observed at Slottsparken with sumPCB (=SumPCB$_7$) of 0.5 ng/day, followed by Alnabru, Fornebu, VEAS and Frognerseteren with 0.08, 0.05, 0.04 and 0.02 ng/day, respectively. The levels at Slottsparken were about two times lower than those measured in 2016 (1 ng/day) while the levels at Alnabru and Frognerseteren were in agreement with the levels measured in 2016.

The calculated estimated air concentrations for the PCBs using 4 m3/day resulted in the following sumPCB$_7$ concentrations: 140 pg/m^3, 22 pg/m^3, 13 pg/m^3, 11 pg/m^3, and 6 pg/m^3 for Slottsparken, Alnabru, Fornebu, VEAS and Frognerseteren, and VEAS, respectively. For comparison, concentrations of SumPCB (=SumPCB$_7$) in air from the background air monitoring station at Birkenes in southern Norway (2.5-4.5 pg/m^3 in 2014-2016) are 5-50 times lower than those in this study (Bohlin-Nizzetto et al, 2015; Bohlin-Nizzetto et al, 2016; Bohlin-Nizzetto et al, 2017). The higher concentrations observed at the five urban sites in this study indicates that the urban area of Oslo is a 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 PCBs in the felts (sumPCB$_7$: 16 ng/100 cm^2). It cannot be excluded that the samplers in Slottsparken can have been affected by the PCBs in these felts, especially if the felts have been extensively used to protect many other trees in the park. The findings of PCBs in both soil and worms from Slottsparken, indicate a local PCB source in the city environment, and most probably also from other sources than only the felt.

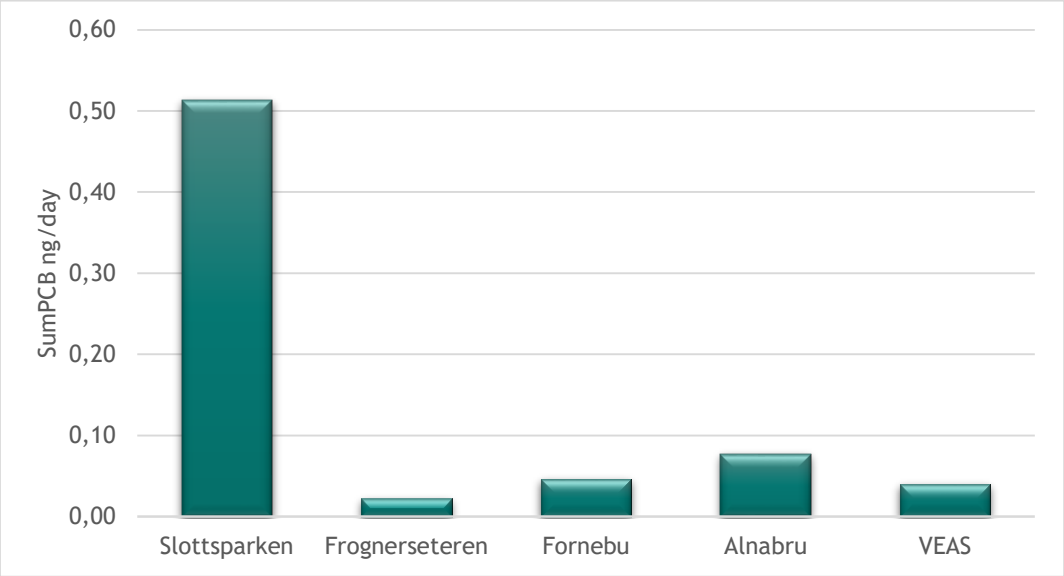


Figure 4: SumPCB$_7$ concentrations (ng/day) from PUF passive air samplers at the five locations in Oslo

3.1.2 Soil

SumPCB concentrations varied between 0.9 and 3.6 ng/g dw, with a median of 2.0 ng/g dw (Table 4). The highest sumPCB concentrations were measured in Slottsparken followed by Alnabru, similar to air samples. 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[2] (). None of the samples analysed in this study exceeded this threshold value.

Table 4: PCB concentrations in soil in ng/g dw. N: number of detected/ analysed samples.

	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180	SumPCB7
N	0/5	0/5	2/5	5/5	5/5	5/5	5/5	
Mean	<LOD	<LOD	0.27	0.35	0.69	0.73	0.33	2.38
Median	<LOD	<LOD	<LOD	0.36	0.65	0.73	0.30	2.13
Minimum	<LOD	<LOD	<LOD	0.23	0.43	<LOD	0.23	1.38
Maximum	<LOD	<LOD	0.55	0.53	1.00	1.02	0.55	3.60

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

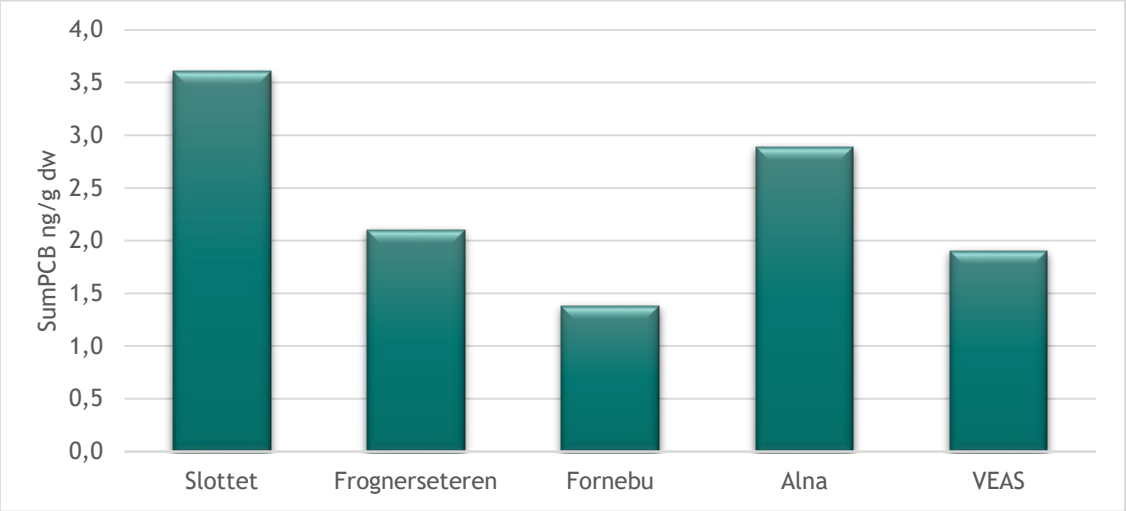


Figure 5: SumPCB concentrations (ng/g dw) in soil at the different sampling sites.

3.1.3 Earthworms

SumPCB concentrations in Earthworms ranged from <LOD to 3.78 ng/g ww. Slottsparken had the highest sumPCB and also for the respective congeners, reflecting a similar spatial trend as found in air and soil. The median sumPCB concentration of 1.15 ng/g ww was in accordance with previous year's data of 2.27, 1.16 and 1.11 ng/g ww in 2016, 2015 and 2014.

Table 5 : PCB concentrations in earthworms in ng/g ww. N: number of detected/ analysed samples.

	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180	SumPCB7
N	3/5	3/5	3/5	3/5	4/5	4/5	5/5	
Mean	0.02	0.09	0.32	0.20	0.44	0.61	0.16	1.71
Median	0.02	0.05	0.23	0.15	0.27	0.34	0.08	1.15
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.07	0.08
Maximum	0.04	0.25	0.77	0.45	0.85	1.23	0.33	3.78

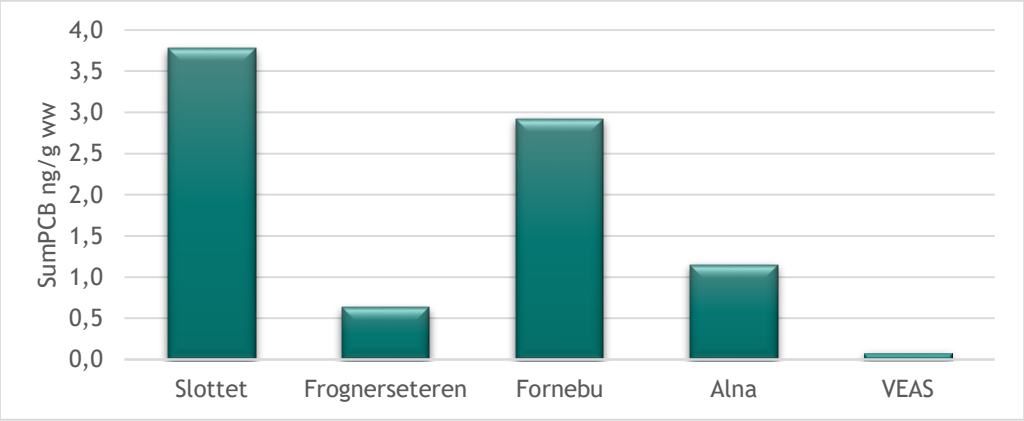


Figure 6: SumPCB concentrations in earthworms at the different sampling sites in ng/g ww.

3.1.4 Fieldfare

SumPCB concentrations varied between 13.3 and 60.9 ng/g ww, with a median of 38.5, which was twice the median concentration 17.9 and 18.7 ng/g ww reported for the 2016 and 2015 data (Herzke et al., 2016; 2017). For fieldfare and the other bird species we have chosen to represent mean data in figures for the various compounds since one nest (and one sample) per locality is not assumed to be sufficient to describe potential differences between the ten sites, but assumed to be sufficient and homogenous enough to describe an average. A summary of values are given in Table 6. PCB 138, 153 and 180 dominate the PCB pattern (Figure 7). For improved interspecies comparability, lipid related concentrations are used (lw) to compare with other published data. Data for great tits (*Parus major*) were available and will be used for comparison purposes. In our study, SumPCB varied between 453 to 2600 ng/g lw in the fieldfare eggs, with an average of 1075 ng/g lw. The average in our study is approximately 1/3 of that found in eggs of great tits in Belgium (average sumPCB_{21} concentrations of 4110 ng/g lw) (Voorspoels et al., 2007).

In a second study, PCBs in eggs of great tits collected all over Europe were studied in 2009 (Van den Steen et al. 2009). This study included a Norwegian location as well, a suburban site close to Oslo. The PCB concentration of 22 congeners of nearly 1000 ng/g lw in the Norwegian location was comparable with mean value of sumPCB_7 (1075 ng/g lw) in our present study. A more recent study on starling eggs (*Sturnus vulgaris*), sampled worldwide, showed less than 500 ng/g lw sumPCBs at the one included Norwegian rural location in Northern Trøndelag (Eens et al. 2013), similar to what was observed in our fieldfare eggs from 2016.

Table 6 : PCB congener concentrations in fieldfare eggs from 2017 in ng/g ww. N: number of detected/ analysed samples.

	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180	SumPCB7
N	1/10	10/10	10/10	10/10	10/10	10/10	10/10	
Mean	<LOD	0.70	3.88	2.20	9.37	14.5	5.57	36.3
Median	<LOD	0.44	3.11	1.52	9.86	15.3	6.09	38.5
Minimum	<LOD	0.20	1.26	0.75	3.54	5.21	1.82	13.3
Maximum	0.59	1.43	8.97	6.53	15.3	22.8	8.95	60.9

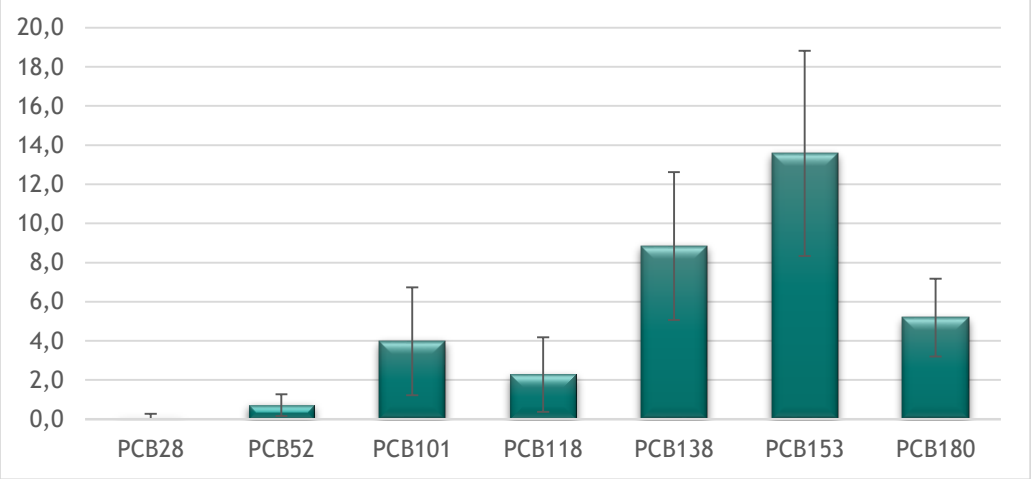


Figure 7: Mean concentrations with standard deviations of PCB congeners in fieldfare eggs (ng/g ww).

3.1.5 Sparrowhawk

Ten eggs were available for analysis, all from the Oslo area. The detailed results are shown in Table 7.

In Figure 8, the mean PCB congener concentrations are shown. Elevated PCB concentrations were found in a number of eggs, with a maximum concentration of sumPCB of 1299 ng/g ww in one egg. This was lower than the maximum concentrations from 2016 data with 1700 ng/g ww. PCB 138, 153 and 180 were the dominating PCB congeners. During the 1970's, average 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, and with eggshells that 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 an average value of 229 ng/g PCBs in sparrowhawk eggs (Nygård and Polder 2012). In our present 2017 data, an average of sumPCBs of 460 ng/g ww was lower compared to our 2016 and 2015 data[3] with 660 and 750 ng/g ww, respectively (Herzke et al., 2016, 2017).
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 form Oslo, however one cannot exclude that the levels above 1000 ng/g ww might cause potential risks.
Its food choice, feeding on other birds (Hagen et al. 1952), makes it vulnerable to trophic magnification of pollutants, 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. For migratory birds, one would expect that the total accumulated body burden of contaminants in mother bird are likely to be most important during egg laying. This would include previous accumulated PCBs 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 expected to be energy demanding and it is uncertain how much of this burden is left in the fat resources of the bird. A study from Svalbard of snow buntings indicated that concentration of POPs in egg were influenced by local pollution (Kristoffersen, 2012). Significant higher concentrations (ng/g wet weigth) 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) settelements, Kristoffersen, 2012. It is obvious that 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).

Table 7 : Concentrations of PCB congeners in sparrowhawk eggs in ng/g ww, N: number of detected/ analysed samples.

	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180	SumPCB7
N	8/10	9/10	10/10	10/10	10/10	10/10	10/10	
Mean	0.88	2.00	8.62	26.4	90.6	204	127	460
Median	0.23	0.40	4.57	13.7	70.2	165	105	372
Minimum	<LOD	<LOD	2.09	7.55	16.2	24.8	14.2	68
Maximum	4.58	10.0	26.6	80.1	259	613	320	1299

[3] http://www.miljodirektoratet.no/no/Tema/Miljoovervakning/Naturovervaking/Giftfritt-miljo/Miljogifter-i-terrestrisk-og-bynart-miljo/Rapporter-fra-programmet-Miljogifter-i-terrestrisk-og-bynart-miljo/

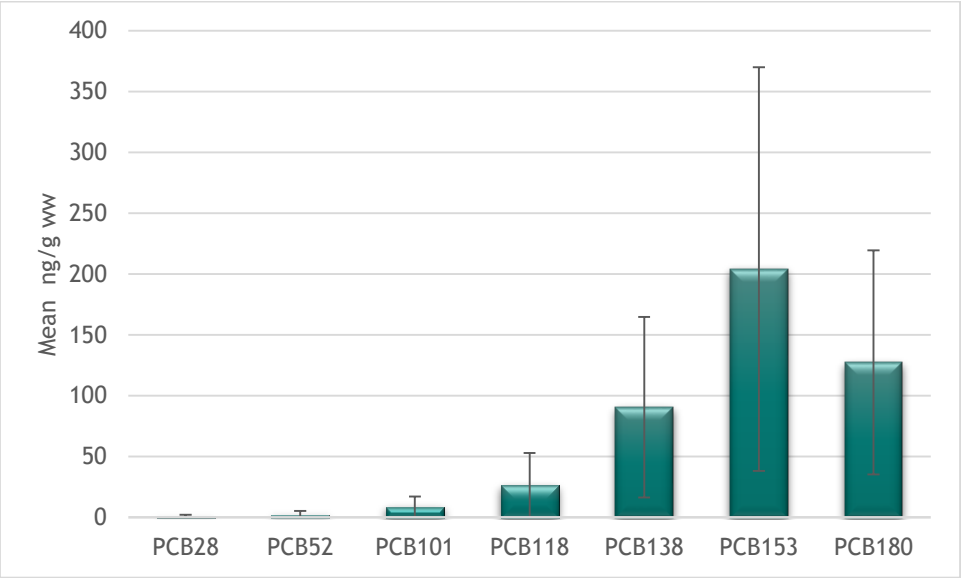


Figure 8: Mean concentrations with standard deviations of PCB congeners in eggs of sparrowhawk (ng/g ww).

3.1.6 Tawny owl

In total, 7 egg samples of tawny owl, all from the Oslo area, were analysed for PCBs.
The PCB concentrations in tawny owl were significantly lower than the levels in sparrowhawk. The mean sumPCB concentration of 34 ng/g ww was slightly lower to last year's report with 41.8 ng/g and higher than 2015 data (26.4 ng/g ww). One tawny owl sample had significantly higher concentrations of PCB 138, 153 and 180, i.e. the maximum values in the table below. PCB 153 and 180 dominated the PCB pattern, like in the sparrowhawk. For comparison, Bustnes et al., (2011), found six times higher meanSumPCB (193 ng/g ww) in tawny owl eggs collected 2009 in Trøndelag, Norway.

Table 8: Concentrations of PCB congeners in tawny owl eggs in ng/g ww. N: number of detected/analysed samples.

	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180	SumPCB7
N	3/7	0/7	1/7	7/7	7/7	7/7	7/7	
Mean	0.08	<LOD	0.14	1.81	6.99	14.9	10.2	34.0
Median	0.05	<LOD	<LOD	1.02	2.92	9.05	5.52	19.5
Minimum	<LOD	<LOD	<LOD	0.67	2.13	4.44	2.46	9.89
Maximum	0.28	<LOD	0.62	6.12	30.0	60.7	43.9	142

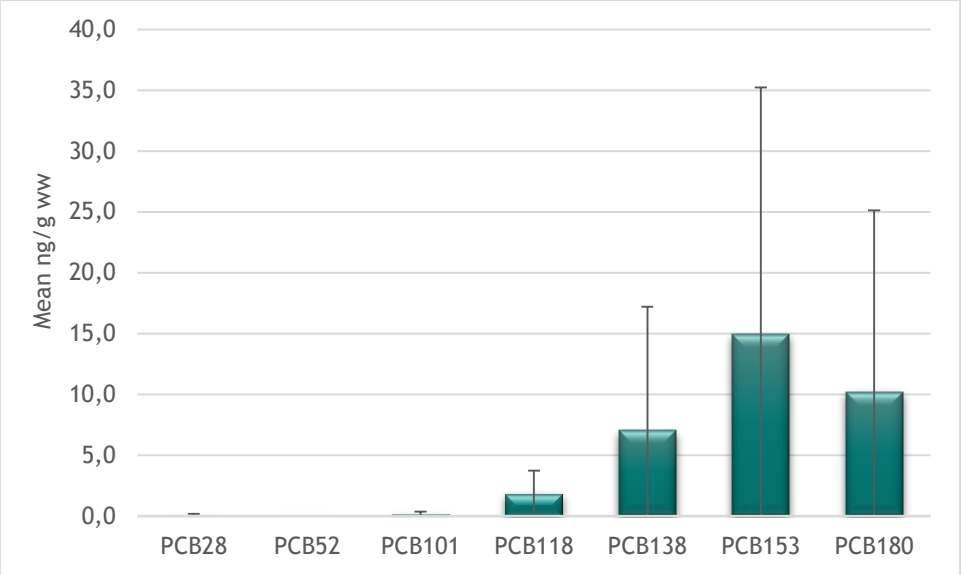


Figure 9: Mean PCB concentrations with standard deviations in tawny owl eggs (ng/g ww).

3.1.7 Brown Rats

PCBs were analysed in 9 available rat samples. SumPCB varied between <LOD to 663 ng/g ww compared to the lower concentrations in 2016 with sumPCB from <LOD and 50.2 ng/g ww. As in 2016, PCB 153, 138 and 180 dominated the PCB pattern, but PCB138 had higher concentrations than 153 and 180 in this year's data. The median of sumPCB of 15 ng/g ww in the present dataset was higher than last year's median of 2.8 ng/g ww (Herzke et al., 2017). Four rat liver samples had much higher PCB138, PCB153 and PCB180 compared to the 5 other samples. The concentrations of each of these 3 congeners varied between 100-250 ng/g ww and were 10-20 times higher than in the rest of the samples. The samples with highest concentrations were pooled samples from Kaldbakken and Ulven, young females and males.

Table 9: Concentrations of PCB congeners in brown rat livers in ng/g ww. N: number *of detected/analysed samples*.

	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180	SumPCB7
N	5/9	1/9	4/9	6/9	7/9	7/9	7/9	
Mean	0.07	<LOD	3.09	6.45	89.5	69.9	59.0	228
Median	0.07	<LOD	<LOD	0.64	4.82	6.07	3.52	15.0
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	2.30
Maximum	0.18	0.07	9.08	15.9	250	201	190	663

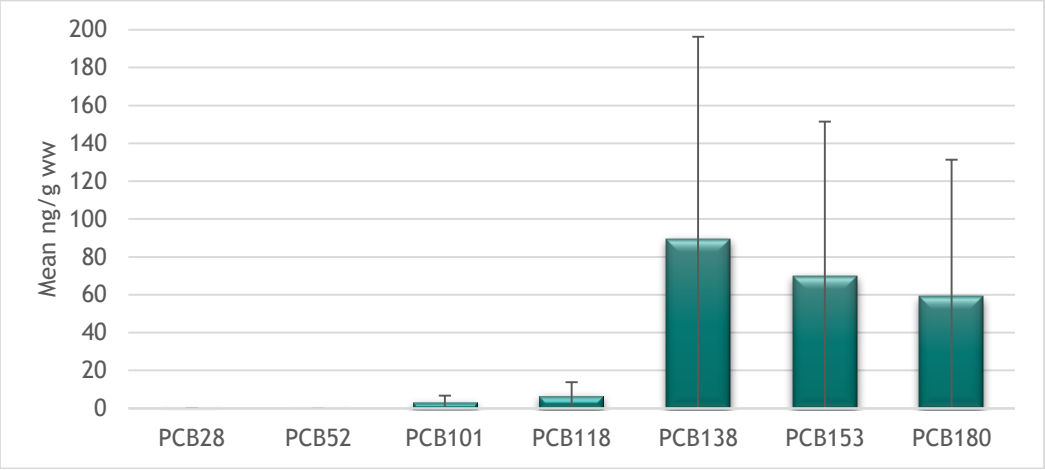


Figure 10: Mean PCB concentrations with standard deviations in rat livers (ng/g ww).

3.1.8 Red fox

In total, 10 livers of foxes, all from the Oslo area, were analysed for PCBs. PCB 153 and 180 were the dominant congeners (Figure 11). The observed sumPCB concentration ranged between 2.4 and 261 ng/g ww, with a median of 9.2 ng/g ww (compared to 14.2 ng/g ww in 2016, 6.8 ng/g ww in 2015 and 6.5 ng/g ww in 2014). One fox liver sample had significantly higher PCB 180 and PCB 153 concentration than the 9 other samples (see maximum values in Table 10). 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 Andalusia in Southern Spain, approximately 5 times higher than the maximum sumPCB concentration in our present study.

Table 10: PCB concentrations in red fox livers from the Oslo area in ng/g ww. N: number of detected/analysed samples.

	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180	SumPCB7
N	0/10	1/10	0/10	1/10	5/10	5/10	10/10	
Mean	<LOD	<LOD	<LOD	<LOD	1.85	9.85	28.0	39.9
Median	<LOD	<LOD	<LOD	<LOD	0.58	2.56	4.78	9.20
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	1.34	2.40
Maximum	<LOD	0.06	<LOD	1.81	7.96	49.1	202	261

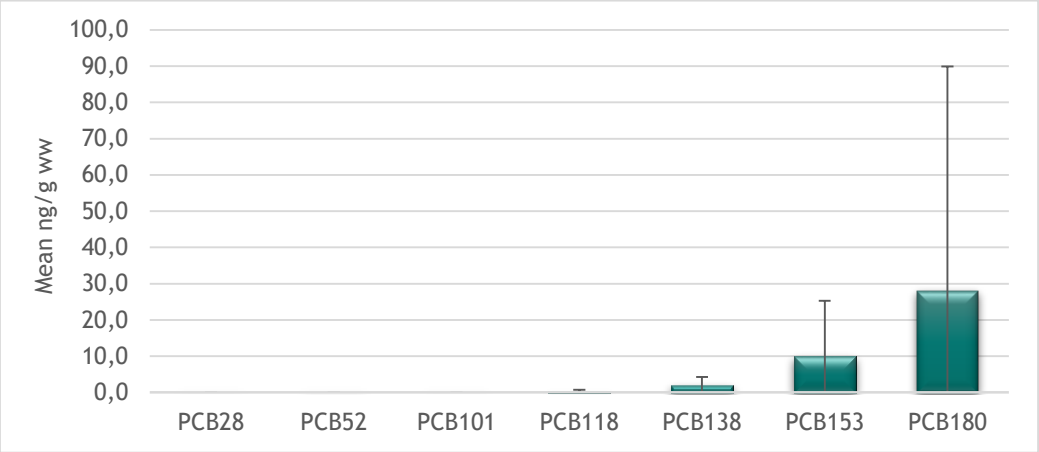


Figure 11: Mean PCB congener concentrations with standard deviations in fox livers in ng/g ww.

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).

3.1.9 Badger

Only 3 badger liver samples were available, and the concentrations were significantly lower than levels detected in fox liver, see Table 11. Mateo et al. (2012) analysed one badger liver sample and the concentrations of the dominating congeners PCB138, PCB153 and PCB180 were 23.5, 12.3 and 25.1 ng/g ww, considerable higher levels than in our 2017 liver samples of badgers.

Table 11 : PCB concentrations in badger livers from the Oslo area in ng/g ww. N: number of detected/analysed samples.

	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180	SumPCB7
N	0/3	0/3	0/3	1/3	1/3	1/3	1/3	
Mean	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	2.60
Median	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.90
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.90
Maximum	<LOD	<LOD	<LOD	1.15	2.10	1.98	0.80	6.00

3.1.10 Summary of PCB results

PCB data across all species and media revealed that sparrowhawk had the highest concentrations with mean sumPCB of 460 ng/g ww followed by rat liver samples and eggs from fieldfare and tawny owl. PCB 153 dominated in most sample types, with the exception of rat where PCB138 dominated and fox where PCB 180 dominated. PCB 52 and 101 dominated in air as expected due to lower chlorinated PCBs and higher volatility.

3.2 PBDEs and new BFR

3.2.1 Air

Of the targeted PBDE congeners only a few of them were detected in air samplers from Alnabru, Slottsparken and Fornebu. BDE 47 was detected at all three sites while BDE 99 and 100 were detected only at Slottsparken and Alnabru and BDE153 and 154 were only detected at Alnabru. BDE-47, -99, and -100 are also the only congeners detected by PUF-PAS in calibration studies and the presence of only these in this study does not necessarily mean that the other are not present in the air but instead reflects what can be detected by the PUF-PAS. The highest levels were observed at Alnabru (sumPBDE: 0.02 ng/day) while the detected levels at Slottsparken and Fornebu were ten-100 times lower. BDE209 was detected at Alnabru and Fornebu at levels of 0.003 ng/day. 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-PAS.

The estimated air concentrations for sum detected PBDEs (BDE47, 99 and 100), using an uptake rate of 2m^3/day, were 0.05, 1.2, and 7.8 pg/m^3 at Alnabru, Slottsparken and Fornebu, respectively. The concentrations at Alna and Slottsparken are approximately 10-100 times higher than concentrations in background air at Birkenes (~0.05 pg/m3 for BDE-47 and -99, individually). This indicates urban sources for PBDEs.

Of the targeted new BFRs, only the isomers α- and ß-TBECH were detected at all sites, γ-TBECH only at Fornebu and Slottsparken, and PBT only at Slottsparken. The highest levels of the detected nBFRs were observed at Slottsparken (sum detected nBFRS: 0.04 ng/day) followed by Fornebu (0.02 ng/day), up to ten times higher than at the other three sites. The levels of α- and ß-TBECH were higher than those of the individual PBDE congeners at Slottsparken.

3.2.2 Soil and earthworm samples

PBDEs and newBFR were not detected in any soil or earthworm samples.

3.2.3 Fieldfare

The concentrations of the PBDEs detected were generally low, median sumPBDE 2.40 ng/g ww compared to 3.2 ng/g ww in 2016 and 2.3 ng/g ww in 2015. BDE 47 and 99 dominated the pattern (Figure 12). No BDE 209 was detected in any of the fieldfare eggs. On average, sumPBDE concentrations in fieldfare eggs were almost 5 times lower than the sumPBDE concentrations found in sparrowhawk eggs. BDE 126, 190 and 209 with no detectable concentrations are not included in the Table 12, but all congeners shown in Figure 12.

Table 12. Values of individual congeners of PBDE and sum PBDEs in fieldfare eggs (ng/g ww). N: number of detected/analysed samples.

	BDE47	BDE99	BDE100	BDE153	BDE154	BDE175	BDE196	BDE202	BDE206	BDE207	Sum PBDE
N	10/10	10/10	10/10	10/10	10/10	9/10	8/10	7/10	2/10	10/10	
Mean	1.18	1.94	0.79	0.45	0.25	0.09	0.07	0.35	0.01	0.06	5.21
Median	0.74	0.86	0.40	0.19	0.15	0.05	0.03	0.03	0.01	0.05	2.40
Minimum	0.30	0.30	0.22	0.08	0.08	<LOD	<LOD	<LOD	<LOD	<LOD	1.08
Maximum	3.38	8.38	3.02	2.36	0.99	0.40	0.37	3.09	0.05	0.16	22.1

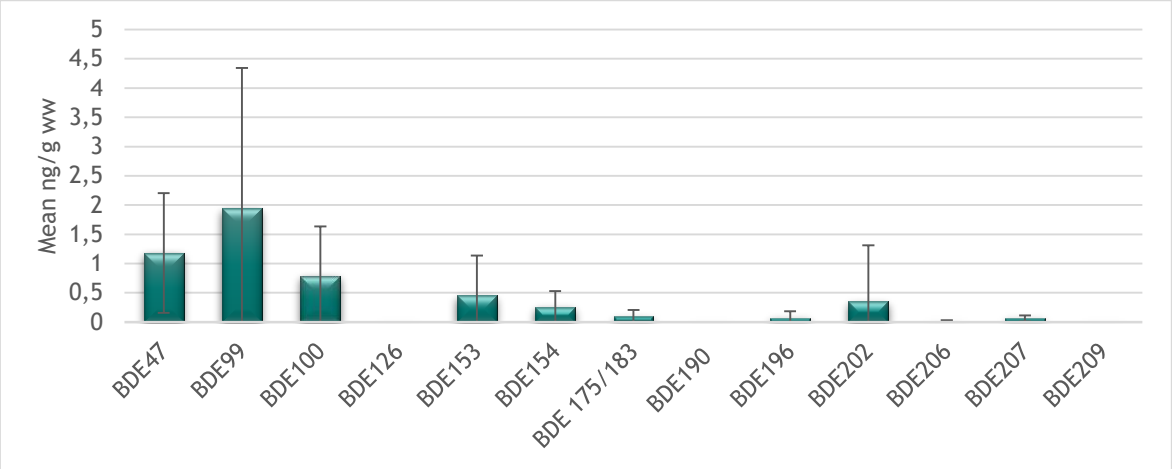


Figure 12: Mean PBDE concentrations with standard deviations in eggs of fieldfare in ng/g ww.

Data for great tits (*Parus major*) were available from a Belgian study. The authors reported that PBDEs were found in eggs of great tits with levels averaging 220 ng/g lw. In our study mean sumPBDE of 162 ng/g lw were found, higher than last year data and more comparable with 2015 data with mean sumPBDE of 143 ng/g lw. PBDEs and PCBs in eggs of great tits collected all over Europe were studied in 2009 (Van den Steen et al. 2009). This study included a Norwegian location as well, a suburban site close to Oslo, showing PBDEs concentrations of 25 ng/g lw. Since the samples from that study were collected in 2006, changes over time in PBDE exposure as well as dietary differences can explain why lower levels were observed in the Van den Steen study. A more recent study on starling eggs (Sturnus vulgaris), sampled worldwide, with one Norwegian rural location in Nord Trøndelag, showed less than 50 ng/g lw of sumPBDEs, (Eens et al. 2013). To obtain comparable figures on a wet weight basis to our study, lipid weight levels should be divided by approximately 27, based on the measured fat levels in the fieldfares in our present study.

Of new BFRs, DBDPE was found in one fieldfare bird egg from Svartdalsparken with 4.6 ng/g ww, significantly lower than was detected last year. The isomers α- and ß- TBECH were found in one fieldfare bird egg from Bøler with 0.25 and 0.22 ng/g ww, respectively.

3.2.4 Sparrowhawk

As previous 3 years data 2014-2016, the dominating PBDE congener was BDE99, followed by BDE47, 100 and 153 (Table 13). One egg sample had significantly higher BDE99, 47 and 100 concentrations than the other samples, see maximum values in Table 13. SumPBDE concentrations ranged from 3.9 to 101 ng/g ww, with a median of 33.5 ng/g ww i.e. on average five times higher than in fieldfare which is lower in the food chain. BDE209 was only detected in one egg sample, which was also the case for BDE206. BDE126 congener was not detected in any samples. Figure 13 shows the average PBDE concentration of the measured congeners. Lacking data for comparable raptor species nesting in urban sites we compared with eggs of the terrestrial passerine birds from the Pearl River Delta, South China, a highly industrialised area (Sun et al., 2014). In the China study sumPBDE concentrations ranged between 6-14 ng/g ww, comparable with this year's median sumPBDE value of the sparrowhawk eggs in Oslo, however these passerine birds 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 present study are well below this threshold.

Table 13: PBDE congener values in sparrowhawk eggs in ng/g ww. N: number of detected/analysed samples.

	BDE47	BDE99	BDE100	BDE153	BDE154	BDE175	BDE196	BDE202	BDE206	BDE207	BDE209	Sum PBDE
N	10/10	10/10	10/10	10/10	10/10	10/10	5/10	7/10	1/10	5/10	1/10	
Mean	4.53	9.73	3.59	4.11	1.57	1.07	0.24	0.49	<LOD	0.37	<LOD	25.6
Median	2.73	5.30	2.19	2.50	1.04	0.60	0.12	0.31	<LOD	0.32	<LOD	13.9
Minimum	0.85	1.43	0.58	0.47	0.20	0.25	0.02	0.05	<LOD	0.13	<LOD	3.87
Maximum	18.5	43.4	14.5	13.4	5.95	2.96	1.02	1.55	0.22	0.67	0.85	101

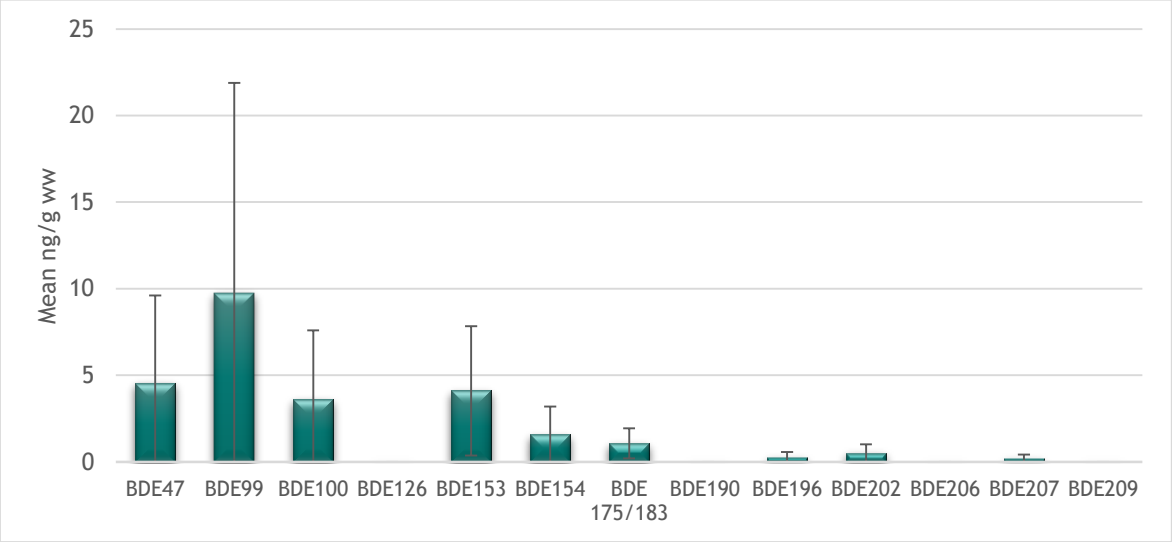


Figure 13: Mean concentrations with standard deviations of different PBDEs in eggs of sparrowhawk in ng/g ww.

New BFR compounds were detected in few samples (Table 14). In the 2015 study, DBDPE was found in 9 of 10 sparrowhawk eggs, 3 of 10 samples in 2016, and in 2017 it was detected in 5 of 10 samples. The concentrations in 2017 were approximately 10 times lower than the 2016 data and more comparable to the 2015 data. The 2015 median concentration of 4.35 ng/g ww was comparable with the maximum concentration found in this year study of 4.39 ng/g ww.

In a study from south China, 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). The sparrowhawk eggs in the Oslo area revealed a median value was 61 ng/g lw, but comparison to levels in muscle are not optimal, the same organs are preferable. In a recent study from Great lakes in Canada measuring DBDPE in plasma of nestling peregrine falcons from rural and urban regions, the median DBDPE concentrations was 4.41 ng/g ww and 2.46 ng/g ww, respectively (Fernie et al., 2017). The lipid content in the plasma was not reported.

Table 14: New BFR congener values in sparrowhawk eggs in ng/g ww. N: number of detected/analysed samples

	ATE	α-TBECH	β-TBECH	γ/δ-TBECH	BATE	PBT	PBEB	HBB	DPTE	EHTBB	BTBPE	TBPH	DBDPE	Sum New BFR
N	0/10	2/10	2/10	2/10	0/10	0/10	0/10	0/10	0/10	0/10	3/10	0/10	5/10	
Mean	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	2.59	2.74
Median	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	2.43	2.69
Min	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Max	<LOD	0.25	0.15	0.12	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.14	<LOD	4.21	4.39

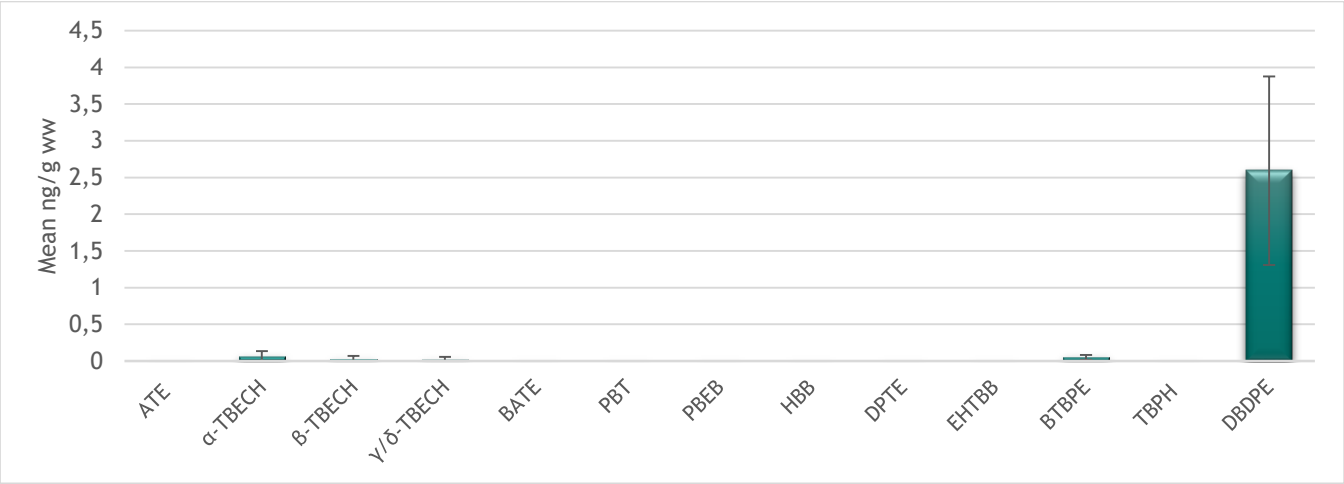


Figure 14: Mean concentrations with standard deviation of different new BFR in eggs of sparrowhawk in ng/g ww.

3.2.5 Tawny owl

With median sumPBDE concentrations of 2.7 ng/g, levels were slightly lower than 2016 data with median sumPBDE of 4.1 ng/g ww, and slightly higher compared to those reported from 2015 (1.15 ng/g ww). The concentrations were clearly lower than for the sparrowhawk 2017 data, and slightly lower than data of fieldfare. PBDE 99, 153,100 and 47 dominated the PBDE pattern (Figure 15). PBDE 207 was detected in all tawny owl eggs, PBDE 209 only in one with 4 ng/g ww. For comparison to our sum median value of 2.7 ng/g ww which equals 55 ng/g lw, Bustnes et al, 2011, reported a comparable median value of 60 ng/g lw of sumPBDE in tawny owl eggs from the period 2001-2009, collected in Trøndelag County, Central Norway.

Table 15: Detected PBDEs in tawny owl egg from the Oslo area, ng/g ww. N: number of detected/analysed samples.

	BDE47	BDE99	BDE100	BDE153	BDE154	BDE175	BDE196	BDE202	BDE206	BDE207	BDE209	Sum PBDE
N	7/7	7/7	6/7	7/7	7/7	7/7	3/7	3/7	2/7	7/7	1/7	
Mean	0.38	0.91	0.41	0.76	0.10	0.12	0.13	0.07	<LOD	0.20	<LOD	3.71
Median	0.23	0.32	0.13	0.68	0.04	0.05	<LOD	<LOD	<LOD	0.04	<LOD	2.68
Minimum	0.10	0.13	<LOD	0.11	0.02	0.04	<LOD	<LOD	<LOD	0.04	<LOD	0.56
Maximum	1.14	2.79	1.20	2.56	0.39	0.38	0.65	0.37	0.10	0.86	4.0	7.70

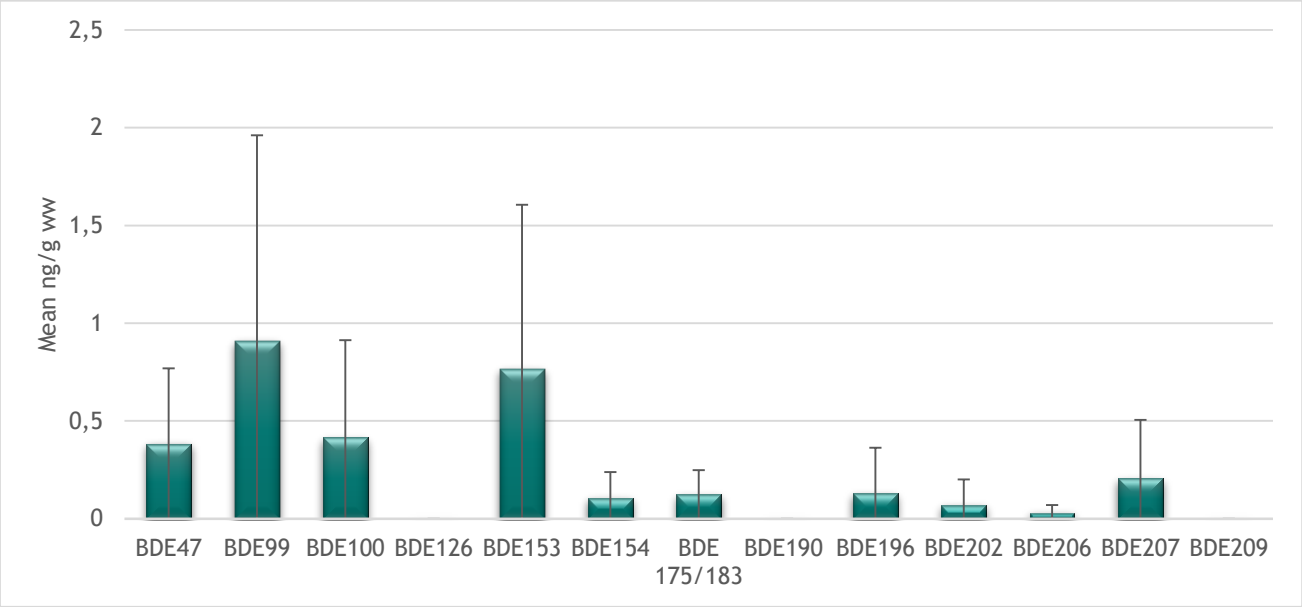


Figure 15: Mean concentrations with standard deviations of different PBDEs in eggs of tawny owl in ng/g ww.

New BFR compounds were not detectable in tawny owl eggs, except for DBDPE in two samples; 3.79 and 3.65 ng/g ww.

3.2.6 Brown rat

PBDEs in nine brown rat livers were more or less comparable with the pattern found in fox liver samples and relatively low levels. SumPBDE concentrations varied between 0.5 and 3.6 ng/g ww which is comparable with the 2016 data with interval from 0.4 ng/g and 4.5 ng/g ww. BDE 209 (detection in five samples) had highest concentrations followed by BDE207, 47 and 99 and 153, indicating a different exposure than that of the other observed species. BDE207 was detected in all eight samples. Median sumPBDE concentration was 2 ng/g ww, slightly higher than last year data with a median of 0.92 ng/g ww.

Table 16: PBDE concentrations in liver of brown rat from Oslo in ng/g. N: number of detected/analysed samples. BDE190, 196 and 202 was not detected in any samples, and not shown in the table below.

	BDE47	BDE99	BDE100	BDE126	BDE153	BDE154	BDE175	BDE206	BDE207	BDE209	Sum PBDE
N	8/9	8/9	4/9	3/9	8/9	1/9	6/9	5/9	9/9	5/9	
Mean	0.18	0.07	0.02	0.01	0.10	<LOD	0.06	0.038	0.23	1.16	1.84
Median	0.19	0.04	<LOD	<LOD	0.10	<LOD	0.04	0.041	0.24	1.07	2.05
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.03	<LOD	0.43
Maximum	0.32	0.17	0.06	0.02	0.17	0.01	0.16	0.067	0.49	2.57	3.55

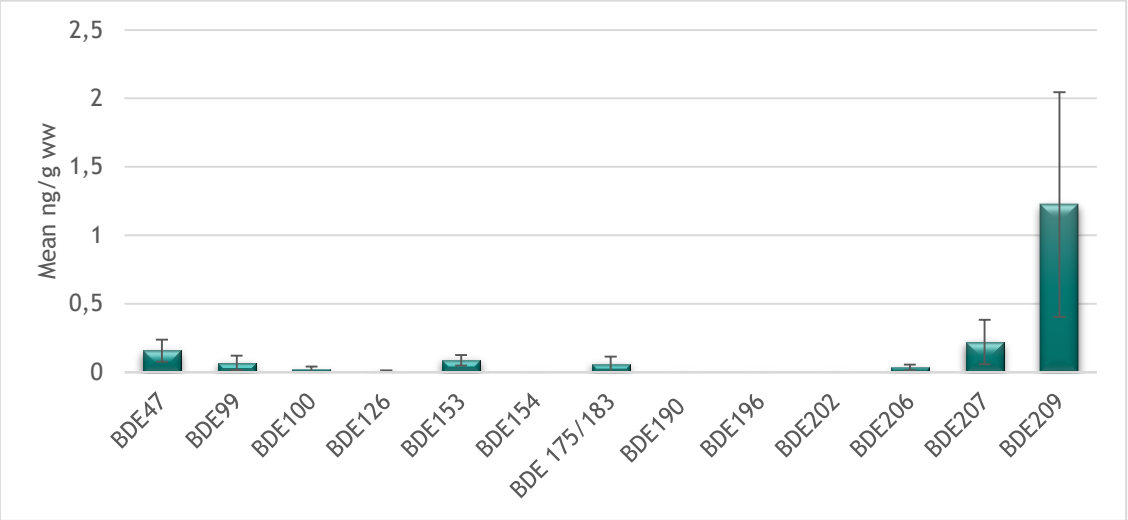


Figure 16: Mean concentrations with standard deviations of different PBDEs in rat livers (ng/g ww).

New BFR: The compounds ATE, α-TBECH and ß-TBECH were found in more than 75 % of the samples, BATE in two of sample, all in relatively low levels. DBDPE was detected in six of the nine rat liver samples and the mean concentration was comparable with the levels found in badger liver samples, but the maximum concentration of 6.5 ng/g ww was lower than in the fox liver samples.

Table 17: New BFR congener values in rat liver in ng/g ww. N: number of detected/analysed samples

	ATE	α-TBECH	ß-TBECH	γ/δ-TBECH	BATE	PBT	PBEB	HBB	DPTE	EHTBB	BTBPE	TBPH	DBDPE	Sum New BFR
N	7/9	8/9	6/9	0/9	2/9	0/9	0/9	0/9	0/9	0/9	0/9	0/9	6/9	
Mean	0.08	0.25	0.08	<LOD	0.01	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	3.99	4.41
Median	0.10	0.16	0.09	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	4.15	4.52
Min	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	1.76	1.94
Max	0.13	1.07	0.11	<LOD	0.02	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	6.55	7.79

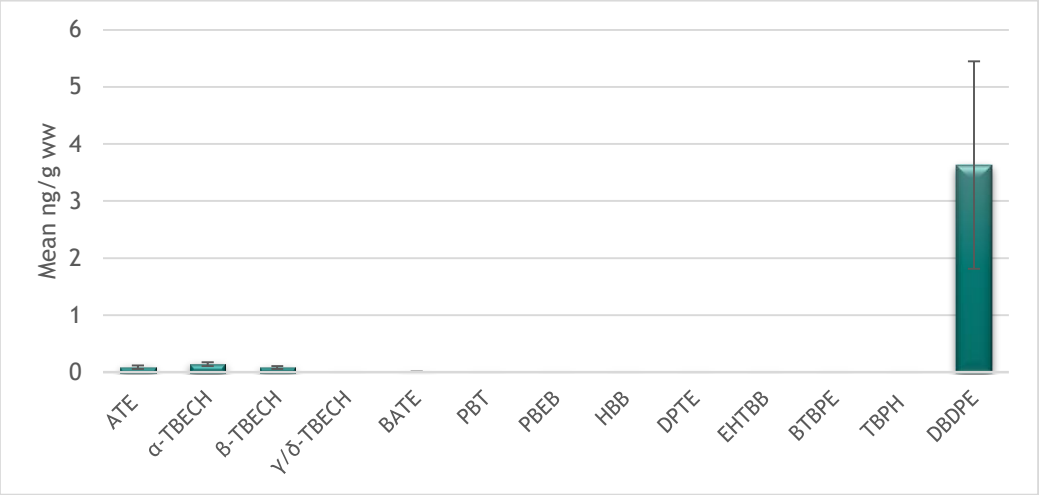


Figure 17: Mean concentration with standard deviation of different new BFR in rat liver samples, in ng/g ww.

3.2.7 Red fox

In red fox, sumPBDE ranged from 0.52 to 9.63 ng/g ww slightly higher than 2016 data with the range 0.31 to 3.5 ng/g ww. The higher chlorinated congeners BDE153, 206, 207 and 209 were detected in at least 7 of 10 samples, and BDE209 was found with highest concentrations (Table 18, Figure 18). BDE99, 126 and 190 had no detectable levels. Levels in this 2017 study were with the median sumPBDE of 1.41 ng/g ww somewhat higher than data reported from 2016 and 2015 with a median of sumPBDE of 0.31 and 0.53 ng/g ww, respectively. Andersen et al. reported PBDEs in Arctic fox liver from Svalbard, Norway, with comparable median PBDE 47 and 153 concentrations of 0.16 and 0.08 ng/g ww respectively (Andersen et al., 2015).

Table 18: Values of individual congeners of PBDE and sumPBDEs in red fox livers in the Oslo area 2017 in ng/g ww. N: number of detected/analysed samples.

	BDE47	BDE99	BDE100	BDE153	BDE154	BDE175	BDE196	BDE202	BDE206	BDE207	BDE209	Sum PBDE	DBDPE
N	3/10	0/10	2/10	8/10	1/10	2/10	1/10	5/10	7/10	8/10	7/10		5/10
Mean	0.04	<LOD	<LOD	0.10	<LOD	<LOD	<LOD	0.03	0.11	0.15	2.02	2.47	6.66
Median	<LOD	<LOD	<LOD	0.04	<LOD	<LOD	<LOD	<LOD	<LOD	0.07	1.12	1.41	2.32
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.52	1.32
Maximum	0.12	<LOD	0.03	0.43	0.02	0.03	0.04	0.10	0.29	0.50	8.67	9.63	23.9

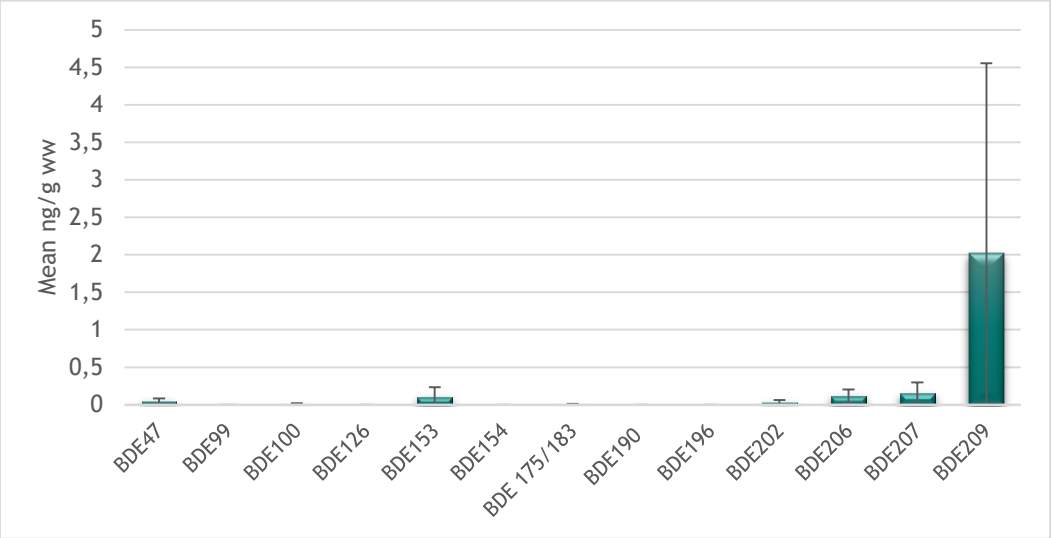


Figure 18: Mean concentrations with standard deviations of different PBDEs in red fox livers in Oslo (ng/g ww).

New BFR compounds were only detected in few of the 10 red fox liver samples. The three isomers α-,β- and γ/δ TBECH were detected in one single sample with 0.93, 0.12 and 0.16 ng/g ww, respectively. HBB was detected in three samples with an average of 0.06 ng/g ww. DBDPE was detected in five samples from 3.3 to 23.9 ng/g ww. Two samples had concentrations of ca. 23 ng/g ww, the three others around 4 ng/g ww. The mean value was 6.65 ng/g ww and the median 2.32 ng/g ww, higher than the mean and median values of BDE209.

3.2.8 Badger

The PBDE concentrations in badger liver were in general low or not detected at all. Only BDE47 and 100 were detected in two of the three liver samples.

Table 19: Values of individual congeners of PBDE and sumPBDEs in badger livers, in ng/g ww. N: number of detected/analysed samples.

	BDE47	BDE99	BDE100	BDE153	BDE154	BDE175	BDE196	BDE202	BDE206	BDE207	BDE209	Sum PBDE	DBDPE
N	2/3	0/3	2/3	0/3	0/3	0/3	0/3	0/3	1/3	1/3	0/3		3/3
Mean	0.08	<LOD	0.02	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.13	15.1
Median	0.07	<LOD	0.02	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.15	5.85
Min	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.05	3.29
Max	0.13	<LOD	0.03	<LOD	<LOD	<LOD	<LOD	<LOD	0.06	0.04	<LOD	0.19	36.2

Of the new BFR compounds, HBB was detected in one sample with a low concentration of 0.08 ng/g ww. DBDPE was detected in all three samples and was the dominating compound of all brominated compounds in badger livers with the following concentrations: 3.29, 5.85 and 36.2 ng/g ww.

3.2.9 Summary PBDEs and new BFR

Similar to PCBs, sparrowhawk eggs had the highest levels of PBDE (mean SumPBDE 25.6 ng/g ww), followed by fieldfare and tawny owl with approximately four times lower concentrations

(5.2 and 3.7 ng/g ww). Rat liver and fox liver showed comparable low concentrations with 1.9 and 2.5 ng/g ww. While PBDE 209 dominated in red fox and brown rat, PBDE 99 followed by PBDE 47 dominated in the other biological samples. As also seen in 2016 data, only in tawny owl, the levels of PBDE 153 was comparable to PBDE 99. Of the new BFR compounds, DBDPe was found in highest frequencies and in highest concentration. The highest concentrations of DBDPE was detected in badger liver with a mean value of 15.1 ng/g ww..

3.3 Per- and polyfluoroalkyl substances (PFASs)

3.3.1 Air

Of the targeted PFAS, only the ionic PFAS; PFBS, PFBA and PFHxA, were detected in the XAD-PAS samplers (Figure 19). The two lower fluorinated four carbon sulfonate (PFBS) and carboxylate (PFBA) were detected at all five stations with low spatial variability across the sites. PFBA was found at highest levels at all sites with average levels of 0.06 ng/day while average levels of PFBS were 0.06 ng/day. PFHxA, with six carbon chain, was only detected at Slottsparken and Fornebu at levels of 0.003 and 0.002 ng/day, respectively. The low detection of PFAS and general low levels of the detected PFAS suggests that the urban area is not an important source for PFAS.

None of the neutral PFAS class or new PFAS were detected in the air samples in this study. Reason for this is not known. In contrast, Ahrens et al. reported passive air data for ionic and neutral (volatile) PFAS in a suburban site in Toronto in 2011 (Ahrens et al., 2013). The most abundant PFAS class for the total air concentration were the neutral FTOHs representing on average ~80% of the ΣPFASs. The presence of ionic PFAS, but none of the volatile PFAS, in the XAD-PAS may possibly be caused by fine dust settling in the sampler, acting as a carrier for these compounds, and/or due to degradation of volatile precursor PFAS.

The data for the PFAS cannot be converted to estimated air concentrations due to lack of uptake rates for this compound class. This hampers the comparison to active air sampling data from Birkenes.

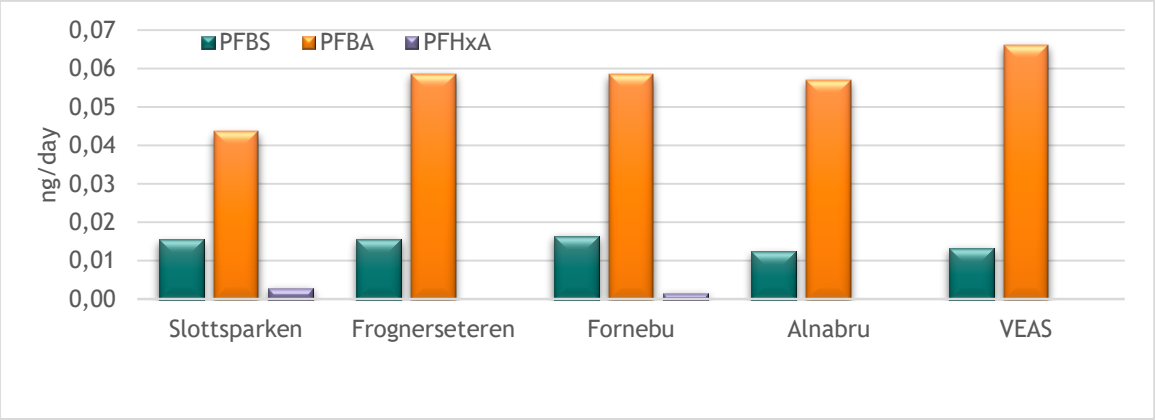


Figure 19: Levels of the three detected PFAS compounds in air (ng/day) at the five Oslo locations.

3.3.2 Soil

The five sampled locations showed both a varying PFAS composition as well as abundancy. In total, Alnabru had the highest sumPFAS concentrations of all sites, see Figure 20. SumPFAS is calculated as the sum of ionic sulfonates (PFSA), ionic carboxylates (PFCA), neutral polyfluorinated compounds (nPFAS) and New PFAS, see Table 1 for definitions. The ionic sulfonates contributed the most to sumPFAS due to the high levels of branched (brPFOS) and linear PFOS (PFOS) at one specific site Alnabru, see maximum concentrations in Table 20. The sum of these isomers was 101 ng/g dw compared to 162 ng/g dw in 2016.

The soil samples from the site Frognerseteren and Fornebu revealed high prevalence of perfluorinated carboxylates (PFCA group). PFOA, PFNA, PFDcA, PFUnA, PFDoA and PFTeA were detected in these samples. PFHpA was only detected at Frognerseteren and PFTrA only at Fornebu. Frognerseteren had the highest PFOA concentration with 3 ng/g dw while Fornebu was characterised by the highest PFUnA concentration with 5.3 ng/g dw, see maximum concentrations in table below. Both direct sources as emissions from use of skiwax in Frognerseteren and from previous use of firefighting foam (AFFF) in the case of Fornebu, as well as indirect sources from degradation of fluorinated precursor compounds used in these applications can be the cause for our findings. Also, atmospheric degradation of fluorinated precursors can lead to PFCAs formation and subsequent precipitation to soil.

Of neutral PFAS (nPFAS), only PFOSA was detected in the sample from Alnabru, and for new PFAS, only 8:2 FTS was detected in the Fornebu sample. Plot of sumPFSA and sumPFCA is shown in Figure 21. The total sum of all per- and polyfluorinated compounds (sumPFAS) was highest at Alnabru with 104 ng/g dw compared to 174 ng/g dw at the same site in 2016. SumPFAS at Fornebu and Frognerseteren were comparable with 8.2 and 7.1 ng/g dw, respectively, and also in agreement with 2016 data for Frognerseteren with 10.3 ng/g dw. According to the Norwegian guidelines on classification of environmental quality of soil (normverdi), concentrations below 100 ng/g dw of PFOS represent the threshold for clean soil, (Lovdata, kap. 2, vedlegg 1)[4]. The sample from Alnabru is at this threshold with 101 ng/g dw of sumPFOS. For comparison, Herzke et al., found up to 54 ng/g PFOS in soil at the local fire station in Tromsø (Herzke et al, 2014b). Also, Xiao et al. found PFOS varying between 0.2 and 28 ng/g dw in surface soil collected in the U.S. metropolitan area of Minneapolis, endangering the quality of the groundwater (Xiao, et al., 2015). The observed levels at Alnabru were comparable with or lower than those detected in soils receiving municipal biosolids (Illinois and Alabama, USA) (Csoil, PFOS < 410 ng/g) (Sepulvado et al., 2011; Washington et al., 2010), or near a PFAS manufacturing facility in China (Csoil, PFOS < 189 ng/g) (Wang et al., 2010). The contamination of soil by PFOS may adversely affect water resources and endanger the health of the surrounding ecosystem and human populations and is recommended to be followed up further.

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

Table 20: Ionic perfluorinated sulfonates (PFSA) and carboxylates (PFCA) in soil in ng/g dw. N: number of detected/analysed samples.

	PFBS	PFPS	PFHxS	PFHpS	brPFOS	PFOS	PFNS	PFDcS	PFUnS	PFDoS	PFTrS	PFTS	SumPFSA
N	0/5	0/5	2/5	1/5	3/5	5/5	0/5	1/5	0/5	0/5	0/5	0/5	
Mean	<LOD	<LOD	0.36	<LOD	5.42	15.73	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	21.6
Median	<LOD	<LOD	<LOD	<LOD	0.05	1.37	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	1.42
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	0.40	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.41
Maximum	<LOD	<LOD	1.74	0.19	26.8	74.4	<LOD	0.11	<LOD	<LOD	<LOD	<LOD	103

	PFBA	PFHxA	PFHpA	PFOA	PFNA	PFDcA	PFUnA	PFDoA	PFTriA	PFTeA	PFHxDA	PFOcDA	SumPFCA
N	0/5	0/5	1/5	5/5	5/5	4/5	5/5	2/5	1/5	2/5	0/5	0/5	
Mean	<LOD	<LOD	<LOD	0.93	0.33	0.23	1.14	0.10	<LOD	0.04	<LOD	<LOD	2.88
Median	<LOD	<LOD	<LOD	0.45	0.21	0.19	0.14	0.10	<LOD	0.04	<LOD	<LOD	1.36
Minimum	<LOD	<LOD	<LOD	0.03	0.10	<LOD	0.04	<LOD	<LOD	<LOD	<LOD	<LOD	0.71
Maximum	<LOD	<LOD	0.87	3.13	0.86	0.48	5.31	0.15	0.33	0.05	<LOD	<LOD	5.91

	PFOSA	8:2 FTS	SumPFAS (PFSA+PFCA+nPFAS+NewPFAS)
N	1/5	1/5	
Mean	<LOD	<LOD	24.5
Median	<LOD	<LOD	7.11
Minimum	<LOD	<LOD	1.12
Maximum	0.21	0.08	104

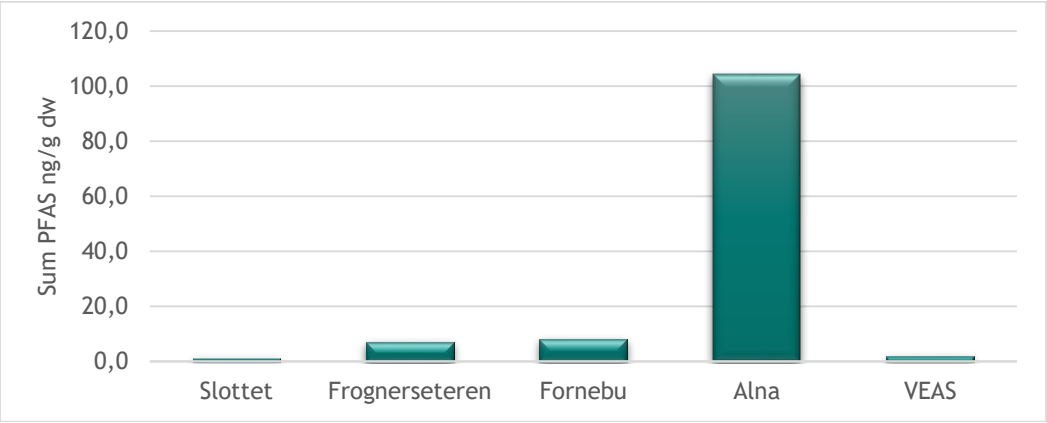


Figure 20: SumPFAS in soil at the different sampling sites in Oslo in ng/g dw

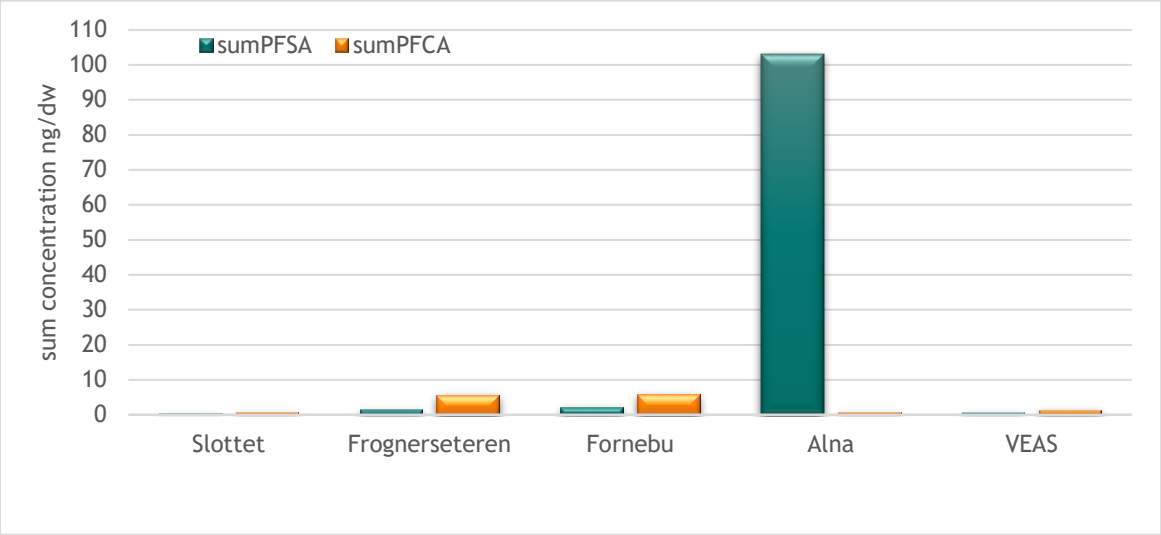


Figure 21: SumPFSA and sumPFCA at the five sampling locations for soil.

3.3.3 Earthworms

As shown in Table 21, PFSA and PFCA were present in all samples. The sumPFAS concentrations (Figure 22) ranged from 10.7 to 572 ng/g ww. The 2016 data ranged from 12.9 ng/g ww to 1164 ng/g ww, and the 2015 data from 5.3 to 157 ng/g ww (without Alnabru). The median sumPFAS for 2017 data was 62.7 ng/g compared to 50.1 ng/g ww in 2016.

PFOS was dominating in all locations, except in worms from Fornebu, where PFUnA was most abundant. As seen in Figure 22, Alnabru and Fornebu show highest SumPFAS concentration (above 500 ng/g ww) in earthworms. The main contribution to the sumPFAS at the Alnabru location are the sulfonates, dominated by PFOS and PFHxS in decreasing order, comparable to the soil samples from the same location. A recent study has revealead a LC50 of PFOS of approximately 540 mg/kg in earthworm (Eisenia fetida), 100-fold higher than our highest PFOS concentration (Yuan et al., 2017). The main contributors to the sumPFAS at Fornebu was PFUnA (261 ng/g ww), PFOS (159 ng/g ww) and PFTriA (107 ng/g ww). For carboxylates, the Alnabru site had lower concentrations than Frognerseteren and Fornebu, 10 ng/g ww, (Figure 23). This result confirmed that skiing areas such as Frognerseteren had higher levels of long chained PFCAs in earthworms than the industrialised station Alnabru, indicating a different source. On the other hand, all five sites show even-numbered PFCAs dominating over the odd-numbered PFCA pattern. In contrast to soil, PFTrA and PFTeA were found in the majority of worm samples, illustrating the bioavailability of these compounds.

When comparing soil and worm PFAS concentrations, the same sites Alnabru, Fornebu and Frognerseteren show highest sumPFAS concentrations, with Fornebu revealing comparable sumPFAS as Alnabru in earthworms, which is not the case for soil. However, it is known that PFAS retention in soil as well as bioavailability is governed by the carbon chain length of the respective PFAS as well as the composition of the soil. Very sandy soil will retain PFAS to a much lesser extent than very humidic soils due to increased water drainage and limited active sites in sand. With increasing carbon chain length, water solubility decreases and surface activity increases, causing a strong soil retention of long chained PFAS and an efficient drainage by water of the short chained PFAS. From uptake experiments, Rich et al. (2015) calculated the bioaccumulation as a biota soil accumulation factor (BSAF), which was normalized for the organic carbon content in the soil. Both BSAFs and BAFs (dry weight based concentrations in earthworm

and soil) increased with increasing chain length for PFCAs and decreased with increasing chain length for the PFSAs (Rich et al., 2015), being in agreement with our findings.

Table 21: Ionic perfluorinated sulfonates (PFSA) and carboxylates (PFCA) in earthworms, ng/g ww. N: number of detected/analysed samples.

	PFBS	PFPS	PFHxS	PFHpS	brPFOS	PFOS	PFNS	PFDcS	PFUnS	PFDoS	PFTrS	PFTS	SumPFSA
N	0/5	0/5	3/5	1/5	3/5	5/5	1/5	1/5	1/5	1/5	0/5	0/5	
Mean	<LOD	<LOD	5.44	<LOD	7.74	140	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	156
Median	<LOD	<LOD	2.33	<LOD	3.19	26.0	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	29.4
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	3.14	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	5.49
Maximum	<LOD	<LOD	21.4	4.2	32.1	499	3.58	1.49	0.40	2.96	<LOD	<LOD	556

	PFBA	PFHxA	PFHpA	PFOA	PFNA	PFDcA	PFUnA	PFDoA	PFTriA	PFTeA	PFHxDA	PFOcDA	SumPFCA
N	0/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	3/5	0/5	
Mean	<LOD	0.94	1.63	2.58	0.98	1.14	53.1	2.87	22.7	3.54	0.97	<LOD	90.5
Median	<LOD	0.71	1.42	1.34	0.35	0.89	1.32	1.42	2.15	1.96	0.33	<LOD	15.5
Minimum	<LOD	0.21	0.54	0.30	0.26	0.22	0.25	0.44	0.51	0.88	<LOD	<LOD	4.83
Maximum	<LOD	1.90	3.63	6.99	2.64	2.35	261	8.57	107.5	8.35	2.56	<LOD	389

None of compounds in the neutral polyfluorinated group were detected and only 6:2 FTS and 8:2 FTS of the new PFAS groups were above LOD and present in all five samples with a mean value of 1.4 and 0.5 ng/g ww, respectively. The maximum value of 5.3 ng/g of 6:2 FTS was found at the Alnabru site, ten times higher than the other sites.

	6:2 FTS	8:2 FTS	Sum NewPFAS	SumPFAS (PFSA+PFCA+nPFAS+NewPFAS)
N	5/5	5/5		
Mean	1.35	0.46	1.82	248
Median	0.32	0.32	1.16	62.7
Minimum	0.28	0.06	0.34	10.7
Maximum	5.34	1.10	5.56	572

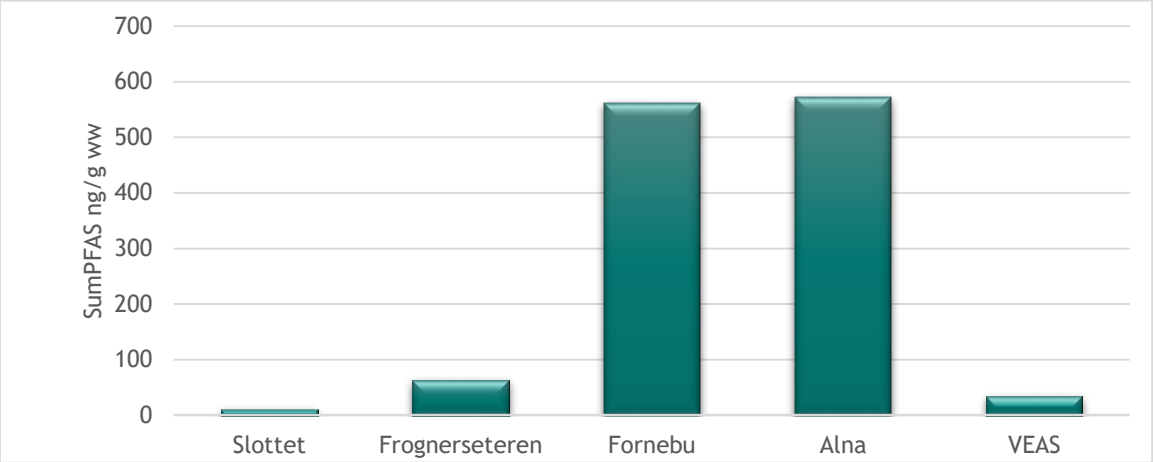


Figure 22: SumPFAS in earthworms at the different sampling sites in ng/g ww.

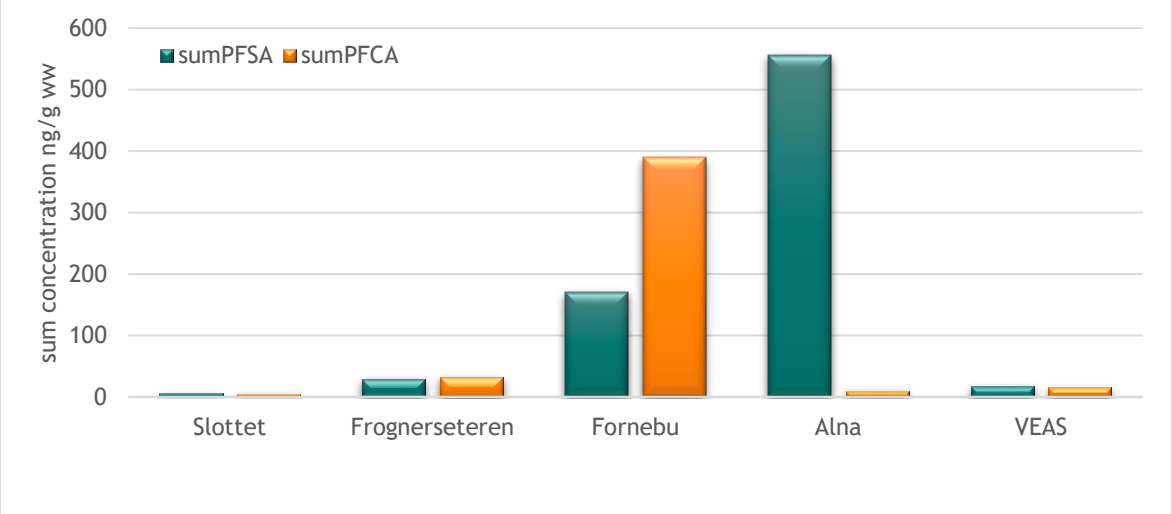


Figure 23: SumPFSA and SumPFCA in earthworms at the five sampling sites.

3.3.4 Fieldfare

PFAS compounds were detected in all fieldfare eggs (Table 22, Figure 25). Linear PFOS (PFOS) dominated in all eggs. The maximum sumPFAS (i.e. sum of PFSA, PFCA, nPFAS and New PFAS) concentration 1015 ng/g ww was detected in fieldfare eggs from Grønmo. This site revealed surprisingly equal amount of the branched (brPFOS) and linear PFOS (PFOS), each of approximately 450 ng/g ww (Figure 26), compared to the technical PFOS mixture, which contains mostly of linear PFOS (70%) when produced with the ECF method (Benskin et al., 2010).High contributions of branched PFOS to the overall PFOS load can be caused by precursor degradation or new manufactures of PFOS, producing a different fingerprint of the branched versus linear PFOS ratio than earlier observed by American production sites (Benskin et al., 2010). The highest PFOS concentration (918 ng/g ww) in fieldfare from present study is lower than a reported toxicity reference value for PFOS of 1900 ng/g ww in bird egg (ECCC, 2017). The site Grønmo was also found to have highest sumPFAS in 2016 with 755 ng/g ww. Grønmo (Figure 24) is a former municipal landfill. It was the main landfill for Oslo from 1969 to 2007. At the site there is currently a collection station for reusable items and a compost facility for garden waste, and further follow up on this site is recommended. Both the collection station and the former

landfill are possible sources to PFAS, and it would be of interest if soil and worms reflect the findings in eggs with equal amounts of branched and linear PFOS, assisting in the elucidation of a possible source. At present the cause of the detected ratio in fieldfare eggs is unclear. But as mentioned above, local sources from direct spills, or degradation from precursors can be the cause. Exposure to different amount of these isomers during migration and/or wintering areas are considered unlikely, as most of the egg contents are formed on the breeding-site.
Kjelsås was the site with lowest PFAS concentrations observed. Only PFDcA was found here with 18.3 ng/g ww. PFOSA was the only compound detected as part of the neutral group. Highest concentration was found at Grønmo with 1 ng/g ww. Of the New PFAS group, 10:2 FTS was detected in nine samples from 0.4 to 4.6 ng/g ww and 8:2 FTS in five samples from <LOD to 3.6 ng/g ww. Maximum value for both compounds were found in fieldfare eggs from Teisen near Alna. 6:2 FTS was only detected in one egg sample from Bøler with 6.9 ng/g ww.

Table 22: Ionic perfluorinated sulfonates (PFSA) and carboxylates (PFCA) in fieldfare, ng/g ww. N: number of detected/analysed samples. Compounds in the nPFAS and NewPFAS group detected in more than one sample is also included, in addition to Sum concentrations.

	PFBS	PFPS	PFHxS	PFHpS	brPFOS	PFOS	PFNS	PFDcS	PFUnS	PFDoS	PFTrS	PFTS	SumPFSA
N	0/10	0/10	8/10	9/10	8/10	9/10	3/10	9/10	0/10	0/10	0/10	0/10	
Mean	<LOD	<LOD	0.35	0.45	48.7	70.7	0.08	3.44	<LOD	<LOD	<LOD	<LOD	124
Median	<LOD	<LOD	0.31	0.19	2.93	25.9	<LOD	0.69	<LOD	<LOD	<LOD	<LOD	31.0
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Maximum	<LOD	<LOD	1.20	2.44	463	455	0.55	24.6	<LOD	<LOD	<LOD	<LOD	947

	PFBA	PFHxA	PFHpA	PFOA	PFNA	PFDcA	PFUnA	PFDoA	PFTriA	PFTeA	PFHxDA	PFOcDA	SumPFCA
N	0/10	1/10	0/10	9/10	9/10	10/10	9/10	9/10	9/10	9/10	4/10	0/10	
Mean	<LOD	<LOD	<LOD	0.78	0.94	4.39	3.11	11.8	5.68	10.5	0.21	<LOD	37.5
Median	<LOD	<LOD	<LOD	0.68	0.86	2.84	3.12	11.0	4.84	10.2	<LOD	<LOD	33.5
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	0.70	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	7.83
Maximum	<LOD	0.51	<LOD	1.55	1.72	18.3	5.46	27.9	15.00	22.00	1.26	<LOD	77.9

	PFOSA	6:2 FTS	8:2 FTS	10:2FTS	Sum (nPFAS+ NewPFAS)	SumPFAS (PFSA+PFCA+nPFAS +NewPFAS)
N	6/10	1/10	6/10	9/9		
Mean	0.16	<LOD	1.04	1.37	3.11	164
Median	0.07	<LOD	0.47	0.80	1.57	72.7
Minimum	<LOD	<LOD	<LOD	0.40	0.18	13.1
Maximum	1.04	6.87	3.59	4.60	8.33	1015

Figure 24: Illustration of nest location relative to a waste recycling site

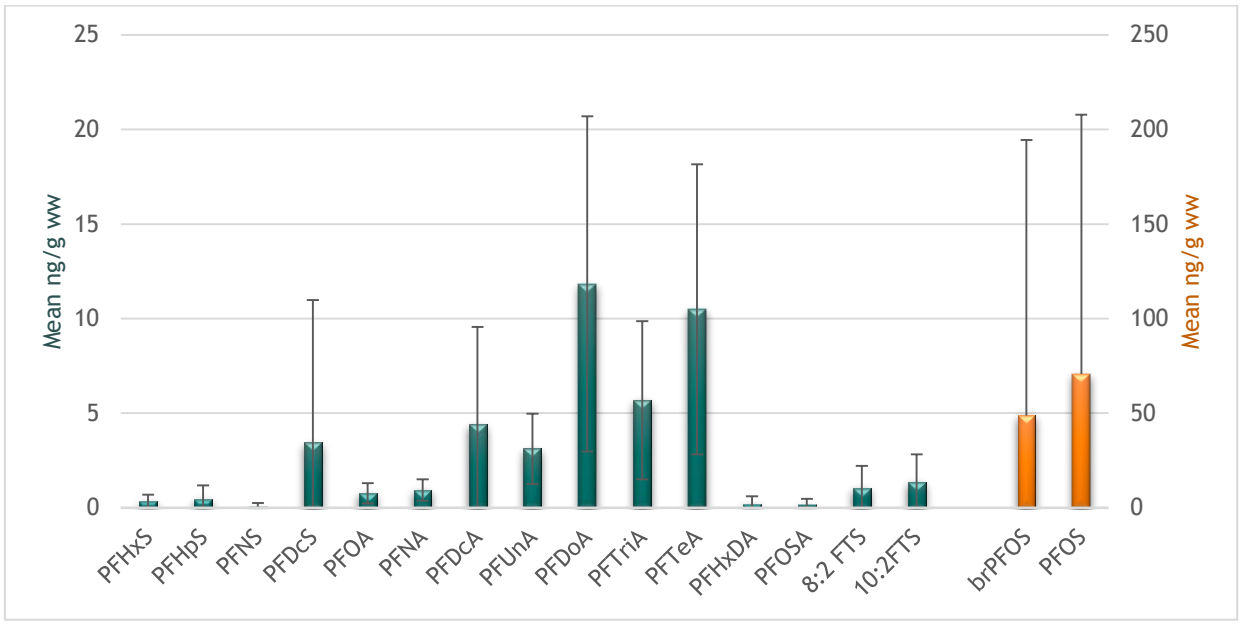


Figure 25: Mean PFAS concentrations with standard deviation in ng/g ww in fieldfare eggs. Only compounds with detection in more than two samples are shown. Combo plot with two y-axis with different scales are used in order to get higher resolution for small values (left y-axis, green coloured bars).

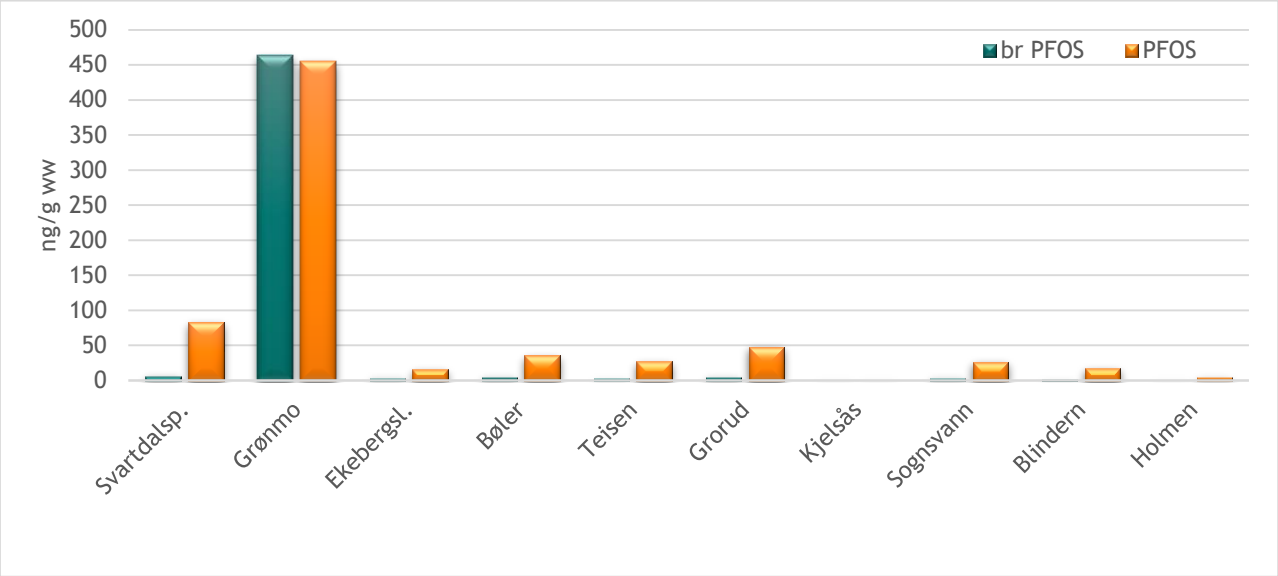


Figure 26: Concentrations of brPFOS (branched) and PFOS (linear) in fieldfare eggs at the various sampling locations.

3.3.5 Sparrowhawk

The highest sumPFAS concentration was 246 ng/g compared to 383 ng/g ww in 2016. (Table 23). SumPFOS was the dominating PFAS ranging from 25.6 to 187 ng/g ww (average 74 ng/g ww) compared to 2016 data with an interval from 11 to 262 ng/g ww (average 108 ng/g ww). Other important PFAS were in decreasing order: PFTrA, PFDoA, PFTeA, PFUnA. Other PFAS were detected in minor concentrations in all eggs; 8:2 FTS, PFDcA, PFNA, PFOA, PFHpS. PFHxS, PFDcS, and PFHpA were found with a high detection rate too. The median concentration of sumPFAS in this study was 102 ng/g ww, compared to 14 ng/g ww reported for the 2015 monitoring data (Herzke et al., 2016). 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 PFASs (Nygård and Polder, 2012). They were collected in the time period 2005-2010 with reported sum concentrations on the average 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 PFAS during the same period.

Table 23: Detected PFAS congener concentrations in sparrowhawk eggs in ng/g ww. N: number of detected/measured samples.

	PFBS	PFPS	PFHxS	PFHpS	brPFOS	PFOS	PFNS	PFDcS	PFUnS	PFDoS	PFTrS	PFTS	SumPFSA
N	0/10	0/10	9/10	9/10	9/10	10/10	4/10	10/10	0/10	0/10	0/10	0/10	
Mean	<LOD	<LOD	0.53	0.68	7.47	66.7	0.07	2.97	<LOD	<LOD	<LOD	<LOD	77.7
Median	<LOD	<LOD	0.47	0.50	6.82	47.5	<LOD	1.01	<LOD	<LOD	<LOD	<LOD	55.1
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	21.9	<LOD	0.29	<LOD	<LOD	<LOD	<LOD	26.4
Maximum	<LOD	<LOD	1.35	1.58	16.8	171	0.23	16.0	<LOD	<LOD	<LOD	<LOD	206

	PFBA	PFHxA	PFHpA	PFOA	PFNA	PFDcA	PFUnA	PFDoA	PFTriA	PFTeA	PFHxDA	PFOcDA	SumPFCA
N	0/10	0/10	0/10	10/10	10/10	10/10	10/10	10/10	10/10	10/10	6/10	0/10	
Mean	<LOD	<LOD	<LOD	1.13	1.74	2.94	4.40	10.67	10.75	12.51	0.44	<LOD	44.6
Median	<LOD	<LOD	<LOD	0.67	1.69	2.88	4.30	8.48	10.44	12.77	0.45	<LOD	42.2
Minimum	<LOD	<LOD	<LOD	0.13	0.57	1.43	2.14	5.23	4.23	5.14	<LOD	<LOD	22.6
Maximum	<LOD	<LOD	0.36	4.87	3.35	5.10	6.50	23.9	18.1	21.5	1.01	<LOD	78.8

	PFOSA	8:2 FTS	10:2FTS	PFECHS	Sum (nPFAS+ NewPFAS)	SumPFAS (PFSA+PFCA+nPFAS +NewPFAS)
N	10/10	6/10	8/10	8/10		
Mean	0.38	0.86	0.85	0.31	2.40	125
Median	0.10	0.48	0.65	0.34	2.15	102
Minimum	0.07	<LOD	<LOD	<LOD	0.83	50.1
Maximum	2.12	3.05	2.70	0.53	5.87	246

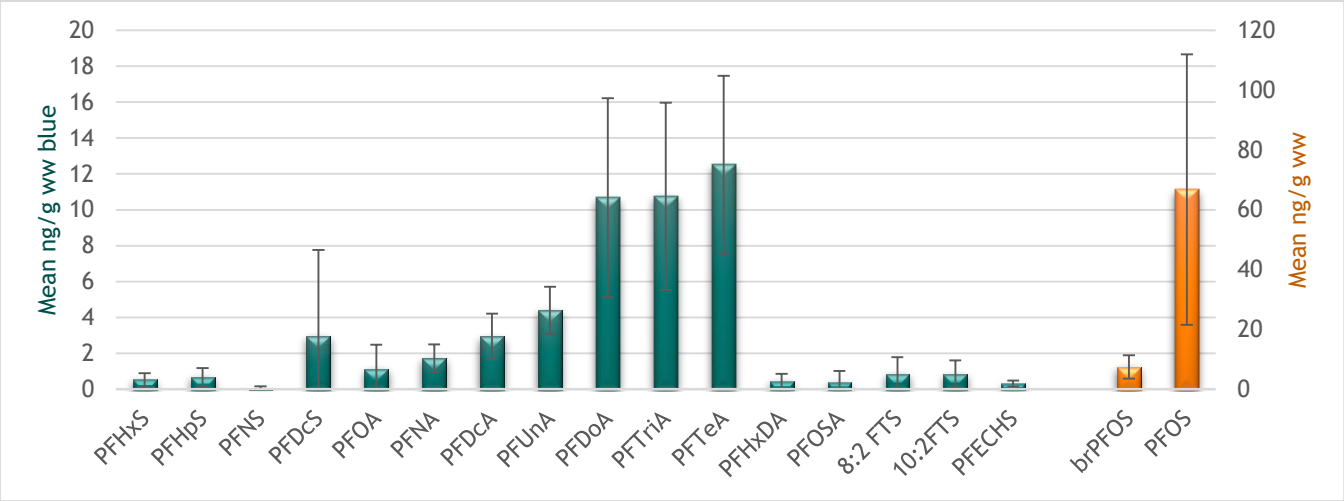


Figure 27: Mean PFAS concentrations with standard deviation in ng/g ww in eggs of sparrowhawk. Only compounds with more than two samples above LOD are shown. Combo plot with two y-axis with different scales are used in order to get higher resolution for small values (left y-axis, green coloured bars).

3.3.6 Tawny owl

SumPFSA and sumPFCA concentrations in tawny owl eggs were lower than in sparrowhawk, approximately half of the mean sumPFSA and sumPFCA values of sparrowhawk eggs. Similar to the findings in sparrowhawk eggs, PFOS dominated in all samples with levels ranging from 8 to 61 ng/g ww compared to 2 and 50 ng/g ww in 2016, (Table 24).

For comparison with a rural location, Bustnes et al. reported a median of 9 ng/g ww in tawny owl eggs collected in Trondheim in Sør-Trøndelag County, Central Norway in 2008 (Bustnes et al., 2013). Besides PFOA, we also detected the PFNA – PFTeA series in all egg samples, with PFDoA, PFTrA and PFUnA dominating the PFCA pattern. In the present 2017 data for tawny owl, one egg from Hugerud had much higher concentration than the other eggs and also compared to last year's data. PFDoA and PFTeA of this egg was 38.1 and 34.8 ng/g ww, respectively; see Table 24 and Figure 28.

Of the neutral PFAS, only PFOSA was detected in one egg from 0.05-0.09 ng/g ww. Only 8:2 FTS in the New PFAS group was detected with 0.8 ng/g ww.

Table 24: PFAS in eggs of tawny owl in the Oslo district in ng/g ww. N: number of detected/measured samples

	PFBS	PFPS	PFHxS	PFHpS	brPFOS	PFOS	PFNS	PFDcS	PFUnS	PFDoS	PFTrS	PFTS	SumPFSA
N	0/7	0/7	6/7	6/7	6/7	7/7	3/7	5/7	0/7	0/7	0/7	0/7	
Mean	<LOD	<LOD	0.18	0.21	5.04	23.4	0.04	0.40	<LOD	<LOD	<LOD	<LOD	29.3
Median	<LOD	<LOD	0.05	0.18	4.28	13.3	<LOD	0.27	<LOD	<LOD	<LOD	<LOD	18.1
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	8.36	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	11.0
Maximum	<LOD	<LOD	0.67	0.60	14.4	61.0	0.10	1.25	<LOD	<LOD	<LOD	<LOD	75.8

	PFBA	PFHxA	PFHpA	PFOA	PFNA	PFDcA	PFUnA	PFDoA	PFTriA	PFTeA	PFHxDA	PFOcDA	SumPFCA
N	0/7	0/7	0/7	5/7	7/7	7/7	7/7	7/7	7/7	7/7	1/7	0/7	
Mean	<LOD	<LOD	<LOD	0.50	1.22	2.48	2.32	7.77	2.83	6.20	<LOD	<LOD	23.3
Median	<LOD	<LOD	<LOD	0.04	0.63	1.38	1.56	2.45	1.94	1.61	<LOD	<LOD	9.78
Minimum	<LOD	<LOD	<LOD	<LOD	0.34	0.59	0.97	0.94	0.46	0.43	<LOD	<LOD	4.28
Maximum	<LOD	<LOD	<LOD	3.19	5.14	10.4	7.94	38.1	10.6	34.8	0.13	<LOD	110

	PFOSA	8:2 FTS	SumPFAS (PFSA+PFCA+nPFAS +NewPFAS)
N	3/7	1/7	
Mean	0.03	<LOD	52.8
Median	<LOD	<LOD	28.0
Minimum	<LOD	<LOD	16.6
Maximum	0.09	0.81	161

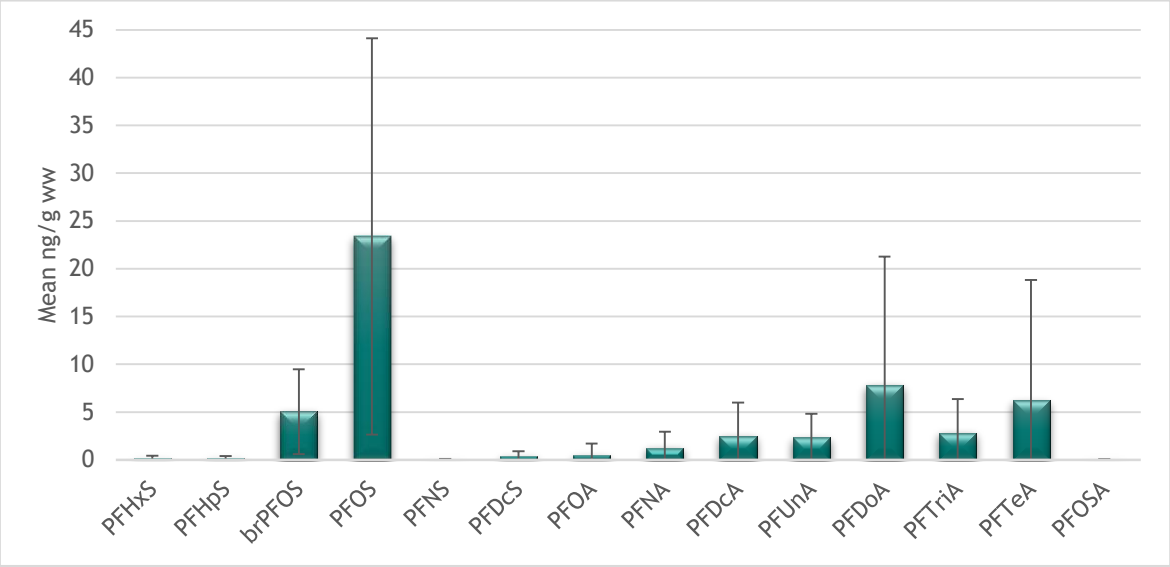


Figure 28: Mean PFAS concentrations with standard deviations in ng/g ww in eggs of tawny owl. Only compounds detected in more than 2 egg samples are shown.

3.3.7 Brown rat

As seen for other pollutants, PFAS in rats varied considerably between individuals (Table 25). SumPFAS ranged between 16 and 168 ng/g ww compared to 2016 data with a range from 12 and 281 ng/ ww, with PFOS being the dominating contributor in all samples. In comparison, in the 2015 monitoring campaign PFAS levels ranging between 3.1 and 72 ng/g ww were detected (Herzke et al., 2016). The highest PFOS concentration measured in this year's monitoring was 116 ng/g ww compared to 188 ng/g in 2016. The routes of exposure is not known at present, but many potential sources are possible within an urban setting by an opportunistic feeder. High PFCA concentrations could be found in a number of rats as well, with a varying pattern, Table 25.

Table 25: PFAS in liver of brown rat, Oslo, in ng/g. N: number of detected/measured samples.

	PFBS	PFPS	PFHxS	PFHpS	brPFOS	PFOS	PFNS	PFDcS	PFUnS	PFDoS	PFTrS	PFTS	SumPFSA
N	0/9	0/9	0/9	6/9	9/9	9/9	1/9	8/9	0/9	0/9	0/9	0/9	
Mean	<LOD	<LOD	<LOD	0.10	7.41	47.0	<LOD	1.06	<LOD	<LOD	<LOD	<LOD	55.6
Median	<LOD	<LOD	<LOD	0.10	6.67	35.9	<LOD	0.65	<LOD	<LOD	<LOD	<LOD	43.3
Minimum	<LOD	<LOD	<LOD	<LOD	2.03	10.0	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	12.2
Maximum	<LOD	<LOD	<LOD	0.19	14.9	116	0.11	3.29	<LOD	<LOD	<LOD	<LOD	132

	PFBA	PFHxA	PFHpA	PFOA	PFNA	PFDcA	PFUnA	PFDoA	PFTriA	PFTeA	PFHxDA	PFOcDA	SumPFCA
N	0/9	0/9	0/9	5/9	9/9	9/9	9/9	9/9	9/9	9/9	0/9	0/9	
Mean	<LOD	<LOD	<LOD	0.11	1.29	5.42	2.77	8.28	4.41	4.39	<LOD	<LOD	26.7
Median	<LOD	<LOD	<LOD	0.07	0.92	3.13	2.23	6.73	4.03	3.56	<LOD	<LOD	21.3
Minimum	<LOD	<LOD	<LOD	<LOD	0.22	1.27	0.44	0.84	0.22	0.32	<LOD	<LOD	3.93
Maximum	<LOD	<LOD	<LOD	0.27	3.11	20.3	7.20	19.9	11.6	12.7	<LOD	<LOD	66.0

	PFOSA	6:2 FTS	8:2FTS	10:2 FTS	Sum(nPFAS+ NewPFAS)	SumPFAS (PFSA+PFCA+nPFAS +NewPFAS)
N	6/9	2/9	1/9	2/9		
Mean	1.08	0.60	<LOD	0.41	3.47	85.7
Median	0.42	<LOD	<LOD	<LOD	0.68	65.6
Minimum	<LOD	<LOD	<LOD	<LOD	0.21	16.3
Maximum	5.51	4.40	12.40	2.10	16.7	168

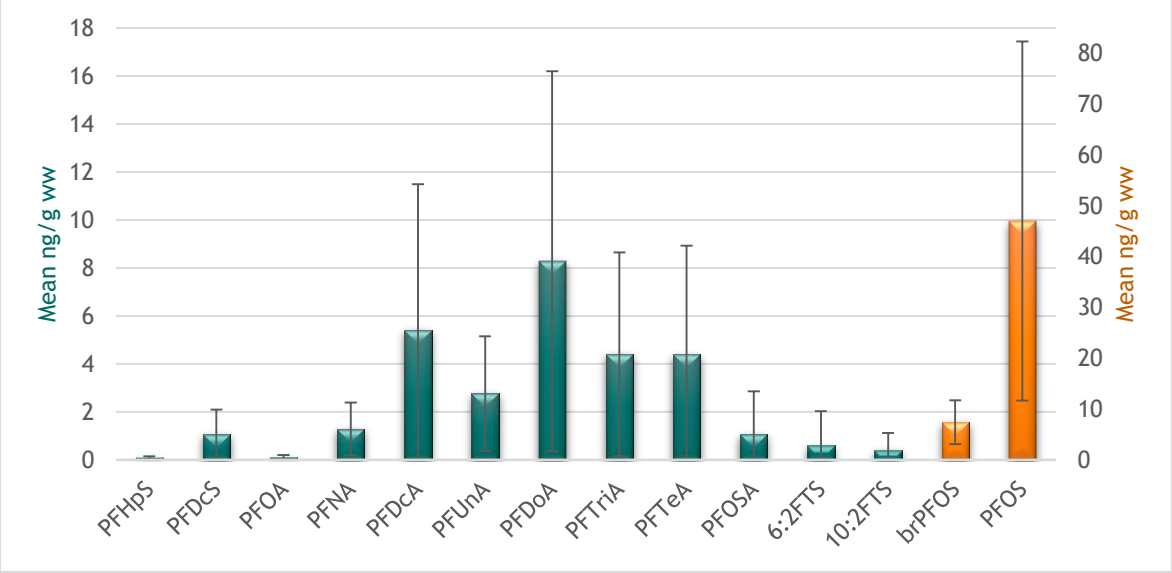


Figure 29: Mean concentrations (ng/g ww) with standard deviations of PFAS in Brown rat livers. Only compounds detected in more than 2 samples are shown. Combo plot with two y-axis with different scales are used to get higher resolution for small values (left y-axis, green coloured bars). PFOS (branched a linear) in orange colour with y-axis to the right.

3.3.8 Red fox

PFAS could be detected in all fox liver samples (Table 26, Figure 30). SumPFAS concentrations were higher than in 2016, ranging from 6.6 to 201 ng/g ww, compared to a range of 4.6 to 37.1

ng/g ww in 2016 (Herzke et al., 2017). Two red fox liver samples had much higher concentrations for many of the compounds than the other samples- PFOS concentration was 88.3 and 144 ng/g ww for these two samples. The sample with PFOS 88.3 ng/g ww, had highest concentration of the new PFAS compounds 8:2 FTS and PFECHS of 8.1 and 5.1 ng/g ww, respectively. PFOS was the dominating PFAS in all samples, followed by PFUnA and PFDcA (Table 26). For comparison, in polar fox liver from Svalbard, PFOS concentrations ranging between 10 and 220 ng/g ww were found, most probably explained by the partly marine diet of polar foxes (Aas et al., 2014).

Table 26: Concentrations of detected PFAS compounds in red fox livers in ng/g ww. N: number of detected/measured samples. For nPFAS and New PFAS, only compounds with more than one detected concentration is shown.

	PFBS	PFPS	PFHxS	PFHpS	brPFOS	PFOS	PFNS	PFDcS	PFUnS	PFDoS	PFTrS	PFTS	SumPFSA
N	1/10	0/10	9/10	7/10	9/10	10/10	0/10	3/7	0/10	0/10	0/10	0/10	
Mean	<LOD	<LOD	0.29	0.15	5.85	37.6	<LOD	0.47	<LOD	<LOD	<LOD	<LOD	44.3
Median	<LOD	<LOD	0.18	0.06	1.92	20.4	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	33.7
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	2.84	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	4.18
Maximum	0.05	<LOD	0.75	0.73	22.2	144	<LOD	1.84	<LOD	<LOD	<LOD	<LOD	166

	PFBA	PFHxA	PFHpA	PFOA	PFNA	PFDcA	PFUnA	PFDoA	PFTriA	PFTeA	PFHxDA	PFOcDA	SumPFCA
N	0/10	1/10	9/10	2/10	10/10	10/10	10/10	10/10	10/10	9/10	10/10	0/10	
Mean	<LOD	<LOD	0.29	<LOD	0.65	1.93	2.77	1.47	1.28	0.99	0.77	<LOD	10.2
Median	<LOD	<LOD	0.29	<LOD	0.41	1.41	1.48	1.42	0.85	0.57	0.30	<LOD	8.41
Minimum	<LOD	<LOD	<LOD	<LOD	0.06	0.83	0.33	0.15	0.10	<LOD	0.05	<LOD	2.27
Maximum	<LOD	0.38	0.72	0.05	1.91	4.76	9.66	4.36	4.22	3.07	2.47	<LOD	28.7

	PFOSA	6:2 FTS	8:2FTS	PFECHS	Sum(nPFAS + NewPFAS)	SumPFAS (PFSA+PFCA+nPFAS +NewPFAS)
N	5/10	1/10	6/10	4/10		
Mean	0.65	0.21	0.99	0.87	2.73	57.3
Median	0.07	0.12	0.04	0.17	0.53	44.0
Minimum	<LOD	<LOD	<LOD	<LOD	0.09	6.56
Maximum	3.3	0.97	8.15	5.16	14.5	201

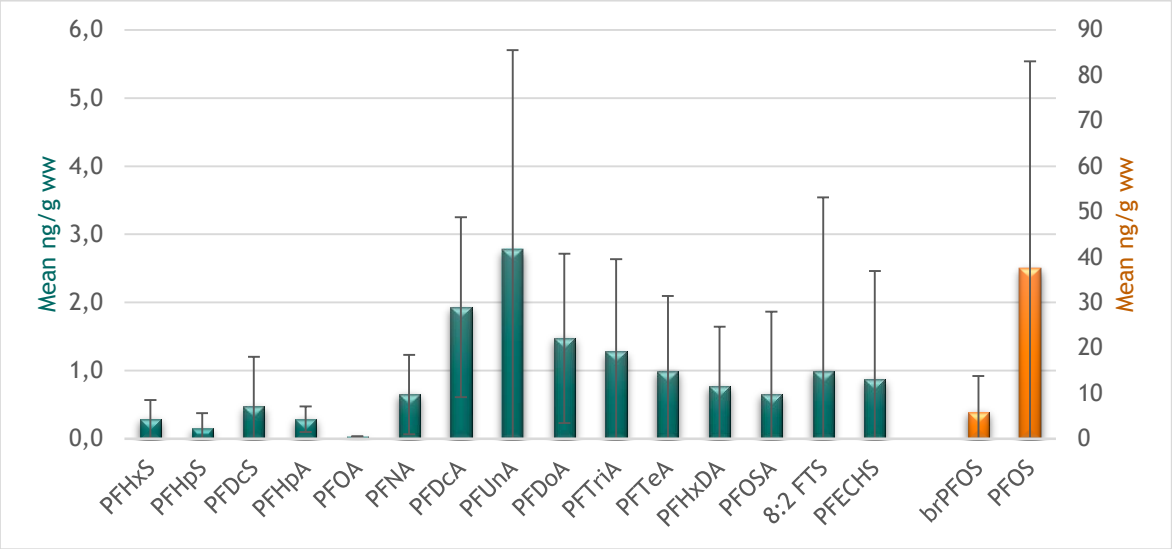


Figure 30: Mean concentrations with standard deviations in ng/g ww of detected PFAS compounds in the analysed fox livers. Only compounds detected in more than 2 samples are shown. Combo plot with two y-axis with different scales are used in order to get higher resolution for small values (left y-axis, green coloured bars).

3.3.9 Badger

PFAS compounds were detected in the three samples of badger livers (Table 27). As with other species, PFOS was the dominating compound with the highest concentrations; higher than rat and red fox. Badgers specialise on earthworms and snails, both species living in close contact with soil and able to accumulate PFAS.

Table 27: Concentrations of detected PFAS compounds in badger livers in ng/g ww. N: number of detected/measured samples. For nPFAS and New PFAS, only compounds with more than one detected concentration is shown.

	PFBS	PFPS	PFHxS	PFHpS	brPFOS	PFOS	PFNS	PFDcS	PFUnS	PFDoS	PFTrS	PFTS	SumPFSA
N	0/10	0/10	3/3	3/3	3/3	3/3	0/10	2/3	1/3	0/3	0/3	0/3	
Mean	<LOD	<LOD	0.76	0.71	7.02	74.0	<LOD	1.60	0.26	<LOD	<LOD	<LOD	84.4
Median	<LOD	<LOD	0.57	0.48	6.78	69.7	<LOD	1.66	<LOD	<LOD	<LOD	<LOD	81.3
Minimum	<LOD	<LOD	0.49	0.37	3.62	37.0	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	41.5
Maximum	<LOD	<LOD	1.22	1.28	10.6	115	<LOD	3.13	0.78	<LOD	<LOD	<LOD	130

	PFBA	PFHxA	PFHpA	PFOA	PFNA	PFDcA	PFUnA	PFDoA	PFTriA	PFTeA	PFHxDA	PFOcDA	SumPFCA
N	0/3	3/3	0/3	3/3	3/3	3/3	3/3	3/3	3/3	3/3	3/3	0/3	
Mean	<LOD	0.26	<LOD	1.91	4.91	6.47	3.89	6.08	5.74	6.87	0.32	<LOD	36.4
Median	<LOD	0.26	<LOD	1.31	4.12	5.84	3.83	6.92	6.02	7.87	0.31	<LOD	36.1
Minimum	<LOD	0.24	<LOD	0.94	3.76	3.58	3.49	3.67	4.78	3.04	0.10	<LOD	24.3
Maximum	<LOD	0.28	<LOD	3.48	6.83	10.0	4.33	7.64	6.41	9.72	0.56	<LOD	48.9

	PFOSA	6:2 FTS	8:2FTS	PFECHS	Sum(nPFAS + NewPFAS)	SumPFAS (PFSA+PFCA+nPFAS+NewPFAS)
N	3/3	2/3	2/3	1/3		
Mean	1.38	0.39	3.29	0.70	5.76	127
Median	1.52	0.39	3.01	<LOD	7.19	125
Minimum	0.55	<LOD	<LOD	<LOD	0.97	66.8
Maximum	2.06	0.59	6.66	2.07	9.12	188

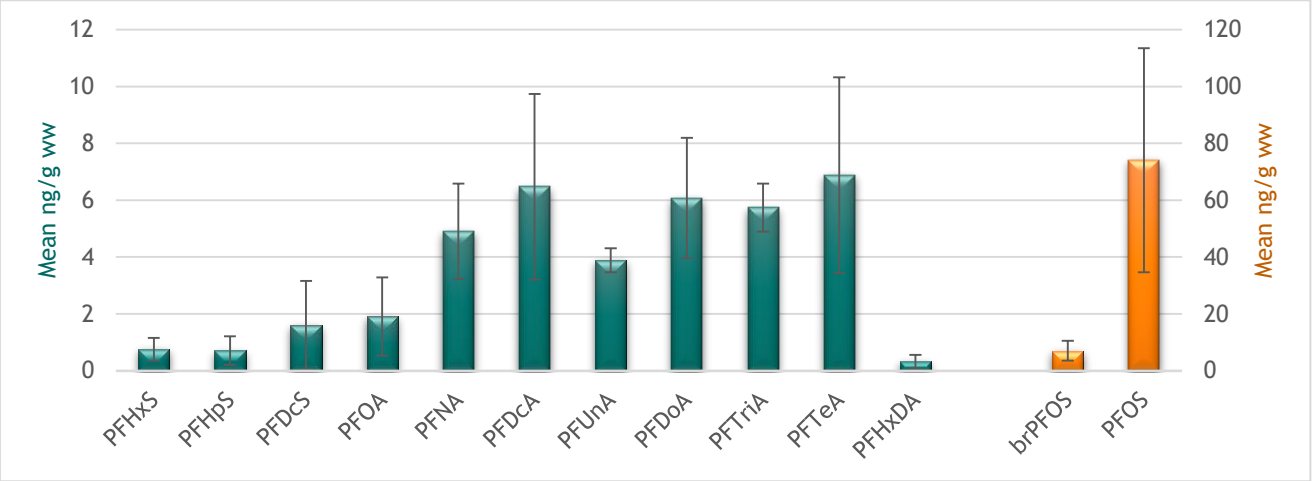


Figure 31: Mean concentrations with standard deviations in ng/g ww of detected PFAS compounds in the analysed badger livers. Only compounds detected in more than 2 samples are shown. Combo plot with two y-axis with different scales is made to get higher resolution for small values (left y-axis, green coloured bars). Branched and linear PFOS (orange coloured bars) follow the right y-axis.

3.3.10 Summary PFAS

The very high PFOS concentrations found in soil and worms at Alnabru raise considerable concern about both the quality of the terrestrial ecosystem at that site, but also for the freshwater- and groundwater system close by. Action must be taken to identify the magnitude of the source. Also skiing areas show elevated levels in soil and earthworms. Earthworm and fieldfare had highest mean sumPFAS concentrations of 248 and 164 ng/g ww, respectively, first and foremost due to the high concentration in earthworm from Alnabru and fieldfare from Grønmo. If excluding these two samples, sparrowhawk and badger had highest mean sumPFAS concentration with 125 and 127 ng/g ww, respectively. The results indicate a moderate biomagnification of PFAS through food-chain and will be further assessed in the chapters below. The higher prevalence of PFCA compounds at Frognerseteren and Fornebu, relative to the other sites for soil and earthworm samples, may be attributed to direct sources as emissions from use of skiwax in Frognerseteren and from previous use of firefighting foam (AFFF) in the case of Fornebu, as well as indirect sources from degradation of fluorinated precursor compounds used in these applications. Also, atmospheric degradation of fluorinated precursors can lead to PFCAs formation and subsequent precipitation to soil. Of newPFAS, 8:2 FTS, 6:2 FTS, 10:2 FTS and PFECHS, in decreasing order, were detected with highest frequencies in the various biota samples, but not in any of the air samples.

3.4 Metals

3.4.1 Soil

Metals have a very high abundancy in soils in general and in urban soils in particular. Zink and chromium were the dominating metals in all soils, except for Frognerseteren, were Pb was highest (Figure 32), and similar to last year's findings (Herzke et al., 2017). The sum concentrations of the subgroup toxic metals (Cd, Pb, Hg, As) ranged from 20793 ng/g dw at Fornebu to approximately 93000 ng/g dw at VEAS and Frognerseteren. The following order of sum toxic metal concentrations was found in decreasing order: Frognerseteren~ VEAS > Slottsparken> Alnabru > Fornebu. 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 (normverdi), 8000 ng/g dw of As, 60 000 ng/g dw of Pb, 1500 ng/g dw of Cd, 1000 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 for clean soil (Lovdata, kap.2, vedlegg 1[5]).

Locations where thresholds were exceeded:

- Pb, all locations except Fornebu exceeded 60 000 ng/g dw
- Cr, all locations except Frognerseteren exceeded 50 000 ng/g dw
- As, Slottsparken and VEAS exceeded the threshold of 8000 ng/g dw
- Ni, all except Frognersteren and Alnabru exceeded the threshold of 60 000 ng/g dw
- Zn, Alnabru exceeded the threshold of 200 000 ng/g
- Cd, Cu and Hg: no locations exceeded the thresholds

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 considerable lower than what was found in Oslo. The authors calculated a bioaccumulation factor (BAF) of 49% for lead and 10% for chromium, indicating potential for lead to enter the terrestrial foodchain. 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, 2008). In soil in parks from Bristol, UK, average concentrations of 22 000 ng/g As, 180 000 ng/g dw of Pb, 500 ng/g dw of Cd, 40 000 ng/g dw of Cu, 250 000 ng/g Zn, 20 000 ng/g dw of Cr and 25 000 ng/g dw of Ni was found (Giusti, 2011). When comparing these Bristol concentrations with our data from Oslo, As and Pb are lower, Cd is higher at Frognerseteren, Alnabru and VEAS, Cu is comparable, Zn is higher at Alnabru, Cr and Ni are higher in all locations except Frognerseteren for Ni. With 450 000 inhabitants Bristol is of comparable size as Oslo, also both coastal cities.

Table 28: Metals soil from Oslo, in ng/g dw. N: number of detected/analysed samples.

	Cr	Ni	Cu	Zn	As	Ag	Cd	Pb	Hg	SumToxicMetals (Cd, Pb, Hg, As)
N	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	
Mean	94535	78546	42770	165977	9591	238	675	61870	146	72282
Median	81329	75567	40320	184111	6106	271	863	67626	150	81295
Minimum	36154	8337	18969	55881	5813	88	135	14816	29	20793
Maximum	149203	143647	65355	300179	17067	327	1113	86001	268	93144

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

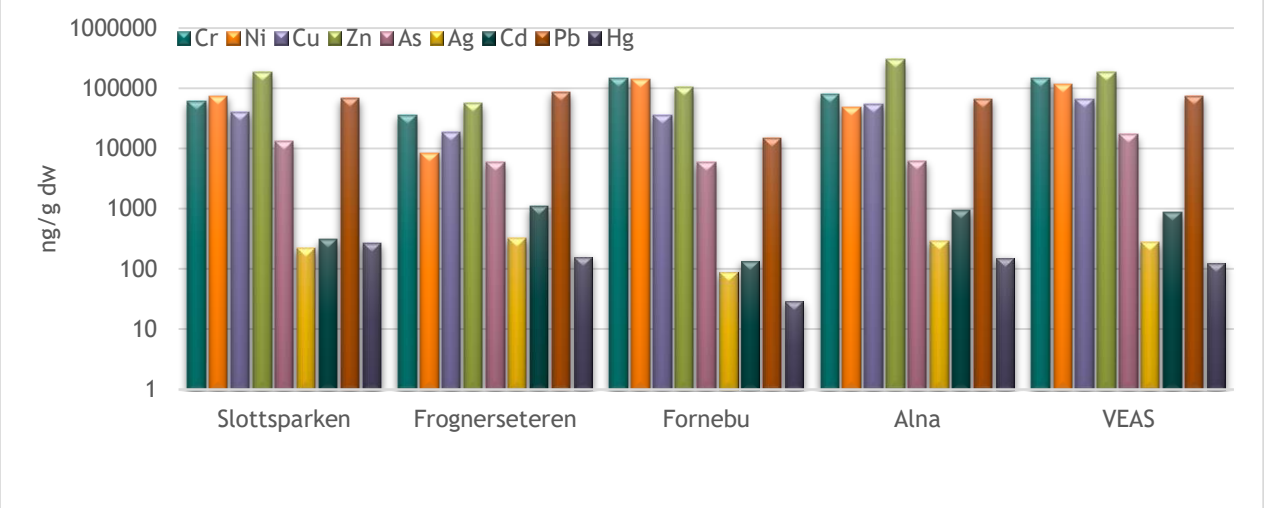


Figure 32: Metal concentrations in soil samples at the different sites in Oslo in ng/g dw, y-axis in log-scale.

3.4.2 Earthworm

Zink was the dominating metal, followed by copper, chromium, lead and cadmium (Table 29). However, as Zn has important physiological functions in all organisms, the concentrations cannot be interpreted as toxic. High levels of lead found in earthworms prove the bioavailability of lead in urban soil. The highest concentration of Pb in soil (86 000 ng/g dw) and earthworm (33 771 ng/g ww) was detected at the same sampling site Frognerseteren. This was also the case for Cd where Frognerseteren was the site with highest soil (1113 ng/g dw) and earthworm (3510 ng/g ww) concentrations. Kumar et al. observed that copper and cadmium were toxic for worms at 1 500 000 ng/g and 100 000 ng/g in soil respectively, concentrations not reached in our study. Cadmium is the most toxic metal to earthworms, followed by copper (Kumar et al. 2008).

Table 29: Metals in pooled earthworms from Oslo, in ng/g ww.

	Cr	Ni	Cu	Zn	As	Ag	Cd	Pb	Hg	SumToxicmetals (Cd, Pb, Hg, As)
N	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	
Mean	2750	1728	2818	197851	1159	43	1531	7401	158	10249
Median	1744	1412	3265	175249	931	33	1317	929	157	3129
Minimum	773	436	1582	95842	535	28	607	467	39	2227
Maximum	8225	4163	3805	385784	2272	80	3510	33771	314	38273

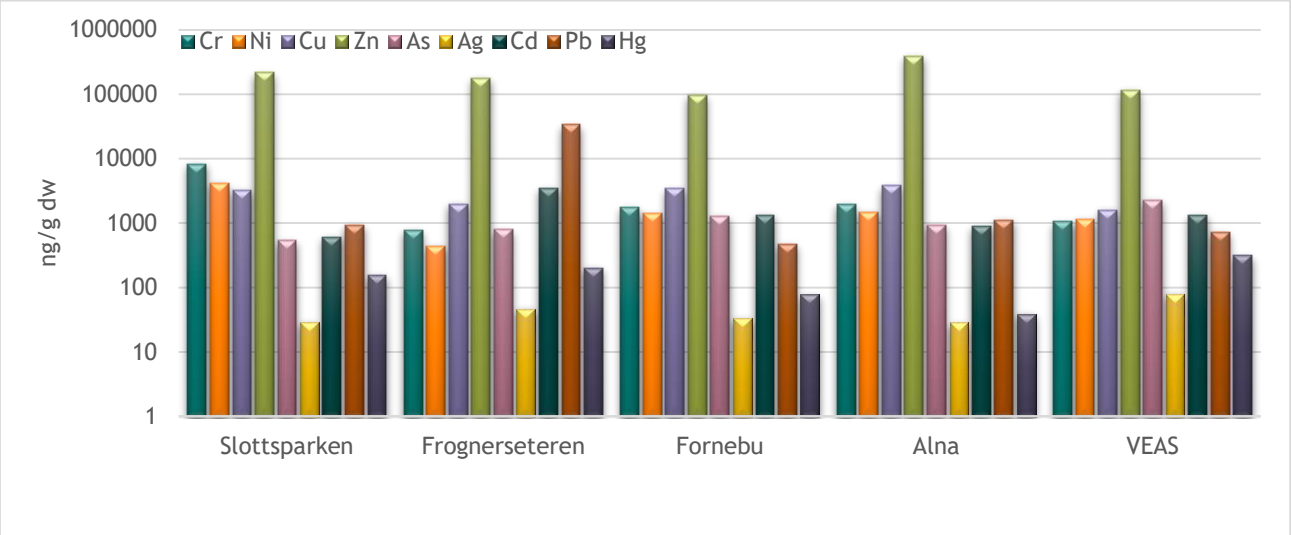


Figure 33: Metal concentrations in earthworms at the different sampling-sites in Oslo in ng/g ww, log-scale on y-axis.

When comparing the different urban locations where earthworm was collected, the highest sum toxic metal concentration was found in Frognerseteren (38 273 ng/g ww) which was 8-10 times higher than the other sites in decreasing order: VEAS (4628 ng/g ww), Fornebu (3129 ng/g ww), Alnabru (2989 ng/g ww), Slottsparken (2227 ng/g ww).

Pb was the major contributor to the toxic metals, and was highest in Frognerseteren and lowest at Fornebu (467 ng/g ww).

Latif et al., 2013 found Pb and Cd concentrations in three different earthworm species varying between 200 – 600 ng/g for lead and 200 and 350 ng/g Cd, which is much lower than found in the samples from 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).

3.4.3 Fieldfare

For the second time, fieldfare eggs from Oslo were available for metal determination (Table 30).

As also shown in the worms, Zn and Cu dominate the metal pattern. However, Zn and Cu are physiologically regulated and supposed to have little toxicological impact (Lukkari et al. 2004). Of the toxic metals investigated, Pb, Hg and As were the most abundant ones (Figure 34). The mean levels of Pb (28 ng/g ww) was lower than 2016 data with 58.5 ng/g ww, Hg and As concentrations were comparable to 2016 data with mean of 8.9 and 2.9 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. Lead levels as low as 0.4 ppm (400 ng/g) in blood can result in adversephysiological

effects, while 4 ppm in feathers is associated with negative effects on behavior, thermoregulation, locomotion, and depth perception resulting in lowered nestling survival (Tsipoura et al, 2008; Tsipoura et al; 2008). One egg from Kjelsås had the maximum Pb concentration of 206 ng/g ww. 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. That egg was collected close to the Kjelsåsmyra artificial turf (kunstgressbane), which also contained highest concentration of sumPCB (60 ng/g ww) and PFDcA (18 ng/g ww) in fieldfare egg.

Table 30: Metals in fieldfare eggs in ng/g ww. N: number *of detected/analysed samples.*

	Cr	Ni	Cu	Zn	As	Ag	Cd	Pb	Hg	SumToxicmetals (Cd, Pb, Hg, As)
N	10/10	10/10	10/10	10/10	10/10	9/10	10/10	10/10	10/10	
Mean	3.85	19.1	429	7144	3.93	0.37	0.20	28.3	9.69	42.1
Median	3.17	20.8	419	7313	3.76	0.36	0.20	10.1	9.34	23.4
Minimum	1.24	7.01	294	3277	1.75	<LOD	0.05	2.01	7.16	13.9
Maximum	6.44	28.5	671	9854	9.82	0.75	0.33	206	12.3	228

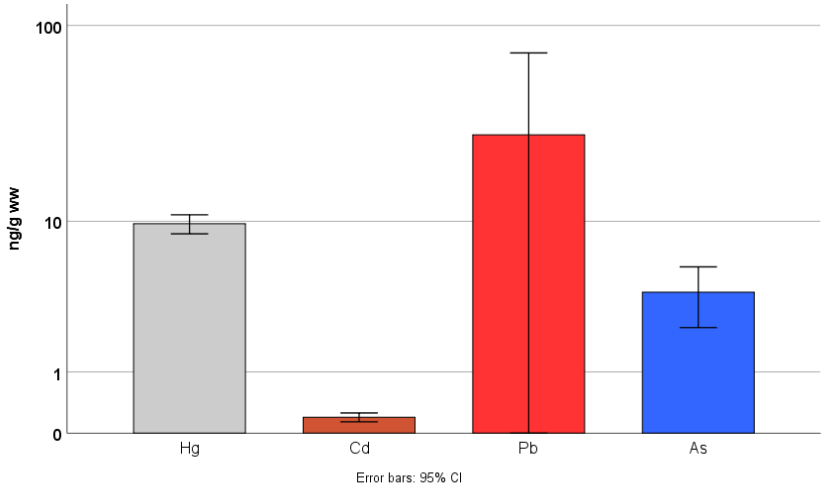


Figure 34: Mean concentrations of toxic metals in fieldfare eggs in ng/g ww.

3.4.4 Sparrowhawk

Zn, Cu and Hg dominated in the sparrowhawk eggs (Table 31). The concentration of Zn found in sparrowhawk eggs were in the range of what was found in Audouins's gull *Larus audouinii* (Morera 1997), and Cory's shearwater *Calonectris diomedea* (Renzoni et al.1986). Cu concentrations found were in agreement with results obtained for *Larus audouinii* (Morera 1997). Since Cu and Zn are physiologically regulated in birds (Richards and Steele 1987), mostly total Hg, Pb, Cd and As can prove toxic at concentrations that can be found in the environment (Depledge et al. 1998). Ag was not detected in any of the analysed egg samples. Cr, Pb, Ni, Cd and As were only found at low concentrations of <81 ng/g ww. Hg was found with an average of

119 ng/g ww in all eggs, more than 10-times higher than in the fieldfare. The levels were comparable and slightly less than 2016 data, however Cr concentrations were much lower in the 2017 samples.

Table 31: The concentrations of the detected metals in the sparrowhawk eggs (ng/g ww). N: number of detected/measured samples.

	Cr	Ni	Cu	Zn	As	Ag	Cd	Pb	Hg	SumToxicmetals (Cd, Pb, Hg, As)
N	10/10	10/10	10/10	10/10	7/10	0/10	8/10	10/10	10/10	
Mean	5.61	43.7	1053	6383	0.74	<LOD	0.09	7.99	119	128
Median	5.63	41.2	637	5612	0.64	<LOD	0.08	7.06	117	124
Minimum	2.12	28.2	249	3244	<LOD	<LOD	<LOD	1.22	59.9	67.0
Maximum	11.0	80.9	2308	13345	1.65	<LOD	0.24	21.2	162	181

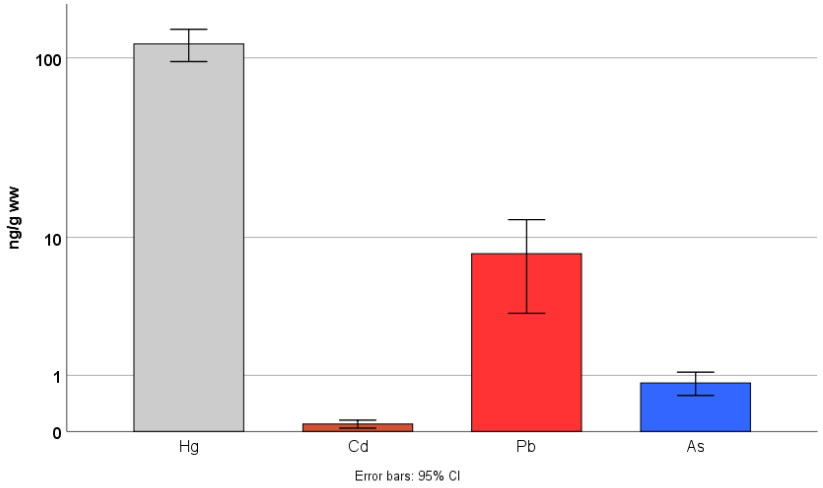


Figure 35: The mean concentration of toxic metals in the sparrowhawk eggs at the different sites in ng/g ww.

Pb and Hg are neurotoxins that cause cognitive and behaviour deficits as well as decreased survival, growth, learning, and metabolism (Carvalho et al., 2008, Khadeim, 2015). 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 21 ng/g ww in the present study for sparrowhawk eggs were more than 20 times lower than this levels. For Hg, levels of 1.5 ng/g egg of *Gallus domesticus* showed induced motor impairments, which correlated to histological damage and alterations in the cerebellar GSH system's development. The MeHg dose (1 µg/egg; 15 ng/g egg) increased the basal activity of the cerebellar antioxidant system in chicks (Carvalho et al., 2008). As shown in 2014, almost all Hg found in sparrowhawk eggs was in the form of MeHg (Herzke et al., 2015). The Hg concentrations found in all sparrowhawk eggs are well above these effect thresholds, indicating a harmful impact of Hg on sparrowhawks. As reported in the 2014 data, MeHg concentrations in a rural reference site showed significantly higher levels, indicating other than urban specific exposure (Herzke et al., 2015). 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 comparable to the maximum concentration of Hg of 162 ng/g ww detected in sparrowhawk eggs in the Oslo area in our study. From the 2016 data set the median Hg concentration was 134 ng/g ww and the maximum was 223 ng/g ww. For Hg, concentrations of 500 ng/g to 2000 ng/g in eggs are sufficient to reduce egg viability, hatchability, embryo survival and chick survival in non-marine birds (Thompson 1996; Mierzykowski, 2005). Embryo deformities may occur in bird eggs containing about 1000 ng/g for Hg, with sensitive embryos experiencing mortality with mercury levels as low as 740 ng/g (Heinz and Hoffman 2003). Mercury sensitivity varies among bird species (Fimreite 1971, Barr 1986) and within clutches (Heinz and Hoffman 2003). 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 Hg effect thresholds of approximately 600- 2700 ng/g ww in bird egg. In the case of the sparrowhawk from the present study, the detected median concentration of 117 ng/g ww as well as the maximum concentration found of 162 ng/g ww are well below these thresholds. The other metals, Cd, Pb and As, were detected in very low levels; median values of 0.1, 7.1 and 0.6 ng/g ww, respectively.

3.4.5 Tawny owl

Cu was, with a median of 1079 ng/g ww (827 ng/g ww in 2016), the second most important metal found after zinc (Table 32). Cr showed also high concentrations with a median of 129 ng/g ww (155 ng/g ww in 2016), with one extreme finding of 1666 ng/g ww which was also the case in 2016 with one extreme concentration of 1474 ng/g ww. All other metals were only present in very low concentrations (median Hg was 12.1 ng/g, for Pb 3.0, Ag 0.3, Cd 0.2, Ni 114 and As 1.1 ng/g ww). Comparable levels were found in 2016, except the Ni concentration that was higher in the 2017 dataset. Elevated Ni and Cr concentrations were found at Kalføss and Gislerud. All eggs were above the reported concentration for induced motor impairments of 1.5 ng/g ww Hg and one egg was above the effect Hg concentration for the increased basal activity of the cerebellar antioxidant system of 15 ng/ww (Carvalho et al., 2008). Otherwise only little data on toxicological thresholds for wild birds exists, even less on terrestrial species.

Table 32: Metal concentrations in tawny owl eggs in ng/g ww; N: number of detected/analysed samples.

	Cr	Ni	Cu	Zn	As	Ag	Cd	Pb	Hg	SumToxicmetals (Cd, Pb, Hg, As)
N	7/7	7/7	7/7	7/7	5/7	7/7	7/7	7/7	7/7	
Mean	446	385	1111	9431	1.91	0.45	0.20	2.39	10.7	15.2
Median	129	114	1079	8924	1.10	0.34	0.18	3.00	12.1	16.7
Minimum	2.96	30.2	444	4447	<LOD	0.06	0.11	0.48	2.97	7.67
Maximum	1666	1115	1780	18112	5.22	0.97	0.39	4.86	15.0	20.5

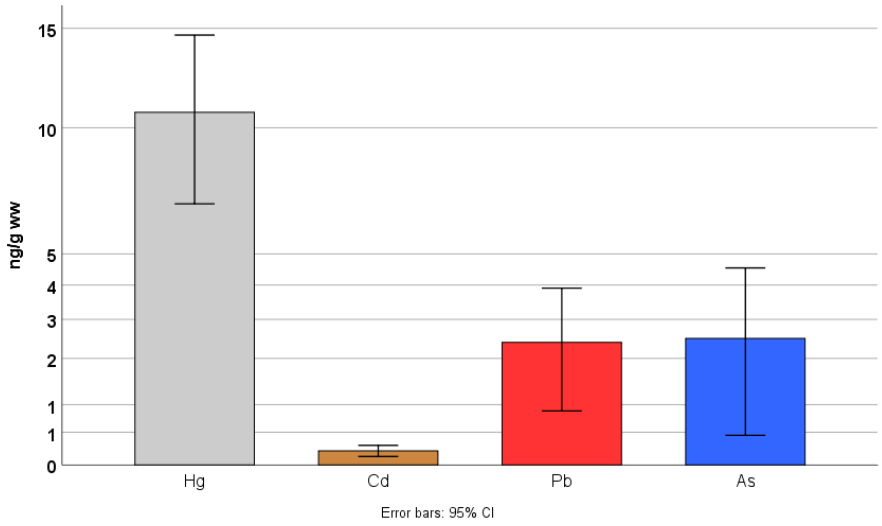


Figure 36: Toxic metal levels in eggs of tawny owl in the Oslo area (ng/g ww).

3.4.6 Brown rat

Metals in rat liver were mostly represented by high levels of Zn (average of 38 826 ng/g ww) followed by Cu and As (average of 5136 and 3927 ng/g respectively), Table 33. As found in 2016, 2017 data also revealed that rats contained, with an average of 3927 ng/g ww, the highest levels of As of all analysed species; with maximum 8261 ng/g ww in one sample and five samples were above 4000 ng/g ww. The samples were pooled from various places in Oslo area, some were from Vålerenga, Kalbakken and Ulven, some a mixture of several samples. The two samples with highest As concentrations also showed the highest Hg concentrations above 30-40 ng/g ww. These samples are among the ones with high Cd concentrations too. Pb played a minor role in rats, with two highest concentrations of 305 and 245 ng/g ww (659 and 913 ng/g ww in 2016).

Table 33: Metal concentrations in brown rat livers from Oslo (ng/g ww). N: number of detected/measured samples.

	Cr	Ni	Cu	Zn	As	Ag	Cd	Pb	Hg	SumToximetals (Cd, Pb, Hg, As)
N	9/9	9/9	9/9	9/9	9/9	9/9	9/9	9/9	9/9	
Mean	960	521	5136	38826	3927	1.85	88	109	18.6	4143
Median	754	400	5069	38153	3956	1.56	111	70.2	14.0	4241
Minimum	338	182	3989	29816	703	0.29	8.51	15.1	1.07	1021
Maximum	2169	1255	6254	47069	8261	5.39	163	305	47.2	8492

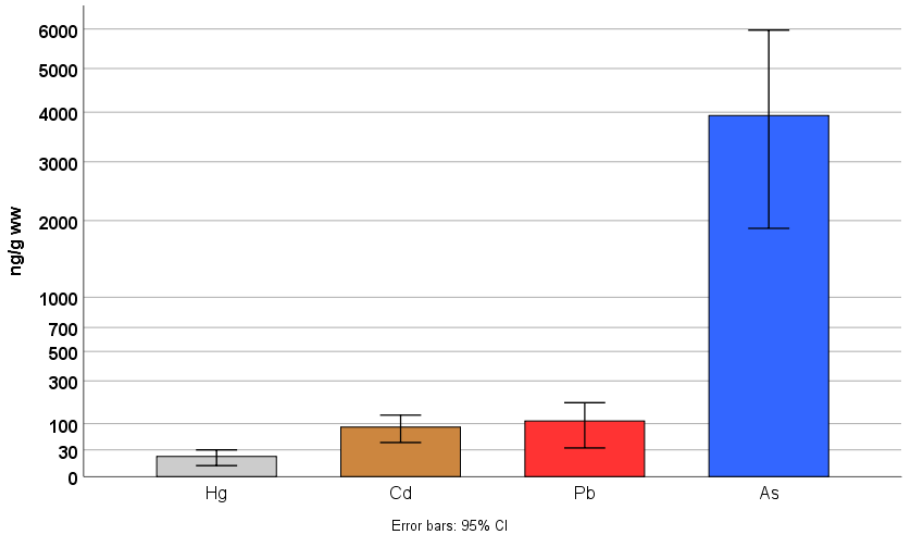


Figure 37: Toxic metals in brown rat livers at different sites in Oslo (ng/g ww).

3.4.7 Red fox

Zn was the dominating metal detected in fox liver, with average concentrations of 53 926 ng/g ww (37 943 ng/g ww in 2016) followed by Cu with 18 873 ng/g ww (10 351 ng/g ww in 2016), Table 34. Of the other elements determined, Hg, Cr, Ni and Cd were found in average concentrations between 131 and 297 ng/g ww. One fox liver as in 2016 (1571 ng/g ww) contained 1107 ng/g for Pb, exceeding the 1000 ng/g threshold for clinical Pb poisoning.

Table 34: Concentrations of metals in livers of red fox from Oslo in ng/g ww. N: number of detected/ measured samples.

	Cr	Ni	Cu	Zn	As	Ag	Cd	Pb	Hg	SumToxicmetals (Cd, Pb, Hg, As)
N	10/10	10/10	10/10	10/10	10/10	10/10	10/10	10/10	10/10	
Mean	297	191	18873	53926	30.8	15.1	273	267	131	703
Median	228	195	15317	54481	11.4	3.64	175	85.7	81.5	444
Minimum	117	78.0	7367	38957	4.11	0.87	43.5	21.4	43.7	174
Maximum	585	368	40176	82807	120	61.5	865	1107	513	2411

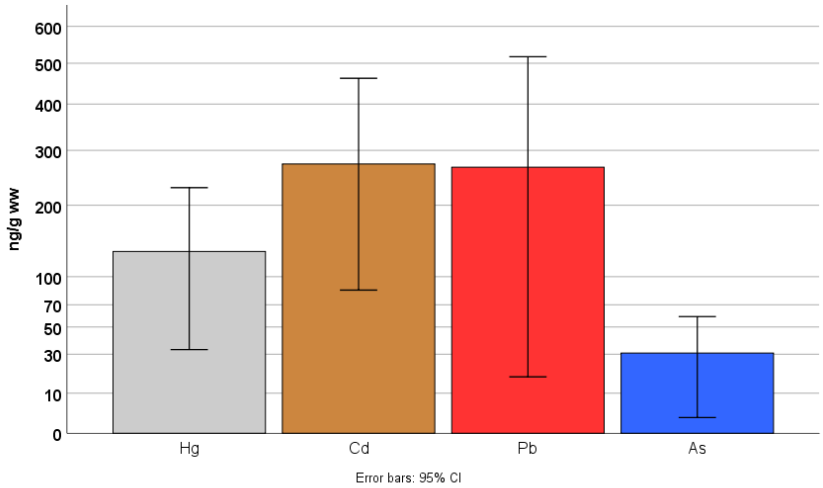


Figure 38: Mean concentrations of toxic metals in red fox liver (ng/g ww).

It is unclear if the high levels found in the one individual in 2016 and in the present study in 2017 is attributed to the previous use of lead ammunition. One possible explanation is that lead ammunition used to kill the animal has contaminated the liver sample, another explanation is that the animal ingested lead ammunition along with prey, prior hurt by lead ammunition.

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 0.52 mg/kg were found (Dip et al., 2001), which is slightly higher than our average of 273 ng/g (0.273 mg/kg). Mean value of Pb in liver in the municipality of Zurich was 1.20 mg/kg which is 4 times higher than our mean value of 0.267 mg/kg.

3.4.8 Badger

All metals could be detected in the three liver samples of badger, Table 35. Very high concentrations of Cd were detected in two of the samples (1628 and 2190 ng/g ww) and for Pb in one sample of 1368 ng/g ww. The sample with highest Cd concentration had also the highest Pb concentration. In a study of metals in badgers from Croatia (Ozimec et al., 2015) the mean Cd concentration was higher in the kidney (3.046 mg/kg) compared to liver (0.395 mg/kg). When comparing the liver concentration with our 2017 data from Oslo, the mean concentration of Cd in the three badger livers is considerable higher with 1.35 mg/kg. The maximum concentration in the Croatian badger livers was 1.628 mg/kg. Further in the Croatian study, the mean Pb concentration which was highest in the liver (0.197 mg kg^{-1}), lower than our 2017 mean value of 0.74 mg/kg and minimum value of 0.36 mg/kg. The maximum value of Pb in badger livers from Croatia was 2.253 mg/kg which was considerable higher than our data.

In another study from the Czech Republic, metals have been analysed in tissues of European badger affected by ovarian tumour (Bukovjan et al., 2014). The concentration of Hg, Pb, Cd and As in liver tissues were 0.49, 2.98, 1.09 and 0.07 mg/kg ww. Pb and As were highest in liver, while Cd and Hg were highest in kidney tissues. The Cd in kidney tissues was 2.06 mg/kg ww. Our three liver samples from the Oslo area reveal comparable concentrations, especially for Cd concentrations with mean and median values of 1.3 and 1.6 mg/kg ww, respectively.

Table 35: Concentrations of metals in livers of badger from Oslo in ng/g ww. N: number of detected/ measured samples.

	Cr	Ni	Cu	Zn	As	Ag	Cd	Pb	Hg	SumToxicmetals (Cd, Pb, Hg, As)
N	3/3	3/3	3/3	3/3	3/3	3/3	3/3	3/3	3/3	
Mean	95.8	142	21909	48647	28.0	27.8	1346	740	48.7	2163
Median	104	152	12705	38914	22.3	14.7	1628	489	51.2	2190
Minimum	73.1	121	8684	34744	20.4	13.8	221	363	22.2	626
Maximum	111	152	44337	72282	41.3	54.8	2190	1368	72.8	3672

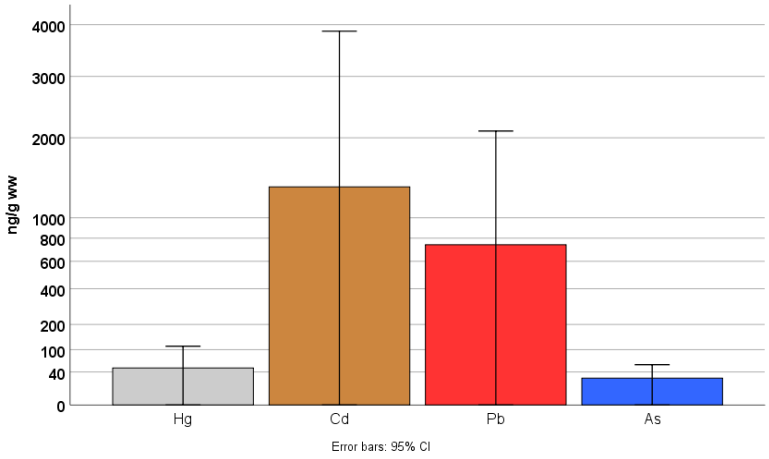


Figure 39: Mean concentrations of toxic metals in badger liver (ng/g ww).

3.4.9 Summary metals

The heavy metal (Hg, Pb, Cd, As) concentrations were highest in soil. Of the biological matrices analysed, earthworms, brown rats, badger and foxes contained the highest amounts. The levels in earthworms are most certainly caused by the feeding technique of the worms, eating their way through the soil. Fieldfare egg from one sampling site (Kjelsås) showed very high Pb concentration of 206 ng/g ww (fieldfare egg from same site had 494 ng/g ww in 2016), more than 20 times higher than at the other sites. There are reasons for concern of the high levels of Hg in sparrowhawk eggs, high levels of Pb in fox liver and both high levels of Pb and Cd in badger livers.

3.5 Chlorinated paraffin's (CPs)

3.5.1 Air

CPs were detected in the PUF-PAS at all five air sampling stations. The SCCPs were three to thirteen times higher than MCCPs at all five locations. The levels of SCCPs ranged from 1.2 to 7.1 ng/day with highest levels at Slottsparken, six times higher than the concentration detected at Frognerseteren (Figure 40). The levels of MCCPs ranged from 0.3-0.9 ng/day with the highest levels at VEAS and Fornebu (Figure 40). The high levels of SCCPs at Slottsparken may indicate a source in this area.

The estimated air concentrations, using an uptake rate of 4 m3/day according to Li et al. (2012), were 0.3-1.8 ng/m3 for SCCPs and 0.08-0.23 ng/m3 for MCCPs. The highest concentrations of SCCPs in this study (i.e. Slottsparken, VEAS and Fornebu) are two to five times higher than those measured at Zeppelin (Nizzetto et al., 2017). In contrast, the estimated concentrations of MCCPs are very similar to those at Zeppelin.

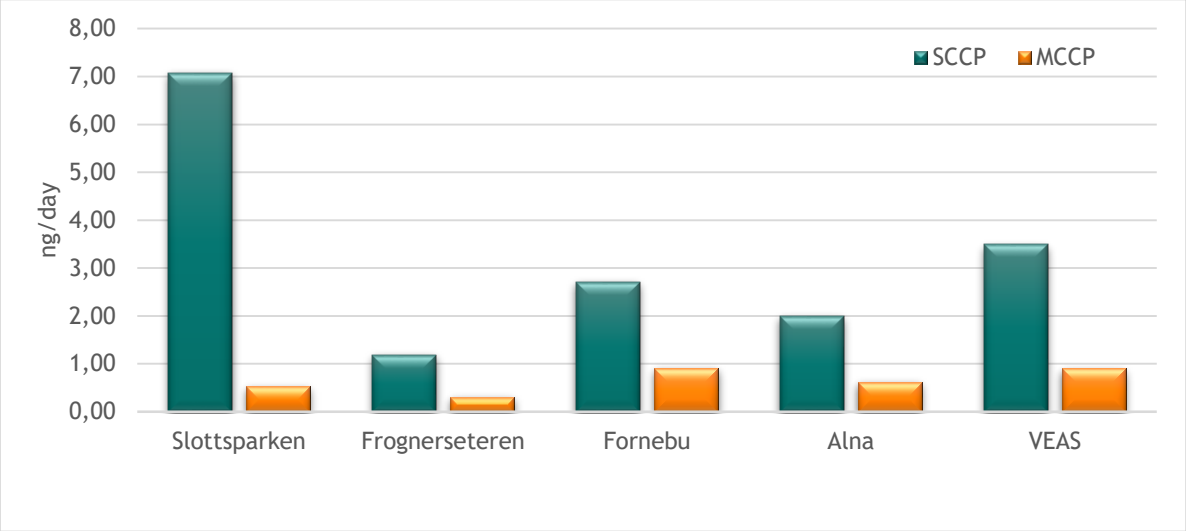


Figure 40: Levels of chlorinated paraffins in air (ng/day) at the sampling sites in Oslo.

3.5.2 Soil

SCCPs and MCCP were also detected in all soil samples, Table 36. SCCP concentrations ranged from 308 to 763 ng/dw compared to 69 and 237 ng/g dw in 2016. MCCP varied between 57 to 282 ng/g dw, higher than 2016 in the range of <LOD to 3.6 ng/g dw. The highest SCCP and MCCP concentrations were found in soil from Slottsparken, similar to highest air concentrations.

For comparison, Wang et al found average SCCP and MCCP concentrations of 18.3 and 59.3 ng/g for soil samples in the Pearl River Delta in South China, (Wang et al., 2013). This is much lower than 10 the average SCCP and MCCP levels detected in our study. However, the same authors also point out the large spatial variation found for CP in soils. Additionally, Wang et al., 2014 reported higher SCCP concentrations in soil from Shanghai, China, compared to MCCPs (median of 15.7 ng/g SCCPs and 7.98 ng/g MCCP). Our data for MCCPs are also higher than levels reported in humus (7–199 ng /g , mean 40 ng /g) in the Alps from five countries (Austria, Germany, Italy, Slovenia, and Switzerland) (Iozza et al., 2009).

Table 36: Chlorinated paraffins found in soil samples in Oslo (ng/g dw). N: number of detected/analysed samples.

	SCCP	MCCP	SumCP
N	5/5	5/5	
Mean	400	183	583
Median	330	193	474
Minimum	249	57	408
Maximum	763	282	1045

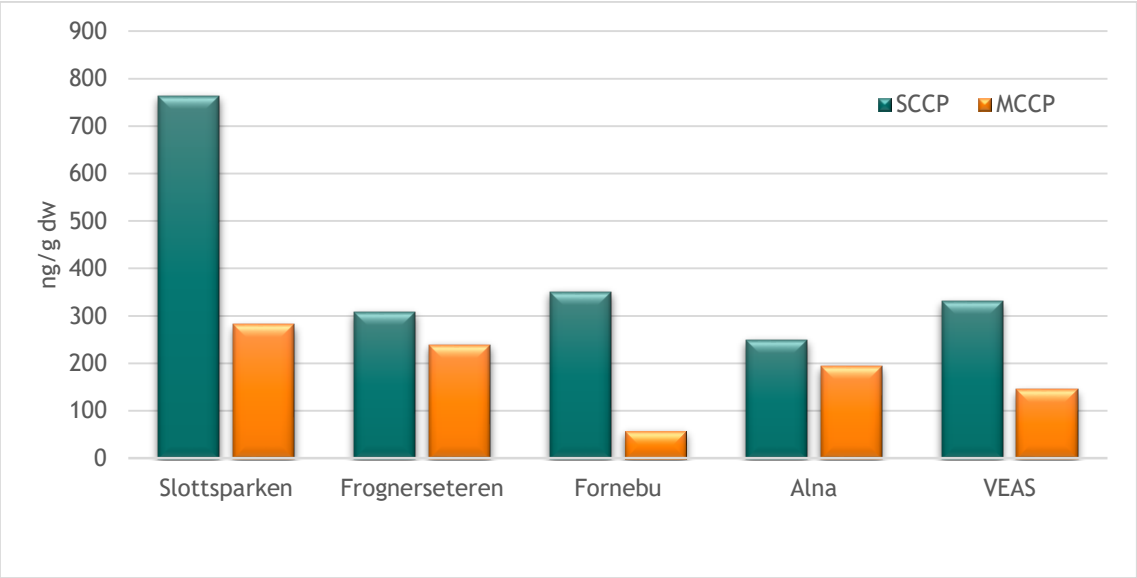


Figure 41: Concentrations of chlorinated paraffins in soil at the different sampling sites in Oslo (ng/g dw).

3.5.3 Earthworms

SCCPs and MCCPs were detected in all earthworms from Oslo, Table 37, Figure 42. Concentrations varied for SCCP between 64 and 187 ng/g ww compared to 2016 data between 28 and 33 ng/g ww. MCCP varied between 25 and 46 ng/g ww compared to 1.2 -12.6 ng/g ww in 2016.Concentrations in worms from Slottsparken did not reflect the elevated SCCP levels found in air and soil, indicating a low biomagnification potential in earthworms. Fornebu showed the highest concentrations of chlorinated paraffins with 233 ng/g ww for sumCPs.

Table 37: Chlorinated paraffins found in earthworms in Oslo (ng/g ww). N: number of detected/analysed samples.

	SCCP	MCCP	SumCP
N	5/5	5/5	
Mean	98	37	135
Median	76	39	116
Minimum	64	25	94
Maximum	187	46	233

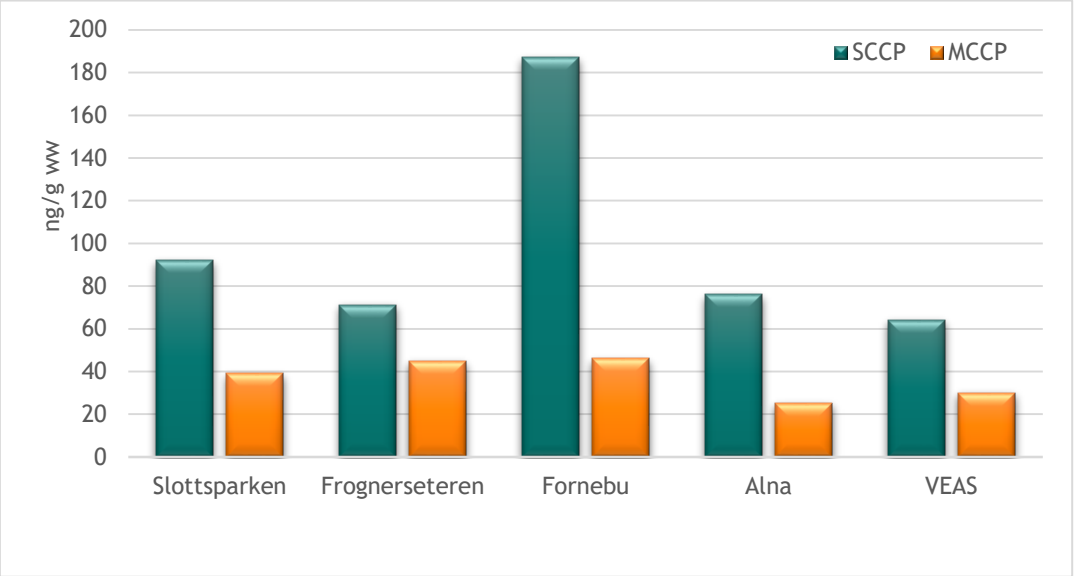


Figure 42: Chlorinated paraffins in earthworms at the different sampling-sites in Oslo (ng/g ww).

Nicholls et al. (2001) investigated the presence of SCCPs and MCCPs in farm soils in the UK and found that they were below detection limits (< 100 ng/g ww); however, CPs were present in earthworms living in the associated soils (<100–1700 ng/g ww), the levels were higher than what was found in Oslo. Thomson (2001) investigated the effects of MCCPs 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 CPs in soil in Oslo likely poses no significant ecological risk for soil organisms in the area.

3.5.4 Fieldfare

SCCPs and MCCPs were found in all fieldfare eggs, only one sample below LOD for SCCP, Table 38. The concentrations were higher than in 2016. One extreme high concentration of SCCP was found in bird egg from Bøler with 1280 ng/g ww. The same egg had also the highest MCCP concentration of 135 ng/g ww. The SCCP concentration from Bøler was 85 times higher than the average based on the other samples and MCCP concentration was 16 times higher. Little information is available on CPs in bird eggs. In an earlier report by NILU on CPs in seabird eggs, similar concentrations to those reported in the 2016 study were found (Huber et al.,2015)

Table 38: Chlorinated paraffins found in eggs of fieldfare in Oslo (ng/g ww). N: number of detected/analysed samples.

	SCCP	MCCP	SumCP
N	9/10	10/10	
Mean	142	21.0	163
Median	15.0	7.35	25.5
Minimum	3.60	4.70	8.70
Maximum	1280	135	1415

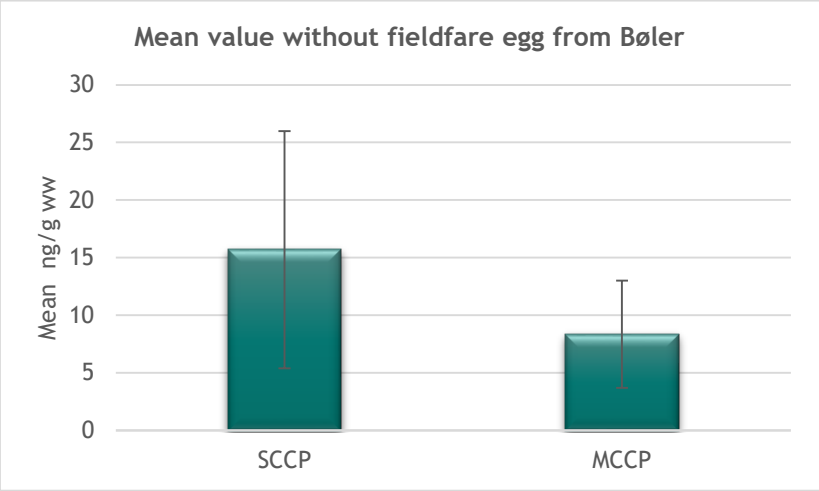


Figure 43: Mean concentrations with standard deviations of chlorinated paraffins in field fare eggs without the extreme sample from Bøler.

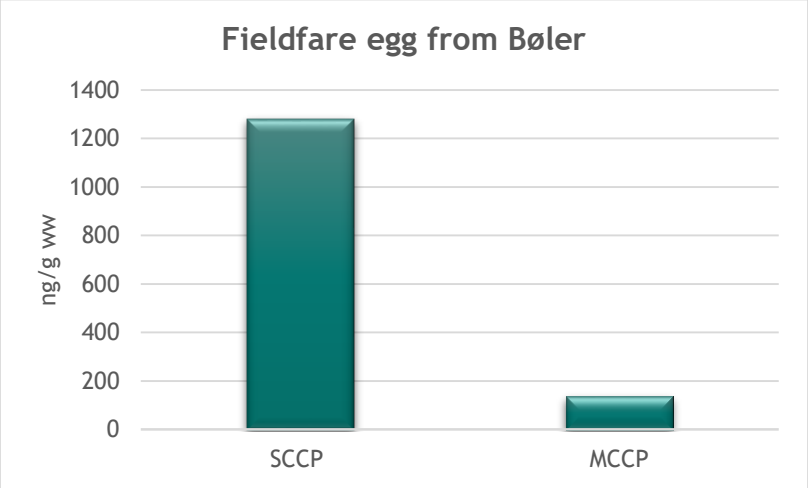


Figure 44: The extreme concentration of SCCP and MCCP (ng/g ww) in fieldfare egg from Bøler.

3.5.5 Sparrowhawk

SCCPs and MCCPs were only found in 3 and 4 eggs for SCCP and MMCP, respectively, Table 39, Figure 45. This year's data ranged from <LOD to 38 ng/g ww for SCCP compared 2016 data from <LOD and 318 ng/g ww. MCCP ranged from <LOD to 74 ng/g ww compared to <LOD and 0.5 ng/g ww in 2016. Interestingly, MCCP have higher maximum value than SCCP.

S/MCCP data for herring gull eggs from Oslo reported by the Norwegian Environment Agency in 2014, were in the same order of magnitude (Norwegian Environment Agency, 2015). A recent study on muscle samples from peregrine falcons in southern-middle of Sweden reported 580 ng/g lipid weight and 410 ng/g lipid weight for SCCP and MCCP, respectively (Yuan and de Wit, 2018). Our 2017 data revealed an average of 141 and 227 ng/g lipid weight on SCCP and MCCP, respectively, slightly lower than the Swedish data.

Table 39: Chlorinated paraffins in sparrowhawk eggs (ng/g ww). N: number of detected/analysed samples.

	SCCP	MCCP	SumCP
N	3/10	4/10	
Mean	10.7	12.2	23.0
Median	<LOD	<LOD	6.90
Minimum	<LOD	<LOD	<LOD
Maximum	38.0	74.0	104

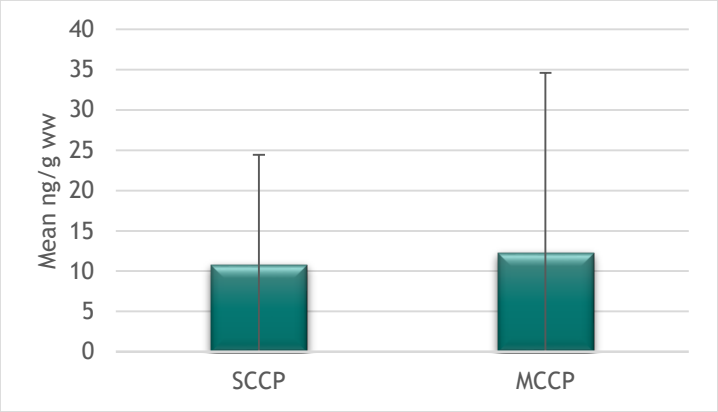


Figure 45: Mean concentrations with standard deviations of chlorinated paraffins in sparrowhawk.

3.5.6 Tawny owl

SCCP was only found in one tawny owl egg with 24 ng/g ww, Table 40.

Table 40: Chlorinated paraffins in tawny owl eggs (ng/g ww). N: number of detected/analysed samples.

	SCCP	MCCP
N	1/7	0/7
Mean	<LOD	<LOD
Median	<LOD	<LOD
Minimum	<LOD	<LOD
Maximum	24.0	<LOD

3.5.7 Brown Rats

S- and MCCPs were found in all of the eight analysed rat liver samples and ranged from 59 to 143 ng/g ww for SCCP and 81 to 327 ng/g ww for MCCP, Table 41, Figure 46. In the 2016 data SCCP were only detected in 4/10 samples with maximum concentration of 160 ng/g ww. MCCP was detected in 9/10 samples in 2016 with maximum concentration of 70 ng/g ww. As with sparrowhawk, MCCP has the highest maximum concentration, but in addition also higher mean and median values than SCCP, indicating direct exposure to MCCPs.

Table 41: Chlorinated paraffins in rat livers (ng/g ww). N: number of detected/analysed samples.

	SCCP	MCCP	SumCP
N	8/8	8/8	
Mean	95.4	183	278
Median	93.5	177	272
Minimum	59.0	81.0	140
Maximum	143	327	426

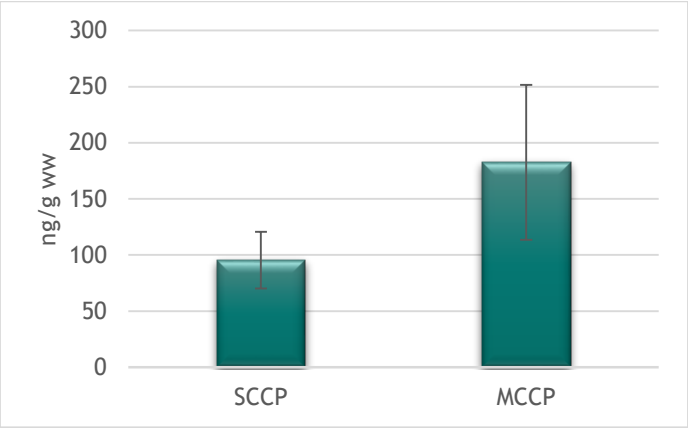


Figure 46: Mean concentrations of chlorinated paraffins in rat livers (ng/g ww) from Oslo area.

3.5.8 Red fox

In fox liver, both SCCP and MCCP were found in all 10 samples and in higher concentrations (Table 42, Figure 47) than 2016 data. Our 2017 data for SCCP were slightly higher with a range from 27 to 65 ng/g ww compared to 2016 data ranging from 18 to 44 ng/g ww. MCCPs were found in much higher concentrations than in 2016.

Table 42: Chlorinated paraffins in red fox livers (ng/g ww). N: number of detected/analysed samples.

	SCCP	MCCP	SumCP
N	10/10	10/10	
Mean	43.0	68.1	111
Median	40.0	61.0	97.0
Minimum	27.0	23.0	50.0
Maximum	65.0	130	189

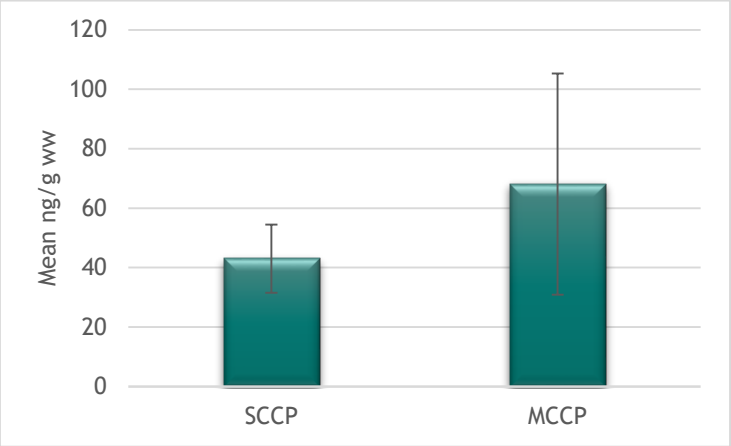


Figure 47: Mean concentrations of chlorinated paraffins in red fox livers (ng/g ww) in Oslo.

3.5.9 Badger

SCCP and MCCP were detected in the three badger liver samples, Table 43, Figure 48. The concentrations of the two compounds were quite similar, and lower than what detected in rat and fox liver samples.

Table 43: Chlorinated paraffins in badger livers (ng/g ww). N: number of detected/analysed samples.

	SCCP	MCCP	SumCP
N	3/3	3/3	
Mean	47.3	43.0	90.3
Median	45.0	41.0	83.0
Minimum	42.0	37.0	82.0
Maximum	55.0	51.0	106

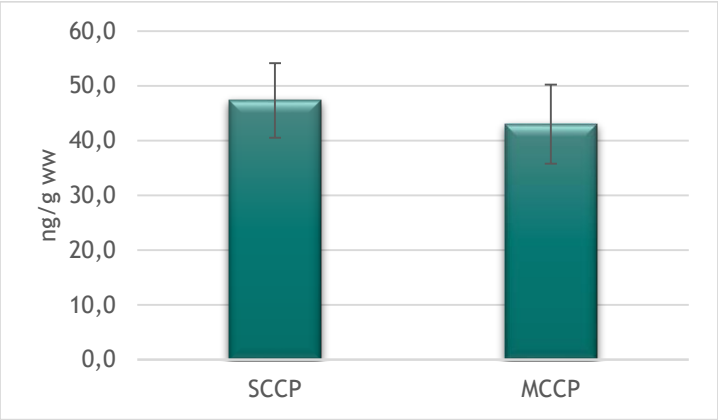


Figure 48: Mean concentrations of chlorinated paraffins in badger livers (ng/g ww) in Oslo

3.5.10 Summary S/MCCPs

SCCP and MCCP were present in all air, soil, earthworm, fieldfare eggs, sparrowhawk eggs, tawny owl, fox, rat and badger samples, indicating an ubiquitous distribution in Oslo. MCCPs were

surprisingly higher than SCCP in sparrowhawk, rat and fox liver. An extreme concentration of SCCP was detected in fieldfare eggs from Bøler in Oslo with over 1200 ng/g ww.

3.6 Cyclic Siloxanes

The three cyclic volatile methylsiloxanes, octamethylcyclotetrasiloxane (D4), decamethylcyclopentasiloxane (D5), and dodecamethylcyclohexasiloxane (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 large varying degrees depending on the chemical and organism studied. The European Community Regulation on Registration, Evaluation, Authorization and Restriction of chemicals (REACH) classified D4 and D5 as very bioaccumulative, in contrast to D6.

All sample concentrations reported for cyclic siloxanes 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 detection limit to insure concentrations reported were well over blank levels and were not influenced by variation introduced by the co-extracted sample matrix.

3.6.1 Air

All three siloxanes were detected at all five sites in Oslo, Figure 49. D5 dominated at all sites, ranging between 3.7 and 22.8 ng/day which is comparable to the 2016 data. The highest SumSiloxane concentration was found at Slottsparken with 36 ng/day.
The estimated air concentrations, using an uptake rate of 0.5 m3/day (Krogseth et al., 2013a), were 7-46 ng/m3 for D5 with an average of 20 ng/m3. D6 ranged from 0.8 to 4 ng/m3 with a maximum observed at Slottsparken, compared to 0.01-0.2 ng/m3 observed at Zeppelin during the summer 2015 (Bohlin-Nizzetto et al 2016). The estimated concentrations of D5 and D6 are ten to hundred times higher than the concentrations measured in summer time at Zeppelin. This reflects the emission sources in urban areas. Genualdi et al., reported in 2011 in a global review, D5 concentrations ranging between 0.3 (Barrow, Alaska) and 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, on line with the findings in the two Norwegian monitoring programmes. 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.

Vicinity to emission source areas is also seen by high D5/D4 ratios at all sites except Frognersetern. Higher ratio closer to sources is due to dominance of D5 in products while a lower ratio is expected with increased distance to sources as D4 has a much longer atmospheric half-life compared to D5. The lower ratio and lower levels at Frognerseteren is in line with the hypothesis that the time taken for cVMS to reach equilibrium in the atmosphere is short and that atmospheric concentrations reflect background levels relatively short distances away from emission sources.

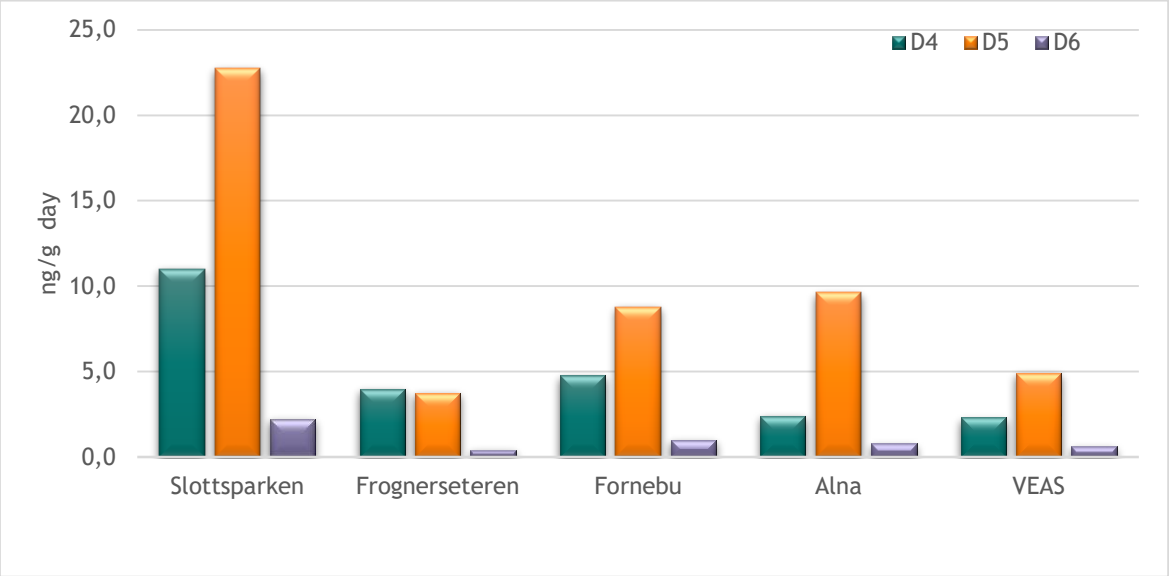


Figure 49: Cyclic siloxanes in air at the different sampling sites in Oslo (ng/day).

3.6.2 Soil and earthworm

Cyclic siloxanes were sparsely found in soil, but the concentrations were not above the limit of quantification (LOQ), except from D4 at Alnabru with 1.6 ng/g dw.

None of the three siloxanes could be detected in the earthworm samples from Oslo. In 2016 the highest concentrations were 3.1, 16.3 and 17.6 ng/g ww for D4, D5 and D6 respectively

3.6.3 Fieldfare

Regarding siloxanes in fieldfare, D4 was below LOD for all samples, Table 44. D5 and D6 were detected in half of the samples and the concentrations were more or less similar with maximum around 4 ng/g ww.

Table 44: Cyclic siloxanes in fieldfare in ng/g ww. *N: number of detected/analysed samples.*

	Siloxane D4	Siloxane D5	Siloxane D6	SumSiloxanes
N	0/10	4/10	5/10	
Mean	<LOD	1.65	1.49	3.14
Median	<LOD	<LOD	<LOD	2.39
Minimum	<LOD	<LOD	<LOD	1.24
Maximum	<LOD	3.95	4.01	7.70

3.6.4 Sparrowhawk

In sparrowhawk eggs, the concentration for the 2017 data were lower than 2016 data. As in 2016, D5 was found at higher concentrations than D6. D4 was not detected, Table 45. D5 concentrations ranged from 1.3 to 5.5 ng/g ww compared to 3.3 to 23.4 ng/g ww in 2016. The concentrations in sparrowhawk were much lower than for Herring gull eggs from Oslo 2015, were the highest concentration of D5 was more than 1000 ng/g ww. Glaucous gull eggs from Svalbard

showed D4 and D5 concentrations varying between <LOD and 5.8 for D4 and 3.1 and 40 ng/g ww for D5 in 2016, comparable to the sparrowhawk in our study (Lucia et al., 2016).

Table 45: Cyclic siloxanes in sparrowhawk in ng/g ww. *N: number of detected/analysed samples.*

	Siloxane D4	Siloxane D5	Siloxane D6	SumSiloxanes
N	0/10	8/10	4/10	
Mean	<LOD	2.51	1.12	3.63
Median	<LOD	2.23	0.48	3.42
Minimum	<LOD	1.28	0.48	1.76
Maximum	<LOD	5.70	2.51	6.18

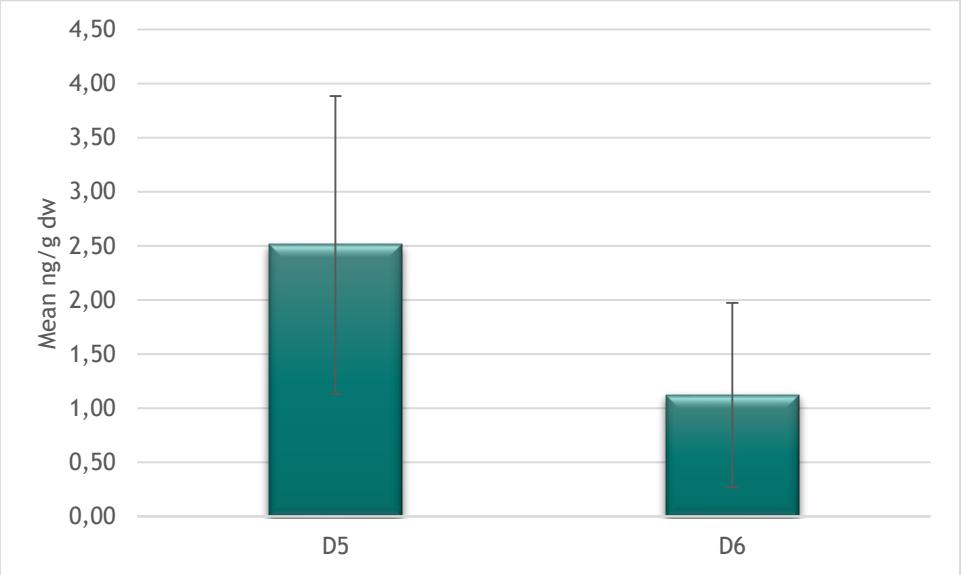


Figure 50: Mean concentrations of cyclic siloxanes in sparrowhawk eggs (ng/g ww).

3.6.5 Tawny owl

Only D5 was detected in two out of six samples with the concentration 3 and 3.9 ng/g ww which was comparable to the mean from 2016 of 4.1 ng/g ww data and the median from 2015 of 3.1 ng/g ww.

3.6.6 Brown Rat

The siloxane analysis revealed higher concentrations for all compounds D4, D5 and D6 (Table 46, Figure 51) than in 2016, and more comparable with 2015 data for D4 (median 15.9 ng/g ww) and D5 (median 15.8 ng/g ww), Herzke et al., 2016.

Table 46: Cyclic siloxanes in brown rat in ng/g ww. *N: number of detected/analysed samples.*

	Siloxane D4	Siloxane D5	Siloxane D6	SumSiloxanes
N	9/9	8/9	5/9	
Mean	14.8	14.9	7.74	37.5
Median	8.27	8.35	5.72	23.1
Minimum	4.08	<LOD	<LOD	12.0
Maximum	50.3	42.0	22.1	106

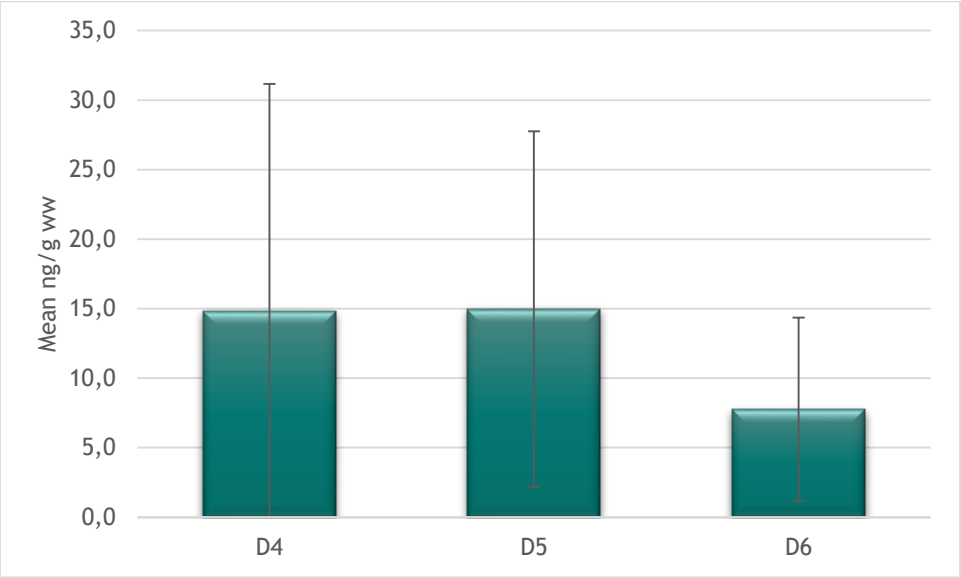


Figure 51: Mean concentrations of cyclic siloxanes in livers of brown rat in ng/g ww.

3.6.7 Red fox

D5 was absent in red fox liver samples, but D4 and D6 was detected in seven and eight samples, respectively, Table 47, Figure 52. The concentrations of D4 and D6 were comparable to 2016 data and lower than 2015 data.

Table 47: Cyclic siloxanes in red fox in ng/g ww. *N: number of detected/analysed samples.*

	Siloxane D4	Siloxane D5	Siloxane D6	
N	2/9	0/9	9/9	
Mean	0.50	<LOD	0.99	0.99
Median	0.26	<LOD	0.69	0.69
Minimum	<LOD	<LOD	0.51	0.51
Maximum	1.77	<LOD	2.69	2.69

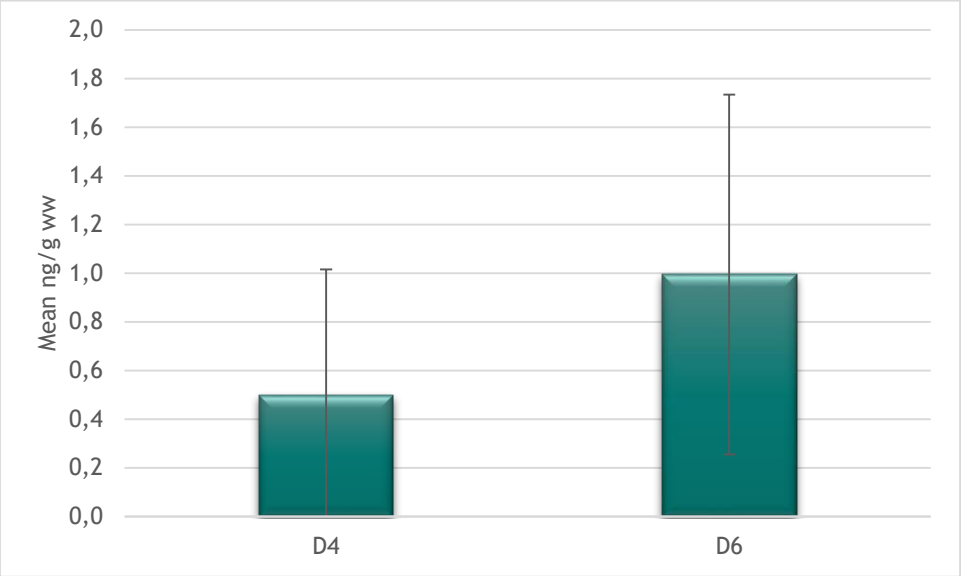


Figure 52: Mean concentrations of cyclic siloxanes in liver of red fox in ng/g ww.

3.6.8 Badger

In the three liver samples of badger only the D6 compound was detected in two of the samples and at low concentrations at 0.63 and 0.43 ng/g ww.

3.6.9 Summary cyclic siloxanes

Besides elevated concentrations in air (average 875 ng/sampler, highest in Slottsparken with 2893 ng/sampler), the levels of cyclic siloxanes D4, D5, D6 were comparable to each other in the various species and lower than detected in 2016, except for rat liver samples. Highest detected siloxane concentration in biota was rat liver with 50 ng/g ww for D4.

3.7 Organic phosphorous flame retardants

3.7.1 Air

A number of OPFRs were detected by PUF-PAS in all sites in 2017. SumOPFR ranged between 0.6 and 3.5 ng/day where the highest levels were observed at Slottsparken and the lowest at VEAS. TCPP was the dominating compound at all sites but Frognerseteren (Figure 53). TCPP was also the dominant OPFR compound at Zeppelin in 2017. In contrast, high levels of TEHP was observed at Frognerseteren while not detected at Zeppelin. Generally, few air data of OPFR exists, however, for comparison, 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 EU and Norway except that the use will decrease even more in years to come. It is a process now in EU where ECHA aims to collect further information in support of a possible restriction proposal to regulate TCEP, TCPP and TDCP, in flexible polyuretane foam, in child products and furnitures and other products. [6]

Conversion to estimated air concentrations is not done for the OPFRs due to lack of uptake rates.

[66] https://www.echa.europa.eu/web/guest/previous-calls-for-comments-and-evidence/-/substance-rev/18028/term

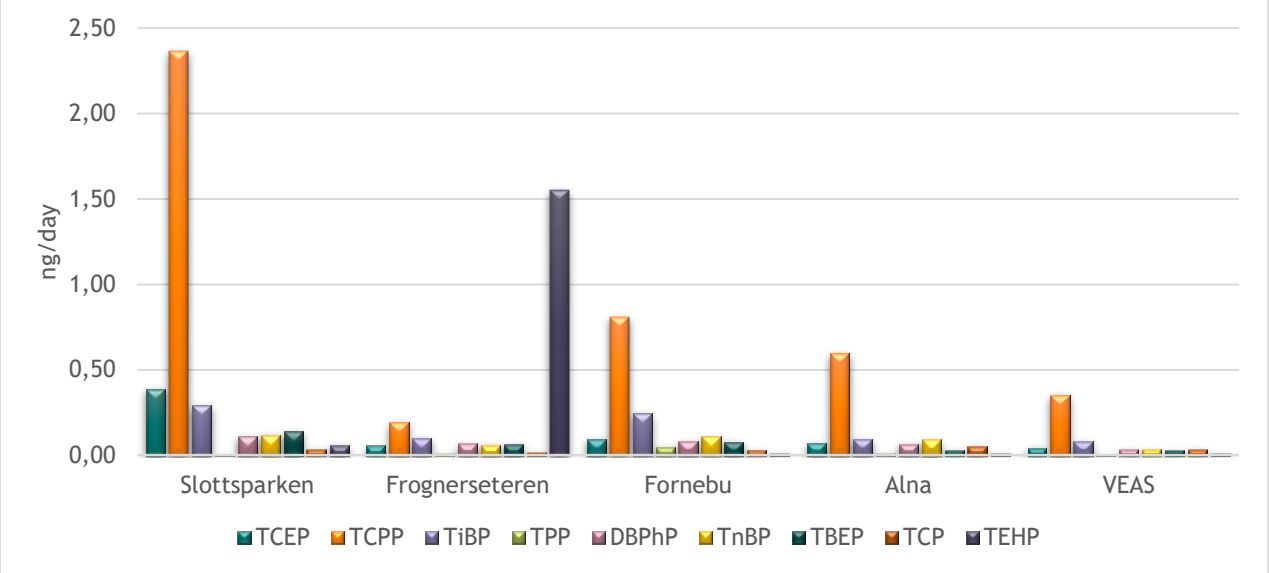


Figure 53: OPFR in air samples from Oslo in ng/day.

3.7.2 Soil

For OPFR analyses we prepared a single pooled sample representing all five locations from Oslo. The sumOPFR concentration for this sample was 7.9 ng/g ww, and the following compounds were detected:

	TEP	TCEP	TPrP	TCPP	TiBP	BdPhP	TPP	DBPhP	TnBP
	0.24	0.48	<LOD	2.24	0.84	<LOD	0.21	<LOD	0.46

	TDCPP	TBEP	TCP	EHDP	TXP	TIPPP	TTBPP	TEHP	Sum OPFR
	0.54	0.83	1.02	<LOD	0.23	<LOD	<LOD	0.84	7.94

TCPP was found at 2.24 ng/g dw, slightly lower than the 2016 concentration of TCPP of 4.2 ng/g dw. SumOPFR of 7.94 ng/g dw was in agreement with 2016 data which showed 8.57 ng/g.

3.7.3 Earthworms

We prepared one pooled sample representing all five locations from Oslo:

	TEP	TCEP	TPrP	TCPP	TiBP	BdPhP	TPP	DBPhP	TnBP
	< LOD	0.15	< LOD	1.57	1.74	< LOD	0.11	< LOD	2.68

	TDCPP	TBEP	TCP	EHDP	TXP	TIPPP	TTBPP	TEHP	Sum OPFR
	< LOD	0.48	3.70	< LOD	0.65	< LOD	< LOD	0.25	11.3

The SumOPFR was 11.3 ng/g ww and lower than in 2016 with 25.4 ng/g ww. The dominating OPFR was TCP with 3.7 ng/g ww followed by TnBP and TCPP with 2.68 and 1.57 ng/g ww respectively.

In the 2015 study, TPP, TCP, EHDP and TEHP were found in most worms, but at low concentrations < 1.5 ng/g ww (Herzke et al., 2016). The dominating OPFR in earthworms then was TBP with concentrations ranging between <LOD and 3.2 ng/g ww.

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 (H&E), oxidative stress, DNA damage and 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 concentration of TCP in earthworm from Oslo in 2017 of 3.7 ng/g ww (0.0037 mg/kg ww) is below the observed neurotoxic effect of 0.1 mg/kg.

3.7.4 Fieldfare

No OPFR analyses were carried out.

3.7.5 Sparrowhawk

For OPFR analyses three pooled samples, each consisting of three eggs, were prepared. Many compounds were not detected or only in one sample. The compounds detected in more than 2 samples and with highest concentrations were TiBP, TnBP, TCPP, TEHP. SumOPFR for the three samples were 1,8, 1.8 and 2.3 ng/g ww, and comparable to the levels found in 2016.

3.7.6 Tawny owl

Like in the sparrowhawk, three pools each consisting of three eggs were prepared. TCPP, TiBP, TnBP and TBEP were detected in three of three samples. TCEP was only detected in one sample (0.06 ng/g ww) and the rest of the compounds were below LOD. There was low variability across the three samples. The mean was 0.29, 1.1, 0.32 and 0.13 ng/g ww for TCP, TiBP, TnBP and TBEP. The sumOPFR was 1.7, 1.8 and 2 of the three samples, and comparable to the sparrowhawk samples.

3.7.7 Brown Rat

In rat liver, three pools consisting of three individuals were prepared prior to analyses. TCPP (1.1.-1.3 ng/ ww) was detected in two samples, TBEP (0.3-4.4 ng/g ww) in three samples, the rest of the compounds were below LOD. TCPP and TBEP were the dominating compounds in 2016 and sumOPFR varied between 1.7 and 6.9 ng/g ww. The sumOPFR in 2017 varied between 0.3 to 5.7 ng/g ww.

3.7.8 Red fox

None of the OPFR compounds were detected in the three pooled fox liver samples. In 2016, only TCPP was detected (0.23 - 3.92 ng/g).

3.7.9 Badger

Only TDCPP (0.78 ng/g ww) and TBEP (5.49 ng/g ww) was detected in one out of the three badger liver samples.

3.7.10 Summary OPFRs

OPFRs were either not detectable or found in very low levels at the higher trophic levels in biota. Earthworms had highest sumOPFR of 11 ng/g ww (approximately 1246 ng/g lw with 1 % lipid) compared to about 50-60 ng/g lw in sparrowhawk and tawny owl eggs. Based on our findings, the trophic magnification potential of these compounds seems to be low and highest level of TCP in earthworm is below observed neurotoxic effects in earthworm.

3.8 Dechloranes

The chlorinated flame retardant group dechloranes were analysed in all samples together with dibromoaldrin. Dibromoaldrin was not detected in any sample. Tables are provided below for the various samples without figures due to sporadic detection and low concentrations.

3.8.1 Air

Of the targeted dechloranes, only dechlorane plus syn (syn-DP) and dechlorane plus anti (anti-DP) were detected in air at the five sites. Anti-DP was about five times higher than syn-DP. The levels of the detected dechloranes in air were low, sum dechloranes ranged between 0.002 and 0.009 ng/day with the highest level observed at Slottsparken. Dechlorane 601 (Dec-601) was only detected at Frognerseteren at 0.002 ng/day.

3.8.2 Soil

The levels of dechloranes in soil were comparable with the levels at higher trophic levels. The compounds Dec-602,syn-DP and anti-DP was detected in 3 or more samples. Maximum sumDP was 3.3 ng/g dw, Table 48.

Table 48: Dechloranes in soil samples from Oslo in ng/dw. *N: number of detected/analysed samples.*

	Dec-602	Dec-603	Dec-604	syn-DP	Dec-601	anti-DP	SumDC
N	3/5	0/5	0/5	5/5	0/5	5/5	
Mean	0.06	<LOD	<LOD	0.64	<LOD	1.25	1.95
Median	0.04	<LOD	<LOD	0.50	<LOD	1.42	1.87
Minimum	<LOD	<LOD	<LOD	0.21	<LOD	0.54	0.77
Maximum	0.15	<LOD	<LOD	1.48	<LOD	1.73	3.29

3.8.3 Earthworm

Fewer dechloranes were detected in earthworm than in soil samples, Table 49. Only syn-DP and anti-DP were found in detectable amounts, but at very low levels with maximum sumDP of 0.15 ng/g ww.

Table 49: Dechloranes in earthworm samples from Oslo in ng/ww. *N: number of detected/analysed samples.*

	Dec-602	Dec-603	Dec-604	syn-DP	Dec-601	anti-DP	SumDC
N	0/5	0/5	0/5	5/5	0/5	5/5	
Mean	<LOD	<LOD	<LOD	0.05	<LOD	0.06	0.11
Median	<LOD	<LOD	<LOD	0.04	<LOD	0.05	0.11
Minimum	<LOD	<LOD	<LOD	0.03	<LOD	0.05	0.08
Maximum	<LOD	<LOD	<LOD	0.10	<LOD	0.07	0.15

3.8.4 Fieldfare

Several dechloranes were detectable in fieldfare eggs, and four compounds were detected in all ten samples, Table 50. Mean values for Dec-602, Dec-603 and anti-DP agreed with each-other, and the highest amount of 2.2 ng/g ww was detected for Dec-602.

Table 50: Dechloranes in fieldfare egg samples from Oslo in ng/ww. *N: number of detected/analysed samples*

	Dec-602	Dec-603	Dec-604	syn-DP	Dec-601	anti-DP	SumDC
N	10/10	10/10	0/10	10/10	0/10	10/10	
Mean	0.31	0.27	<LOD	0.11	<LOD	0.26	0.95
Median	0.08	0.25	<LOD	0.08	<LOD	0.15	0.69
Minimum	0.03	0.06	<LOD	0.06	<LOD	0.11	0.27
Maximum	2.16	0.50	<LOD	0.31	<LOD	0.95	3.57

3.8.5 Sparrowhawk

The same four dechloranes that were detected in fieldfare were also found in the ten sparrowhawk eggs, Table 51. Dec-602 and 603 had highest concentrations. The mean and median value of sumDC was slightly higher in sparrowhawk eggs than in fieldfare eggs, but maximum sumDC was lower.

A study from China (Chen et al., 2013) studied the levels of syn- and anti-DP in vaious 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. Lipid normalised concentrations of the sparrowhawk eggs from Oslo were lower and ranged from 1.3 to 36.2 (median 2.3) and from 3.7 to 35.8 ng/g lw (median 5.6) for syn- and anti-DP, respectively. The maximum concentrations of 36 ng/g lw in present study was in the same egg with only 0.3 %

lipids. The other eggs revealed lipids content of 2.9-6.9 %. Chen et al. 2013 also suggested that the DP burdens in terrestrial raptors could be driven by the accumulation of anti-isomer, and factors other than lipid solubility such as hepatic binding protein could be important in determining tissue deposition of DP.

A study of peregrine falcon eggs collected from Canada and Spain showed a sharp difference in the DP levels in 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 greater use of the chemical in North America (Guerra et al., 2011)

Table 51: Dechloranes in sparrowhawk egg samples from Oslo in ng/ww. *N: number of detected/analysed samples*

	Dec-602	Dec-603	Dec-604	syn-DP	Dec-601	anti-DP	SumDC
N	10/10	10/10	0/10	10/10	0/10	10/10	
Mean	0.64	0.71	<LOD	0.11	<LOD	0.29	1.76
Median	0.64	0.72	<LOD	0.10	<LOD	0.27	1.75
Minimum	0.08	0.17	<LOD	0.05	<LOD	0.14	0.75
Maximum	1.35	1.21	<LOD	0.25	<LOD	0.52	3.08

3.8.6 Tawny owl

The same dechloranes was also detected in tawny owl, but mean and median sumDC were more in agreement with fieldfare results, Table 52. Chen et al 2013 reported concentrations of decloranes in six muscle samples of three types of owls, little owl, scops owl and long-eared owls. Little owl had highest concentations with syn-DP ranging from 10 to 200 ng/g lw and anti-DP from 40 to 1300 ng/g lw. In scops owls the range was <LOD-70 ng/g lw for syn-DP and 5-82 ng/g lw for anti-DP. In our present study of tawny owl eggs, syn-DP ranged from 1.3 to 36.2 ng/g lw (median 2.3 ng/g lw) and anti-DP ranged from 4.6 to 35.8 ng/g lw (median 5.6 ng/g lw). The median concentrations were comparable to levels detected in the long-eared owls (Chen et al 2013) with <LOD-17 (median 2.5) ng/g lw for syn-DP and <LOD-90 (median 7) ng/g lw for anti-DP.

Table 52: Dechloranes in tawny owl egg samples from Oslo in ng/ww. *N: number of detected/analysed samples*

	Dec-602	Dec-603	Dec-604	syn-DP	Dec-601	anti-DP	SumDC
N	7/7	3/7	0/7	7/7	0/7	7/7	
Mean	0.39	0.29	<LOD	0.13	<LOD	0.30	1.08
Median	0.13	0.04	<LOD	0.10	<LOD	0.25	0.62
Minimum	0.03	0.01	<LOD	0.06	<LOD	0.11	0.27
Maximum	2.16	1.95	<LOD	0.31	<LOD	0.95	3.57

3.8.7 Brown rat

In brown rat liver samples syn- anti DP were detected in all samples and with highest concentrations compared to the other compounds, Table 53. One sample had higher concentrations than the other where anti-DP and syn-DP concentrations were 8.9 and 1.9 ng/g ww, respectively. A Norwegian screening study from 2016 in the Oslo area (Schlabach et al, 2017a) reported average concentrations of syn- anti-DP in rat liver samples of 0.1 and 0.2 ng/g ww, respectively. Our present study from 2017 revealed slightly higher concentrations. Yu et al. (2013) reported sum of syn- anti-DP in eight brown rat livers from <LOD to 160 ng/g lw (median 24). These levels are comparable with present study where sum of syn- and anti-DP ranged from 8 to 362 ng/g lw (median 21). The maximum concentration of syn- and anti-DP in present study were from the same rat liver samples.

Table 53: Dechloranes in brown rat liver samples from Oslo in ng/ww. *N: number of detected/analysed sample*

	Dec-602	Dec-603	Dec-604	syn-DP	Dec-601	anti-DP	SumDC
N	8/9	1/9	0/9	9/9	0/9	9/9	
Mean	0.02	<LOD	<LOD	0.33	<LOD	1.33	1.67
Median	0.02	<LOD	<LOD	0.16	<LOD	0.54	0.72
Minimum	<LOD	<LOD	<LOD	0.06	<LOD	0.14	0.22
Maximum	0.02	0.02	<LOD	1.94	<LOD	8.91	10.9

3.8.8 Red fox

As with rat liver samples, anti-DP was the dominating compound, followed by syn-DP and Dec-602, Table 54. The maximum value of anti- and syn-DP was detected in the same sample. 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). The analogue composition in the raccoons was dominated by Dec-603, followed by Dec-602, as in the study with bobcats. In the present study of red fox livers from Oslo the sumDC ranged from 4.9 to 158 ng/g lw (median of 7.5 ng/g lw).

Table 54: Dechloranes in red fox liver samples from Oslo in ng/ww. *N: number of detected/analysed samples*

	Dec-602	Dec-603	Dec-604	syn-DP	Dec-601	anti-DP	SumDC
N	10/10	3/10	0/10	10/10	0/10	10/10	
Mean	0.12	0.03	<LOD	0.11	<LOD	0.76	1.02
Median	0.04	<LOD	<LOD	0.05	<LOD	0.16	0.25
Minimum	0.02	<LOD	<LOD	0.04	<LOD	0.11	0.18
Maximum	0.60	0.18	<LOD	0.66	<LOD	5.79	7.11

3.8.9 Badger

The levels in the three badger liver samples were lower than in most other samples and slightly higher than the concentrations detected in earthworm samples, Table 55.

Table 55: Dechloranes in badger liver samples from Oslo in ng/ww. *N: number of detected/analysed samples.*

	Dec-602	Dec-603	Dec-604	syn-DP	Dec-601	anti-DP	SumDC
N	3/3	0/3	0/3	3/3	0/3	3/3	
Mean	0.04	<LOD	<LOD	0.06	<LOD	0.14	0.24
Median	0.04	<LOD	<LOD	0.06	<LOD	0.12	0.22
Minimum	0.03	<LOD	<LOD	0.05	<LOD	0.11	0.21
Maximum	0.06	<LOD	<LOD	0.08	<LOD	0.18	0.30

3.8.10 Summary dechloranes

Dechloranes were found in many of the samples, but at relatively low levels compared to the dominating contaminants. Dechlorane plus-, anti- and syn- were the dominating congeners in air, soil and earthworm, but in the biological samples also the compounds Dechlorane 602 and 603 were detected, especially in the bird eggs. Although no known study on birds for Dec-602, a recent 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., 2016). Another study of Dechlorane plus revealed no effects on pipping success up to 500 ng/g egg (Crump et al., 2011) Anti-DP was dominating in red fox and rat livers with maximum concentration up to 9 ng/g ww in rat livers.

3.9 Phenolic compounds and alkyl ethoxilates

Due to the sporadic detection of phenolic compounds, results are discussed in the text and not all compounds are shown in the tables and figures. Detailed information regarding concentrations of the various phenolic compounds can be found in the Appendix. Phenolic

compounds were not analysed in air samples. Some compounds are only semi-quantitative; these compounds are Bis-FL, Bis-BP, Bis-TMC and Bis-M, marked with grey colour in the tables, and the concentrations of these should be treated with caution.

3.9.1 Soil

None of the bisphenols were detected in soil. Of the four alkylphenol ethoxilates Octylphenol MonoEthoxylate (OPEO), Nonylphenol MonoEthoxylate (NPEO), Octylphenol DiEthoxylate (OPEO2) and Nonylphenol DiEthoxylate (NPEO2), only NPEO was detected in two samples (0.6-1.1 ng/g dw) and OPEO2 in one sample (0.43 ng/g dw).

3.9.2 Earthworms

None of the phenols were detected in earthworms, and alkylphenol ethoxilates were not analysed due to lack of sample material.

3.9.3 Fieldfare

Phenolic compounds were detected in eggs of fieldfare. Bisphenol F was the most abundant phenol, Figure 54, with a detection frequency of 50% (<LOD – 164 ng/g). Bisphenol A was found in four eggs from <LOD to 50 ng/g ww. SumPhenols ranged from <LOD to 186 ng/g ww (median of 20.9 ng/g ww), Table 56, Figure 54. No alkylphenol ethoxilates were detected.

Table 56: Phenols in fieldfare egg samples from Oslo in ng/ww. *N: number of detected/analysed samples*

	Bisphenol P	Bisphenol M	Bisphenol S	Bisphenol F	2,2- bisphenol F	Bisphenol A	Sum Phenols
N	1/10	1/10	3/10	5/10	3/10	4/10	
Mean	0.19	0.07	0.31	29.1	0.98	15.2	45.8
Median	<LOD	<LOD	<LOD	2.20	<LOD	<LOD	20.9
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Maximum	1.64	0.61	1.36	164	5.00	50.4	186

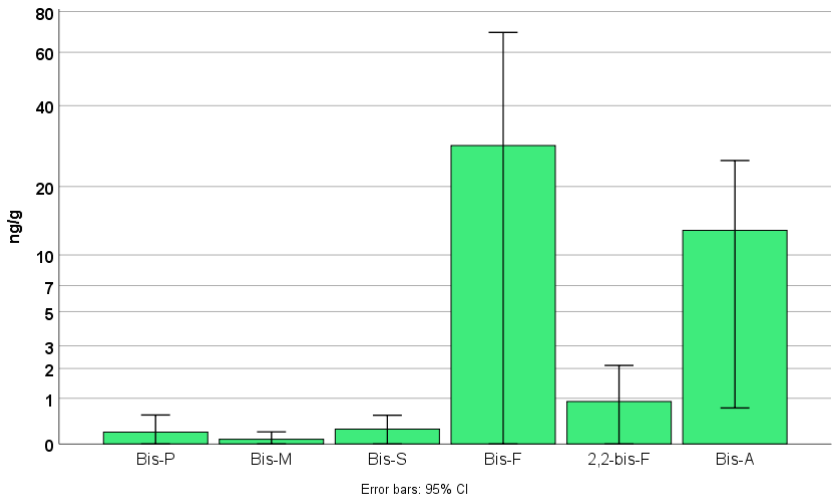


Figure 54: Detected phenols in fieldfare eggs, mean concentration with standard deviations, ng/g ww

3.9.4 Sparrowhawk

Of the analysed phenols, Bisphenol A, Bisphenol F and 2,2-bisphenol F were detected in the samples, Table 57, Figure 55. SumPhenol concentrations ranged from <LOD to 84 ng/g ww. For comparison, Herzke et al. reported in 2017 lower concentrations. (Herzke et al., 2017). No alkylphenol ethoxilates were detected.

Table 57: Phenols in sparrowhawk egg samples from Oslo in ng/ww. *N: number of detected/analysed samples*

	Bisphenol F	2,2- bisphenol F	Bisphenol A	SumPhenols
N	5/9	3/9	6/9	
Mean	6.40	1.54	18.9	26.9
Median	4.21	<LOD	12.6	14.6
Minimum	<LOD	<LOD	<LOD	<LOD
Maximum	20.0	6.48	73.1	83.8

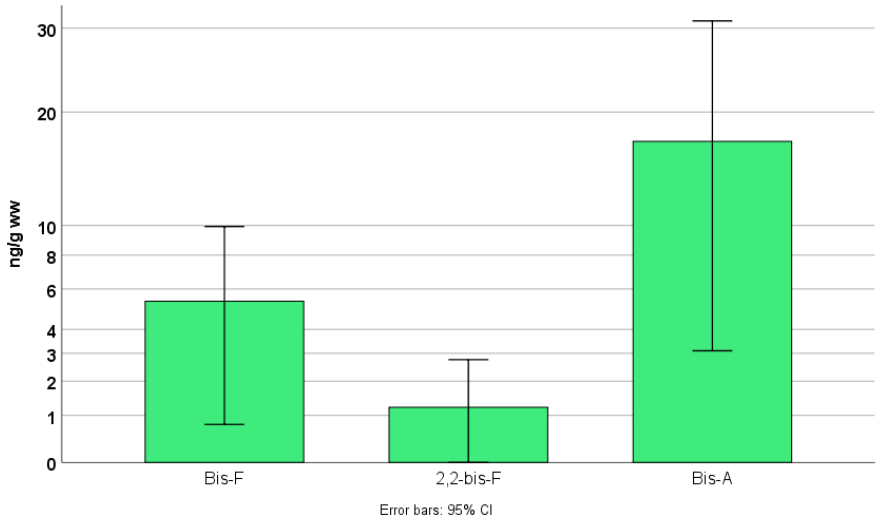


Figure 55: Detected phenols in sparrowhawk eggs, mean concentration with standard deviations, ng/g ww

3.9.5 Tawny owl

Phenolic compounds were also detected in the tawny owl eggs, Table 58, Figure 56. It was only one sample with NILU id 17/1477 from Langerud which contained all the high concentrations of the various bisphenols and was the driver of the sumPhenols concentration. Bis-FL, Bis-BP and Bis-M were detected in high concentrations, but the concentrations of these are uncertain and semi-quantitative and are marked in grey colour. If they are removed from sumPhenols calculations, the range of sumPhenols is <LOD to 370 ng/g ww with a mean sumPhenols of 57 ng/g ww.

Little is known about toxicological effects of phenolic compounds in birds. However, Halldin et al., 2005, showed that bisphenol A (BPA) had oestrogen-like effects in bird embryos, causing malformations of the oviducts in Japanese quail (Coturnix japonica) and feminisation of the left testis in chicken (Gallus domesticus). In their study, neither BPA (200 µg/g egg) nor TBBPA (15 µg/g egg) caused any significant oestrogen-like effects on the variables studied, although effects on the female oviducts after BPA exposure were indicated. None of alkylphenol ethoxilates were analysed due to lack of sample material.

Table 58: Phenols in tawny owl egg samples from Oslo in ng/ww. *N: number of detected/analysed samples*

	Bs-FL	Bis-BP	Bis-P	Bis-M	Bis-Z	Bis-AF	2,2-Bis-F	Sum Phenols	SumPhenols excluded Bis-Fl, Bis-Bp and Bis-M
N	1/7	1/7	3/7	3/7	1/10	1/10	1/7		
Mean	14.8	16.1	11.6	3.57	34.9	4.42	5.83	91.3	56.8
Median	<LOD	<LOD	1.29	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Maximum	103	112	64.7	19.4	240	27.5	37.4	604	370

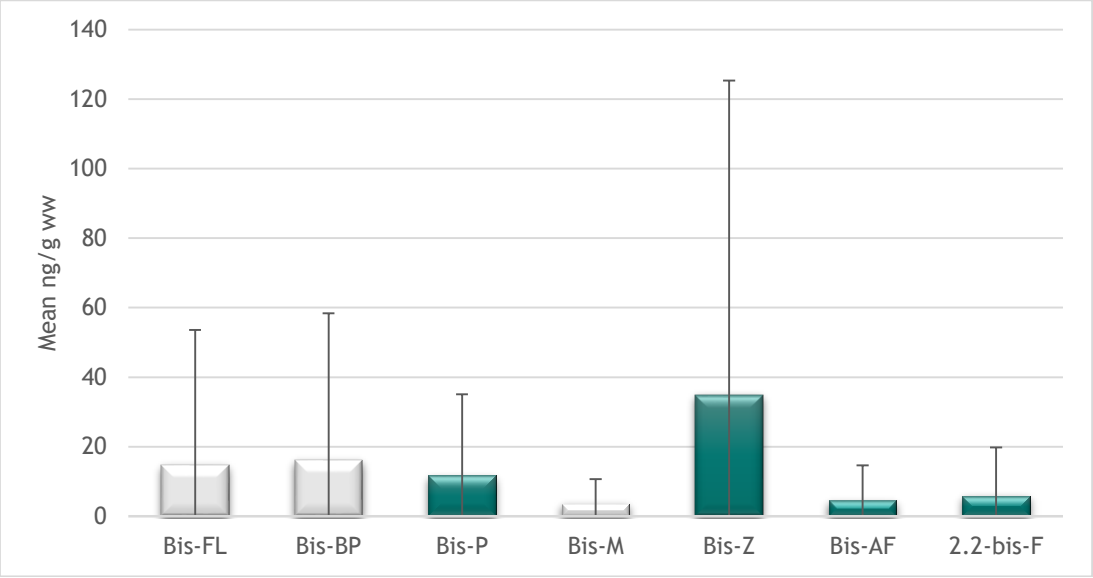


Figure 56: Detected phenols in tawny owl eggs, mean concentration with standard deviations, ng/g ww. Bis-FL, Bis-BP and Bis-M were detected, but the concentrations of these are semi-quantitative and are marked in light grey colour.

3.9.6 Red fox, badger and brown rats

Only bisphenol A was detected in one sample of brown rat of 52.3 ng/g ww.

3.9.7 Summary phenols

Phenols were only detected in bird eggs this year. The highest levels of phenols were found in tawny owl eggs with a mean sumPhenols of 91 ng/g ww. However, some of the compounds making up the sum are semi-quantitative and removing these gave a mean sumPhenols of 57 ng/g ww. Reported effect concentrations for birds have not been found from literature. A NOAEL value has been reported for BPA from rat studies of 5 mg/kg-bw/day for bisphenol A (US

EPA, 2010). None were detected in soil, earthworm, red fox and badger, and only Bis-A was detected in one sample of brown rat.

3.10UV compounds

Due to the sporadic detection of UV compounds, results are given in one single table in the text below without further illustration. Detailed information regarding concentrations can be found in the Appendix. Pooled samples were used for analyses, one sample for soil, one sample for earthworm and three samples of the other animals. Fieldfare and rat samples were not analysed due to lack of material. Mean data of UV compounds is provided for sparrowhawk egg, red fox and badger livers.

Earthworm, red fox and badger liver samples had highest number of detected compounds and highest sum value. The compound EHMC was the dominated compound in earthworm, red fox and badger liver samples.

	No of samples	BP3	EHMC	OC	UV-329	UV-328	UV-327	Sum UV compounds
Soil (ng/g dw)	1	<LOD	3.2	<LOD	<LOD	0.7	<LOD	3.9
Earthworm (ng/g ww)	1	1.3	4.5	<LOD	0.26	0.24	0.06	6.4
Tawny owl (ng/g ww)	3	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Sparrowhawk (ng/g ww)	3	<LOD	<LOD	<LOD	<LOD	0.7	<LOD	0.7
Red fox (ng/g ww)	3	0.26	5.2	<LOD	0.08	0.17	<LOD	5.5
Badger (ng/g ww)	3	0.32	6.5	<LOD	0.10	0.12	<LOD	7.0

3.11Biocides

Biocides were only analysed for in red fox, rat and badger liver samples i.e. species that were more likely to be exposed to these substances via their diet. Four biocides were selected for analyses in these samples (Bromadiolone, Brodifacoum, Flocumafen and Difenacoum).They were not analysed for in soil, earthworms, fieldfare, sparrowhawk and tawny owl. Results are given in tables below and discussed briefly without further illustration by figures.

3.11.1 Red fox

Bromadiolone and brodifacoum were the dominating compounds and in agreement and slightly higher than 2016 data for bromadiolone (12 - 3883 ng/g ww) and brodifacoum (69 -1072 ng/g ww). Bromadiolone persists very long in the liver, up to 270 days. Compared to a Swedish (Nordström et al., 2012) and Finnish study (Koivisto et al., 2016), our concentrations of bromadiolone in red fox from Oslo were higher. Bromadiolone was found in the range (<LOQ to 1100 ng/g ww in red fox livers (n=10) from Sweden. The mean and maximum concentration in fox livers (n=11) from Finland were 209 and 911 ng/g ww, respectively. A study from Spain

(Sánchez-Barbudo et al., 2012) reported bromadiolone mean concentration of 150 ng/g ww with maximum concentration of 12300 ng/g ww. Berny et al. (1997) described liver concentrations ranging from 800 to 6900 ng/g ww (median of 1500 ng/g) in confirmed bromadiolonepoisoned foxes. Our results of bromadiolone concentrations in some of the red foxes from Oslo are within this range and the ones with highest concentrations can be suspected to be poissoned.

Brodifacoum is a highly lethal 4-hydroxycoumarin vitamin K antagonist anticoagulant poison, showing a half life of 120 days in dogs and 156 hours in rats. In recent years, it has become one of the world's most widely used pesticides. It is typically used as a rodenticide, but is also toxic to all mammal species. Flocumafen was not detected and Difenacoum was detected in two samples.

	Bromadiolone	Brodifacoum	Flocumafen	Difenacoum	SumBiocides
N	10/10	9/10	0/10	2/10	
Mean	1800	299	<LOD	30.0	2105
Median	996	47.9	<LOD	<LOD	2040
Minimum	9.8	<LOD	<LOD	<LOD	17
Maximum	4412	1597	<LOD	30.5	4502

3.11.2 Brown rats

In rats, of the four biocides analysed, bromadiolone was found in six of nine samples. The concentration in rats were lower than in red fox, also in agreement with what was found in the 2016 data.

	Bromadiolone	Brodifacoum	Flocumafen	Difenacoum	SumBiocides
N	6/9	1/9	0/10	0/10	
Mean	649	<LOD	<LOD	<LOD	435
Median	72.1	<LOD	<LOD	<LOD	28.5
Minimum	8.6	<LOD	<LOD	<LOD	<LOD
Maximum	3560	17.1	<LOD	<LOD	3577

3.11.3 Badger

The bromadiolone and brodifacoum were also detected in two of the three badger liver samples and the levels were lower than in brown rat and red fox liver samples.

	Bromadiolone	Brodifacoum	Flocumafen	Difenacoum	SumBiocides
N	2/3	2/3	0/3	0/3	
Mean	277	108	<LOD	<LOD	385
Median	33.7	28.3	<LOD	<LOD	325
Minimum	<LOD	<LOD	<LOD	<LOD	6.67
Maximum	795	291	<LOD	<LOD	823

3.11.4 Summary biocides

For the second year we find that the levels of rat poisons were much higher in the red fox than in the target species; the rats. A possible explanation for this may be the fact that 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. Badger might also feed on poisoned rats, or from contaminated soil species, but this is not known for the authors.

3.12Pesticides

In the following we present the results for pesticides for sparrowhawk eggs from Oslo area. The analysed compounds are given in Table 59.

Table 59: Pesticides in eggs of sparrowhawk (ng/g ww). N: number of detected/analysed samples. SumPest is sum of all compounds.

	HCB	α-HCH	β-HCH	γ-HCH	SumHCH
N	10/10	3/10	10/10	5/10	
Mean	11.7	0.02	1.53	0.05	1.60
Median	9.06	<LOD	1.32	0.04	1.41
Minimum	3.43	<LOD	0.26	<LOD	0.27
Maximum	36.6	0.06	3.34	0.11	3.48

	o.p'-DDE	p,p'-DDE	o,p'-DDD	p,p'-DDD	o,p'-DDT	p,p'-DDT	sumDDT	sumPest
N	0/10	**10/10**	0/10	9/10	0/10	10/10		
Mean	<LOD	**874**	<LOD	8.95	<LOD	9.05	892	905
Median	<LOD	**828**	<LOD	7.30	<LOD	6.96	838	846
Minimum	<LOD	**113**	<LOD	<LOD	<LOD	1.53	115	118
Maximum	<LOD	**1600**	<LOD	17.8	<LOD	20.3	1626	1636

Pesticides, especially *p,p'*-DDE are still a dominating pollutants in sparrowhawk egg, despite the fact that DDT has been banned for general use in Norway since 1972. One suspects long-range transport to be the main factor behind this, either via air, precipitation or ocean currents, but due to the long half-life of DDTs, especially in cold environments, one cannot write off that some of the DTTs may be of local origin. Equally important may be the fact that this species also feeds on migrating prey, i.e. small birds, especially passerines, which may have spent their winter in Europe or Africa (Haftorn, 1971), thus being able to carry pollutants in their bodies from areas more polluted than ours. However, its eggs are probably primarily formed in its body after the return to Norway from its winter quarters in south-western Europe, since it is energetically costly to migrate with a body burden of eggs that may weigh up to half of its own mass (Haftorn,

1971). Relatively low concentrations of HCB, was found relative to *p,p'*-DDE. The concentration range for HCB was 3.4 to 36.6 ng/g ww and in agreement with the range of 5.4 to 28.9 ng/g ww in 2016. The concentration range for ppDDE is comparable and slightly less than data from the year 2016 (range of 615-2400 ng/g ww). Some of the concentrations of p,p'-DDE from both 2016 and 2017 exceed the reported PNEC of 870 ng/g ww associated with 20% eggshell thinning in osprey (Chen et al., 2010).

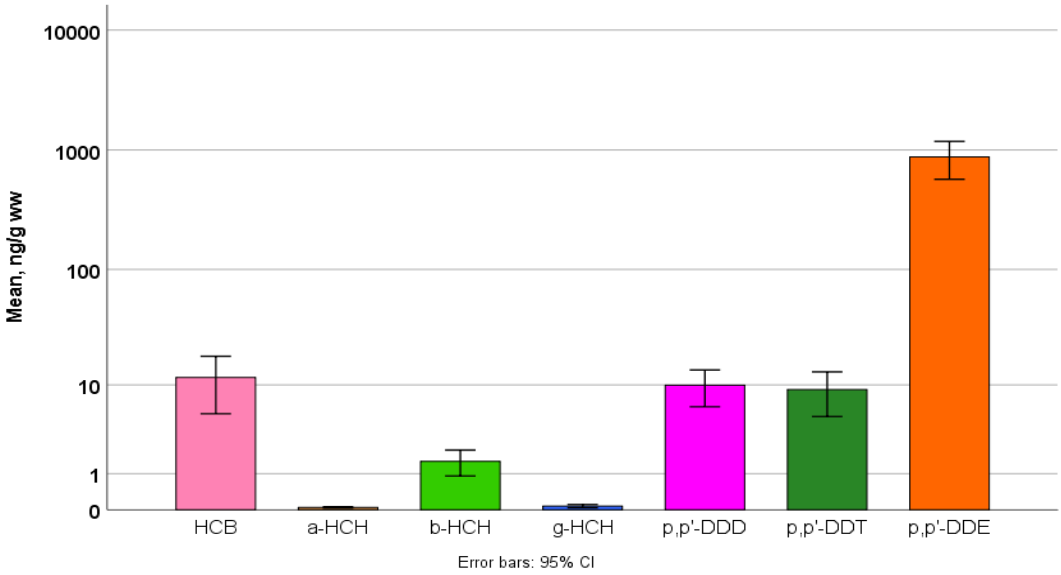


Figure 57: Mean concentrations (ng/g ww) with standard deviations of pesticides in sparrowhawk eggs. Only compounds detected in more than 1 sample are shown.

Compared to the eggshell index levels of eggs prior to 1947 (the year normally chosen as dividing the pre- and post-DDT era, the eggshell index was significantly lowered in the 2015-17 eggs compared to the pre-DDT period. The reference index before 1947 is 1.44, while the index for 2015-17 is 1.27 (- 11.8 %). The difference is significant (Paired sample T-test, F = 1.14, P = 0.005). The sparrowhawk has been one of the species most affected by shell thinning on a European level (Ratcliffe, 1970, Newton and Bogan, 1978), and also in Norway (Nygård and Polder, 2012)

The effect on eggs was determined by measuring the eggshell thickness and by computing the eggshell index (see Methods chapter), and comparing them to the values of eggs collected before DDT was introduced to combat unwanted insects in agriculture and in domestic use (before 1947). The results show that eggshells from our data 2015-17 are on median 2.2 % thinner than the pre-1947 average. This difference was not significant (Paired sample T-test, F = 2.7, P = 0.29). There was a significant correlation between eggshell thickness and logSumDDT levels (Pearson corr., N = 32, P < 0,001). The mean SumDDT level during 2015-17 was 891 ng/g ww, which is lower than the critical level of 3000 ng/g of DDE proposed for population decline by Newton & Bogan (1986). The time-trend of the eggshell index is shown in Figure 58. There was a significant correlation between eggshell index and logDDT levels (Figure 59).

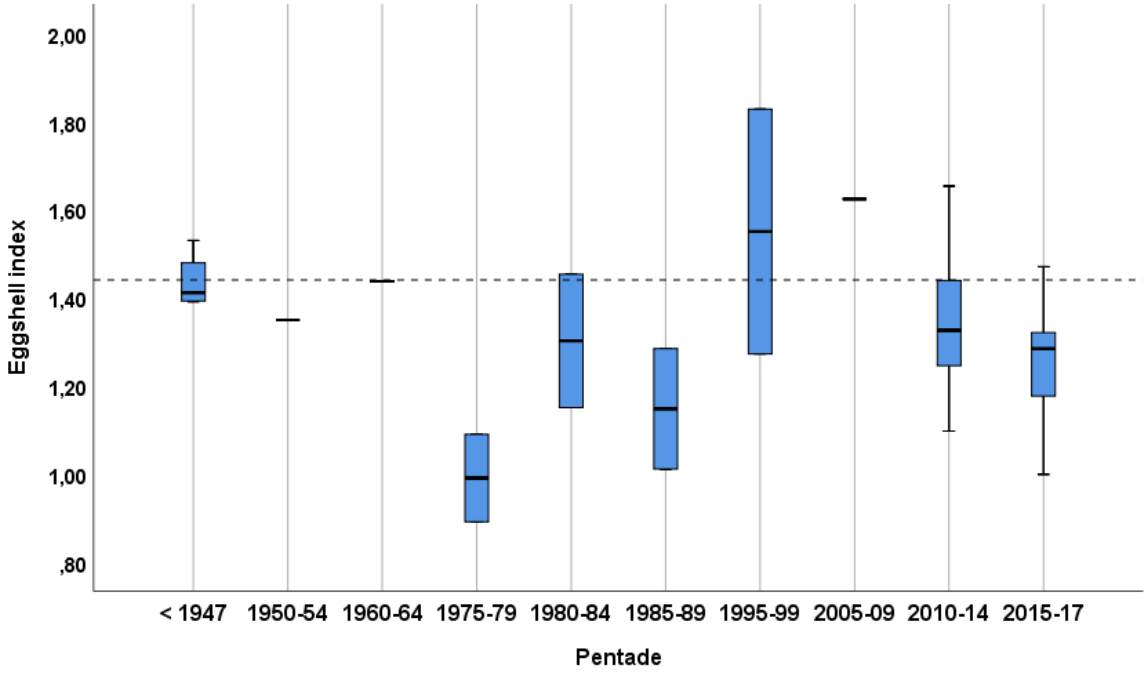


Figure 58 : Eggshell index of sparrowhawk eggs from Norway by pentade. The eggs from the monitoring scheme reported here are represented in the box to the right (2015-17). The dashed line shows the pre-1947 mean.

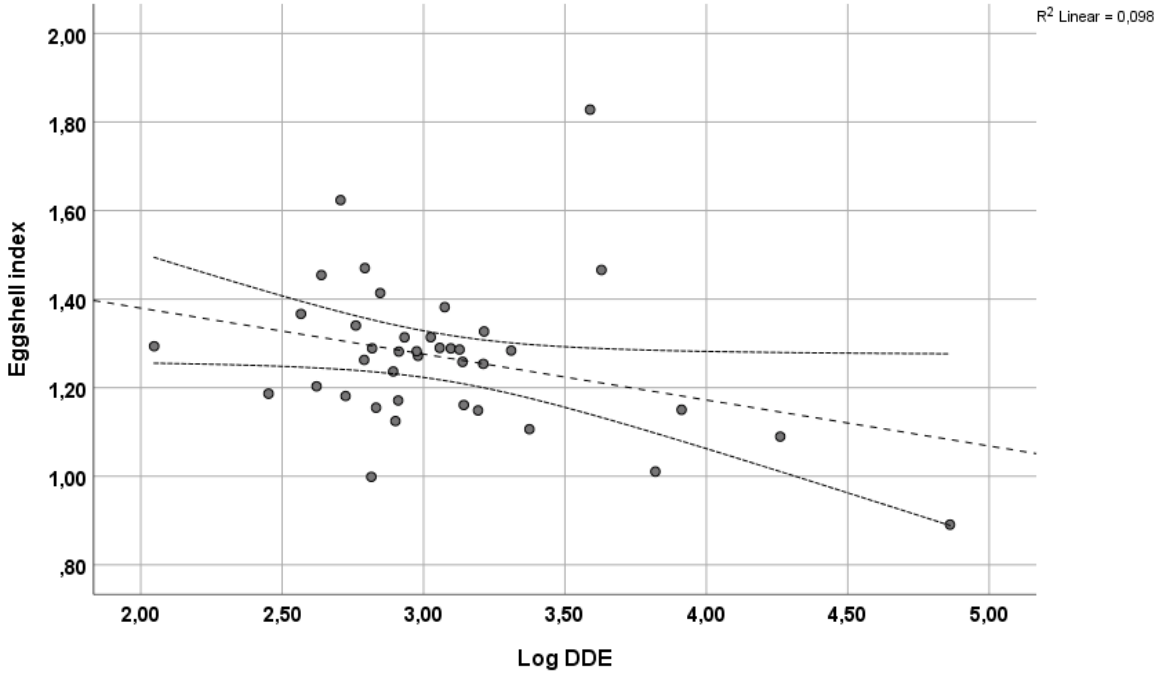


Figure 59: The relation between log SumDDT in eggs and eggshell index in sparrowhawk eggs. The graph contains all relevant egg data of sparrowhawks from Norway.

P,p'DDE still dominates among the pesticides, despite the fact that is more than 40 years since it was banned for most uses in Norway. The levels are generally decreasing over time in birds of prey in Norway, but the decrease rate is slow (Nygård & Polder 2012). The DDT compounds are

still affecting the sparrowhawk egg, by reducing their shell quality. The levels of HCB and HCH were very low compared to p,p'DDE, and are not expected to have any notable negative effects on the sparrowhawk.

3.12.1 Summary pesticides

P,p'-DDE still dominates among the pesticides, despite the fact that it is more than 40 years since it was banned for most uses in Norway. A study in Vietnam showed that the half-life in soil of SumDDT was 6.7 years, but it may be much longer in temperate and cold climates, since the breakdown rate is very temperature-dependent (Toan et al., 2009). Compared to reference eggs collected before the DDT era (before 1947), there is still some reduction in the eggshell index in the sparrowhawk eggs (ca. 10 %), and there is a significant correlation between degree of shell thinning (as measured by the eggshell index) and sumDDT concentration in the eggs. The shell thinning agent is the breakdown product *p,p'*-DDE (Lundholm, 1997), the dominating form of DDT present in the eggs. HCB and HCHs were found at very low concentrations, and are not expected to have any adverse effects on the sparrowhawk.

3.13 Compound classes across species

In the following chapter we will give a summary of similarities and the dissimilarities in the load of the major compound classes across species, and this overview will first and foremost be given in form of graphical information in figures. In addition, we will assess the relationship between pollutant groups to better understand exposure routes and bioaccumulation. Interspecies comparison will be discussed as well, improving the understanding of uptake and accumulation of pollutants in urban terrestrial environments.

Mostly sum parameters of the investigated pollutants will be given, but some single compounds will also be included, more detailed information for single compounds can however be found in the chapters above. Of the analysed metals, mainly the metals Hg, Pb, Cd and As are known to be toxic at concentrations that can be found in the environment. We have chosen to show long-chained PFCA, SCCP, MCCP, D4, D5 and D6 in the figures since some of these compounds are attributed for evaluation in connection with international regulation.

Note that pesticides including DDTs were only measured in the sparrowhawk eggs, and will not be discussed in details below. Individual data can be found in the Annex 1.

Air

When comparing concentrations, emerging pollutants like siloxanes and OPFRs dominate the overall pattern with respect to concentrations. The very volatile siloxanes constitute more than 90% of the measured contaminants, indicating the existence of a number of point sources/emissions caused by human activities in Oslo

Figure 60 shows the dominating airmasses (i.e. emission sensitivity maps) during the observed time period of air sampling (nearly 90 days from June 23 to September 20 2017). A high resolution atmospheric transport simulation on a 0.1 degree grid was performed for the stations in Oslo for the 90 days study period. An emission sensitivity shows in which region emission can potentially be taken up and transported to the receptor (measurement location). They are residence times of the air masses in the lowest layer of the model simulation. If values are high

(red colour), it means that there is a greater potential that emission from this regions can be transported to the measurement then if the value is low.

The Oslo area is in general dominated by airmasses being advected from the southwest, for intercontinental transport this means that Denmark, Great Britain and Northern Europe are a potential source region. On a local scale a clear south-west to north-east orientation can be seen, which is also reflected in the prevailing wind direction. Station VEAS is greatly influenced by air masses coming from the fjord. The source region for Alnabru stretches far to the Northeast.

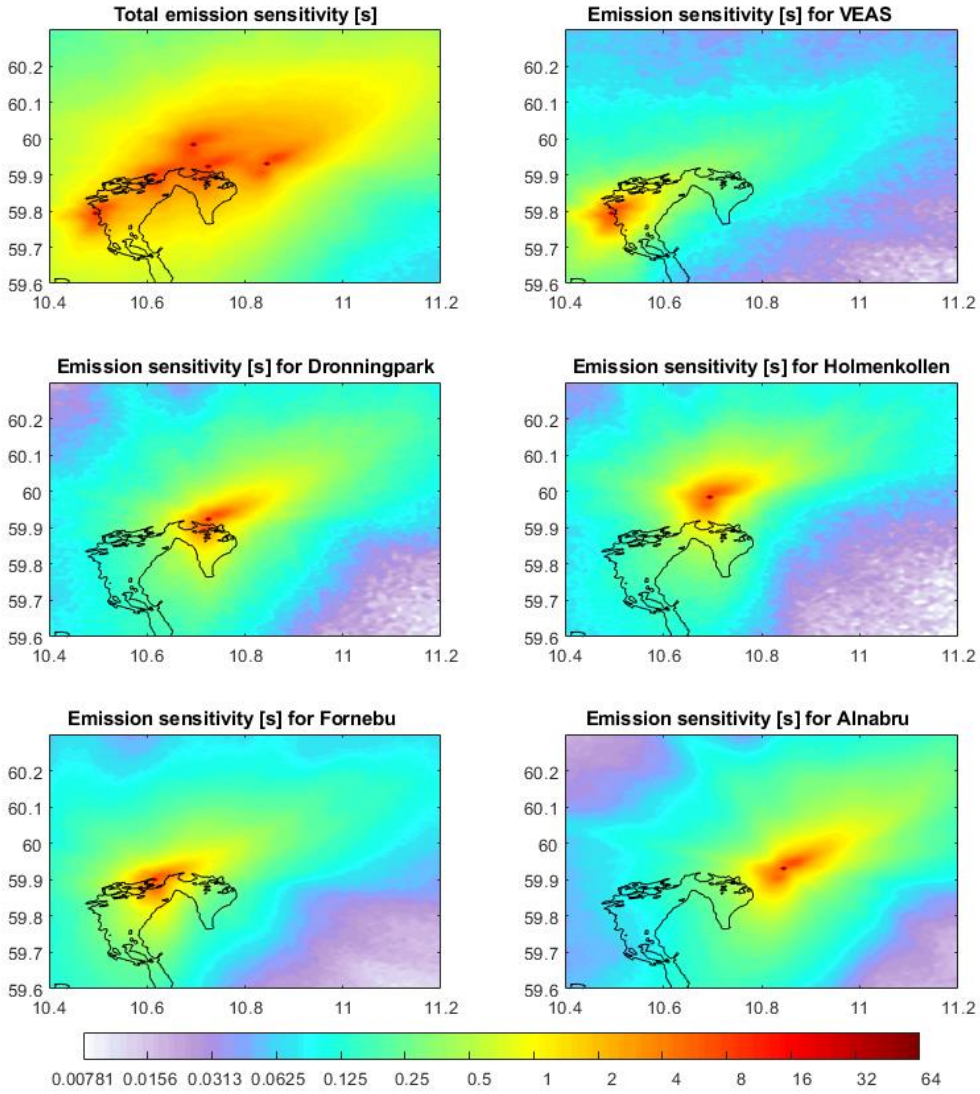


Figure 60: Source of dominating airmasses in the time period of 23.06-20.9.2017. *There is a greater potential for emissions and air transport from regions with high values to the respective measuring sites, compared to regions where the value is low*

However, the dominating compounds observed in air consist of D5, OPFRs and CPs, all closely related to urban point sources. More sampling sites, measurements and calculations would be

needed to improve the understanding of the contribution of long-range transport versus point source pollution.

Soil

In soil, the main contributors to the overall pollution are besides metals (where Pb was the major toxic metal), chlorinated paraffins (CPs) and PFAS. PCBs and PBDEs play only a small role of the overall contamination. The high levels of PFAS in soil from Alnabru (sumPFAS of 106 ng/g dw) are concerning and more than 10-times higher compared to the other locations related to skiing activities. High levels of CPs were also found in soil, but Slottsparken had the highest concentrations as also found in the air samples from Slottsparken.

Contaminant loads across species and inter-species comparisons

In general, direct comparison of the pollutant concentrations found in the investigated species is difficult, since different tissue types were sampled. 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 (see below). Levels of organic pollutants, especially PCBs, 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. PFAS, which primarily binds to proteins, behaves differently in biota compared to the "classic" organic pollutants such as PCBs, however some PFAS have been shown to bioaccumulate like PCBs.

Figure 61 shows the mean concentrations of the toxic metals analysed in the various samples. The metal concentrations of Hg, Cd, Pb are highest in soil, followed by earthworm, badger and red fox. However, rat liver contained highest concentrations of the toxic metal As, and sparrowhawk eggs contained high levels of Hg, on the same level as red fox liver, badger liver and earthworms. The figure also reveals that the bioaccumulation potential of metals from earthworm via fieldfare egg to sparrowhawk egg is low or non-existent, except for mercury, where the levels in sparrowhawk eggs is ten times that of the fieldfare. However, bioaccumulation of mercury or any other of the toxic metals from earthworm to fieldfare does not seem to happen.

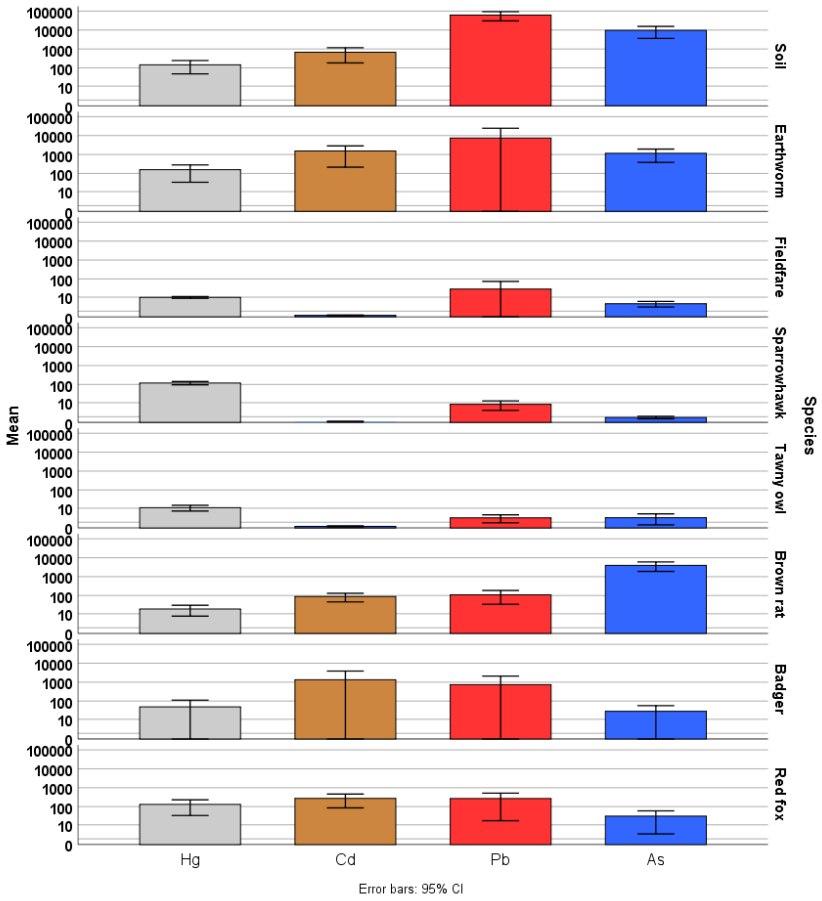


Figure 61: Mean concentrations of Hg, Cd, Pb and As with standard deviations in the various samples from Oslo area, 2017. The units are given as ng/g dw for soil and ng/g ww for biota samples

Figure 62 gives the distribution of PCB and PBDE congeners in the various samples. The egg samples had highest percentage detection of the PCB and PBDE congeners. Sparrowhawk and brown rat contained the highest concentration for PCBs, and there is an apparent bioaccumulation potential from earthworm-fieldfare-sparrowhawk; however, here given in wet weight concentration and not in lipid weight concentrations commonly used for evaluating biomagnification.

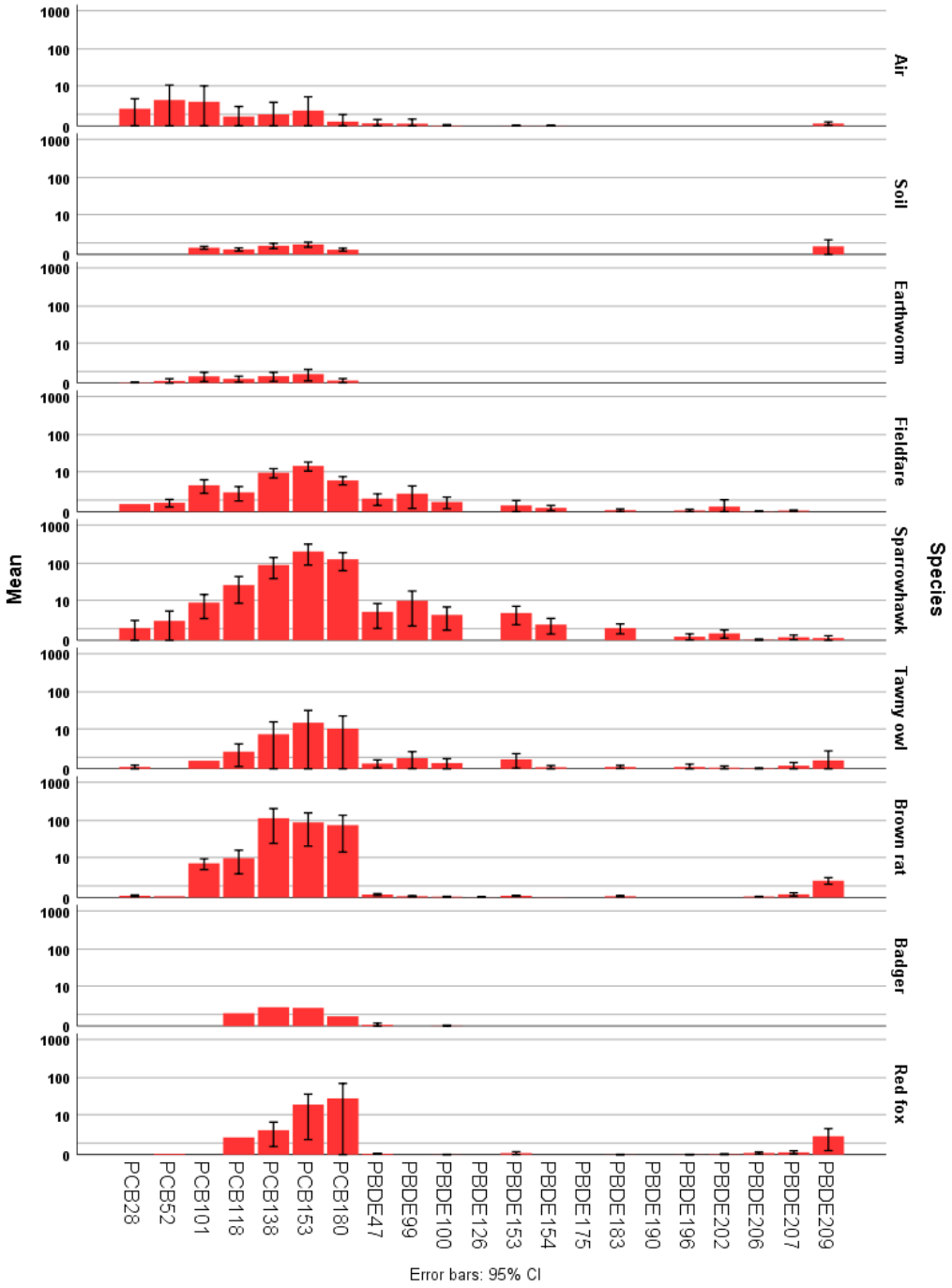


Figure 62: Mean concentrations of PCB and PBDE congener with standard deviations in the various samples from Oslo area, 2017. Mean sum concentrations are given as ng/sampler for air, ng/g dw for soil and ng/g ww for biota samples.

Figure 63 gives an overview of sum concentrations of the various PFAS groups and sumOPFRs. As seen from the figure, OPFRs have highest concentrations in air samples followed by earthworms and soil. The sulfonated PFAS (PFSA in tables) and carboxylated PFAS (PFCA in tables) are highest in earthworm and fieldfare, while the neutral PFAS (nPFAS in tables) is highest in brown rat and badger, and the new PFAS in brown rat.

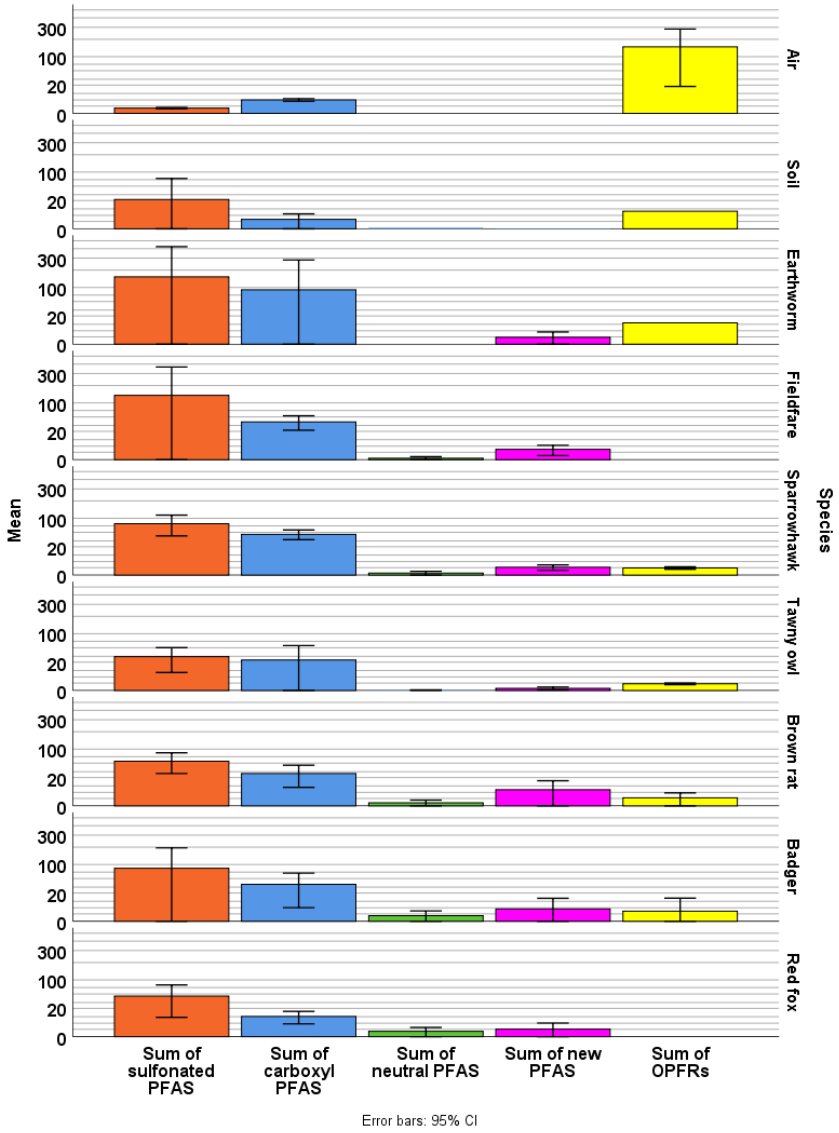


Figure 63: Mean sum concentration of the different PFAS group and OPFR with standard deviations across samples from Oslo area, 2017. Mean sum concentrations are given as ng/sampler for air, ng/g dw for soil and ng/g ww for biota samples.

Long-chained perfluorinated carboxylates are not the ones that are detected in highest concentrations in the samples, but some relatively high concentrations were detected in earthworm (261 ng/g ww for PFUnA and 107 ng/g ww for PFTriA) from Fornebu, and reported to show an increase in most temporal studies (Houde et al., 2011. Sturm and Ahrens, 2010). Figure 64 shows a comparison across species for the long chained perfluorinated carboxylates with 10 to 16 carbon atoms. For the other species, and especially bird eggs, the PFDoA (12 carbon atoms) and PFTeA (14 fourteen carbon atoms) are the dominating compounds.

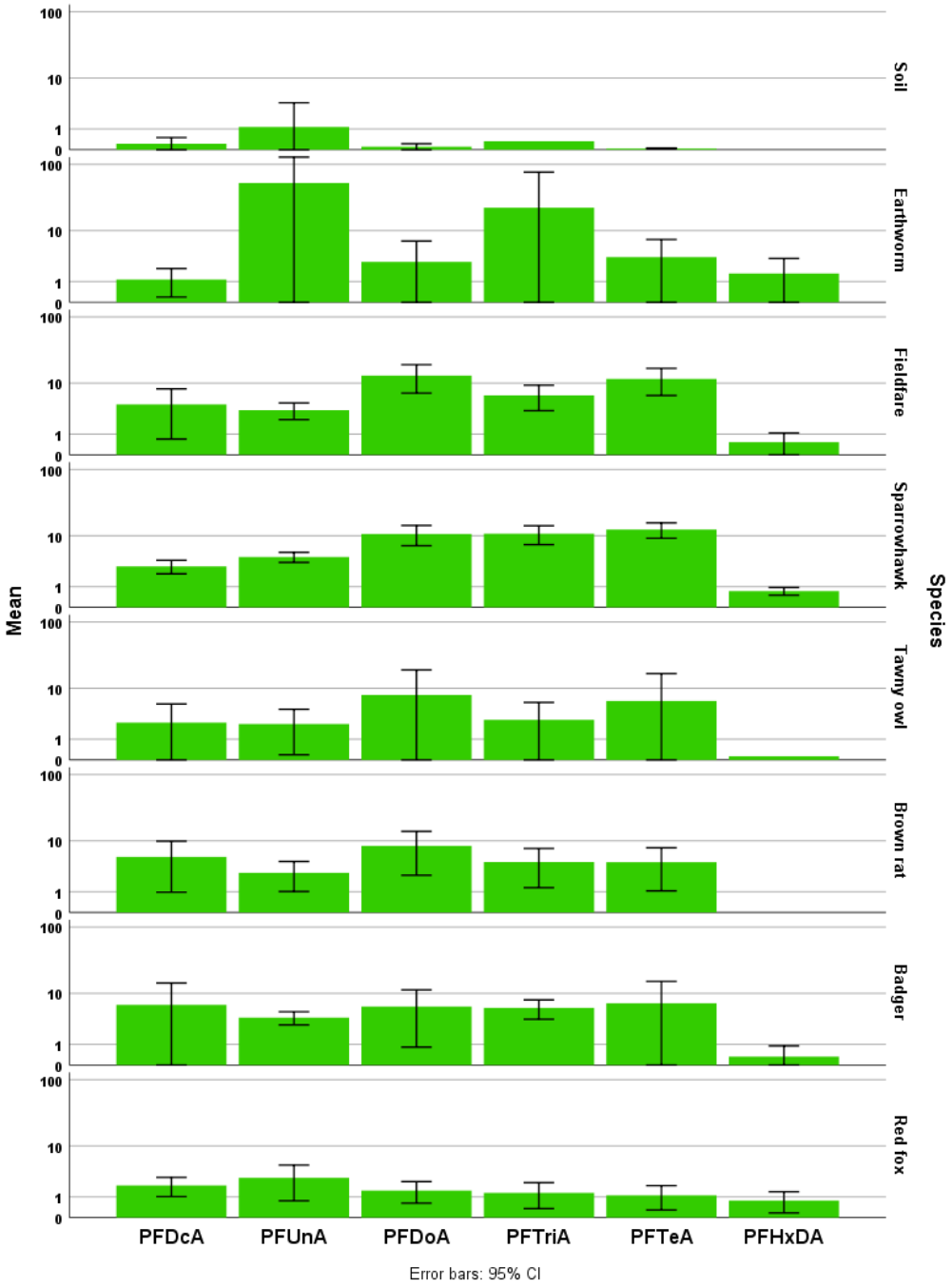


Figure 64: Comparison of mean concentrations with standard deviations of long chained carboxylates across samples and species. Mean sum concentrations are given as ng/g dw for soil and ng/g ww for biota samples.

When comparing various compound classes across species (Figure 65), mean sum concentrations of siloxanes dominate in air, chlorinated paraffins are highest in soil followed by brown rat, UV compounds highest in badger and brown rat, and biocides highest in red fox.

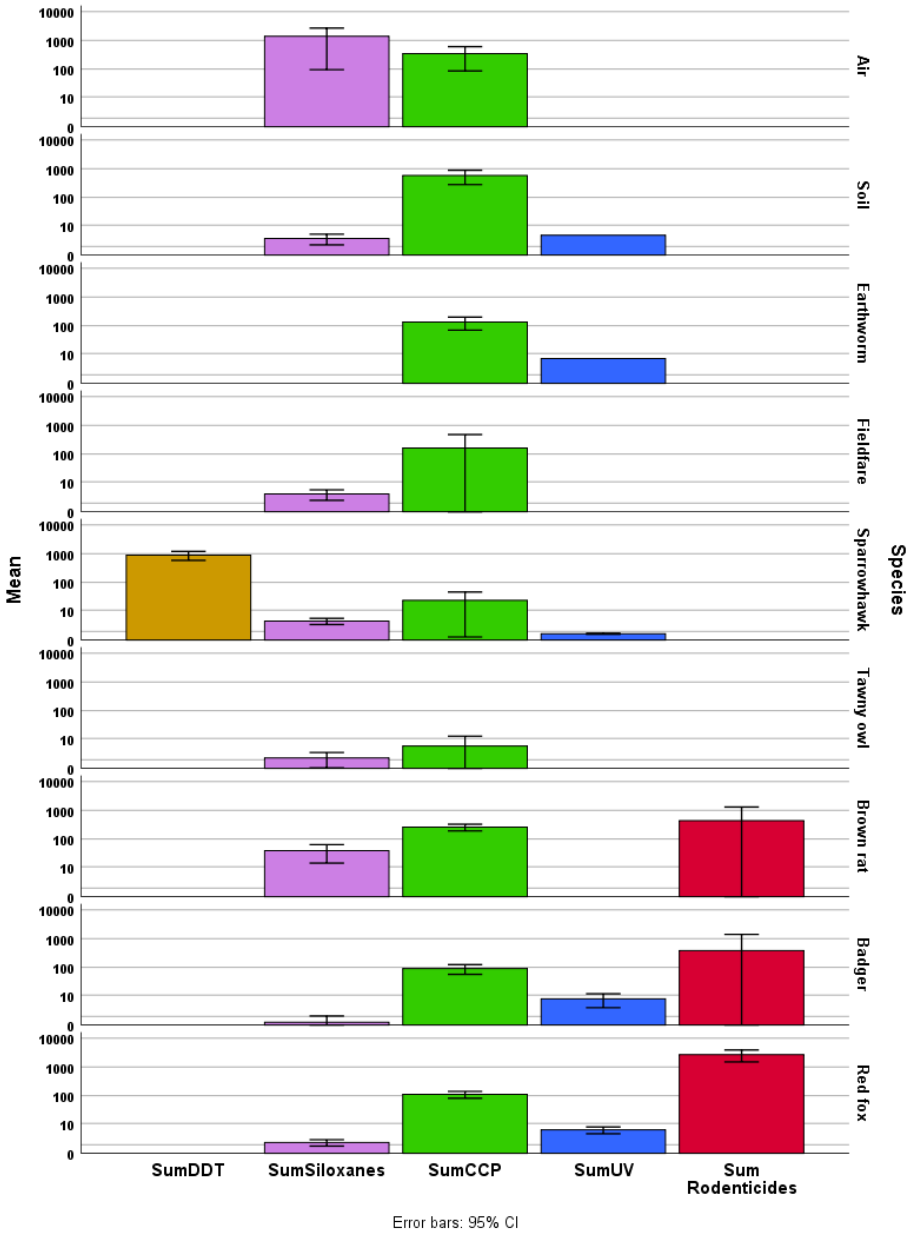


Figure 65; Comparison across samples and species for mean concentrations of SumDDT (only analysed in sparrowhawk eggs), SumSiloxanes, SumCCPS (chlorinated paraffins), SumUV compounds and Sumrodenticides (biocides). Mean sum concentrations are given as ng/sampler for air, ng/g dw for soil and ng/g ww for biota samples.

Since some compounds of cyclic siloxanes and chlorinated paraffins are recently being regulated and/or on the priority list of REACH and Stockhom convention, it is of interest to compare across species and to evaluate the potential for biomagnification (Figure 66). Among the species, siloxanes are detected in highest concentrations in brown rat. SCCP across species are highest in fieldfare and MCCP is highest in brown rat. Interestingly, MCCP is detected in comparable and/or slightly higher amount than SCCP in some species.

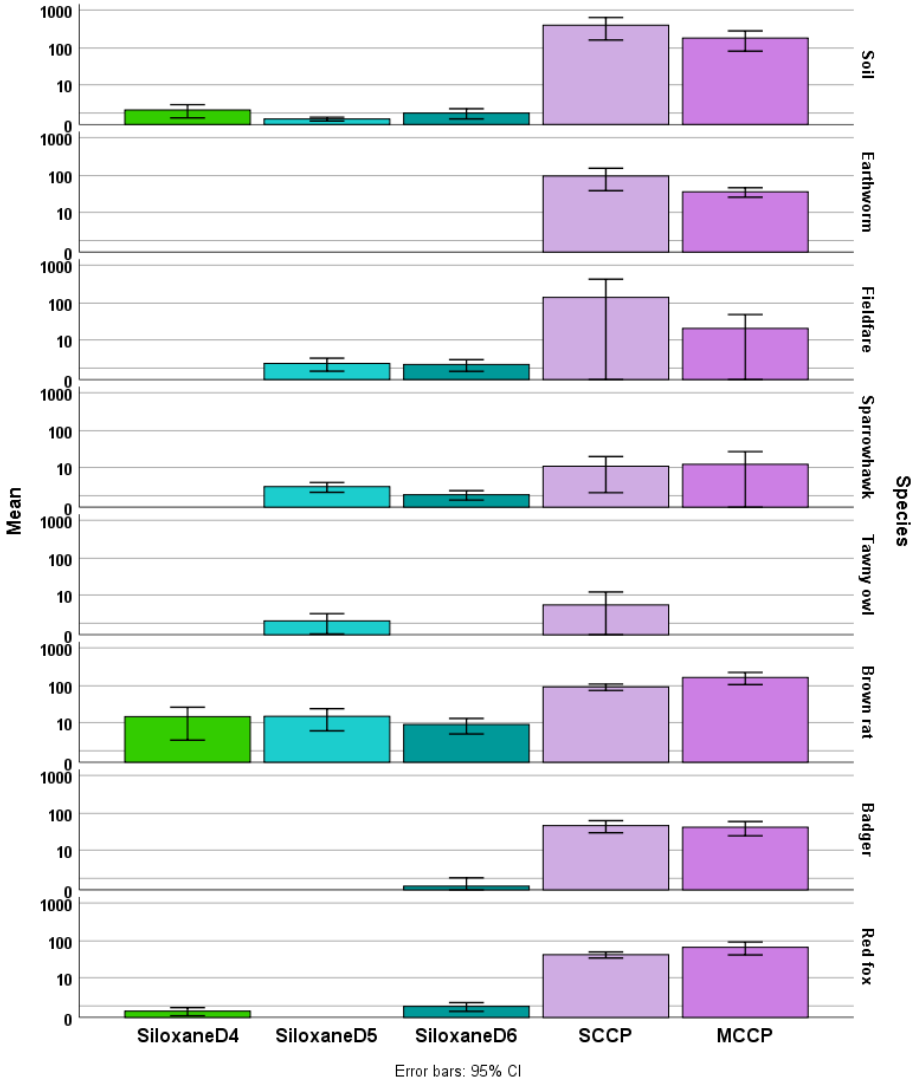


Figure 66: Comparison across species of mean concentration of cyclic siloxanes (D4, D5 and D6) and chlorinated paraffins (SCCP and MCCP). Mean sum concentrations are given as ng/g dw for soil and ng/g ww for biota samples.

Figure 67 shows comparison across species of mean concentrations of all compound classes investigated in 2017 from the Oslo area. This overview reveals clear differences, but also similarities, both in the presence and amount of contaminants. In air, OPFR, siloxanes and chlorinated paraffins are the dominating compound classes. In soil, metals (Hg, Cd, Pb and As) and chlorinated paraffins dominate, in earthworm metals, PFAS and CPs are highest. PFAS, CPs, dominate in fieldfare. DDTs (only measured in sparrowhawk), PCB and PFAS are dominating in sparrowhawk and tawny owl, and metals and biocides in brown rats, red fox and badger. Please note that comparison across species on a wet weight basis. Typical hydrophobic contaminants, for

instance PCBs, PBDEs, pesticides, dechloanes, will concentrate in lipids, and comparison across species and organs should ideally be done on lipid weight basis.

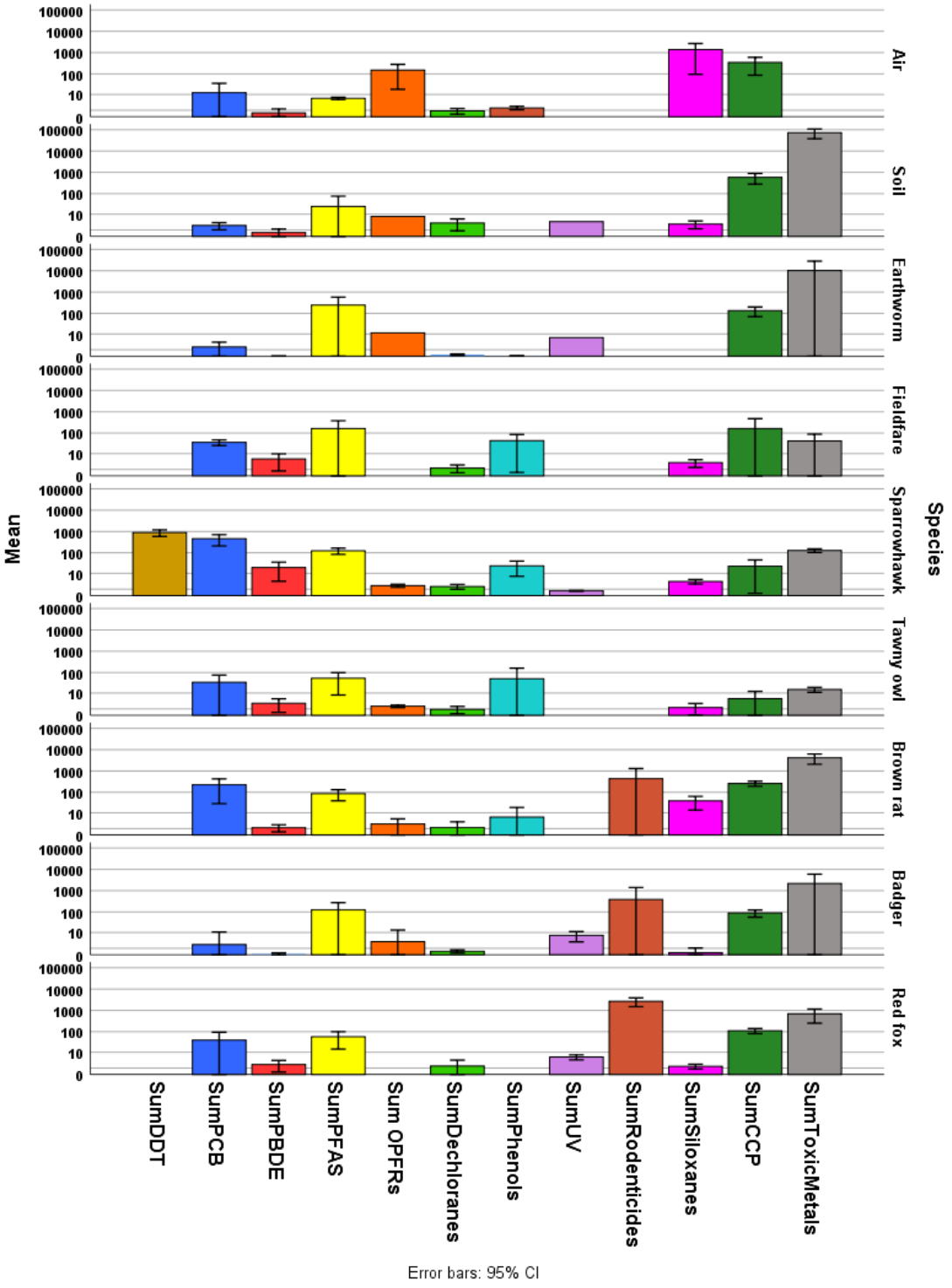


Figure 67: Comparison across species of mean concentrations in ww of all compound classes investigated in 2017 from the Oslo area. Mean sum concentrations are given as ng/sampler for air, ng/g dw for soil and ng/g ww for biota samples.

When removing the contribution of metals, and only comparing mean sum concentrations of organic pollutants and biocides across species, the red fox and sparrowhawk revealed highest

cumulated load due to the high concentrations of biocides for red fox and DDE and PCB burden in sparrowhawk. Badger liver samples have higher cumulative load compared to the bird eggs and earthworm, also due to a relative high contribution of biocides in addition to sumCPs and sumPCB. Soil with highest load of sumCP is in agreement with the total load in badger. Earthworm and fieldfare have almost same total load, dominated by PFAS and CPs, respectively.

For percentage distribution of the various pollutant groups in the various species, see Figure 69.

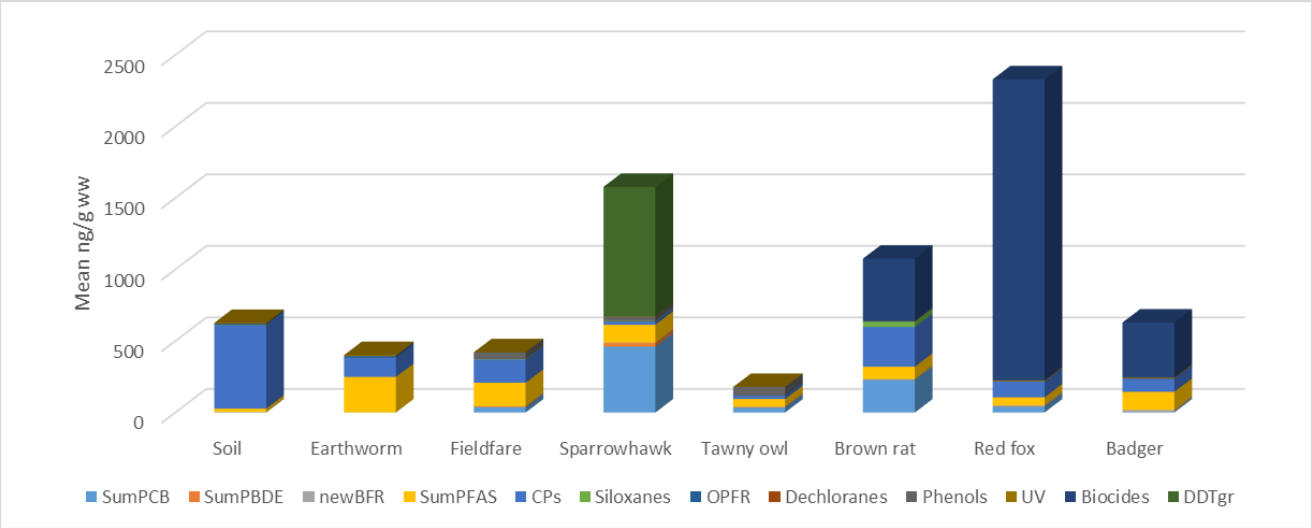


Figure 68: Mean sum concentrations of organic pollutants distribution in the various species. Air samples are omitted.

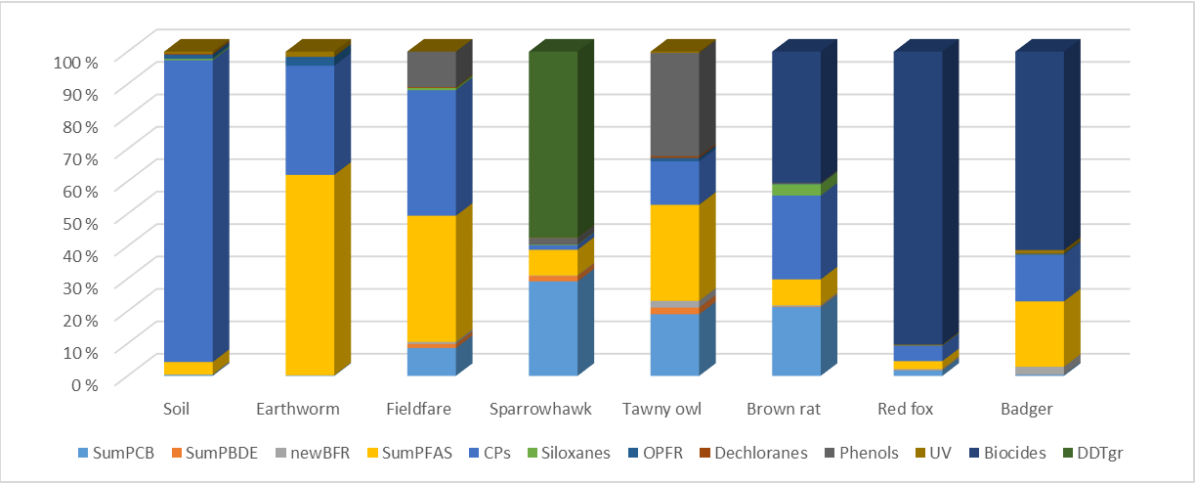


Figure 69: Mean percentage distribution of organic pollutants in the various species. Air samples are omitted.

3.14Bioaccumulation 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.

3.14.1 Results from stable nitrogen and carbon isotope analyses

δ^{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 60: $\delta^{15}N$ in the different sample types from the Oslo area.

Species	N	Mean	Median	Minimum	Maximum
Soil	5	4.78	5.73	3.16	5.91
Earthworm	5	4.74	4.73	3.04	6.75
Fieldfare	10	7.05	7.29	5.62	8.09
Sparrowhawk	10	7.54	7.77	6.23	8.43
Brown rat	9	8.19	8.13	6.65	10.0
Tawny owl	7	8.05	8.24	6.92	9.20
Red fox	10	8.58	8.34	7.91	10.6
Badger	3	7.16	7.14	6.75	7.60

According to the measured δ^{15}N data, the organisms included in this monitoring cover different trophic levels. Earthworms showed the lowest δ^{15}N which is consistent with the fact that it holds the lowest tropic position among the different organisms/species in this study, while rats and red foxes were at the highest. Sparrowhawks, tawny owls and fieldfares were closely together in between.

Figure 70 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.

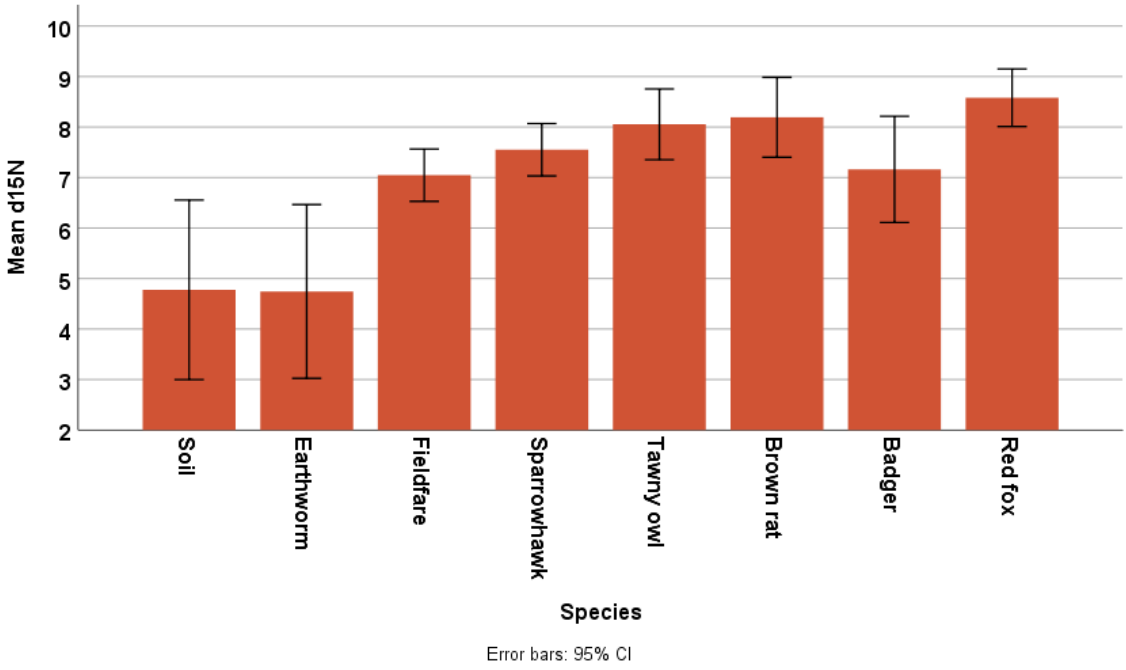


Figure 70: Mean $\delta^{15}N$ concentrations in all species analysed (‰).

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 study, the brown rat and the red fox were characterized by the highest $\delta^{15}N$ concentrations (mean of 8.2 and 8.6 respectively), followed by tawny owl (8.1), sparrowhawk (7.6), badger (7.2), fieldfare (7.1) and earthworms (4.7). Soil showed an average $\delta^{15}N$ of 4.8, which was higher than the mean value of 2.1 from 2016. Fieldfare and badger are known to prey on earthworm and showed very similar $\delta^{15}N$ values. In the literature $\delta^{15}N$ were reported for polar fox, varying between 10 and 12 ‰ (Andersen et al., 2015). Similar to the 2015 and 2016 data, the finding that the sparrowhawk had relatively low levels of $\delta^{15}N$ was quite surprising, and may indicate that the fractionation rate in this species or its prey species is different than expected, but it might more likely be caused by the fact that the prey of the sparrowhawk is almost dominated by terrestrial prey (Hagen, 1952). Also like the 2016 findings, 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 $\delta^{15}N$ concentrations. Still, these findings were surprising, and deserve further study of their respective prey items. 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 analyzed 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 differences in $\delta^{13}C$ concentrations found in sparrowhawk eggs ranged between -26.2 to -24.5 (Table 61, Figure 71), but with a mean of -25.5. For comparison with the marine food chain, a range of $\delta^{13}C$ concentrations between different gull species of -17 to -25 has been reported previously (Gebbink and Letcher 2012; Gebbink et al. 2011). Tawny owl eggs showed the lowest $\delta^{13}C$ of all biota samples (average of -28.3), indicating a $\delta^{13}C$ depleted food source such as rodents from the 2016 data (one sample -28.3). Herring gull eggs sampled in Oslo in 2014, showed a median $\delta^{13}C$ of -26.4, indicating a terrestrial prey source similar to the fieldfare from our present study (median -26.6, mean -26.7).

Red fox and brown rat liver showed similar concentrations, averaging at -25.1 and -25.2, respectively. Earthworm and badger had also quite similar $\delta^{13}C$ concentrations with average values of -25.8 and -25.7 ‰ respectively, Figure 71, indicating that most species are part of a similar food chain, feeding on terrestrial food items.

Table 61: $\delta^{13}C$ levels in the different sample types.

Species	N	Mean	Median	Minimum	Maximum
Soil	5	-26.87	-27.58	-28.23	-23.71
Earthworm	5	-25.76	-25.47	-27.64	-25.01
Fieldfare	10	-26.68	-26.63	-27.38	-26.26
Sparrowhawk	10	-25.45	-25.57	-26.18	-24.50
Brown rat	9	-25.24	-25.16	-26.44	-24.77
Tawny owl	7	-28.29	-28.18	-29.69	-27.04
Red fox	10	-25.14	-25.06	-26.64	-23.66
Badger	3	-25.70	-25.67	-26.30	-25.14

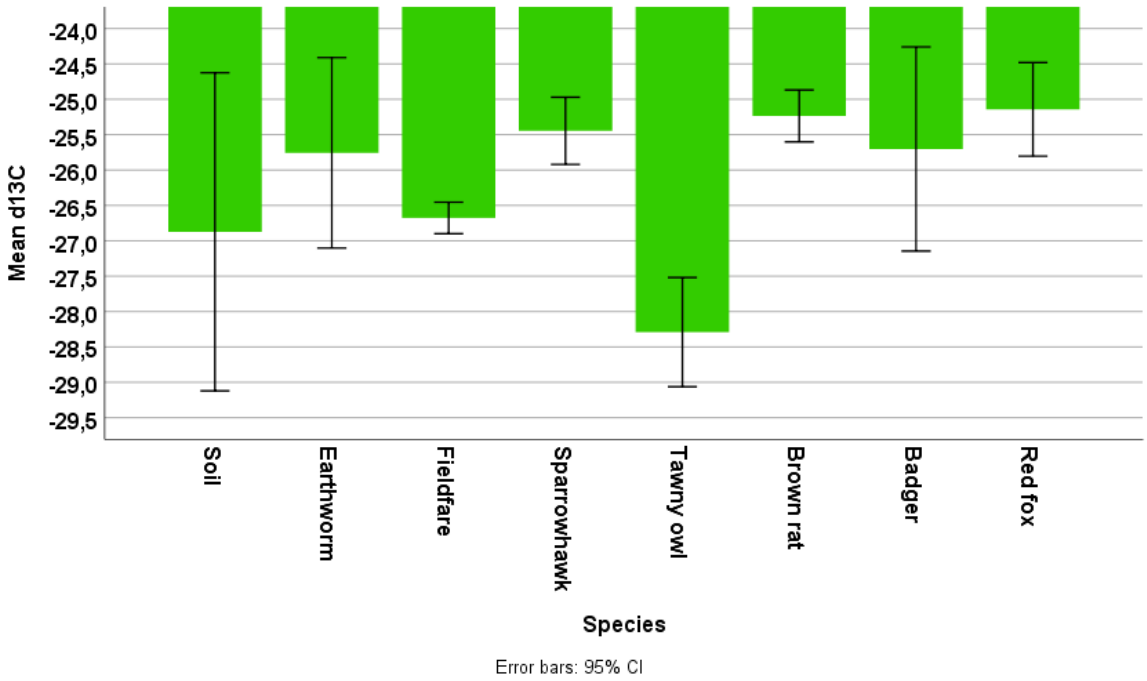


Figure 71: Mean δ^{13}C concentrations in the different species analysed.

δ^{34}S values provide information regarding the foraging ecology of certain species. Marine sulfate generally has higher δ^{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 72 illustrates the four foraging groups from Lott et al., 2003. Sparrowhawk would belong to the bird eater category, tawny owls belong to the generalist's category and fieldfare to the inland generalists. The investigated mammals are in the same range as the sparrowhawk.

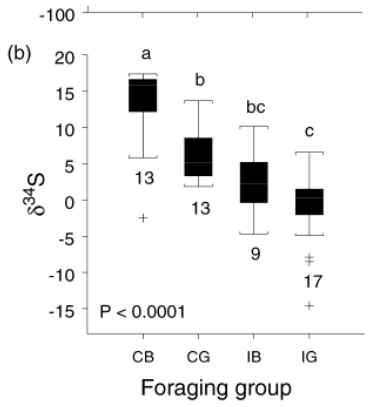


Fig. 2 Box plot showing the central 50% (*boxes*) and range (*lines*) of **a** δD_{f-p} and **b** $\delta^{34}S$ for four foraging groups of raptors: coastal bird-eaters (*CB*), coastal generalists (*CG*), inland bird-eaters (*IB*), and inland generalists (*IG*). Letters above boxes indicate group membership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

Figure 72: Boxplot illustrating δ ^{34}S relationships in respect to foraging strategies in raptors, taken from (Lott et al., 2003).

Table 62: $\delta^{34}S$ levels in the different sample types.

Species	N	Mean	Median	Minimum	Maximum
Earthworm	5	-1.17	1.28	-11.90	4.33
Fieldfare	10	3.34	3.61	0.60	5.40
Sparrowhawk	10	6.71	6.84	5.71	7.32
Brown rat	9	2.96	3.25	0.88	4.06
Tawny owl	7	6.11	6.20	5.59	6.80
Red fox	10	5.18	4.96	4.32	7.63
Badger	3	2.59	3.57	0.48	3.73

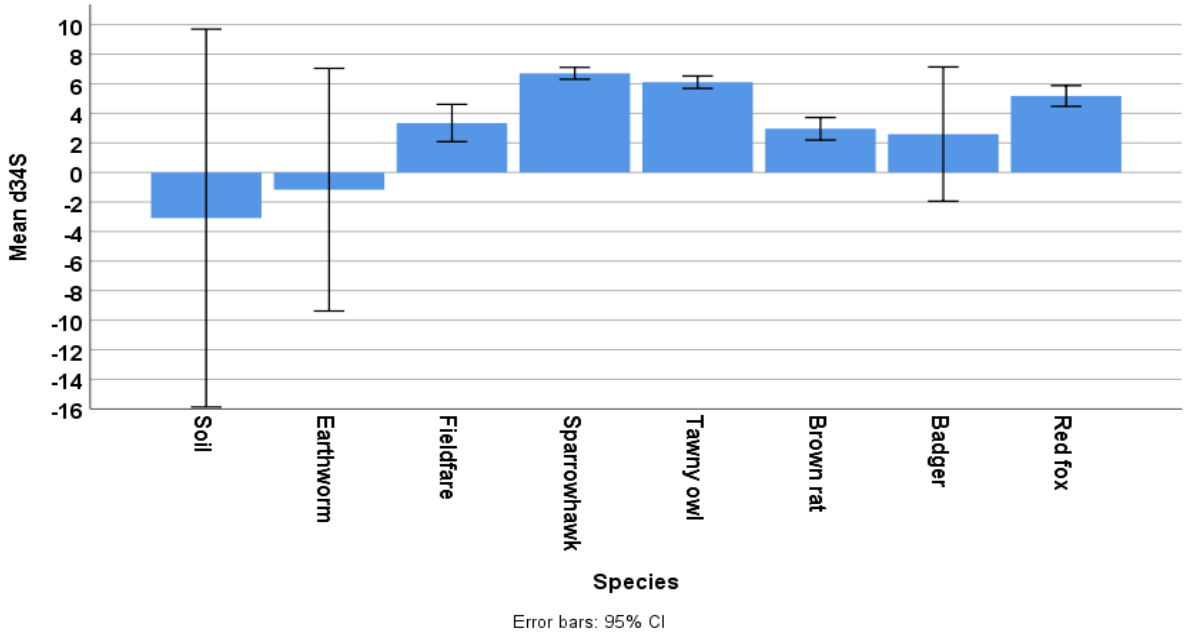


Figure 73: δ^{34}S data measured in the urban terrestrial environment in the Oslo area.

However, according to the δ^{34}S data acquired in this study, no clear grouping into foraging classes of the here observed birds of prey, sparrowhawk and tawny owl, can be found (overlapping of data). Fieldfare as a terrestrial omnivore (seeds, berries, earthworms and insects), on the other hand, shows a distinction to the other bird species, overlapping earthworm data, as opposite to tawny owl and sparrowhawk, which are clearly distinguished from the 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, showing differences between tawny owl, sparrowhawks and fieldfare with some overlap, spanning more than one trophic level, but without any distinct clustering of the species, indicating a more complex food web rather than a food chain, Figure 74. Soil and earthworm values are pretty similar, which was not surprising. The tawny owl distinguish itself from other species, which is surprising, as we would expect some overlap with the red fox, as they both feed on rodents. But there may be differences in fractionation processes between birds and mammals lying behind. The fieldfare, sparrowhawk and tawny owl data show little spread, indicating a rather narrow food niche. The omnivores, rat and fox have a large spread in their values, indicating a wide food-niche, which was expected. The variation in δ^{13}C values in earthworm is difficult to explain, as we know little about the diet of earthworms, except that they feed on organic matter in the soil where they live. The badger data was too few to evaluate. In general, little stable isotope data exist from terrestrial food chains like the one sampled here. The difference may depend on the local origin and parent organisms of this organic matter, and on different species of earthworms involved, but this is only open to speculations.

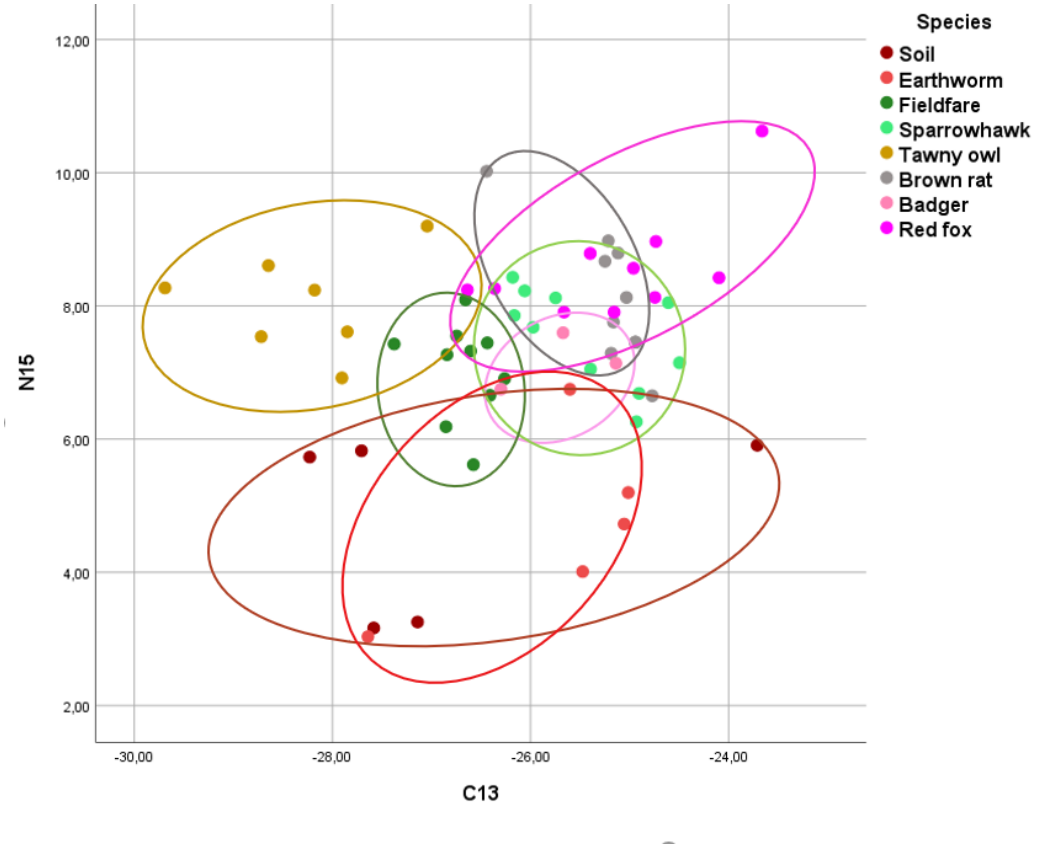


Figure 74: Relationship between the dietary descriptors $\delta^{15}N$ and $\delta^{13}C$ in biota from urban terrestrial environments.

3.14.2 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 (tawny owl, 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 (Figure 75). Within the frame of this study, the foodchain earthworm – fieldfare– sparrowhawk was included, enabling the estimation of the TMF. Note that these predictions do not include whole organisms of fieldfares and sparrowhawks, only the eggs.

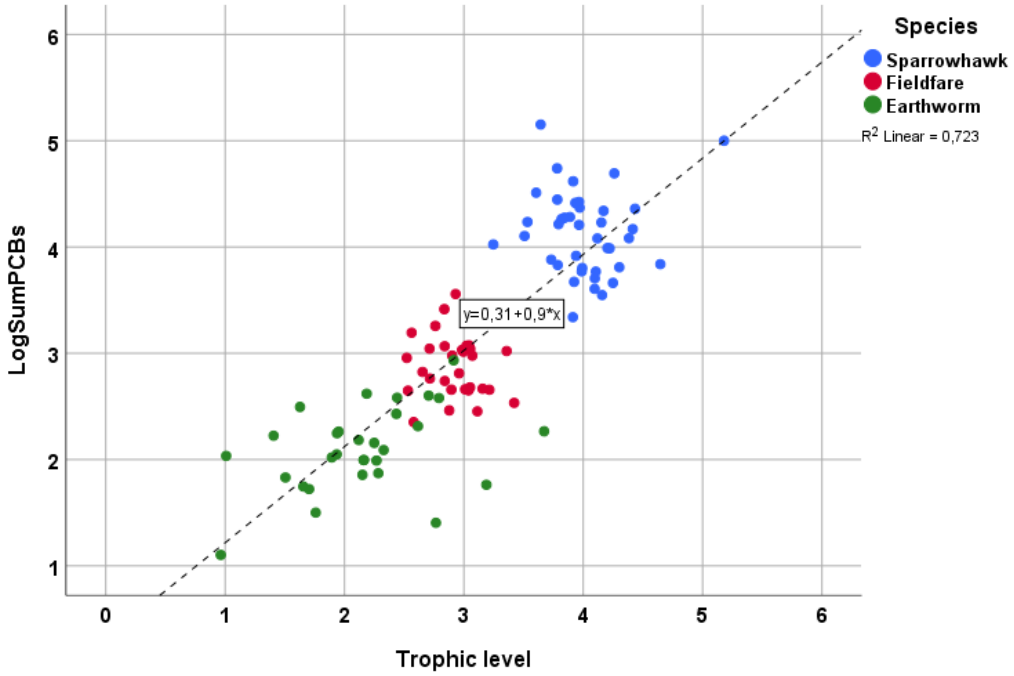


Figure 75: Relationship between trophic level and SumPCB from 2014-2017 datasets, concentrations in ng/g lw.

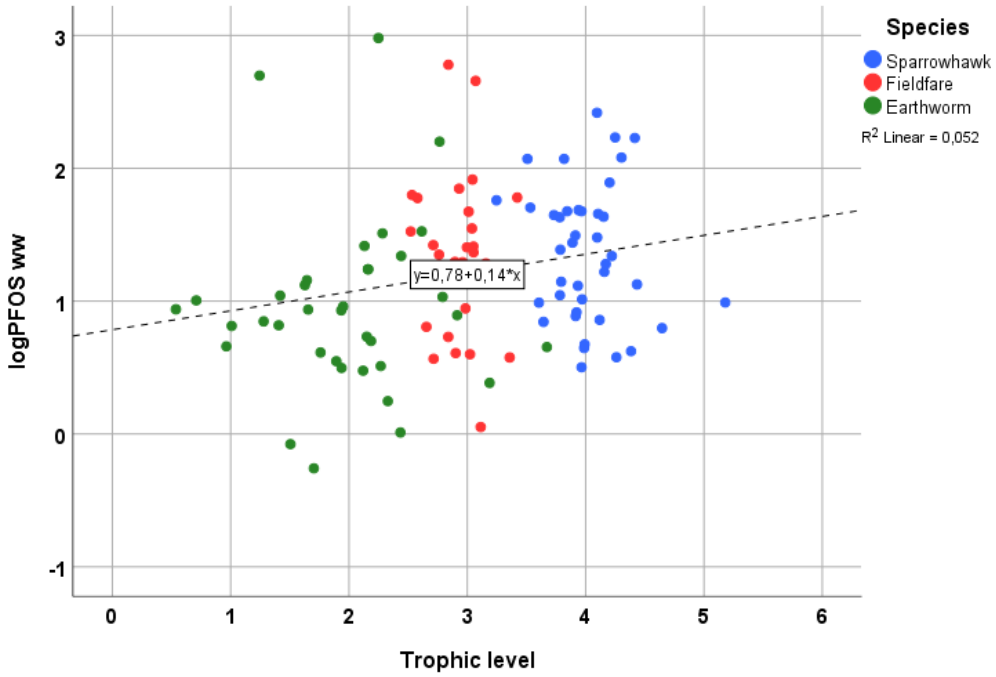


Figure 76: Relationship between trophic level and PFOS from 2014-2017 datasets, concentrations in ng/g ww.

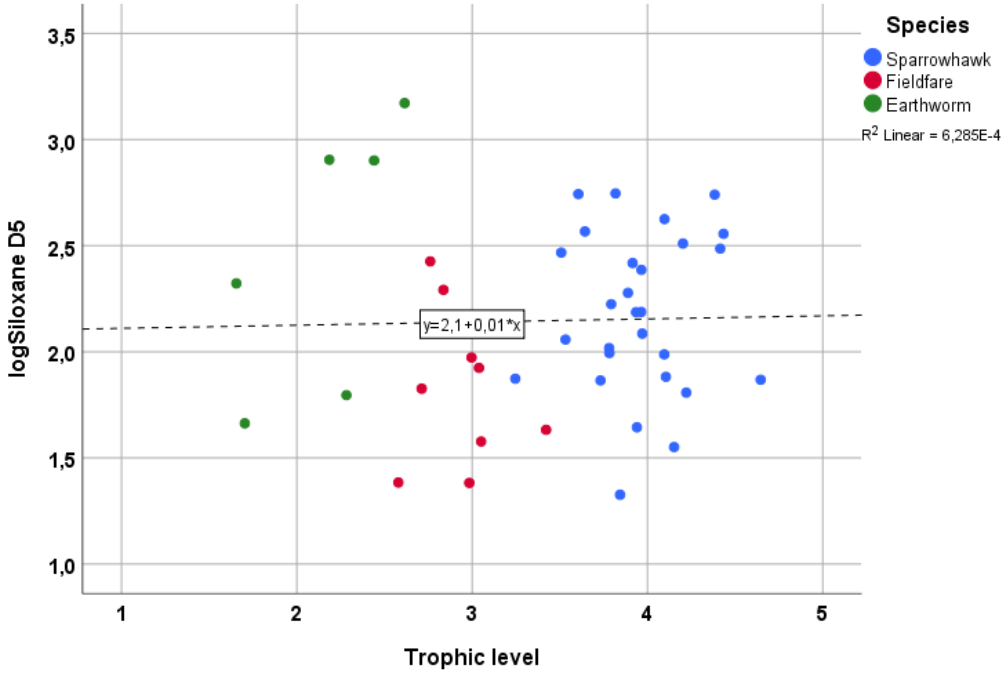


Figure 77: Relationship between trophic level and D5 from 2014-2017 datasets, concentrations in ng/g lw.

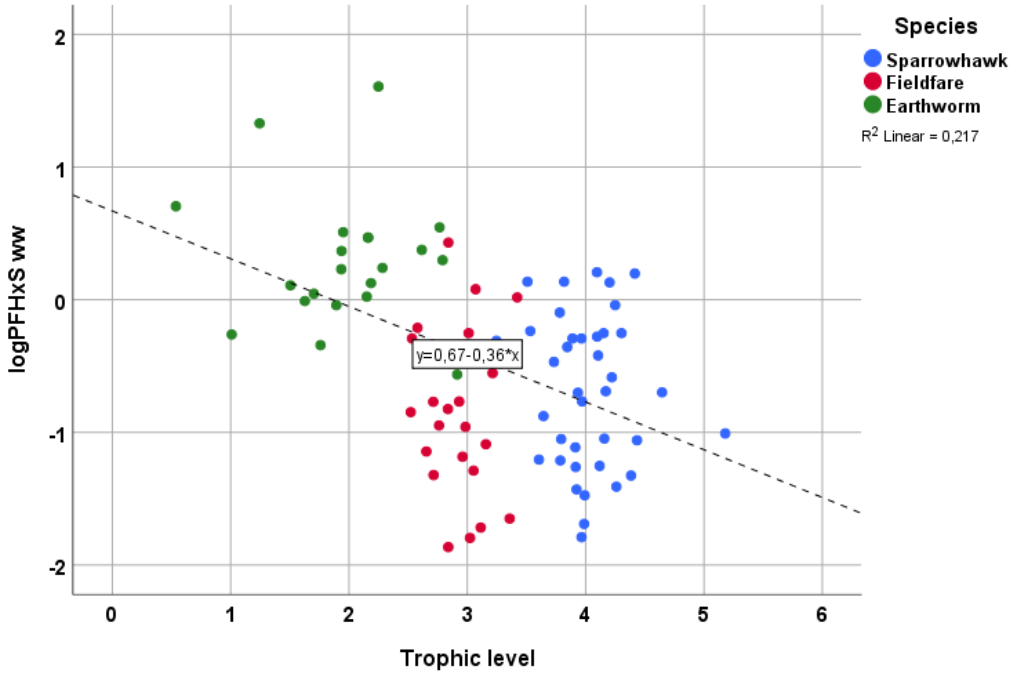


Figure 78: Relationship between trophic level and PFHxS from 2014-2017 datasets, concentrations in ng/g ww.

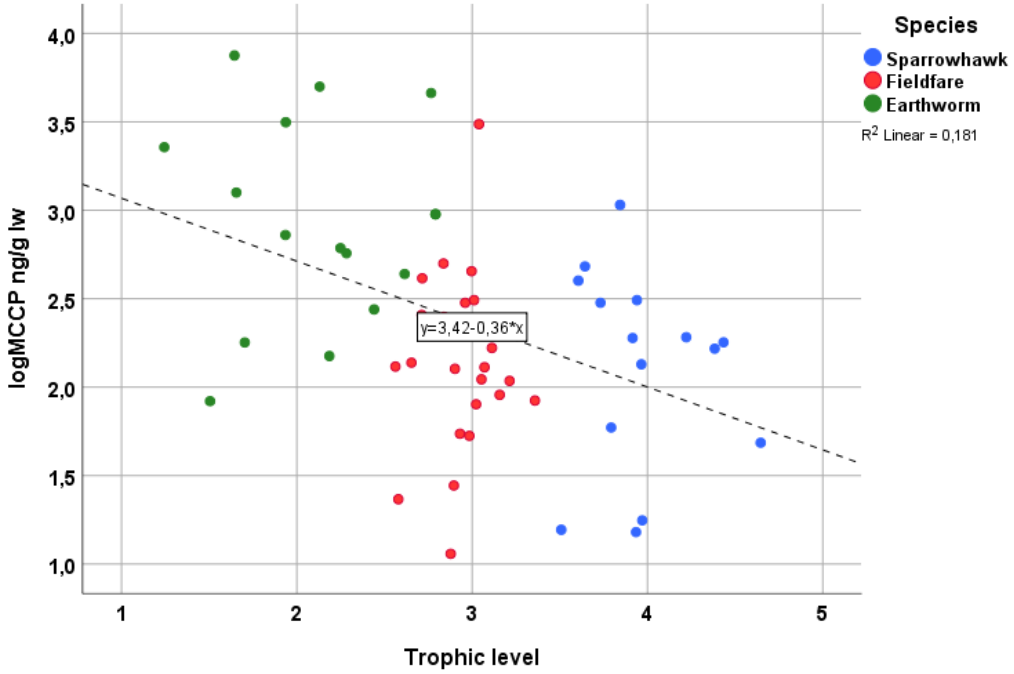


Figure 79: Relationship between trophic level and MCCP from 2014-2017 datasets, concentrations in ng/g lw.

The red fox, brown rat and tawny owl were omitted from the calculations, as they do not belong to the studied food-chain, due to their omnivore diet. We obtained the following TMFs for Oslo, based on lipid concentrations and on a wet weight basis for PFOS, for four years dataset (2014-2017) using the equation Log [compound] = a + *b*TL, and TMF = 10^b:

TMF's based on four years of data, 2014-2017 (on ww basis for PFAS and on a lw basis for all other substances)

	SumPCB	SumPBDEs	PFOS	PFUnA	PFHxS	D5	SCCP	MCCP
TMF	7.9	4.4	1.4	1.7	0.44	1.0	0.8	0.6

TMFs >1 indicate biomagnification of these compounds in the terrestrial foodchain. In respect to these criteria, PCBs and PBDEs bioaccumulate in the observed food-chain. PFOS and PFUnA show a moderate biomagnification across trophic levels in the studied foodchain, while e.g. PFHxS, do not biomagnify, but decrease with trophic levels. Loi et al 2011 reported comparable 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 and PFUnA, and further concluded that the biomagnification process was mainly dependent on the fluorinated chain and not on the functional group of PFCAs and PFSAs.

Only datasets with more than 60 % detection of the respective compounds measured in earthworm, fieldfare and sparrowhawk were used for TMF calculations. For the dechloranes, dec-602 was not detected above LOD in earthworms. The calculated BMF (sparrowhawk egg/fieldfare egg) based on lipid normalised concentrations for syn-DP, anti-DP and dec-602 was

1.9, 1.4 and 2.0. However, only egg in both predator and prey were used in this BMF calculation, and not the whole animals, and with the assumption that fieldfare (egg) was the only prey for sparrowhawk.

Following TMFs were found from previous years; a reference location in 2014 (Herzke et al., 2015) and in Oslo in 2015 and 2016 (Herzke et 2016; 2017), showing approximately the same levels of biomagnification.

	2014 dataset Herzke et al. 2015	2015 dataset Herzke et al. 2016	2016 dataset Herzke et al. 2017
SumPCBs:	10.2	11.5	9.8
SumPBDEs:	6.0	6.3	5.2
SumPFAS	1.4	1.3 (PFOS)	1.1

3.15 Changes over time of pollution loads in bird eggs

Data acquired within the past four years of this project for sparrowhawk, tawny owl and fieldfare (2014/5 - 2017) were used to assess potential changes over time. No statistical trend analysis was performed due to insufficient data material.

Data from soil and earthworm locations were omitted since the data from the five sites have revealed high variability across sites, and also since some localities have changed during the years. The sites for rats varied even more due to hot spots and the omnivorous feeding strategy of rats, and were therefore omitted. Changes over time of a broad variety of pollutants within the frame of this study in foxes were reported in 2016 and not repeated here.

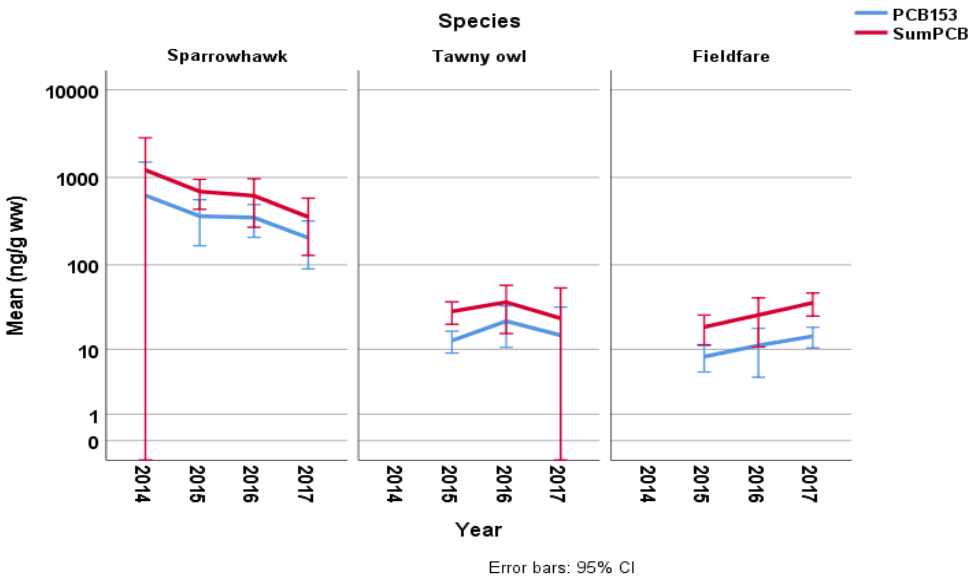


Figure 80: Changes over time of mean concentrations (ng/g ww) with standard deviations of PCB153 and SumPCB.

As Figure 80 shows, PCB concentrations in sparrowhawks seem to drop slightly (not significantly), and no indication of change for tawny owls and fieldfares.

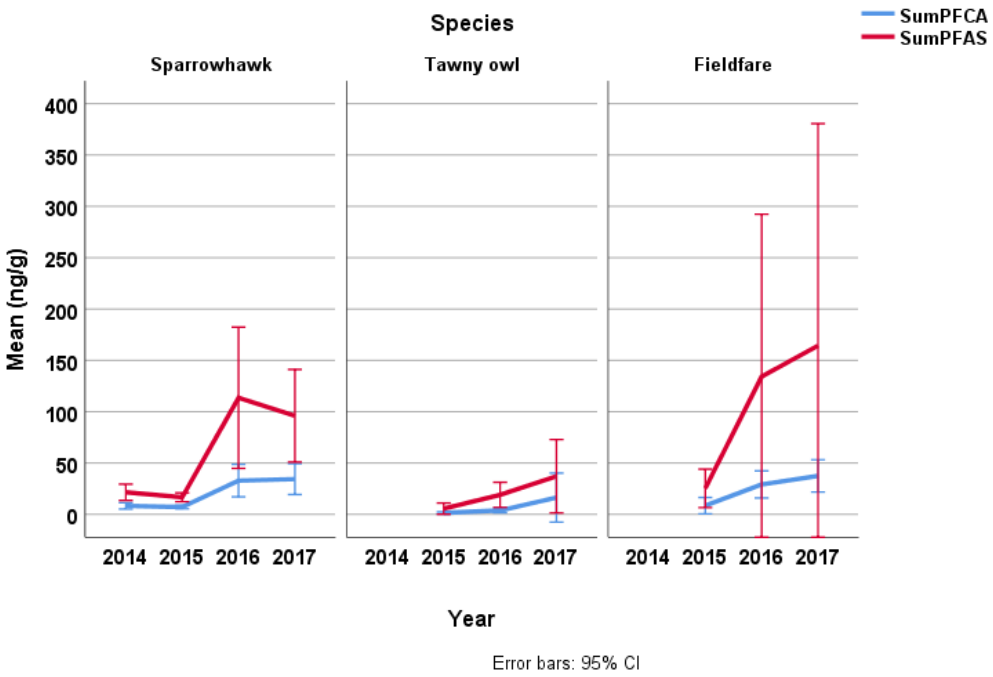


Figure 81: Changes over time of mean concentrations (ng/g ww) with standard deviations of sumPFCA and SumPFAS

For PFAS and PFCAs in general (Figure 81), large intra- and inter-year variations are indicating no significant change over time in any of the observed bird species, proving the need of longer time series for the establishment of trends.

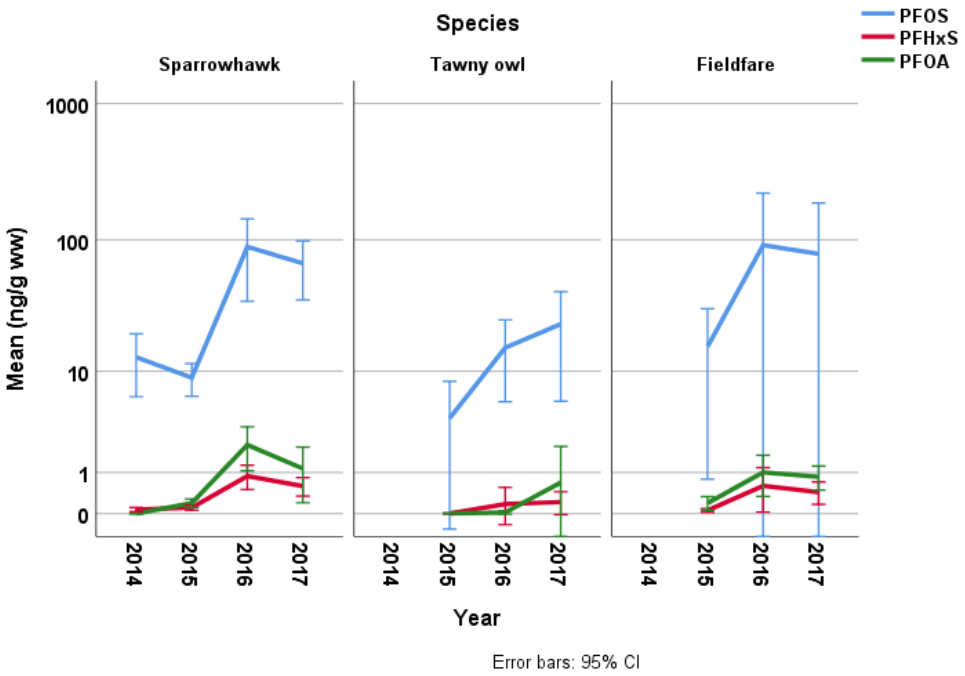


Figure 82: Changes over time of mean concentrations (ng/g ww) with standard deviations of PFOS, PFHxS and PFOA

When only selecting the main PFAS, PFHxS, PFOS and PFOA, a similar picture appears (Figure 82), with no significant changes and large intra- and inter-year variations, especially for PFOS.

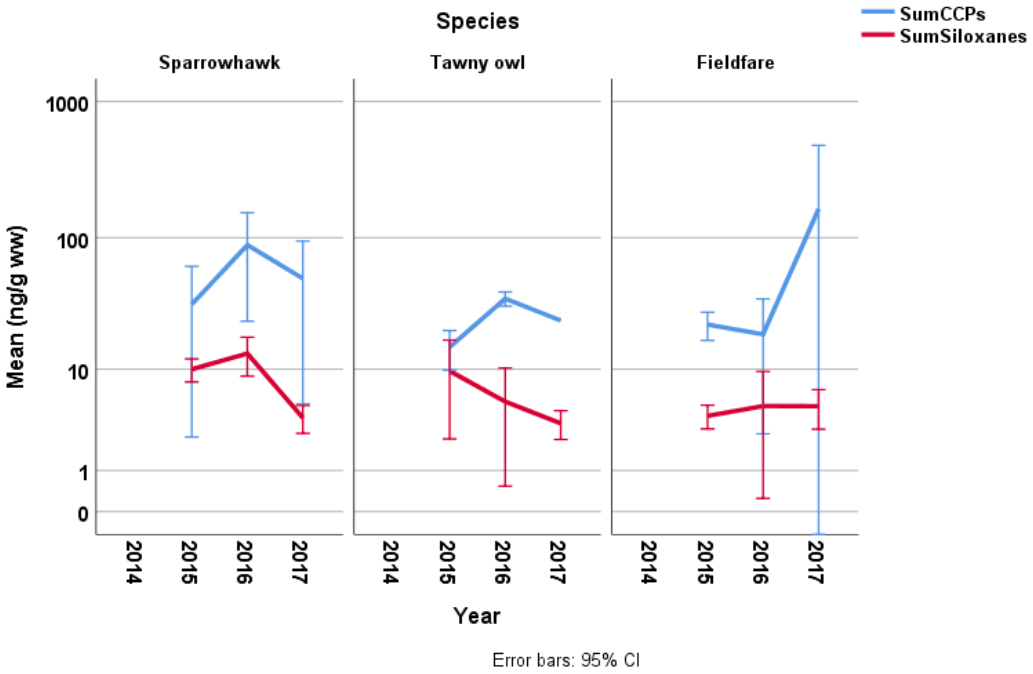


Figure 83: Changes over time of mean concentrations (ng/g ww) with standard deviations of SumSiloxanes and SumChlorinated paraffins.

Sofar, only three years of measuring siloxanes and CPs prevent any assessment of changes over time, but are valuable nevertheless in illustrating the individuality of the observed bird species as well as differences between years.

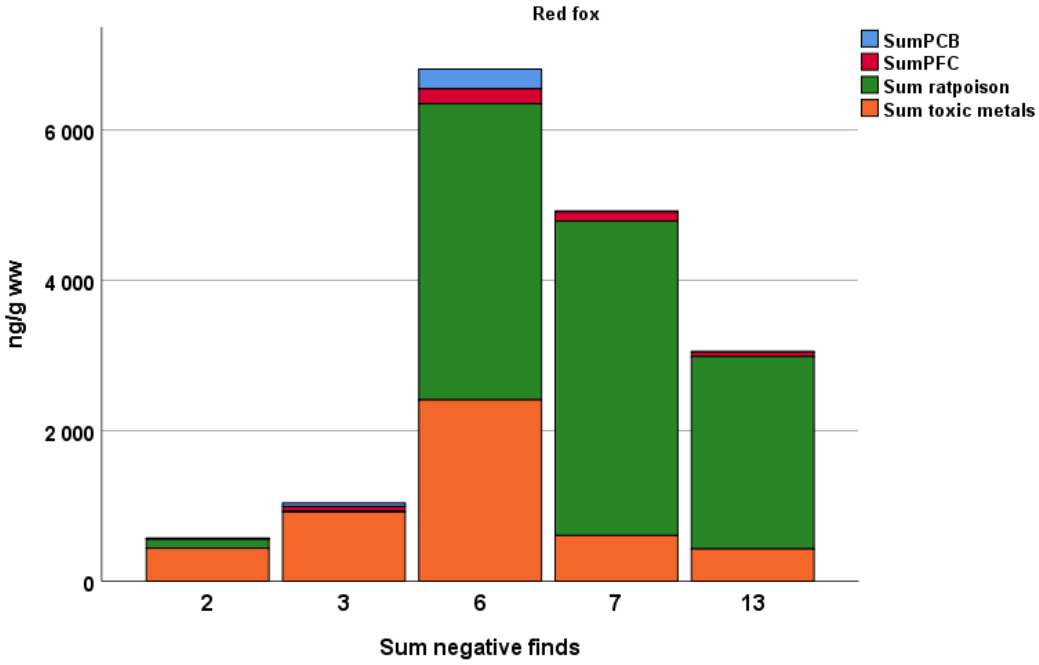
4. Pathology and pollutants

A necropsy was performed on 10 rats and five foxes at the laboratory at NINA in Trondheim by a trained veterinary pathologist and certified wildlife population health specialist (Dr. Bjørnar Ytrehus.) The necropsy was performed according to standard routines at NINA and included gross examination of all organ systems. In the foxes we also performed a routine histological examination of tissue samples from myocard, lung, liver, spleen, kidney and any lesions found. One of the foxes (RR1196, NILU id 17/1433) was cachectic and suffered from lesions consistent with an old trauma to the right hindleg, where it had severe, chronic gonitis and chronic necrotizing myositis of musculus biceps femoris with granulation tissue and fibrosis, resulting in contraction of the muscle and flexion of the knee. This animal also had severe gingivitis and multiple abscesses in its cranial lung lobes, and it had numerous nematodes (ascarids) and tape worms in its intestines. Two of the other foxes had moderate numbers of old focal lesions in lung and liver consistent with parasite migration. None of the foxes had any signs of ectoparasite infestation. Another fox (RR1193, NILU id 17/1446) had severe dental wear. Its stomach content was dominated by mussels, a quite unusual diet.

A broad spectre of parameters were noted: Body condition, General looks, corpus, digestive channel, liver, spleen and pancreas, kidney, sexual organs, lungs, heart, head, endocrine and lymphatic system, joints and skeleton, histological diagnosis, general diagnosis. No animals had mites or scabies. A total of 15 variables connected with the health status of the animals were registered. They were classified subjectively as good, neutral or bad. The number of ‘bad’ findings were summed for each individual. The five foxes had 2,3,6,7 and 13 negative finds each. The seven rats with complete datasets had 0 (2 ind.), 1, 2 (3 ind.) and 3 negative finds each. A total of five foxes and ten rats were necropsied (three of which with no pollutants analysed for). Apart from one rat (6383, part of NILU id 17/1455) which had a round, well-defined, pale and homogenous tumor with a diameter of 18 mm adherent to its thoracic spine, no signs of disease were observed on the rats. Most of them (8 of 10) were in below average condition. The two that were in average condition were a female pregnant with eight fetuses (6371, NILU id 17/1450) and a male with large testes (6373, part of mixed sample) compared to the other males. Because livers of some of the rats were lumped together to improve the detection of rare pollutants, they could not be used in this context, as pollutant levels thus could not be linked to individuals. The coarse and summarised findings are shown in Figure 84. In general, there was a tendency of the animals showing highest number of pathological findings to have the highest levels of pollutants. The figures do not take into account the toxic effects of the different pollutants, they are only showing the total load of the most common pollutants, and we are not attempting to evaluate their potential effect on the different animals. The foxes showed much higher levels of rat poison than the rats themselves. We suspect that this may be an effect of ingestion of rats or other animals that have been exposed to rat poison, and perhaps had been affected in a way that have made them vulnerable to predation. Sum toxic metals is the sum of Pb, Hg, Cd and As. Among these, Pb was the dominating metal. Sum ratpoison is the sum of

three different compounds, Bromadiolone, Brodifacoum and Difenacoum, among which Bromadiolone was the dominating poison. The findings indicate a link between the load of pollutant to the health status of the animals, but whether the health status is influenced by pollutant levels, or if animals of low health status are more prone to ingest foodstuffs that are more polluted is impossible to conclude from this limited survey. More research is needed to give insight into that question.

The rats examined may not be representative for the population, as most of them seem to be juvenile animals below average condition. However, we do not have any knowledge of the demography of the rat populations in Oslo and do consequently not have any background for a discussion of this. More knowledge should in our opinion be sought, as an animal's social status may affect its habitat and food choice and thereby its exposure to contaminants.



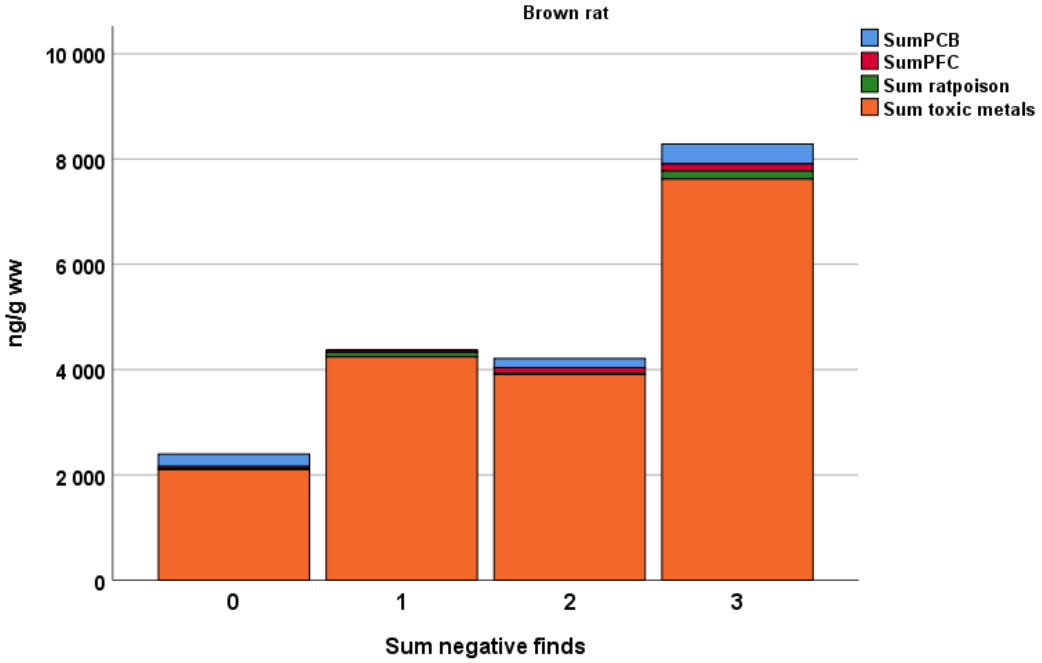


Figure 84: Sum negative finds in red fox (upper) and brown rats (lower) in relation to levels of selected groups of poisons and pollutants. The x axis denotes the number of negative finds in animal, and the y axis the average levels of selected poisons and pollutants for each category on the x axis.

5. Conclusions and Recommendations

The concentration of the main contaminant group in the investigated species was as follows (on a wet weight basis):

The average of sum concentrations of the various contaminant group in the investigated species in 2017 was as follows (on a wet weight basis): Note that pesticides were only measured in sparrowhawk eggs.

- Air : SumSiloxanes >> SumCPs >SumOPFRs
- Soil : SumMetals > SumCPs > SumPFAS
- Earthworms : SumMetals >> SumPFAS >SumCPs
- Fieldfare : SumPFAS~SumCP> SumPhenols ~ SumMetals > SumPCB
- Sparrowhawk: Sum Pesticides > SumPCBs > SumMetals~SumPFAS
- Tawny owl : SumPhenols ~ SumPFAS ~ SumPCB> SumCPs> SumMetals
- Red fox : SumBiocides > SumMetals > SumCPs>SumPFAS~SumPCB
- Brown rat : SumMetals > SumBiocides> SumCPs ~ SumPCB > SumPFAS
- Badger : SumMetals > SumBiocides> SumPFAS> SumCPs

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 indicated trophic magnification for PCBs, PBDEs and PFOS in the terrestrial food chain, also in agreement with published literature on fresh- and marine food webs (Ruus et al., 2017; Munoz et al., 2017; Zhou et al., 2016; Walters et al, 2011).

A successful campaign for collecting sparrowhawk egg was conducted in 2014, 2015, 2016 and 2017. It shows high levels of pollutants, and shows eggshell thinning compared to pre-DDT levels. We recommend to carry on using this species as a true trophic level 4 representative for long-term studies.

Experience from this monitoring program with sampling same species from same locations indicate that the species fieldfare is maybe more affected by local pollution sources than first expected. Egg from this species may reflect and act as marker for local polluted areas. This has been seen for the following contaminants and locations: Pb at Kjelsås, linear and branched PFOS at Grønmo in 2016 and 2017, and possible SCCP at Bøler with high concentration in 2017. Alnabru is highly polluted for PFAS as reflected in soil and earthworms samples from several years, and it is recommended to collect fieldfare eggs from this location to assess if high PFAS concentrations are reflected in this species.

Since PFAS and phenolic compounds play an important role in the overall urban contamination situation, new emerging PFAS as well as phenols are recommended to be included in the analytical portfolio. Sampling is recommended to occur in a short time period, at the same location, and similar types of sample matrix should be collected. We also recommend to increase the sites for fieldfare sampling to allow a more detailed assessment of the potential impact of local polluted areas on this species.

The following findings should have particular attention and should also be followed up in future campaigns:

- The location Alnabru, as last year, had high concentrations of PFAS, revealed by the concentrations in soil and earthworm. The new location Fornebu revealed also high concentrations in earthworm. Alnabru was dominated by PFOS, but PFUnA was dominating compound together with PFOS and PFTriA at Fornebu. The potential risk for worm eating species such as fieldfare should be investigated.

- Fieldfare eggs may act as an important sampling matrix to detect pollution hotspots on local/regional scale (as the Oslo city region) due to their fast adaption to their habitat:
    - Fieldfare from the locality Grønmo had very high concentrations of both branched and linear PFOS
    - Fieldfare from Bøler had very high concentration of SCCP and potential sources should be investigated
    - Fieldfare from Kjelsås revealed for the second year high concentration of Pb and potential sources should be investigated

- Biocides are still highest in red fox liver compared to rat livers. Some red foxes might be at risk due to high concentrations of biocides.
- The emerging brominated compound DBDPE had higher concentrations than SumPBDE in the three badger liver samples.
- S/MCCPs and cyclic siloxanes play an important role as air pollutants in Oslo
- S/MCCPs revealed very high concentrations in soil samples and one of the dominated pollutant groups in earthworm, fieldfare and brown rat.
- Earthworms ingest pollutants directly from the soil, making pollutants bioavailable

By keeping and building on this monitoring scheme, we can expect to follow the trends in time of pollutant levels in biota in the Oslo region, and identify hotspots where mitigation and management measures can be implemented.

6. Acknowledgements

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Appendix 1

Concentrations of pollutants in individual samples

PCB, PBDE, CP

NILU-Sample number:	17/1410	17/1411	17/1412	17/1413	17/1414	17/1415	17/1416	17/1417	17/1418	17/1419	17/1421	17/1422	17/1423	17/1424	17/1425
Customers sample ID:	Slottet	Frogner-setra	Fornebu	Alna	VEAS	Slottet	Frogner-setra	Fornebu	Alna	VEAS	Slotts-parken	Frogner-setra	Fornebu	Alna	VEAS
Sample type:	Air	Air	Air	Air	Air	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Earthworm	Earthworm	Earthworm	Earthworm	Earthworm
Concentration units:						ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name															
PCB 28	4.90	0.40	0.72	2.12	0.87	<LOD	<LOD	<LOD	<LOD	<LOD	0.03	<LOD	0.04	0.02	<LOD
PCB 52	13.5	0.60	1.28	2.20	1.17	<LOD	<LOD	<LOD	<LOD	<LOD	0.12	<LOD	0.25	0.05	<LOD
PCB 101	13.0	0.43	0.92	1.16	0.70	0.55	<LOD	<LOD	0.45	<LOD	0.77	<LOD	0.49	0.23	<LOD
PCB 118	2.85	0.13	0.27	0.26	0.19	0.53	0.28	0.23	0.36	0.36	0.45	<LOD	0.25	0.15	<LOD
PCB 138	4.02	0.13	0.29	0.30	0.21	1.00	0.65	0.43	0.84	0.54	0.84	0.22	0.69	0.27	<LOD
PCB 153	6.16	0.21	0.39	0.43	0.32	1.02	0.73	<LOD	0.94	0.57	1.23	0.34	0.92	0.34	<LOD
PCB 180	1.27	0.03	0.06	0.07	0.05	0.50	0.35	0.23	0.30	0.28	0.32	0.07	0.27	0.08	0.08
TBA	1.96	1.26	1.44	1.19	1.99	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.019	0.024	<LOD	<LOD
BDE 47	0.17	<LOD	0.01	0.57	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.019	0.024	<LOD	<LOD
BDE 99	0.168	<LOD	0.009	0.574	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 100	0.031	<LOD	<LOD	0.651	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 126	0.009	<LOD	<LOD	0.104	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 153	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 154	<LOD	<LOD	<LOD	0.045	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 175/183	<LOD	<LOD	<LOD	0.028	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 190	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 196	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 202	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 206	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 207	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 209	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
SCCP	630	105	230	170	310	763	308	351	249	330	92.0	71.0	187	76.0	64.00
MCCP	47.0	27.0	77.0	52.0	80.0	282	239	57.0	193	144	39.0	45.0	46.0	25.0	30.00

PCB, PBDE, CP

NILU-Sample number:	17/1427	17/1428	17/1429	17/1430	17/1431	17/1432	17/1433	17/1434	17/1435	17/1436
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name										
PCB 28	<LOD	<LOD	<LOD	<LOD	0.588	<LOD	<LOD	<LOD	<LOD	<LOD
PCB 52	0.597	1.050	0.204	0.277	1.390	0.236	1.270	1.430	0.254	0.270
PCB 101	3.00	5.82	1.69	1.65	4.93	1.60	8.97	6.63	1.26	3.22
PCB 118	1.56	2.59	1.02	0.83	2.66	0.87	6.53	3.74	0.75	1.47
PCB 138	14.1	9.61	5.29	5.59	12.2	3.54	15.3	10.9	7.03	10.1
PCB 153	22.8	15.7	9.60	8.16	18.9	5.21	21.6	15.4	12.4	15.2
PCB 180	8.95	7.03	3.50	3.19	6.86	1.82	7.20	5.32	6.90	4.90
TBA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 47	0.475	2.7	0.298	3.38	0.635	1.11	0.8	0.672	1.11	0.624
BDE 99	0.763	2.89	0.304	8.38	0.85	1.42	0.769	0.866	2.41	0.75
BDE 100	0.395	1.13	0.223	3.02	0.37	0.679	0.396	0.313	1.02	0.365
BDE 126	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 153	0.231	0.593	0.0771	2.36	0.17	0.197	0.183	0.166	0.402	0.137
BDE 154	0.144	0.332	0.0768	0.991	0.147	0.166	0.124	0.129	0.32	0.116
BDE 175/183	<LOD	0.151	0.0239	0.4	0.0919	0.0354	0.0369	0.059	0.073	0.0414
BDE 190	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 196	<LOD	0.128	<LOD	0.368	0.0342	0.028	0.034	0.0331	0.0513	0.0216
BDE 202	<LOD	0.118	<LOD	3.09	0.0318	0.0677	<LOD	0.0223	0.0734	0.0336
BDE 206	<LOD	0.0472	<LOD	<LOD	<LOD	<LOD	<LOD	0.0406	<LOD	<LOD
BDE 207	<LOD	0.158	0.0211	0.149	0.043	0.0301	0.0483	0.0727	0.0531	0.0282
BDE 209	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
SCCP	16.00	15.00	<4	1280.00	14.00	22.00	39.00	15.00	6.70	9.90
MCCP	10.00	5.70	5.10	135.00	11.00	9.00	5.10	19.00	5.50	4.70

<LOD Less than Limit of Quantification

PCB, PBDE, CP

NILU-Sample number:	17/1473	17/1474	17/1475	17/1476	17/1477	17/1478	17/1479
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name							
PCB 28	<LOD	<LOD	0.052	0.062	<LOD	0.081	0.282
PCB 52	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PCB 101	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.62
PCB 118	0.67	0.77	0.95	1.57	1.02	1.54	6.12
PCB 138	2.13	2.22	2.52	4.36	2.92	4.80	30.0
PCB 153	5.53	4.44	5.26	9.72	9.05	9.59	60.7
PCB 180	3.76	2.46	3.03	6.13	6.46	5.52	43.9
TBA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 47	0.231	0.111	0.138	1.14	0.0978	0.294	0.665
BDE 99	0.324	0.125	0.261	2.79	0.192	0.682	1.99
BDE 100	0.131	0.0969	0.0984	1.2	<LOD	0.197	1.08
BDE 126	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 153	0.679	0.111	0.131	0.779	0.324	0.767	2.56
BDE 154	0.0612	0.0224	0.0311	0.149	0.0227	0.0425	0.394
BDE 175/183	0.196	0.0357	0.0546	0.0423	0.052	0.108	0.376
BDE 190	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 196	0.649	<LOD	<LOD	<LOD	<LOD	0.102	0.115
BDE 202	0.0541	<LOD	<LOD	<LOD	0.0258	<LOD	0.368
BDE 206	0.0694	<LOD	<LOD	<LOD	<LOD	0.104	<LOD
BDE 207	0.281	0.0396	0.0387	0.0358	0.0442	0.855	0.14
BDE 209	<LOD	<LOD	<LOD	<LOD	<LOD	4.04	<LOD
SCCP	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	24.00
MCCP	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

<LOD Less than Limit of Quantification

PCB, PBDE, CP

NILU-Sample number:	17/1485	17/1486	17/1487	17/1488	17/1489	17/1490	17/1491	17/1492	17/1493	17/1494
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg	Sparrowhawk	Sparrow-hawk egg	Sparrowhawk egg	Sparrow-hawk egg	Sparrow-hawk egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name										
PCB 28	1.030	4.580	0.223	<LOD	0.235	0.264	<LOD	1.960	0.185	0.125
PCB 52	6.150	1.800	0.419	0.214	0.531	0.389	<LOD	10.00	0.185	0.193
PCB 101	12.9	20.9	3.90	2.82	4.80	5.66	4.34	26.6	2.17	2.09
PCB 118	43.6	80.1	8.64	9.88	15.4	12.0	15.4	63.7	7.94	7.55
PCB 138	80.5	259	16.2	39.7	86.7	59.8	129	160	39.6	35.9
PCB 153	198	613	25	106	194	136	246	314	121	89.7
PCB 180	136	320	14.2	69.6	155.0	73.5	202	189	63.3	51.2
TBA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 47	4.61	18.5	0.847	2.54	1.66	2.9	4.49	4.79	2.56	2.39
BDE 99	8.69	43.4	1.43	5.05	5.55	3.93	9.18	10.8	4.3	4.92
BDE 100	3.51	14.5	0.584	2.5	1.6	1.74	3.55	4.43	1.59	1.88
BDE 126	<LOD	0.0556	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 153	4.36	13.4	0.474	2.59	2.37	1.46	5.41	6.39	2.4	2.22
BDE 154	1.57	5.95	0.2	1.08	1	0.726	1.66	1.99	0.763	0.753
BDE 175/183	0.996	2.96	0.248	0.607	0.521	0.48	1.76	1.95	0.593	0.554
BDE 190	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 196	0.195	0.486	<LOD	<LOD	<LOD	<LOD	1.02	0.4	<LOD	0.197
BDE 202	0.418	1.24	<LOD	<LOD	<LOD	0.547	1.55	0.625	0.178	0.203
BDE 206	<LOD	<LOD	<LOD	<LOD	<LOD	0.215	<LOD	<LOD	<LOD	<LOD
BDE 207	<LOD	0.259	<LOD	<LOD	<LOD	0.496	0.671	0.316	<LOD	0.129
BDE 209	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.849	<LOD	<LOD	<LOD
SCCP	38.00	30.00	<LOD	<LOD	21.00	<LOD	<LOD	<LOD	<LOD	<LOD
MCCP	18.00	74.00	<LOD	9.00	9.00	<LOD	<LOD	<LOD	<LOD	<LOD

<LOD Less than Limit of Quantification

PCB, PBDE, CP

NILU-Sample numbr:	17/1437	17/1438	17/1439	17/1440	17/1441	17/1442	17/1443	17/1444	17/1445	17/1446	17/1498	17/1499	17/1500
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo			
Sample type::	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Badger liver	Badger liver	Badger liver
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g			
Compound name													
PCB 28	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PCB 52	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.1	<LOD	<LOD	<LOD	<LOD	<LOD
PCB 101	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PCB 118	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	1.8	<LOD	1.2	<LOD
PCB 138	2.4	<LOD	2.0	<LOD	<LOD	0.8	<LOD	3.5	<LOD	8.0	<LOD	2.1	<LOD
PCB 153	6.2	<LOD	14.8	<LOD	<LOD	4.5	<LOD	20.7	<LOD	49.1	<LOD	2.0	<LOD
PCB 180	5.5	2.7	30.6	2.5	1.3	4.0	8.0	20.7	2.8	202.0	<LOD	0.8	<LOD
TBA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 47	0.11	<LOD	0.071	<LOD	<LOD	0.062	<LOD	0.12	<LOD	0.075	<LOD	0.125	0.069
BDE 99	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 100	0.03	<LOD	0.013	<LOD	<LOD	<LOD	<LOD	0.026	<LOD	<LOD	<LOD	0.028	0.018
BDE 126	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 153	0.075	0.03	0.039	<LOD	<LOD	0.43	0.149	0.035	0.021	0.204	<LOD	<LOD	<LOD
BDE 154	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 175/183	0.026	0.016	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 190	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 196	0.041	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BDE 202	0.02	<LOD	<LOD	<LOD	<LOD	0.045	0.035	0.055	<LOD	0.103	<LOD	<LOD	<LOD
BDE 206	0.223	0.067	0.037	<LOD	<LOD	0.117	0.195	<LOD	0.06	0.29	<LOD	<LOD	0.064
BDE 207	0.5	0.076	0.06	<LOD	<LOD	0.182	0.06	0.211	0.043	0.279	<LOD	<LOD	0.036
BDE 209	3.19	0.616	<LOD	1.45	<LOD	2.69	0.782	1.55	<LOD	8.67	<LOD	<LOD	<LOD
SCCP	27	37	52	45	35	55	34	43	37	65	45	42	55
MCCP	23	40	24	88	62	76	60	54	130	124	37	41	51

<LOD Less than Limit of Quantification

PFAS

NILU-Sample number:		17/1410	17/1411	17/1412	17/1413	17/1414	17/1415	17/1416	17/1417	17/1418	17/1419	17/1421	17/1422	17/1423	17/1424	17/1425
Customers sample ID:		Slottet	Frogner-setra	Fornebu	Alnabru	VEAS	Slottet	Frogner-setra	Fornebu	Alnabru	VEAS	Slotts-parken	Frogner-setra	Fornebu	Alnabru	VEAS
Sample type::		Air	Air	Air	Air	Air	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Earth-worm	Earth-worm	Earth-worm	Earth-worm	Earth-worm
Concentration units:							ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name																
	PFOSA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.210	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	PFBS	1.38	1.39	1.39	1.05	1.18	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	PFPS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	PFHxS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.07	1.74	<LOD	2.33	<LOD	3.51	21.36	<LOD
	PFHpS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.19	<LOD	<LOD	<LOD	<LOD	4.17	<LOD
	brPFOS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.05	<LOD	26.8	0.18	<LOD	3.37	<LOD	32.13	3.19
	PFOS	<LOD	<LOD	<LOD	<LOD	<LOD	0.40	1.37	2.00	74.4	0.44	3.14	26.0	159	499	14.4
	PFNS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	3.580	<LOD	<LOD
	PFDcS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.110	<LOD	<LOD	<LOD	<LOD	1.492	<LOD	<LOD
	PFUnS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.396	<LOD	<LOD
	PFDoS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	2.961	<LOD	<LOD
	PFTrS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	PFTS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	PFBA	3.875	5.214	4.962	4.844	5.875	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	PFHxA	0.253	<LOD	0.134	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.208	1.902	0.259	1.631	0.710
	PFHpA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.870	<LOD	<LOD	<LOD	0.650	3.627	0.536	1.416	1.897
	PFOA	<LOD	<LOD	<LOD	<LOD	<LOD	0.451	3.129	0.028	0.282	0.779	0.938	6.988	0.302	1.340	3.351
	PFNA	<LOD	<LOD	<LOD	<LOD	<LOD	0.208	0.856	0.119	0.101	0.368	0.270	2.640	0.265	0.352	1.383
	PFDcA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.485	0.032	0.315	0.074	0.216	2.351	0.706	1.542	0.893
	PFUnA	<LOD	<LOD	<LOD	<LOD	<LOD	0.048	0.150	5.309	0.041	0.144	0.250	1.322	260.9	1.179	1.751
	PFDoA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.149	0.058	<LOD	<LOD	0.578	3.323	8.566	0.443	1.425
	PFTriA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.326	<LOD	<LOD	0.508	2.872	107	0.647	2.147
	PFTeA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.048	0.034	<LOD	<LOD	0.885	5.135	8.354	1.358	1.965
	PFHxDA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.330	2.558	1.969	<LOD	<LOD
	PFOcDA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	6:2FTS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.276	0.290	0.547	5.341	0.319
	8:2 FTS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.083	<LOD	<LOD	0.061	0.320	0.614	0.215	1.102

PFAS

NILU-Sample number:	17/1410	17/1411	17/1412	17/1413	17/1414	17/1415	17/1416	17/1417	17/1418	17/1419	17/1421	17/1422	17/1423	17/1424	17/1425
Customers sample ID:	Slottet	Frogner-setra	Fornebu	Alnabru	VEAS	Slottet	Frogner-setra	Fornebu	Alnabru	VEAS	Slotts-parken	Frogner-setra	Fornebu	Alnabru	VEAS
Sample type::	Air	Air	Air	Air	Air	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Earth-worm	Earth-worm	Earth-worm	Earth-worm	Earth-worm
Concentration units:						ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name															
10:2FTS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	<LOD	-
meFOSA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	<LOD	-
etFOSA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	<LOD	-
meFOSEA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	<LOD	-
meFOSE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	<LOD	-
etFOSE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	<LOD	-
6:2 FTOH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	<LOD	-
8:2 FTOH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	<LOD	-
10:2 FTOH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	<LOD	-
12:2 FTOH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	<LOD	-
HFPO-DA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Cl-PFOA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Cl-PFHxS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Cl-PFOS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
NaDONA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFECHS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
F53	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
F53B	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

<LOD Less than Limit of Quantification

PFAS

NILU-Sample number:		17/1427	17/1428	17/1429	17/1430	17/1431	17/1432	17/1433	17/1434	17/1435	17/1436
Customers sample ID:		Oslo Fieldfare egg	Oslo Fieldfare egg	Oslo Fieldfare egg	Oslo Fieldfare egg	Oslo Fieldfare egg	Oslo Fieldfare egg	Oslo Fieldfare egg	Oslo Fieldfare egg	Oslo Fieldfare egg	Oslo Fieldfare egg
Sample type::											
Concentration units:		ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name											
	PFOSA	<LOD	1.04	0.06	0.12	<LOD	0.209	<LOD	0.080	<LOD	0.110
	PFBS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	PFPS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	PFHxS	0.39	1.20	0.28	0.39	0.17	0.56	<LOD	0.35	0.15	<LOD
	PFHpS	0.64	2.44	0.17	0.39	0.07	0.45	<LOD	0.20	0.12	0.03
	brPFOS	6.00	**463**	2.84	4.16	2.28	4.82	<LOD	3.02	1.20	<LOD
	PFOS	82.3	**455**	15.0	35.3	26.4	47.1	<LOD	25.4	17.2	4.06
	PFNS	0.111	0.56	<LOD	<LOD	<LOD	<LOD	<LOD	0.129	<LOD	<LOD
	PFDcS	0.881	24.6	0.093	2.830	3.522	1.256	<LOD	0.384	0.302	0.507
	PFUnS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	PFDoS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	PFTrS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	PFTS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	PFBA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	PFHxA	<LOD	<LOD	<LOD	<LOD	<LOD	0.508	<LOD	<LOD	<LOD	<LOD
	PFHpA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	PFOA	1.408	1.555	0.516	0.675	0.494	0.968	<LOD	0.676	1.342	0.090
	PFNA	1.681	1.724	0.721	0.751	0.705	1.113	<LOD	1.444	0.974	0.268
	PFDcA	3.801	5.792	0.700	5.175	2.676	3.007	18.268	1.864	1.892	0.710
	PFUnA	4.994	5.462	1.778	5.168	2.235	3.655	<LOD	4.165	2.578	1.086
	PFDoA	19.783	21.091	4.339	27.874	7.791	12.367	<LOD	12.689	9.588	2.817
	PFTriA	5.050	6.544	4.551	15.001	7.472	4.620	<LOD	8.515	3.834	1.257
	PFTeA	14.693	20.647	3.189	21.996	7.202	9.611	<LOD	15.101	10.889	1.597
	PFHxDA	<LOD	<LOD	0.208	1.260	0.348	<LOD	<LOD	0.276	<LOD	<LOD
	PFOcDA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	6:2FTS	<LOD	<LOD	<LOD	6.871	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	8:2 FTS	2.337	1.817	0.074	0.545	3.590	0.398	<LOD	0.946	0.276	0.210
	10:2FTS	1.2	3	0.4	0.8	4.6	0.9	-	0.6	0.4	0.4
	meFOSA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	<LOD	<LOD	<LOD
	etFOSA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	<LOD	<LOD	<LOD
	meFOSEA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	<LOD	<LOD	<LOD
	meFOSE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	<LOD	<LOD	<LOD

<LOD Less than Limit of Quantification

PFAS

NILU-Sample number:	17/1427	17/1428	17/1429	17/1430	17/1431	17/1432	17/1433	17/1434	17/1435	17/1436
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name										
etFOSE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	<LOD	<LOD	<LOD
6:2 FTOH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	<LOD	<LOD	<LOD
8:2 FTOH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	<LOD	<LOD	<LOD
10:2 FTOH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	<LOD	<LOD	<LOD
12:2 FTOH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	<LOD	<LOD	<LOD
HFPO-DA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Cl-PFOA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Cl-PFHxS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Cl-PFOS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
NaDONA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFECHS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
F53	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
F53B	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

<LOD Less than Limit of Quantification

PFAS

NILU-Sample number:	17/1473	17/1474	17/1475	17/1476	17/1477	17/1478	17/1479
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name							
PFOSA	0.091	<LOD	<LOD	<LOD	<LOD	0.050	0.073
PFBS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFPS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFHxS	0.67	0.24	0.03	0.01	0.29	0.05	<LOD
PFHpS	0.60	<LOD	0.08	0.08	0.18	0.28	0.25
brPFOS	4.90	4.61	3.19	3.93	4.28	14.39	<LOD
PFOS	44.1	17.6	8.36	8.86	13.34	60.99	10.42
PFNS	<LOD	<LOD	<LOD	0.094	<LOD	0.104	0.095
PFDcS	0.387	<LOD	1.250	0.861	0.038	<LOD	0.271
PFUnS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFDoS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFTrS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFTS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFBA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFHxA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFHpA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFOA	3.189	0.056	<LOD	0.021	<LOD	0.041	0.135
PFNA	5.142	0.378	0.627	0.585	0.339	0.674	0.788
PFDcA	10.421	0.587	1.381	1.730	0.736	1.496	0.987
PFUnA	7.937	1.088	1.575	1.563	1.477	1.620	0.971
PFDoA	38.131	1.290	4.066	5.584	2.454	1.936	0.935
PFTriA	10.566	0.456	1.936	2.005	3.147	0.789	0.898
PFTeA	34.809	0.427	2.098	2.465	1.606	1.332	0.667
PFHxDA	<LOD	<LOD	<LOD	0.131	<LOD	<LOD	<LOD
PFOcDA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
6:2FTS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
8:2 FTS	0.320	0.806	<LOD	0.079	0.095	0.101	0.059
10:2FTS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
meFOSA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
etFOSA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
meFOSEA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
meFOSE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

<LOD Less than Limit of Quantification

PFAS

NILU-Sample number:	17/1473	17/1474	17/1475	17/1476	17/1477	17/1478	17/1479
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name							
etFOSE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
6:2 FTOH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
8:2 FTOH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
10:2 FTOH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
12:2 FTOH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
HFPO-DA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Cl-PFOA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Cl-PFHxS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Cl-PFOS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
NaDONA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFECHS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
F53	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
F53B	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

<LOD Less than Limit of Quantification

PFAS

NILU-Sample number:	17/1485	17/1486	17/1487	17/1488	17/1489	17/1490	17/1491	17/1492	17/1493	17/1494
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/	ng/g	ng/g	ng/g	ng/g
Compound name										
PFOSA	0.095	0.106	0.340	0.079	0.080	0.068	0.336	0.067	0.514	2.123
PFBS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFPS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFHxS	<LOD	0.44	1.35	0.34	0.26	0.38	0.51	0.56	0.91	0.56
PFHpS	<LOD	0.41	1.58	0.50	0.29	0.46	0.50	0.53	1.33	1.20
brPFOS	4.77	6.45	9.40	<LOD	3.68	4.87	6.82	7.18	16.76	7.30
PFOS	48.40	47.50	78.06	44.45	21.87	45.41	47.51	43.22	170.66	120.41
PFNS	0.235	<LOD	<LOD	<LOD	<LOD	0.132	<LOD	0.164	0.144	<LOD
PFDcS	1.158	0.868	5.062	2.206	0.286	0.847	0.706	0.863	16.039	1.709
PFUnS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFDoS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFTrS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFTS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFBA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFHxA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFHpA	0.364	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFOA	0.128	0.698	4.872	0.562	0.485	0.623	0.645	1.029	1.358	0.946
PFNA	0.572	2.451	3.348	1.899	0.991	1.904	1.745	1.471	1.634	1.342
PFDcA	4.147	5.098	3.852	1.433	1.626	3.588	2.081	2.174	3.663	1.785
PFUnA	4.252	6.330	6.505	4.346	2.137	4.563	3.580	4.931	3.461	3.860
PFDoA	7.281	23.882	16.761	10.926	5.225	8.288	7.955	8.615	8.349	9.466
PFTriA	4.230	18.084	16.409	8.451	4.317	5.077	11.019	14.614	9.859	15.435
PFTeA	5.145	21.487	17.348	13.964	7.795	10.075	15.144	11.576	7.961	14.622
PFHxDA	<LOD	0.768	1.010	<LOD	<LOD	<LOD	0.604	0.760	0.295	0.907
PFOcDA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
6:2FTS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
8:2 FTS	0.270	1.083	0.260	0.296	0.199	1.299	0.767	3.054	1.449	0.309
10:2FTS	<LOD	0.9	0.4	0.4	0.6	0.8	<LOD	2.7	0.7	1.5

<LOD Less than Limit of Quantification

PFAS

NILU-Sample number:	17/1485	17/1486	17/1487	17/1488	17/1489	17/1490	17/1491	17/1492	17/1493	17/1494
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg	Sparrowhawk egg	Sparrow-hawk egg	Sparrow-hawk egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name										
meFOSA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
etFOSA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
meFOSEA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
meFOSE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
etFOSE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
6:2 FTOH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
8:2 FTOH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
10:2 FTOH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
12:2 FTOH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
HFPO-DA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Cl-PFOA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Cl-PFHxS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Cl-PFOS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
NaDONA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFECHS	0.31	0.52	<LOD	0.25	0.23	0.36	0.43	<LOD	0.53	0.38
F53	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
F53B	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

<LOD Less than Limit of Quantification

PFAS

NILU-Sample number:	17/1437	17/1438	17/1439	17/1440	17/1441	17/1442	17/1443	17/1444	17/1445	17/1446	17/1498	17/1499	17/1450
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo			
Sample type::	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Badger liver	Badger liver	Badger liver
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name													
PFOSA	0.300	<LOD	<LOD	<LOD	<LOD	0.259	0.134	2.504	<LOD	3.317	0.553	2.057	1.525
PFBS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.049	<LOD	<LOD	<LOD
PFPS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFHxS	0.05	<LOD	0.39	0.09	0.18	0.52	0.69	0.17	0.04	0.75	0.57	1.22	0.49
PFHpS	<LOD	<LOD	0.14	0.00	0.00	0.22	0.26	0.12	<LOD	0.73	0.37	1.28	0.48
brPFOS	2.23	1.02	4.00	1.60	1.16	<LOD	22.18	5.62	1.59	19.04	3.62	10.65	6.78
PFOS	40.99	5.68	18.51	8.62	2.84	88.33	22.35	39.95	4.42	143.94	36.97	115.48	69.66
PFNS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFDcS	1.005	<LOD	<LOD	<LOD	<LOD	1.843	<LOD	0.282	<LOD	1.598	<LOD	1.664	3.131
PFUnS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.783
PFDoS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFTrS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFTS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFBA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFHxA	0.378	0.231	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.257	0.278	0.239
PFHpA	0.717	0.190	0.238	0.070	0.328	0.369	0.294	0.038	0.283	0.330	<LOD	0.033	<LOD
PFOA	0.042	<LOD	<LOD	<LOD	0.046	<LOD	<LOD	<LOD	<LOD	<LOD	1.307	3.478	0.938
PFNA	0.255	0.421	0.395	0.057	0.366	1.259	0.466	0.266	1.908	1.109	3.761	6.832	4.123
PFDcA	0.945	0.834	2.583	0.915	0.852	3.279	2.311	1.826	0.986	4.764	3.575	10.011	5.837
PFUnA	4.737	0.693	1.584	0.928	0.331	4.910	1.369	2.831	0.679	9.659	3.834	4.334	3.491
PFDoA	2.408	0.549	1.676	0.600	0.149	1.755	1.561	1.284	0.401	4.358	3.666	7.638	6.925
PFTriA	0.854	0.301	0.847	0.205	0.103	2.944	1.795	1.238	0.305	4.218	4.784	6.018	6.411
PFTeA	0.727	0.423	1.036	0.211	0.038	1.548	3.066	0.000	0.171	2.678	3.040	9.716	7.868
PFHxDA	0.302	0.195	0.299	0.125	0.053	2.475	1.965	0.598	0.205	1.487	0.097	0.559	0.312
PFOcDA	0.009	<LOD	<LOD	<LOD	<LOD	0.034	0.015	0.011	<LOD	0.031	<LOD	<LOD	<LOD
6:2FTS	0.124	0.145	0.095	0.119	0.068	0.966	0.121	0.131	0.051	0.247	0.074	0.385	0.587
8:2 FTS	<LOD	<LOD	0.040	0.075	<LOD	8.145	0.040	0.186	<LOD	1.415	0.268	6.662	3.007

<LOD Less than Limit of Quantification

PFAS

NILU-Sample number:	17/1437	17/1438	17/1439	17/1440	17/1441	17/1442	17/1443	17/1444	17/1445	17/1446	17/1498	17/1499	17/1450
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo			
Sample type::	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Badger liver	Badger liver	Badger liver
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name													
10:2FTS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
meFOSA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
etFOSA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
meFOSEA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
meFOSE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
etFOSE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
6:2 FTOH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
8:2 FTOH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
10:2 FTOH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
12:2 FTOH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
HFPO-DA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Cl-PFOA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Cl-PFHxS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Cl-PFOS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
NaDONA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFECHS	<LOD	0.95	<LOD	<LOD	<LOD	5.16	0.30	0.70	<LOD	1.47	<LOD	<LOD	2.07
F53	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
F53B	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

<LOD Less than Limit of Quantification

PFAS

NILU-Sample number:	17/1450	17/1451	17/1452	17/1453	17/1454	17/1455	17/1456	17/1457	17/1458
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name									
PFOSA	<LOD	0.23	0.55	0.70	<LOD	0.42	5.51	2.11	0.11
PFBS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFPS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFHxS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFHpS	<LOD	0.07	0.12	0.10	<LOD	0.13	0.17	0.19	<LOD
brPFOS	2.03	3.50	9.98	12.50	4.79	6.67	14.89	7.92	4.43
PFOS	10.01	25.48	62.86	72.31	19.44	35.88	115.50	69.35	12.44
PFNS	<LOD	0.11	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFDcS	<LOD	0.36	1.13	1.99	0.36	0.65	1.42	3.29	0.28
PFUnS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFDoS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFTrS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFTS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFBA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFHxA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFHpA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFOA	<LOD	<LOD	0.16	0.19	<LOD	0.22	<LOD	0.27	0.07
PFNA	0.22	0.22	2.99	1.48	0.50	1.42	0.78	3.11	0.92
PFDcA	1.27	2.46	20.30	6.60	1.35	3.13	4.39	7.94	1.34
PFUnA	0.66	1.00	7.20	4.72	0.71	2.23	3.03	4.94	0.44
PFDoA	0.84	1.87	18.30	16.45	1.35	6.73	8.00	19.93	1.06
PFTriA	0.58	0.85	9.02	8.15	0.89	4.03	4.35	11.57	0.22
PFTeA	0.335	0.799	8.039	9.135	0.669	3.562	3.999	12.656	0.317
PFHxDA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFOcDA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
6:2FTS	<LOD	<LOD	<LOD	<LOD	<LOD	0.5	4.4	<LOD	<LOD
8:2 FTS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	12.4	<LOD
10:2FTS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	1.1	2.1	<LOD

<LOD Less than Limit of Quantification

PFAS

NILU-Sample number:	17/1450	17/1451	17/1452	17/1453	17/1454	17/1455	17/1456	17/1457	17/1458
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name									
meFOSA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
etFOSA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
meFOSEA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
meFOSE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
etFOSE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
6:2 FTOH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
8:2 FTOH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
10:2 FTOH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
12:2 FTOH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
HFPO-DA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Cl-PFOA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Cl-PFHxS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Cl-PFOS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
NaDONA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PFECHS	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
F53	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
F53B	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

<LOD Less than Limit of Quantification

Metals

NILU-Sample number:	17/1410	17/1411	17/1412	17/1413	17/1414	17/1415	17/1416	17/1417	17/1418	17/1419	17/1421	17/1422	17/1423	17/1424	17/1425
Customers sample ID:	Slottet	Frogner-setra	Fornebu	Alnabru	VEAS	Slottet	Frogner-setra	Fornebu	Alnabru	VEAS	Slotts-parken	Frogner-setra	Fornebu	Alnabru	VEAS
Sample type::	Air	Air	Air	Air	Air	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Earthworm	Earthworm	Earthworm	Earthworm	Earthworm
Concentration units:	ng/filter	ng/filter	ng/filter	ng/filter	ng/filter	ng/g tørrvekt	ng/g tørrvekt	ng/g tørrvekt	ng/g tørrvekt	ng/g tørrvekt	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name															
Cr	-	-	-	-	-	60302	36154	145691	81329	149203	8225	773	1744	1956	1054
Ni	-	-	-	-	-	75567	8337	143647	47916	117263	4163	436	1412	1485	1144
Cu	-	-	-	-	-	40320	18969	35200	54006	65355	3265	1991	3448	3805	1582
Zn	-	-	-	-	-	186246	55881	103468	300179	184111	216290	175249	95842	385784	116089
As	-	-	-	-	-	13093	5875	5813	6106	17067	535	790	1267	931	2272
Ag	-	-	-	-	-	219	327	88	286	271	29	47	33	28	80
Cd	-	-	-	-	-	308	1113	135	957	863	607	3510	1317	897	1326
Pb	-	-	-	-	-	67626	86001	14816	65930	74980	929	33771	467	1122	716
Hg	-	-	-	-	-	268	156	29	150	125	157	202	78	39	314

<LOD Less than Limit of Quantification

Metals

NILU-Sample number:	17/1427	17/1428	17/1429	17/1430	17/1431	17/1432	17/1433	17/1434	17/1435	17/1436
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name										
Cr	5	4	3	3	1	6	3	3	3	6
Ni	7	11	14	19	15	25	25	28	25	23
Cu	294	407	671	493	466	386	344	431	457	343
Zn	8343	6038	7448	9854	5808	7396	9646	7230	3277	6394
As	3	3.63	4.51	2.57	4.00	1.81	9.82	3.90	1.75	4.11
Ag	0.1	0.33	0.65	0.67	0.14	0.11	0.39	0.54	0.03	0.75
Cd	0.15	0.12	0.15	0.22	0.29	0.20	0.33	0.20	0.05	0.25
Pb	12.33	8.67	11.43	9.91	10.33	3.75	206	7.61	2.01	10.80
Hg	9	7	9	11	12	10	12	9	10	8

<LOD Less than Limit of Quantification

Metals

NILU-Sample number:	17/1473	17/1474	17/1475	17/1476	17/1477	17/1478	17/1479
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name							
Cr	8	488	129	18	3	1666	808
Ni	30	242	106	114	34	1054	1115
Cu	444	735	1079	1545	878	1317	1780
Zn	4840	4447	8924	11078	6755	11860	18112
As	4.11	0.93	<LOD	5.22	<LOD	1.10	1.10
Ag	0.75	0.34	0.34	0.97	0.06	0.40	0.28
Cd	0.11	0.12	0.18	0.21	0.27	0.15	0.39
Pb	0.48	0.57	3.20	3.00	0.79	4.86	3.85
Hg	3	15	14	12	11	14	6

<LOD Less than Limit of Quantification

Metals

NILU-Sample number:	17/1485	17/1486	17/1487	17/1488	17/1489	17/1490	17/1491	17/1492	17/1493	17/1494
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk e	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name										
Cr	4	6	5	7	6	5	4	11	6	2
Ni	46	33	35	28	38	46	43	81	39	46
Cu	705	426	365	249	1658	1400	2299	570	2308	549
Zn	6290	7716	4600	3244	3273	10448	3504	13345	6474	4934
As	<LOD	<LOD	1.0	<LOD	1.0	0.7	0.6	0.8	1.7	0.6
Ag	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Cd	0.08	0.11	<LOD	0.07	<LOD	0.23	0.10	0.24	0.02	0.07
Pb	8.0	3.6	6.1	1.2	2.2	9.6	21.2	17.6	8.9	1.5
Hg	107	162	60	128	84	154	159	99	101	137

<LOD Less than Limit of Quantification

Metals

NILU-Sample number:	17/1437	17/1438	17/1439	17/1440	17/1441	17/1442	17/1443	17/1444	17/1445	17/1446	17/1498	17/1499	17/1450
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo			
Sample type::	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Badger liver	Badger liver	Badger liver
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name													
Cr	330	117	117	234	585	220	222	576	383	187	111	73	104
Ni	168	78	91	191	368	244	199	277	212	81	152	121	152
Cu	12176	17388	24765	16106	13778	40176	14528	7367	11398	31052	8684	44337	12705
Zn	39558	38957	44420	61075	58580	60466	82807	55517	53444	44440	38914	72282	34744
As	8	93	9	14	4	18	8	25	9	120	20	41	22
Ag	4	4	3	2	1	28	42	1	3	62	14	55	15
Cd	61	228	170	865	93	44	180	161	262	671	221	2190	1628
Pb	75	21	96	28	31	491	71	628	122	1107	363	1368	489
Hg	45	98	173	65	46	56	169	105	44	513	22	73	51

<LOD Less than Limit of Quantification

Metals

NILU-Sample number:	17/1450	17/1451	17/1452	17/1453	17/1454	17/1455	17/1456	17/1457	17/1458
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name									
Cr	754	1346	412	2169	475	470	1342	338	1333
Ni	400	728	198	1255	283	220	755	182	665
Cu	3989	4574	4802	6254	4778	5493	5069	5446	5820
Zn	29816	47069	35054	46579	38021	38842	34781	38153	41117
As	1432	3956	5983	7321	948	2523	4216	8261	703
Ag	0.6	0.3	1.7	1.6	0.8	3.1	5.4	2.2	1.0
Cd	9	36	138	142	111	73	163	113	12
Pb	15	245	23	123	46	124	32	70	305
Hg	13	4.0	30	33	5.1	14	20	47	1.1

<LOD Less than Limit of Quantification

Dechloranes & pesticides

NILU-Sample number:	17/1410	17/1411	17/1412	17/1413	17/1414	17/1415	17/1416	17/1417	17/1418	17/1419	17/1421	17/1422	17/1423	17/1424	17/1425
Customers sample ID:	Slottet	Frogner-setra	Fornebu	Alnabru	VEAS	Slottet	Frogner-setra	Fornebu	Alnabru	VEAS	Slotts-parken	Frogner-setra	Fornebu	Alnabru	VEAS
Sample type::	Air	Air	Air	Air	Air	Pooled sample	Pooled sample	Pooled sample	Pooled sample	Pooled sample	Earthworm	Earthworm	Earthworm	Earthworm	Earthworm
Concentration units:	ng/filter	ng/filter	ng/filter	ng/filter	ng/filter	Soil ng/g tørrvekt	Soil ng/g tørrvekt	Soil ng/g tørrvekt	Soil ng/g tørrvekt	Soil ng/g tørrvekt	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name															
Dibromo-aldrin	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Dechlorane 602	<LOD	<LOD	<LOD	<LOD	<LOD	0.147	0.078	<LOD	<LOD	0.037	<LOD	<LOD	<LOD	<LOD	<LOD
Dechlorane 603	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Dechlorane 604	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Dechlorane plus syn	0.11	0.06	0.07	0.08	0.04	0.50	1.48	0.21	0.43	0.60	0.05	0.10	0.04	0.03	0.03
Dechlorane 601	<LOD	0.212	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Dechlorane plus anti	0.69	0.22	0.37	0.32	0.16	1.57	1.73	0.54	1.42	1.00	0.06	0.05	0.07	0.05	0.05
HCB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
a-HCH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
b-HCH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
g-HCH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
o.p'-DDE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
p.p'-DDE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
o.p'-DDD	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
p.p'-DDD	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
o.p'-DDT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
p.p'-DDT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

<LOD Less than Limit of Quantification

Dechloranes & pesticides

NILU-Sample number:	17/1427	17/1428	17/1429	17/1430	17/1431	17/1432	17/1433	17/1434	17/1435	17/1436
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name										
Dibromo-aldrin	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Dechlorane 602	2.16	0.09	0.13	0.06	0.37	0.03	0.13	0.05	0.03	0.06
Dechlorane 603	0.15	0.30	0.29	0.50	0.21	0.06	0.24	0.17	0.50	0.26
Dechlorane 604	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Dechlorane plus syn	0.31	0.11	0.07	0.09	0.15	0.06	0.08	0.08	0.06	0.06
Dechlorane 601	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Dechlorane plus anti	0.95	0.26	0.15	0.23	0.35	0.11	0.15	0.15	0.13	0.13
HCB	-	-	-	-	-	-	-	-	-	-
a-HCH	-	-	-	-	-	-	-	-	-	-
b-HCH	-	-	-	-	-	-	-	-	-	-
g-HCH	-	-	-	-	-	-	-	-	-	-
o.p'-DDE	-	-	-	-	-	-	-	-	-	-
p.p'-DDE	-	-	-	-	-	-	-	-	-	-
o.p'-DDD	-	-	-	-	-	-	-	-	-	-
p.p'-DDD	-	-	-	-	-	-	-	-	-	-
o.p'-DDT	-	-	-	-	-	-	-	-	-	-
p.p'-DDT	-	-	-	-	-	-	-	-	-	-

<LOD Less than Limit of Quantification

Dechloranes & pesticides

NILU-Sample number:	17/1473	17/1474	17/1475	17/1476	17/1477	17/1478	17/1479
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name							
Dibromo-aldrin	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Dechlorane 602	0.08	0.09	0.13	0.54	0.22	0.13	0.41
Dechlorane 603	0.03	<LOD	<LOD	<LOD	0.04	<LOD	1.95
Dechlorane 604	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Dechlorane plus syn	0.08	0.07	0.09	0.19	0.12	0.13	0.12
Dechlorane 601	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Dechlorane plus anti	0.20	0.16	0.22	0.28	0.29	0.30	0.36
HCB	-	-	-	-	-	-	-
a-HCH	-	-	-	-	-	-	-
b-HCH	-	-	-	-	-	-	-
g-HCH	-	-	-	-	-	-	-
o.p'-DDE	-	-	-	-	-	-	-
p.p'-DDE	-	-	-	-	-	-	-
o.p'-DDD	-	-	-	-	-	-	-
p.p'-DDD	-	-	-	-	-	-	-
o.p'-DDT	-	-	-	-	-	-	-
p.p'-DDT	-	-	-	-	-	-	-

<LOD Less than Limit of Quantification

Dechloranes & pesticides

NILU-Sample number:	17/1485	17/1486	17/1487	17/1488	17/1489	17/1490	17/1491	17/1492	17/1493	17/1494
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name										
Dibromo-aldrin	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Dechlorane 602	0.69	1.35	0.08	0.56	0.68	0.71	0.66	0.60	0.62	0.46
Dechlorane 603	0.51	1.21	0.17	0.45	0.76	0.96	1.03	0.68	1.07	0.30
Dechlorane 604	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Dechlorane plus syn	0.09	0.10	0.25	0.05	0.13	0.06	0.12	0.09	0.13	0.09
Dechlorane 601	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Dechlorane plus anti	0.27	0.42	0.25	0.14	0.52	0.18	0.35	0.21	0.27	0.30
HCB	14.20	36.60	3.43	7.86	8.09	12.40	9.47	9.52	8.64	6.63
a-HCH	0.0351	0.0471	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
b-HCH	1.03	3.34	0.26	1.03	2	1.64	0.893	1.6	2.48	1.03
g-HCH	0.0392	0.0897	<LOD	0.0347	0.0895	<LOD	<LOD	0.11	<LOD	<LOD
o.p'-DDE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
p.p'-DDE	871	1350	113	868	1600	493	700	646	1310	788
o.p'-DDD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
p.p'-DDD	7.41	14.2	<LOD	6.21	10.3	16.7	7.18	5.8	17.8	3.82
o.p'-DDT	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
p.p'-DDT	7.12	12.2	1.53	6.41	15.8	20.3	4.63	6.79	12.1	3.66

<LOD Less than Limit of Quantification

Dechloranes & pesticides

NILU-Sample number:	17/1437	17/1438	17/1439	17/1440	17/1441	17/1442	17/1443	17/1444	17/1445	17/1446	17/1498	17/1499	17/1450
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo			
Sample type::	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Badger liver	Badger liver	Badger liver
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name													
Dibromo-aldrin	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Dechlorane 602	0.03	0.02	0.04	0.04	0.02	0.10	0.27	0.05	0.04	0.60	0.04	0.03	0.06
Dechlorane 603	<LOD	<LOD	<LOD	<LOD	<LOD	0.01	0.18	<LOD	<LOD	0.06	<LOD	<LOD	<LOD
Dechlorane 604	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Dechlorane plus syn	0.07	0.05	0.05	0.04	0.04	0.10	0.06	0.05	0.04	0.66	0.06	0.08	0.05
Dechlorane 601	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Dechlorane plus anti	0.21	0.13	0.12	0.12	0.14	0.55	0.27	0.19	0.11	5.79	0.11	0.18	0.12
HCB	-	-	-	-	-	-	-	-	-	-	-	-	-
a-HCH	-	-	-	-	-	-	-	-	-	-	-	-	-
b-HCH	-	-	-	-	-	-	-	-	-	-	-	-	-
g-HCH	-	-	-	-	-	-	-	-	-	-	-	-	-
o.p'-DDE	-	-	-	-	-	-	-	-	-	-	-	-	-
p.p'-DDE	-	-	-	-	-	-	-	-	-	-	-	-	-
o.p'-DDD	-	-	-	-	-	-	-	-	-	-	-	-	-
p.p'-DDD	-	-	-	-	-	-	-	-	-	-	-	-	-
o.p'-DDT	-	-	-	-	-	-	-	-	-	-	-	-	-
p.p'-DDT	-	-	-	-	-	-	-	-	-	-	-	-	-

<LOD Less than Limit of Quantification

Dechloranes & pesticides

NILU-Sample number:	17/1450	17/1451	17/1452	17/1453	17/1454	17/1455	17/1456	17/1457	17/1458
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name									
Dibromo-aldrin	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Dechlorane 602	0.004	0.009	0.014	0.019	0.019	0.021	0.025	0.015	0.019
Dechlorane 603	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.01837	<LOD
Dechlorane 604	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Dechlorane plus syn	0.081	0.075	0.067	0.179	0.159	0.161	0.062	1.945	0.205
Dechlorane 601	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Dechlorane plus anti	0.199	0.160	0.143	0.564	0.547	0.541	0.142	8.908	0.766
HCB	-	-	-	-	-	-	-	-	-
a-HCH	-	-	-	-	-	-	-	-	-
b-HCH	-	-	-	-	-	-	-	-	-
g-HCH	-	-	-	-	-	-	-	-	-
o.p'-DDE	-	-	-	-	-	-	-	-	-
p.p'-DDE	-	-	-	-	-	-	-	-	-
o.p'-DDD	-	-	-	-	-	-	-	-	-
p.p'-DDD	-	-	-	-	-	-	-	-	-
o.p'-DDT	-	-	-	-	-	-	-	-	-
p.p'-DDT	-	-	-	-	-	-	-	-	-

<LOD Less than Limit of Quantification

Siloxanes

NILU-Sample number:	17/1410	17/1411	17/1412	17/1413	17/1414	17/1415	17/1416	17/1417	17/1418	17/1419	17/1421	17/1422	17/1423	17/1424	17/1425
Customers sample ID:	Slottet	Frogner-setra	Fornebu	Alnabru	VEAS	Slottet	Frogner-setra	Fornebu	Alnabru	VEAS	Slotts-parken	Frogner-setra	Fornebu	Alnabru	VEAS
Sample type::	Air	Air	Air	Air	Air	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Earthworm	Earthworm	Earthworm	Earthworm	Earthworm
Concentration units:	ng/filter	ng/filter	ng/filter	ng/filter	ng/filter	ng/g tørrvekt	ng/g tørrvekt	ng/g tørrvekt	ng/g tørrvekt	ng/g tørrvekt	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name															
D4	980	352	405	204	203	1.22	2.07	0.38	2.32	1.03	<LOD	<LOD	<LOD	<LOD	<LOD
D5	2025	331	745	817	437	0.46	0.21	0.38	0.58	0.34	<LOD	<LOD	<LOD	<LOD	<LOD
D6	196	36	85	66	54	1.17	1.17	0.35	1.68	0.63	<LOD	<LOD	<LOD	<LOD	<LOD

<LOD Less than Limit of Quantification

Siloxanes

NILU-Sample number:		17/1427	17/1428	17/1429	17/1430	17/1431	17/1432	17/1433	17/1434	17/1435	17/1436
Customers sample ID:		Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::		Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg
Concentration units:		ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name											
	D4	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	D5	<LOD	<LOD	<LOD	3.69	2.88	<LOD	<LOD	3.95	2.15	<LOD
	D6	<LOD	<LOD	<LOD	4.01	1.79	<LOD	2.91	1.71	1.45	<LOD

<LOD Less than Limit of Quantification

Siloxanes

NILU-Sample number:	17/1473	17/1474	17/1475	17/1476	17/1477	17/1478	17/1479
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name							
D4	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-
D5	2.96	<LOD	<LOD	3.89	<LOD	<LOD	-
D6	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-

<LOD Less than Limit of Quantification

Siloxanes

NILU-Sample number:		17/1485	17/1486	17/1487	17/1488	17/1489	17/1490	17/1491	17/1492	17/1493	17/1494
Customers sample ID:		Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::		Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg	Spurveha egg	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg
Concentration units:		ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name											
	D4	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	D5	2.56	1.46	2.27	2.20	3.02	3.73	5.70	1.60	<LOD	<LOD
	D6	<LOD	1.88	2.23	2.51	<LOD	1.72	<LOD	<LOD	<LOD	<LOD

<LOD Less than Limit of Quantification

Siloxanes

NILU-Sample number:	17/1437	17/1438	17/1439	17/1440	17/1441	17/1442	17/1443	17/1444	17/1445	17/1446	17/1498	17/1499	17/1450
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo			
Sample type::	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Badger liver	Badger liver	Badger liver
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name													
D4	0.23	0.45	1.77	0.74	-	0.26	0.20	0.56	<LOD	<LOD	<LOD	<LOD	<LOD
D5	<LOD	<LOD	<LOD	<LOD	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
D6	2.69	0.68	0.61	1.75	-	0.55	0.51	0.74	0.69	0.71	0.430	<LOD	0.631

<LOD Less than Limit of Quantification

Stable isotopes

NILU-Sample number:	17/1410	17/1411	17/1412	17/1413	17/1414	17/1415	17/1416	17/1417	17/1418	17/1419	17/1421	17/1422	17/1423	17/1424	17/1425
Customers sample ID:	Slottet	Frogner-setra	Fornebu	Alnabru	VEAS	Slottet	Frogner-setra	Fornebu	Alnabru	VEAS	Slotts-parken	Frogner-setra	Fornebu	Alnabru	VEAS
Sample type::	Air	Air	Air	Air	Air	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Earth-worm	Earth-worm	Earth-worm	Earth-worm	Earth-worm
Concentration units:	ng/filter	ng/filter	ng/filter	ng/filter	ng/filter	ng/g tørrvekt	ng/g tørrvekt	ng/g tørrvekt	ng/g tørrvekt	ng/g tørrvekt	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name															
d13CVPDB	-	-	-	-	-	-27.71	-27.14	-23.71	-28.23	-27.58	-25.05	-25.01	-25.60	-27.64	-25.47
d15NAIR	-	-	-	-	-	5.82	3.25	5.91	5.73	3.16	4.73	5.20	6.75	3.04	4.01
W% C	-	-	-	-	-	5.65	15.4	2.94	5.52	14.8	48.2	48.8	46.3	47.2	48.4
W% N	-	-	-	-	-	0.57	0.94	0.29	0.57	1.07	10.3	10.8	10.0	9.89	11.7
C/N	-	-	-	-	-	10.00	16.4	10.1	9.71	13.8	4.70	4.51	4.61	4.77	4.12
d34SVCDT	-	-	-	-	-	2.46	6.58	<LOD	<LOD	<LOD	3.36	4.33	<LOD	<LOD	1.28
W% S	-	-	-	-	-	0.06	0.06	0.06	0.10	0.08	0.88	1.17	1.14	1.06	1.28

Stable isotopes

NILU-Sample number:	17/1427	17/1428	17/1429	17/1430	17/1431	17/1432	17/1433	17/1434	17/1435	17/1436
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name										
d13CVPDB	-26.44	-26.75	-26.66	-27.38	-26.85	-26.61	-26.58	-26.84	-26.41	-26.26
d15NAIR	7.44	7.55	8.09	7.43	6.19	7.32	5.62	7.27	6.66	6.91
W% C	54.9	53.7	56.4	54.2	57.0	55.4	53.2	56.8	50.9	51.8
W% N	8.64	8.92	8.87	9.04	8.76	9.67	8.80	8.45	9.84	8.29
C/N	6.35	6.01	6.36	6.00	6.51	5.73	6.04	6.72	5.17	6.25
d34SVCDT	0.95	2.56	4.52	4.61	2.71	4.98	5.40	0.60	2.17	4.94
W% S	0.91	0.91	0.89	0.94	0.83	1.04	0.93	0.83	1.09	0.89

Stable isotopes

NILU-Sample number:	17/1473	17/1474	17/1475	17/1476	17/1477	17/1478	17/1479
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name							
d13CVPDB	-29.69	-27.85	-28.72	-28.18	-28.65	-27.04	-27.90
d15NAIR	8.27	7.61	7.54	8.24	8.61	9.20	6.92
W% C	58.1	56.2	59.9	58.8	58.0	51.2	53.1
W% N	8.13	10.5	8.51	9.11	9.31	10.8	14.2
C/N	7.15	5.36	7.04	6.45	6.24	4.73	3.73
d34SVCDT	5.65	6.80	6.20	6.27	5.59	6.48	5.76
W% S	0.92	1.19	1.02	0.98	1.06	1.37	0.73

Stable isotopes

NILU-Sample number:	17/1485	17/1486	17/1487	17/1488	17/1489	17/1490	17/1491	17/1492	17/1493	17/1494
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg	Sparrowhawk egg	Sparrow-hawk egg	Sparrow-hawk egg	Sparrowhawk egg	Sparrow-hawk egg	Sparrow-hawk egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name										
d13CVPDB	-25.39	-24.90	-24.61	-24.39	-25.75	-25.97	-24.50	-26.16	-26.06	-26.18
d15NAIR	7.05	6.69	8.05	6.26	8.12	7.68	7.15	7.86	8.23	8.43
W% C	56.8	55.6	53.7	54.2	50.2	52.2	48.7	56.2	50.8	56.7
W% N	9.61	9.94	9.68	9.44	6.74	8.57	11.6	8.30	8.00	8.23
C/N	5.91	5.59	5.55	5.74	7.45	6.09	4.21	6.77	6.35	6.89
d34SVCDT	6.36	5.91	6.62	6.81	5.71	7.31	7.15	7.01	7.32	6.86
W% S	1.17	0.97	1.15	1.05	0.60	0.94	1.06	0.94	0.85	0.87

Stable isotopes

NILU-Sample number:	17/1437	17/1438	17/1439	17/1440	17/1441	17/1442	17/1443	17/1444	17/1445	17/1446	17/1498	17/1499	17/1450
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo			
Sample type::	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Badger liver	Badger liver	Badger liver
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name													
d13CVPDB	-24.96	-24.74	-25.16	-26.36	-26.64	-24.73	-25.40	-24.10	-25.66	-23.66	-26.30	-25.14	-25.67
d15NAIR	8.57	8.13	7.91	8.26	8.24	8.97	8.79	8.42	7.91	10.6	6.75	7.14	7.60
W% C	54.9	55.3	52.7	56.2	55.7	54.6	55.2	55.7	54.2	57.0	55.8	53.3	53.7
W% N	10.4	10.8	10.3	10.3	10.9	10.3	10.6	10.3	10.1	10.5	10.6	10.7	9.12
C/N	5.26	5.14	5.11	5.45	5.11	5.28	5.20	5.41	5.38	5.42	5.25	4.97	5.88
d34SVCDT	4.38	5.47	5.19	4.59	4.32	4.78	4.55	5.73	5.13	7.63	3.57	0.48	3.73
W% S	1.05	1.09	1.02	1.41	1.28	1.28	1.10	1.23	1.12	1.25	1.08	1.41	1.15

Stable isotopes

NILU-Sample number:	17/1450	17/1451	17/1452	17/1453	17/1454	17/1455	17/1456	17/1457	17/1458
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name									
d13CVPDB	-25.16	-25.03	-26.44	-25.19	-25.25	-25.94	-25.12	-25.21	-24.77
d15NAIR	7.76	8.13	10.0	7.29	8.67	7.45	8.79	8.98	6.65
W% C	52.9	52.0	54.2	51.0	53.4	53.2	53.3	54.0	54.2
W% N	12.3	12.8	11.7	12.5	12.1	12.3	13.1	13.0	12.2
C/N	4.30	4.06	4.64	4.07	4.41	4.33	4.05	4.16	4.44
d34SVCDT	3.92	4.06	3.61	2.62	0.88	3.25	2.18	2.71	3.37
W% S	1.05	1.03	1.08	1.17	1.10	1.08	1.17	1.24	1.08

UV compounds and biocides

NILU-Sample number:	17/1420	17/1426	17/1482	17/1483	17/1484	17/1495	17/1496	17/1497
Customers sample ID:								
Sample type::	Mixed sample Soil	Mixed sample Earthworm	Mixed sample Tawny owl egg	Mixed sample Tawny owl egg	Mixed sample Tawny owl egg	Mixed sample Sparrow hawk egg	Mixed sample Sparrow hawk egg	Mixed sample Sparrow hawk egg
Concentration units:	ng/filter	ng/filter	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name								
BP3	<LOD	1.3	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
EHMC	3.2	4.5	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
OC	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
UV-329	<LOD	0.26	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
UV-328	0.7	0.24	<LOD	<LOD	<LOD	0.7	0.6	0.7
UV-327	<LOD	0.06	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bromadiolone	-	-	-	-	-	-	-	-
Brodifacoum	-	-	-	-	-	-	-	-
Flocumafen	-	-	-	-	-	-	-	-
Difenacoum	-	-	-	-	-	-	-	-

<LOD Less than Limit of Quantification

UV compounds and biocides

NILU-Sample number:	17/1437	17/1438	17/1439	17/1440	17/1441	17/1442	17/1443	17/1444	17/1445	17/1446	17/1447	17/1448	17/1449
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo		
Sample type::	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Mixed sample Fox liver	Mixed sample Fox liver	Mixed sample Fox liver
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name													
BP3	-	-	-	-	-	-	-	-	-	-	0.26	<LOD	<LOD
EHMC	-	-	-	-	-	-	-	-	-	-	6.13	3.76	5.57
OC	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
UV-329	-	-	-	-	-	-	-	-	-	-	0.12	0.06	0.06
UV-328	-	-	-	-	-	-	-	-	-	-	0.22	0.14	0.14
UV-327	-	-	-	-	-	-	-	-	-	-	0.03	<LOD	<LOD
Bromadiolone	1031	4412	743	75	2630	4113	961	10	106	3915	5515	4032	2796
Brodifacoum	94	60	777	<LOD	379	36	1597	7	14	20	271	989	251
Flocumafen	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Difenacoum	<LOD	<LOD	<LOD	<LOD	<LOD	31	<LOD	<LOD	<LOD	<LOD	26	32	13

<LOD Less than Limit of Quantification

UV compounds and biocides

NILU-Sample number:		17/1498	17/1499	17/1450	17/1450	17/1451	17/1452	17/1453	17/1454	17/1455	17/1456	17/1457	17/1458
Customers sample ID:													
Sample type::		Badger liver	Badger liver	Badger liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver
Concentration units:		ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name													
BP3	0.32	<LOD	<LOD	0.32	-	-	-	-	-	-	-	-	-
EHMC	7.6	4.9	7.0	7.6	-	-	-	-	-	-	-	-	-
OC	<LOD	<LOD	<LOD	<LOD	-	-	-	-	-	-	-	-	-
UV-329	0.12	0.08	0.10	0.12	-	-	-	-	-	-	-	-	-
UV-328	0.07	0.13	0.16	0.07	-	-	-	-	-	-	-	-	-
UV-327	<LOD	<LOD	0.54	<LOD	-	-	-	-	-	-	-	-	-
Bromadiolone	<LOD	795	33.7	<LOD	28.5	87	<LOD	153	<LOD	8.6	57.2	<LOD	3560
Brodifacoum	<LOD	28.3	291	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	17.1
Flocumafen	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Difenacoum	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

<LOD Less than Limit of Quantification

Phenolic compounds

NILU-Sample number:	17/1410	17/1411	17/1412	17/1413	17/1414	17/1415	17/1416	17/1417	17/1418	17/1419	17/1421	17/1422	17/1423	17/1424	17/1425
Customers sample ID:	Slottet	Frogner-setra	Fornebu	Alnabru	VEAS	Slottet	Frogner-setra	Fornebu	Alnabru	VEAS	Slotts-parken	Frogner-setra	Fornebu	Alnabru	VEAS
Sample type::	Air	Air	Air	Air	Air	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Earthworm	Earthworm	Earthworm	Earthworm	Earthworm
Concentration units:	ng/filter	ng/filter	ng/filter	ng/filter	ng/filter	ng/g tørrvekt	ng/g tørrvekt	ng/g tørrvekt	ng/g tørrvekt	ng/g tørrvekt	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name															
OPEO	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-	-	-
NPEO	-	-	-	-	-	<LOD	<LOD	<LOD	0.62	1.1	-	-	-	-	-
OPEO2	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD	0.43	-	-	-	-	-
NPEO2	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-	-	-
Bis-FL	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-	-	-
Bis-BP	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-TMC	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-P	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-M	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-Z	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Hexafluorobisfenol A (Bis AF)	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-AP	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-S	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
4.4-bis-F	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2.2-bis-F	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-E	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-A	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-B	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
4-tert-octylphenol	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
4-nonylphenol	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
dodekylefenol	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
TBBPA	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-G	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Phenolic compounds

NILU-Sample number:	17/1427	17/1428	17/1429	17/1430	17/1431	17/1432	17/1433	17/1434	17/1435	17/1436
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name										
OPEO	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
NPEO	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
OPEO2	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
NPEO2	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-FL	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-BP	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-TMC	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-P	<LOD	<LOD	<LOD	1.64	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-M	<LOD	<LOD	<LOD	0.61	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-Z	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Hexafluorobisfenol A (Bis AF)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-AP	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-S	<LOD	<LOD	<LOD	1.36	<LOD	<LOD	<LOD	0.46	0.42	<LOD
4.4-bis-F	<LOD	3.41	11.0	7.61	164	<LOD	<LOD	<LOD	<LOD	99.5
2.2-bis-F	<LOD	0.78	<LOD	2.91	5.00	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-E	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-A	32.96	<LOD	20.99	50.39	16.23	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-B	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
4-tert-octylphenol	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
4-nonylphenol	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
dodekylefenol	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
TBBPA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-G	-	-	-	-	-	-	-	-	-	-

<LOD Less than Limit of Quantification

Phenolic compounds

NILU-Sample number:	17/1473	17/1474	17/1475	17/1476	17/1477	17/1478	17/1479
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name							
OPEO	-	-	-	-	-	-	-
NPEO	-	-	-	-	-	-	-
OPEO2	-	-	-	-	-	-	-
NPEO2	-	-	-	-	-	-	-
Bis-FL	<LOD	<LOD	<LOD	<LOD	103	<LOD	<LOD
Bis-BP	<LOD	<LOD	<LOD	<LOD	112	<LOD	<LOD
Bis-TMC	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-P	7.22	<LOD	<LOD	<LOD	64.7	4.29	<LOD
Bis-M	2.52	<LOD	<LOD	<LOD	19.4	2.54	<LOD
Bis-Z	<LOD	<LOD	<LOD	<LOD	240	<LOD	<LOD
Hexafluorobisfenol A (Bis AF)	<LOD	<LOD	<LOD	<LOD	27.5	<LOD	<LOD
Bis-AP	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-S	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
4.4-bis-F	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2.2-bis-F	<LOD	<LOD	<LOD	<LOD	37.41	<LOD	<LOD
Bis-E	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-A	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-B	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
4-tert-octylphenol	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
4-nonylphenol	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
dodekylefenol	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
TBBPA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-G	-	-	-	-	-	-	-

<LOD Less than Limit of Quantification

Phenolic compounds

NILU-Sample number:	17/1485	17/1486	17/1487	17/1488	17/1489	17/1490	17/1491	17/1492	17/1493	17/1494
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg	Sparrow-hawk egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name										
OPEO	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
NPEO	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
OPEO2	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
NPEO2	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-FL	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-BP	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-TMC	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-P	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-M	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-Z	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Hexafluorobisfenol A (Bis AF)	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-AP	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-S	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
4.4-bis-F	-	5.22	12.19	20.00	9.36	4.21	<LOD	<LOD	<LOD	<LOD
2.2-bis-F	-	<LOD	3.98	6.48	1.41	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-E	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-A	-	<LOD	13.74	16.34	73.08	<LOD	<LOD	18.30	12.62	12.30
Bis-B	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
4-tert-octylphenol	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
4-nonylphenol	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
dodekylefenol	-	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
TBBPA	-	0.84	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-G	-	-	-	-	-	-	-	-	-	-

<LOD Less than Limit of Quantification

Phenolic compounds

NILU-Sample number:	17/1437	17/1438	17/1439	17/1440	17/1441	17/1442	17/1443	17/1444	17/1445	17/1446	17/1498	17/1499	17/1450
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo			
Sample type::	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Badger liver	Badger liver	Badger liver
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name													
OPEO	-	-	-	-	-	-	-	-	-	-	-	-	-
NPEO	-	-	-	-	-	-	-	-	-	-	-	-	-
OPEO2	-	-	-	-	-	-	-	-	-	-	-	-	-
NPEO2	-	-	-	-	-	-	-	-	-	-	-	-	-
Bis-FL	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-BP	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-TMC	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-P	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-M	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-Z	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Hexafluorobisfenol A (Bis AF)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-AP	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-S	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
4.4-bis-F	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2.2-bis-F	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-E	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-A	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-B	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
4-tert-octylphenol	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
4-nonylphenol	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
dodekylefenol	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
TBBPA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-G	-	-	-	-	-	-	-	-	-	-	-	-	-

<LOD Less than Limit of Quantification

NILU-Sample number:	17/1451	17/1452	17/1453	17/1454	17/1455	17/1456	17/1457	17/1458
Customers sample ID:								
Sample type::	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name								
OPEO	-	-	-	-	-	-	-	-
NPEO	-	-	-	-	-	-	-	-
OPEO2	-	-	-	-	-	-	-	-
NPEO2	-	-	-	-	-	-	-	-
Bis-FL	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-BP	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-TMC	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-P	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-M	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-Z	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Hexafluorobisfenol A (Bis AF)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-AP	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-S	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
4.4-bis-F	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2.2-bis-F	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-E	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-A	<LOD	<LOD	<LOD	**52.3**	<LOD	<LOD	<LOD	<LOD
Bis-B	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
4-tert-octylphenol	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
4-nonylphenol	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
dodekylefenol	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
TBBPA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Bis-G	-	-	-	-	-	-	-	-

<LOD Less than Limit of Quantification

OPFR

NILU-Sample number:	17/1410	17/1411	17/1412	17/1413	17/1414	17/1415	17/1416	17/1417	17/1418	17/1419	17/1420
Customers sample ID:	Slottet	Frogner-setra	Fornebu	Alnabru	VEAS	Slottet	Frogner-setra	Fornebu	Alnabru	VEAS	VEAS
Sample type::	Air	Air	Air	Air	Air	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Mixed sample
Concentration units:	ng/filter	ng/filter	ng/filter	ng/filter	ng/filter	ng/g tørrvekt	ng/g tørrvekt	ng/g tørrvekt	ng/g tørrvekt	ng/g tørrvekt	ng/g tørrvekt
Compound name											
TEP	11.52	<LOD	<LOD	<LOD	<LOD	-	-	-	-	-	0.24
TCEP	34.37	4.96	7.98	6.09	3.88	-	-	-	-	-	0.48
TPrP	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-	-	-	
TCPP	210.56	<LOD	68.71	50.74	31.36	-	-	-	-	-	2.24
TiBP	26.10	8.80	20.79	8.07	7.21	-	-	-	-	-	0.84
BdPhP	<LOD	<LOD	0.26	<LOD	<LOD	-	-	-	-	-	<LOD
TPP	0.61	0.93	4.05	1.03	0.66	-	-	-	-	-	0.21
DBPhP	9.79	5.91	6.89	5.46	<LOD	-	-	-	-	-	<LOD
TnBP	10.25	5.17	9.16	7.71	2.92	-	-	-	-	-	0.46
TDCPP	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-	-	-	0.54
TBEP	12.30	5.61	6.72	<LOD	<LOD	-	-	-	-	-	0.83
TCP	2.98	1.60	2.74	4.39	3.00	-	-	-	-	-	1.02
EHDP	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-	-	-	<LOD
TXP	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-	-	-	0.23
TIPPP	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-	-	-	<LOD
TTBPP	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-	-	-	<LOD
TEHP	5.21	138	<LOD	<LOD	<LOD	-	-	-	-	-	0.84

<LOD Less than Limit of Quantification

OPFR

NILU-Sample number:	17/1410	17/1411	17/1412	17/1413	17/1414	17/1415	17/1416	17/1417	17/1418	17/1419	17/1420
Customers sample ID:	Slottet	Frogner-setra	Fornebu	Alnabru	VEAS	Slottet	Frogner-setra	Fornebu	Alnabru	VEAS	VEAS
Sample type::	Air	Air	Air	Air	Air	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Pooled sample Soil	Mixed sample
Concentration units:	ng/filter	ng/filter	ng/filter	ng/filter	ng/filter	ng/g tørrvekt	ng/g tørrvekt	ng/g tørrvekt	ng/g tørrvekt	ng/g tørrvekt	ng/g tørrvekt
Compound name											
ATE (TBP-AE)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-
a-TBECH	2.1	0.228	0.742	0.247	0.269	<LOD	<LOD	<LOD	<LOD	<LOD	-
b-TBECH	1.24	0.132	0.449	0.139	0.152	<LOD	<LOD	<LOD	<LOD	<LOD	-
g/d-TBECH	0.1	<LOD	0.104	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-
BATE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-
PBT	0.143	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-
PBEB	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-
HBB	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-
DPTE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-
EHTBB	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-
BTBPE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-
TBPH (BEH /TBP)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-
DBDPE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-

<LOD Less than Limit of Quantification

OPFR

NILU-Sample number:	17/1421	17/1422	17/1423	17/1424	17/1425	17/1426
-	Slotts-parken	Frogner-setra	Fornebu	Alnabru	VEAS	Mixed sample
Sample type::	Earthworm	Earthworm	Earthworm	Earthworm	Earthworm	Earthworm
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name						
TEP	-	-	-	-	-	<LOD
TCEP	-	-	-	-	-	0.15
TPrP	-	-	-	-	-	<LOD
TCPP	-	-	-	-	-	1.57
TiBP	-	-	-	-	-	1.74
BdPhP	-	-	-	-	-	<LOD
TPP	-	-	-	-	-	0.11
DBPhP	-	-	-	-	-	< 0.01
TnBP	-	-	-	-	-	2.68
TDCPP	-	-	-	-	-	<LOD
TBEP	-	-	-	-	-	0.48
TCP	-	-	-	-	-	3.70
EHDP	-	-	-	-	-	<LOD
TXP	-	-	-	-	-	0.65
TIPPP	-	-	-	-	-	<LOD
TTBPP	-	-	-	-	-	<LOD
TEHP	-	-	-	-	-	0.25

<LOD Less than Limit of Quantification

OPFR

NILU-Sample number:	17/1421	17/1422	17/1423	17/1424	17/1425	17/1426
Customers sample ID:	Slotts-parken	Frogner-setra	Fornebu	Alnabru	VEAS	Mixed sample
Sample type::	Earthworm	Earthworm	Earthworm	Earthworm	Earthworm	Earthworm
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name						
ATE (TBP-AE)	<LOD	<LOD	<LOD	<LOD	<LOD	-
a-TBECH	<LOD	<LOD	<LOD	<LOD	<LOD	-
b-TBECH	<LOD	<LOD	<LOD	<LOD	<LOD	-
g/d-TBECH	<LOD	<LOD	<LOD	<LOD	<LOD	-
BATE	<LOD	<LOD	<LOD	<LOD	<LOD	-
PBT	<LOD	<LOD	<LOD	<LOD	<LOD	-
PBEB	<LOD	<LOD	<LOD	<LOD	<LOD	-
HBB	<LOD	<LOD	<LOD	<LOD	<LOD	-
DPTE	<LOD	<LOD	<LOD	<LOD	<LOD	-
EHTBB	<LOD	<LOD	<LOD	<LOD	<LOD	-
BTBPE	<LOD	<LOD	<LOD	<LOD	<LOD	-
TBPH (BEH /TBP)	<LOD	<LOD	<LOD	<LOD	<LOD	-
DBDPE	<LOD	<LOD	<LOD	<LOD	<LOD	-

<LOD Less than Limit of Quantification

OPFR

NILU-Sample number:	17/1427	17/1428	17/1429	17/1430	17/1431	17/1432	17/1433	17/1434	17/1435	17/1436
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name										
TEP	-	-	-	-	-	-	-	-	-	-
TCEP	-	-	-	-	-	-	-	-	-	-
TPrP	-	-	-	-	-	-	-	-	-	-
TCPP	-	-	-	-	-	-	-	-	-	-
TiBP	-	-	-	-	-	-	-	-	-	-
BdPhP	-	-	-	-	-	-	-	-	-	-
TPP	-	-	-	-	-	-	-	-	-	-
DBPhP	-	-	-	-	-	-	-	-	-	-
TnBP	-	-	-	-	-	-	-	-	-	-
TDCPP	-	-	-	-	-	-	-	-	-	-
TBEP	-	-	-	-	-	-	-	-	-	-
TCP	-	-	-	-	-	-	-	-	-	-
EHDP	-	-	-	-	-	-	-	-	-	-
TXP	-	-	-	-	-	-	-	-	-	-
TIPPP	-	-	-	-	-	-	-	-	-	-
TTBPP	-	-	-	-	-	-	-	-	-	-
TEHP	-	-	-	-	-	-	-	-	-	-

<LOD Less than Limit of Quantification

OPFR

NILU-Sample number:	17/1427	17/1428	17/1429	17/1430	17/1431	17/1432	17/1433	17/1434	17/1435	17/1436
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type::	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg	Fieldfare egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name										
ATE (TBP-AE)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
a-TBECH	<LOD	<LOD	<LOD	0.249	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
b-TBECH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
g/d-TBECH	<LOD	<LOD	<LOD	0.222	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BATE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PBT	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PBEB	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
HBB	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
DPTE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
EHTBB	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BTBPE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
TBPH (BEH /TBP)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
DBDPE	<LOD	4.55	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

<LOD Less than Limit of Quantification

OPFR

NILU-Sample number:	17/1473	17/1474	17/1475	17/1476	17/1477	17/1478	17/1479	17/1482	17/1482	17/1483	17/1484
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Mixed sample	Mixed sample	Mixed sample	Mixed sample
Sample type::	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name											
TEP	-	-	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD
TCEP	-	-	-	-	-	-	-	<LOD	<LOD	<LOD	0.06
TPrP	-	-	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD
TCPP	-	-	-	-	-	-	-	0.26	0.26	0.3	0.31
TiBP	-	-	-	-	-	-	-	0.96	0.96	1.08	1.16
BdPhP	-	-	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD
TPP	-	-	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD
DBPhP	-	-	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD
TnBP	-	-	-	-	-	-	-	0.33	0.33	0.27	0.35
TDCPP	-	-	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD
TBEP	-	-	-	-	-	-	-	0.13	0.13	0.15	0.12
TCP	-	-	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD
EHDP	-	-	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD
TXP	-	-	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD
TIPPP	-	-	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD
TTBPP	-	-	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD
TEHP	-	-	-	-	-	-	-	<LOD	<LOD	<LOD	<LOD

<LOD Less than Limit of Quantification

OPFR

NILU-Sample number:	17/1473	17/1474	17/1475	17/1476	17/1477	17/1478	17/1479	17/1482	17/1483	17/1484
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Mixed sample	Mixed sample	Mixed sample
Sample type::	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg	Tawny owl egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name										
ATE (TBP-AE)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
a-TBECH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
b-TBECH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
g/d-TBECH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
BATE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
PBT	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
PBEB	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
HBB	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
DPTE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
EHTBB	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
BTBPE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
TBPH (BEH /TBP)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
DBDPE	<LOD	<LOD	3.79	<LOD	<LOD	3.65	<LOD	-	-	-

<LOD Less than Limit of Quantification

OPFR

NILU-Sample number:	17/1485	17/1486	17/1487	17/1488	17/1489	17/1490	17/1491	17/1492	17/1493	17/1494	17/1485	17/1495	17/1496	17/1497
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Mixed sample	Mixed sample	Mixed sample
Sample type::	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg	Sparrowhawk egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name														
TEP	-	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TCEP	-	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	0.069
TPrP	-	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TCPP	-	-	-	-	-	-	-	-	-	-	-	0.26	<LOD	0.34
TiBP	-	-	-	-	-	-	-	-	-	-	-	1.12	0.88	1.06
BdPhP	-	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TPP	-	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
DBPhP	-	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TnBP	-	-	-	-	-	-	-	-	-	-	-	0.33	0.30	0.33
TDCPP	-	-	-	-	-	-	-	-	-	-	-	<LOD	0.15	<LOD
TBEP	-	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	0.15
TCP	-	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
EHDP	-	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TXP	-	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TIPPP	-	-	-	-	-	-	-	-	-	-	-	0.028	<LOD	0.039
TTBPP	-	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TEHP	-	-	-	-	-	-	-	-	-	-	-	<LOD	0.32	0.34

<LOD Less than Limit of Quantification

OPFR

NILU-Sample number:	17/1485	17/1486	17/1487	17/1488	17/1489	17/1490	17/1491	17/1492	17/1493	17/1494	17/1495	17/1496	17/1497
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Mixed sample	Mixed sample	Mixed sample
Sample type::	Sparrow hawk egg	Sparrow hawk egg	Sparrow hawk egg	Sparrow hawk egg	Sparrow hawk egg	Sparrow hawk egg	Sparrow hawk egg	Sparrow hawk egg	Sparrow hawk egg	Sparrow hawk egg	Sparrow hawk egg	Sparrow hawk egg	Sparrow hawk egg
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name													
ATE (TBP-AE)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
a-TBECH	0.253	0.17	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
b-TBECH	0.0668	0.153	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
g/d-TBECH	0.118	0.0409	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
BATE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
PBT	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
PBEB	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
HBB	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
DPTE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
EHTBB	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
BTBPE	0.0625	0.062	<LOD	<LOD	<LOD	<LOD	0.141	<LOD	<LOD	<LOD	-	-	-
TBPH (BEH /TBP)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
DBDPE	2.69	3.51	<LOD	<LOD	<LOD	3.52	4.21	4.13	2.92	3.93	-	-	-

<LOD Less than Limit of Quantification

OPFR

NILU-Sample number:	17/1437	17/1438	17/1439	17/1440	17/1441	17/1442	17/1443	17/1444	17/1445	17/1446	17/1447	17/1448	17/1449
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Mixed sample	Mixed sample	Mixed sample
Sample type::	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name													
TEP	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TCEP	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TPrP	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TCPP	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TiBP	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
BdPhP	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TPP	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
DBPhP	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TnBP	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TDCPP	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TBEP	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TCP	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
EHDP	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TXP	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TIPPP	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TTBPP	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TEHP	-	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD

<LOD Less than Limit of Quantification

OPFR

NILU-Sample number:	17/1437	17/1438	17/1439	17/1440	17/1441	17/1442	17/1443	17/1444	17/1445	17/1446	17/1447	17/1448	17/1449
Customers sample ID:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Mixed sample	Mixed sample	Mixed sample
Sample type::	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver	Fox liver
Concentration units:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Compound name													
ATE (TBP-AE)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
a-TBECH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.931	<LOD	<LOD	<LOD	-	-	-
b-TBECH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.119	<LOD	<LOD	<LOD	-	-	-
g/d-TBECH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.163	<LOD	<LOD	<LOD	-	-	-
BATE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
PBT	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
PBEB	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
HBB	0.057	0.057	0.074	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
DPTE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
EHTBB	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
BTBPE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
TBPH (BEH /TBP)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	-	-
DBDPE	4.5	23.9	4.84	<LOD	<LOD	3.31	<LOD	<LOD	23.4	<LOD	-	-	-

<LOD Less than Limit of Quantification

OPFR

NILU-Sample number:	17/1498	17/1499	17/1500	17/1450	17/1451	17/1452	17/1453	17/1454	17/1455	17/1456	17/1457	17/1458	17/1460	17/1461	17/1462
Customers sample ID:													Mixed sample	Mixed sample	Mixed sample
Sample type::	Badger liver	Badger liver	Badger liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver
Concentration units:															
Compound name															
TEP	<LOD	<LOD	<LOD	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TCEP	<LOD	<LOD	<LOD	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TPrP	<LOD	<LOD	<LOD	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TCPP	<LOD	<LOD	<LOD	-	-	-	-	-	-	-	-	-	0.34	1.07	1.25
TiBP	<LOD	<LOD	<LOD	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
BdPhP	<LOD	<LOD	<LOD	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TPP	<LOD	<LOD	<LOD	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
DBPhP	<LOD	<LOD	<LOD	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TnBP	<LOD	<LOD	<LOD	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TDCPP	<LOD	0.78	<LOD	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TBEP	<LOD	<LOD	5.49	-	-	-	-	-	-	-	-	-	0.32	1.75	4.4
TCP	<LOD	<LOD	<LOD	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
EHDP	<LOD	<LOD	<LOD	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TXP	<LOD	<LOD	<LOD	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TIPPP	<LOD	<LOD	<LOD	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TTBPP	<LOD	<LOD	<LOD	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD
TEHP	<LOD	<LOD	<LOD	-	-	-	-	-	-	-	-	-	<LOD	<LOD	<LOD

<LOD Less than Limit of Quantification

OPFR

NILU-Sample number:	17/1498	17/1499	17/1500	17/1450	17/1451	17/1452	17/1453	17/1454	17/1455	17/1456	17/1457	17/1458	17/1460	17/1461	17/1462
Customers sample ID:													Mixed sample	Mixed sample	Mixed sample
Sample type::	Badger liver	Badger liver	Badger liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver	Rat liver
Concentration units:															
Compound name															
ATE (TBP-AE)	<LOD	<LOD	<LOD	0.0959	0.11	0.055	0.125	0.107	0.098	<LOD	-	0.072	-	-	-
a-TBECH	<LOD	<LOD	<LOD	0.16	0.182	<LOD	0.154	0.171	0.158	0.105	-	0.13	-	-	-
b-TBECH	<LOD	<LOD	<LOD	0.107	0.112	<LOD	0.085	0.105	0.087	<LOD	-	0.072	-	-	-
g/d-TBECH	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	<LOD	-	-	-
BATE	<LOD	<LOD	<LOD	0.0174	0.016	<LOD	<LOD	<LOD	<LOD	<LOD	-	<LOD	-	-	-
PBT	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	<LOD	-	-	-
PBEB	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	<LOD	-	-	-
HBB	<LOD	0.08	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	<LOD	-	-	-
DPTE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	<LOD	-	-	-
EHTBB	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	<LOD	-	-	-
BTBPE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	<LOD	-	-	-
TBPH (BEH /TBP)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	-	<LOD	-	-	-
DBDPE	3.29	5.85	36.2	3.98	4.16	6.28	4.15	5.54	<LOD	<LOD	-	<LOD	-	-	-

<LOD Less than Limit of Quantification

Appendix 2

GPS coordinates for sampling locations

GPS coordinates for sampling locations

ID	Location	UTM-zone	Latitude	Longitude
Air				
17/1410	Slottsparken	32V	59.91703	10.72428
17/1411	Frognerseteren	32V	59.983611	10.690833
17/1412	Fornebu	32V	59.896919	10.611171
17/1413	Alnabru	32V	59.925	10.838333
17/1414	VEAS	32V	59.794786	10.497712
Soil				
17/1415	Slottsparken	32V	59.917025	10.724283
17/1416	Frognerseteren	32V	59.977092	10.680456
17/1417	Fornebu	32V	59.89717	10.611989
17/1418	Alnabru	32V	59.914238	10.829149
17/1419	VEAS	32V	59.794483	10.498429
Earthworm				
17/1421	Slottsparken	32V	59.917025	10.724283
17/1422	Frognerseteren	32V	59.977092	10.680456
17/1423	Fornebu	32V	59.89717	10.611989
17/1424	Alnabru	32V	59.914238	10.829149
17/1425	VEAS	32V	59.794483	10.498429
Brown rat				
17/1450	Grønland	32V	59.91218	10.7628
17/1451	Vålerenga	32V	59.90786	10.7887
17/1452	Kalbakken	32V	59.95429	10.86656
17/1453	Kalbakken og Ulven	32V	59.95429	10.86656
17/1454	Kalbakken og Ulven	32V	59.95429	10.86656
17/1455	Kalbakken og Ulven	32V	59.95429	10.86656
17/1456	Oslo (mixed)		-	-
17/1457	Oslo (mixed)		-	-
17/1458	Oslo (mixed)		-	-
Red fox				
17/1439	Oslo komm sentroid	32V	59.973429	10.774309
17/1440	Oslo komm sentroid	32V	59.973429	10.774309
17/1441	Oslo komm sentroid	32V	59.973429	10.774309
17/1442	Mosseveien	32V	59.864718	10.783583
17/1443	Maridalen	32V	59.997482	10.768276
17/1444	Gressholmen	32V	59.883395	10.719074
17/1445	Maridalen	32V	60.024158	10.788203
17/1446	Bleikøya	32V	59.889171	10.739586
Badger				

17/1498	-	32V	-	-
17/1499	-	32V	-	-
17/1500	-	32V	-	-
Fieldfare				
17/1427	Svartdalsparken	32V	59.904325	10.791661
17/1428	Grønmo	32V	59.840073	10.853116
17/1429	Ekebergsletta	32V	59.891641	10.771871
17/1430	Bøler	32V	59.880296	10.852299
17/1431	Teisen	32V	59.913032	10.828045
17/1432	Grorud	32V	59.951245	10.903209
17/1433	Kjelsås	32V	59.964246	10.787319
17/1434	Sognsvann	32V	59.973145	10.725337
17/1435	Blindern	32V	59.936057	10.722873
17/1436	Holmen	32V	59.953615	10.680449
Tawny owl and Sparrow hawk	Confidential for species protection	Confidential for species protection	Confidential for species protection	Confidential for species protection

Appendix 3

Eggshell data in sparrowhawks from the Oslo area 2017.

Eggshell data in sparrowhawks from the Oslo area 2017.

NILU ID	NINA ID	Eggshell index	Eggshell thickness (mm/1000)
17/1484	5903	1,31	250,00
17/1485	5904	1,26	251,25
17/1486	5905	1,29	248,75
17/1487	5906	1,00	241,25
17/1488	5907	1,25	247,50
17/1489	5908	1,18	
17/1490	5909	1,41	268,75
17/1491	5910	1,47	282,50
17/1492	5911	1,29	251,25
17/1493	5912	1,12	

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The Norwegian Environment Agency is working for a clean and diverse environment. Our primary tasks are to reduce greenhouse gas emissions, manage Norwegian nature, and prevent pollution.

We are a government agency under the Ministry of Climate and Environment and have 700 employees at our two offices in Trondheim and Oslo and at the Norwegian Nature Inspectorate's more than sixty local offices.

We implement and give advice on the development of climate and environmental policy. We are professionally independent. This means that we act independently in the individual cases that we decide and when we communicate knowledge and information or give advice.

Our principal functions include collating and communicating environmental information, exercising regulatory authority, supervising and guiding regional and local government level, giving professional and technical advice, and participating in international environmental activities.