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Miljøgifter i terrestrisk og bynært miljø 2015
Environmental pollutants in the terrestrial and urban environment 2015

Summary - sammendrag

We analysed biological samples from the terrestrial and urban environment for various inorganic and organic contaminants in the Oslo area. A foodchain approach was used, in order to detect bioaccumulation of the different compounds. The species analysed were earthworms, fieldfare, sparrowhawk, rats, tawny owl and red fox. Soil samples were also included in the study.

Biologiske prøver fra det urbane terrestriske miljøet i Oslo-området ble analysert for organiske og uorganiske miljøgifter. En næringskjede bla valgt for å undersøke bioakkumulasjon av de forskjellige stoffene. De utvalgte artene var meitemark, gråtost, spurvehauk, rotte, kattugle og rødrev. Jordprøver ble også analysert.

4 emneord

POPs, PFAS, tungmetaller, spurvehauk, kattugle, gråtrost, brunrotte, rødrev, meitemark, jord, terrestrisk miljø

4 subject words

POPs, PFAS, heavy metals, sparrowhawk, tawny owl, fieldfare, brown rat, red fox, earthworms, soil, terrestrial environment

Front page photo

Fieldfare, by Jan Ove Gjershaug, NINA

Summary

On behalf of the Norwegian Environment Agency, the Norwegian Institute for Air Research (NILU) in collaboration with Norwegian Institute for Nature Research (NINA) analysed biological samples from the terrestrial and urban environment for various inorganic and organic contaminants. Stable isotope analysis for nitrogen, carbon and sulphur ($\delta^{15}N$, $\delta^{13}C$ and $\delta^{34}S$) was carried out by the Institute for Energy Technology (IFE). Sample collection was carried out by NINA and associates. The purpose of this report is to provide an updated assessment of pollution present within the terrestrial urban environment in Norway in order to evaluate potential environmental hazard, and to provide information to ongoing regulatory work at both national and international level.

The project had the following key goals:

- Report concentrations of chosen environmental pollutants in several levels of the terrestrial food chain
- Evaluate the bioaccumulation potential of pollutants in a terrestrial food chain
- Evaluate the combined exposure and mixture risk assessment of pollutants in terrestrial animals
- Evaluate how land-living species are exposed to a variety of pollutants

The incorporation of soil as an abiotic compartment allowed us for the first time to assess the exposure from soil into the food chain and also the combined risk caused by polluted soil. This improved the understanding of the complex relationship within the ecosystem. The tawny owl was also added as a top predator in the agricultural landscape.

Secondly, a much broader cocktail of pollutants, consisting both of persistent organic pollutants, organic phenolic pollutants, biocides, UV compounds and metals was included in this year's study. This reflects the real exposure of organisms living in a large city to a much better extent, improving the risk estimation and evaluation.

Large differences of pollutant contribution were found in soil and earthworms compared to higher trophic organisms as sparrowhawk and tawny owl. Fieldfare acted as an optimal link between lower and higher trophic levels in this study. The data for brown rat and red fox on the other hand were valuable indicators of animals feeding on trash and human offal.

Of all the organisms and tissues measured in the study, sparrowhawks had the highest average concentration of the sum of all organic pollutants measured, followed by red fox and tawny owl. When only focusing on the toxic metals mercury, cadmium, lead and arsenic, soil was the highest contaminated compartment followed by earthworm and rats.

Rats and foxes were highly contaminated with the rodenticide bromadiolone.

Organic phosphorous flame retardants (OPFRs) and perfluorinated alkylic substances (PFAS) were first and foremost found in soil and earthworms, but to a much lesser degree in species higher up the food chain.

UV compounds only played a minor role in the overall contamination burden of terrestrial urban animals.

An estimation of the trophic magnification was possible for the food chain earthworm - fieldfare - sparrowhawk. In order to assess the bioaccumulation potential, trophic magnification factors (TMF) were calculated. The TMF calculations indicated trophic biomagnification for PCBs, PBDEs, pesticides (without DDTs), the siloxanes D5 and D4, PFTrA and PFOS in decreasing order.

The prediction of combined risk was carried out with the use of the concentration addition approach. It revealed a potential risk for soil living organisms, predominately due to the addition of risk ratios (RQ), of the measured effect concentration divided by the predicted no environment concentration in soil (MEC/PNECsoil) >1 of 4-octylphenol, TCP and some metals.

The prediction of combined risk by using the concentration addition approach revealed potential risk for soil living organisms where the sum was driven mostly by the risk factors of 4-octylphenol, tricresyl phosphate (TCP) and some metals. A potential cumulative risk was predicted for birds/predators preying on earthworm from the sites Slottsparken, Grorud and Voksenkollen, where cadmium and bisphenol A were identified as main risk drivers. Potential risk for predators of fieldfares where only found for the sum of the highest concentrations in fieldfare eggs where PFOS and HCB where shown to be the most important risk drivers.

Sammendrag

På oppdrag fra Miljødirektoratet analyserte Norsk institutt for luftforskning (NILU) og Norsk institutt for naturforskning (NINA) en lang rekke uorganiske og organiske miljøgifter i dyrearter fra bynært og terrestrisk miljø. Institutt for energiteknikk (IFE) analyserte stabile isotoper av nitrogen, karbon og svovel ($\delta^{15}N$, $\delta^{13}C$ og $\delta^{34}S$). NINA, med samarbeidspartnere, var ansvarlig for innsamling av prøvene. Formålet med studien var å gi en vurdering av forurensningssituasjonen i det terrestriske miljøet i bynære områder samt å se på samlet effekt av miljøgifter. 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
- Vurdere bioakkumuleringspotensialet av forurensninger i en terrestrisk næringskjede
- Vurdere kombinert eksponering og risikovurdering av miljøgiftblandinger
- Vurdere hvordan terrestriske arter er utsatt for en rekke miljøgifter

Inkludering av jord som prøvetakingsmedium ga oss for første gang mulighet til å vurdere eksponeringen fra jord til næringskjede, samt predikere risiko for jordlevende organismer fra miljøgiftblandinger. Dette bedret forståelsen av det komplekse samspillet i økosystemet. Kattugle ble også lagt til som en topp predator i kulturlandskapet.

I tillegg ble en utvidet blanding (cocktail) av miljøgifter, som besto av både organiske miljøgifter, organiske fenoliske miljøgifter, biocider, UV-forbindelser og metaller inkludert i årets undersøkelse. Dette ville reflektere en mer reell miljøgifteksponering fra ulike lokale kilder for organismer som lever i byområder.

Jord og meitemark viste større variasjon av type og mønster av detekterte miljøgifter enn høyere trofiske organismer som spurvehauk og kattugle. Gråtrost fungerte som en optimal kobling mellom lavere og høyere trofiske nivåer i denne studien. Dataene for brunrotte og rødrev på den annen side var verdifulle indikatorer på eksponering fra søppel og kadaver.

Høyest gjennomsnittlig konsentrasjon av summen av alle organiske miljøgifter ble målt i spurvehauk, etterfulgt av rødrev og kattugle. Summen av metallene kvikksølv, kadmium, bly og arsen viste høyest konsentrasjon i jord etterfulgt av meitemark og rotter.

Rotter og rever viste høy konsentrasjon av rottegiften bromadiolon.

Organiske fosforflammehemmere ble først og fremst funnet i jord og meitemark, og i mye mindre grad i arter høyere opp i næringskjeden.

UV-forbindelser utgjorde kun en liten del av den totale forurensningsbyrden for terrestriske urbane dyr.

En vurdering av trofisk magnifisering var mulig for næringskjeden meitemark, gråtrost og spurvehauk. Trofisk magnifiseringsfaktor (TMF) ble beregnet for å vurdere bioakkumuleringspotensialet. TMF-beregningene indikerte trofisk biomagnifisering for PCB, PBDE, plantevernmidler (uten DDT), siloksanene D5 og D4, PFTrA og PFOS i avtagende rekkefølge.

Prediksjon av kombinert risiko ved bruk av konsentrasjonsaddisjonstilnærming viste potensiell risiko for jordlevende organismer. Summen av risikofaktorene var hovedsakelig dominert av de enkeltvise risikofaktorene av 4-oktylfenol, tricresyl phosphate (TCP) og metaller. Prediksjon av risiko for predatorer med stort inntak av meitemark fra lokalitetene

Slottsparken, Grorud og Voksenkollen, viste potensiell risiko der kadmium og bisfenol A ble identifisert som viktigste risikodrivere. Ingen entydig kumulativ risiko ble identifisert for rovfugl eller rovdyr med høyt inntak av kylling/egg fra gråtrost. Kun de høyeste konsentrasjonen av miljøgiftene i gråtrostegg viste potensiell risiko for rovfugl der PFOS og HCB viste seg å være viktigste risikodrivere.

Abbreviations

BFR	brominated flame retardants
CA	concentration addition
CI	confidence interval
EI	electron impact ionization
ESI	electrospray ionization
EAC	ecotoxicological assessment criteria
EQS	environmental quality standard
fw	fresh 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
MEC	measured environmental concentration
M-W U	Mann-Whitney *U* test
MSCP	medium-chain chlorinated paraffins
NCI	negative chemical ionization
NOEC	no observed effect concentration
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
ww	wet weight

Content

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 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 hazard, 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 and predict the risk from mixture of pollutants in terrestrial animals
- Evaluate how land-living species are exposed to a variety of pollutants

1.2 Investigated species

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 cultured 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, foxes, hedgehogs), and invertebrates (e.g. ground beetles, snails. They are found almost anywhere in soil that contains some moisture (Macdonald 1983). Lumbricus terrestris was the most common species. Estimated trophic level 2 (Hui et al. 2012).

Red fox (*Vulpes vulpes*)
The red fox is the most abundant carnivore in Europe, and is widespread. It is found over most of the world. It inhabits most of Norway, from the mountains, through the forests and the agricultural landscape, but 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.

1.3 Investigated pollutants

In this study a total of 73 compounds were investigated, consisting of 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 $\delta^{34}S$. In eggs of Tawny owl and sparrowhawk, pesticides and DDTs were also analysed. As part of a timetrend investigation, OPFRs, PFAS, PCBs and PBDEs were analysed in fox liver samples from 2011 to 2015 as well. 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
Methyl Mercury	Me-Hg	22967-92-6
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)		
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 butane sulfonate	PFBS	375-73-5
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 nonane sulfonate	PFNS	17202-41-4
Perfluorinated decane sulfonate	PFDcS	67906-42-7
Polybrominated diphenylethers (PBDE)		
2,2',4,4'-Tetrabromodiphenylether 47	BDE-47	5436-43-1
2,2',4,4',5-Pentabromodiphenylether 99	BDE-99	60348-60-9
2,2',4,4',6-Pentabromodiphenylether 100	BDE-100	189084-64-8
3,3',4,4',5-Pentabromodiphenylether 126	BDE-126	366791-32-4
2,2',4,4',5,5'-Hexabromodiphenylether 153	BDE-153	68631-49-2
2,2',4,4',5,6'-Hexabromodiphenylether 154	BDE-154	207122-15-4
2,2’,3,3’,4,5’,6-Heptabromodiphenylether 175	BDE-175	446255-22-7
2,2',3,4,4',5',6-Heptabromodiphenylether 183	BDE-183	207122-16-5
2,3,3’,4,4’,5,6- Heptabromodiphenylether 190	BDE-190	189084-68-2
2,2',3,3',4,4',5,6'-Octabromodiphenylether196	BDE-196	446255-38-5
2,2’,3,3’,5,5’6,6’-Octabromodiphenylether 202	BDE-202	67797-09-5
2,2',3,3',4,4',5,5',6-Nonabromdiphenylether 206	BDE-206	63936-56-1
2,2’,3,3’4,4’,5,6,6’-Nonabromodiphenylether 207	BDE-207	

Decabromodiphenylether 209	BDE-209	1163-19-5
Decabromodiphenyl ethane	DBDPE	84852-53
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
Phosphorous organic flame retardants (PFR):		
Tri(2-chloroethyl)phosphate	TCEP	115-96-8
Tri(1-chlor-2-propyl) phosphate	TCPP	13674-84-5
Tri(1,3-dichloro-2-propyl)phosphate	TDCPP	13674-87-8
Tri(2-butoxyethyl) phosphate	TBEP	78-51-3
2-etylhexyl-di-phenyl phosphate	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
UV compounds:		
Octocrylen		6197-30-4
Benzophenone-3		131-57-7
Ethylhexylmethoxycinnamate		5466-77-3
UV-327		3864-99-1
UV-328		25973-55-1
UV-329		3147-75-9
Biocids:		
Bromadiolon		28772-56-7
Phenols:		
Bisphenol A		80-05-7
Bisphenol S		80-09-1
Bisphenol F		1333-16-0
Nonylphenol		104-40-5
Octylphenol		1806-26-4
Tetrabromobisphenol A	TBBPA	79-94-7
Pesticides:		
α-HCH		
β-HCH		
γ-HCH		
HCB		
Oxy-Chlordane		
Trans-Chlordane		
Cis-Chlordane		
Trans- Nonachlor		
Cis- Nonachlor		
Mirex		
o,p-DDT		
p,p'-DDT		
o,p-DDE		
p,p'-DDE		

1.3.1 Metals including Hg

Mercury (Hg), Lead (Pb) and Cadmium (Cd) are metals that are toxic and have adverse effects on environment and health, even at very low concentrations. 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 three 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 biphenyles (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 results, 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.

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 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 is also under discussion in the EU. 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, decaBDE is currently being considered for inclusion in the Stockholm Convention as a persistent organic pollutant.

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 equivocation in 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).

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. 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). Among others, long-range transport of PFAS has been suggested by Barber et al (2007), and Cousins et al. (2011). 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 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.

1.3.5 Cyclic siloxanes, (cVMS)

There have been raised concern about the properties and environmental fate of the three most common cyclic siloxanes D4, D5, and D6. 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, and in 2015 a current restriction intention to REACH was submitted for the use of D4 and D5 in wash-off personal care products in EU/ECHA.

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).

CPs have been studied in the environment, but data from Scandinavia and the Arctic is limited (Bayen et al. 2006). In air collected at Bear Island (Norway), concentrations were 1.8 to 10.6 ng/m^3 (Borgen et al. 2003) while SCCPs have been detected in river water in a range of 15.7 to 59.6 ng/L in the St. Lawrence River, Canada (Moore et al., 2004) and < 0.1 to 1.7 µg/L in England and Wales (Nicholls et al., 2001). SCCP have been detected in surface sediments in Arctic lakes in Canada 1.6 to 257 ng/g (Tomy et al., 1997), and 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). Levels of MCCPs ranged from 276 to 563 ng/g ww in carp and 0.257 to 4.39 µg/g ww in trout from Lake Ontario. In Beluga whales collected between 1987 and 1991, SCCPs ranged from 1.78 to 80.0 µg/g ww in blubber and 0.545 to 20.9 µg/g ww in liver samples (Bennie et al. 2000). 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).So far S/MCCPs are not globally regulated, however, SCCP is currently being considered for inclusion in the Stockholm Convention as a persistent organic pollutant and on November 14, 2015, the EU published Regulation (EU) 2015/2030 in the Official Journal of the European Union (OJEU) amending the scope and requirements for SCCPs under Part B of ANNEX I to the POPs Regulation (EC) 850/2004.

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 PFR 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 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 (BPA) is an industrial chemical with high production volumes used in the production of polycarbonate plastics and epoxy resins. Due to its versatile use, BPA 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. These days two of the analogues – bisphenol S (BPS) and bisphenol F (BPF) have been mostly used as bisphenol A replacements. BPS 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). BPS is also used as a wash fastening agent in cleaning products, an electroplating solvent and constituent of phenolic resins (Clark 2000). BPF 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.

1.3.9 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, 2007) irrespective of their PBT characteristics. The increase in public awareness over the dangers of over-exposure to sunlight has lead in 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 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 form 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 (Christin 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).

1.3.10 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 a single aerial spraying episode, 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 anthropod 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.

1.3.11 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 & 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 pollution present in selected terrestrial urban environments in Norway, and to evaluate the combined risk of these pollutants and assess their bioaccumulation. The different species included in the study were selected to represent different trophic levels, from primary consumers (earthworm) via secondary consumers (fieldfare) to a top predator (sparrowhawk). In addition, an omnivore generalist representing a truly urban environment, the red fox, was chosen. Sparrowhawk and tawny owl eggs were used in this study to give insights in how a terrestrial top predator within both urban and rural habitats is affected by pollution levels. An overview over the analysed 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*
Soil	5	Oslo	2015	Pool of individual samples
Earthworms (*Lumbricidae*)	5	Oslo	2015	Pool of individual samples
Fieldfare (*Turdus pilaris*)	10	Oslo	2015	Fresh eggs
Sparrowhawk (*Accipiter nisus*)	10	Oslo	2015	Fresh eggs
Brown rat (*Rattus norvegicus*)	10	Oslo	2015	Pool of individual samples
Tawny owl (*Strix aluco*)	10	Oslo	2015	Fresh eggs
Red fox (*Vulpes vulpes*)	10	Oslo	2015	Individual liver samples
Red fox (*Vulpes vulpes*)	50	Lierne	2011-2015	Individual liver samples

Soil

Soil samples were collected at five locations (Figure 1). The upper layer of 5-15 cm of soil was sampled. The different locations varied between forest soil (Voksenkollen, Maridalen, Grorud), and urban soil characterized by little plant debris and artificial fertilisation (Slottsparken, Svartedalsparken).

Figure 1: Locations for soil and earthworms sampled in Oslo (orange) and fieldfare samples (yellow).

Earthworms (Lumbricidae)

Earthworms were collected at the same five locations in Oslo as the earth samples to allow a direct comparison (Figure 1). 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 2: Habitat (left) and soil profile (right) of the soil and worm sampling-site in Maridalen

Fieldfare *(Turdus pilaris)*

Ten fieldfare eggs were collected from 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. Only one egg from each nest was taken. 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 were removed from the shell and transferred to clean glass vials for storage at – 21 ˚C. The dried eggshells were measured (length, breadth an 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 in order to protect the nesting sites. Nests were located early in the breeding season, and sampled in April-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. 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 were removed from the shell and transferred to clean glass vials for storage at − 21 °C. The eggs were handled by the same method as the fieldfare eggs at NINA.

Brown rat *(Rattus norvegicus)*
Rats were caught using clap-traps (no rat poison involved). Liver samples of four rats of each sex were selected for single analyses, and liver samples of two rats per sex had to be pooled together due to limited liver size. The final sample number was 5 liver samples of female rats and 5 liver samples of male rats. The bodyweight of the female rats ranged between 131 g and 318 g and for male rats between 132 g and 286 g. Liver weights varied between 44 g and 9 g. Ano-genital distance was measured in all individuals. This is the distance from the anus to the genitalia, the base of the penis or vagina.

Red fox *(Vulpes vulpes)*
Red foxes for the urban pollution measurements were collected in Oslo, Nittedal and Furuset. The foxes were shot by local hunters on assignment from NINA. Dissection of their livers was carried out at the laboratories of NINA, applying the siloxane relevant precautions. The samples were wrapped in aluminium foil and thereafter put into sealed polyethylene bags before being frozen at – 21°C. Among the sampled foxes, we collected 6 males and 6 females. 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). Foxes for the timetrend study were collected in Lierne in the years 2011 – 2015.

2.2 Quality assurance

NINA and NILU are certified to both ISO 9001 and 14001. 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 so as 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.

2.3 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

$$V = 0.51 * L * B^2$$

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

The shell index was calculated according to following equation:

$$SI = W_s \text{ (mg)}/L \times B.$$

As the eggs were brooded by the parent bird for a different length of time, a desiccation index (DI) value was calculated for each egg as a measure of water loss through the shell (Helander et al., 2002). This index was used to back-calculate the measured values of pollutants to those of a fresh egg (fw), by relating the egg weight (with content) to its volume given by its measurements:

First, the net volume (V_n) was found by subtracting two times the eggshell thickness from the lengths and breadths in the formula for V given above, giving the initial fresh weight (W_f) of the content assuming a factor of 1.0 for specific gravity. The DI is the calculated as:

$$DI = W_b/(W_f+W_s)$$

Then, all the measured pollutant concentrations (C_i) in eggs were corrected to fresh weight as follows:

$$C_{fw} = C_i \times DI$$

Chemical analysis

Due to the differing physicochemical properties of the pollutants of interest, several sample preparations methods were applied. Lipophilic compounds as PBDEs and PCBs were analyzed together. PFAS and metals required a dedicated sample preparation each. Together three different sample preparation methods were applied.

<u>PBDEs, CPs, DDTs, pesticides and PCBs.</u> 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.

<u>PFAS.</u> Samples were extracted with acetonitrile and treated with emulsive clean-up prior to analyses with UPLC/MS/MS in ESI(-) mode.

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 220ºC 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. Established methods based on liquid/liquid extraction (Warner et al. 2010; Warner et al. 2013) were used to extract and quantify siloxanes, in addition to headspace extraction techniques (Sparham et al. 2008) for analysing siloxanes in water and sediment samples. Analysis of siloxanes (D4, D5 and D6) was performed using gas chromatography with mass spectrometric detection (GC-MS).

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 the 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 with 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 either 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. In general, only analytes with concentrations above the detection limit are presented in tables and figures. 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. Using a state-of-the-art cleancabinet, NILU may perform trace analysis of these compounds in matrices from pristine environments, such as the Arctic (Krogseth et al. 2013; Warner et al. 2013). Samples were analysed in groups with at least one additive standard sample and a blank control. The data from these were used to calculate the uncertainty for each sample group. To ensure repeatability, a random sample from each matrix was selected for duplicate analysis. Field blanks were prepared for the sampling of samples 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. Subsequently, used hexane was removed and substituted with clean hexane and the field blanks were sonicated once more for 30 min. After ultrasonic treatment, the field blanks were dried in a clean cabinet equipped with HEPA- and charcoal filter to prevent contamination from indoor air. After drying, the field blanks were put in 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.

Ano genital distance. The ano-genital distance was measured in all individuals in mm. This is the distance from the anus to the genitalia, the base of the penis or vagina.

2.4 Biomagnification

In contrast to the monitoring performed in 2013, a more complete food chain was available to the project, thereby allowing a better assessment of the biomagnification of the different chemicals investigated. Similar to the urban terrestrial study from 2013, (Herzke et al., 2014), 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, fieldfare = 3, 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):

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

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

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 have to 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 those only reflect the short term exposure rather than the long term one.

2.5 Statistical methods

Statistics were performed using SPSS statistics, ver. 21 (® 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).

2.6 Mixture risk assessment

The method of summing up PEC/PNEC or MEC/PNEC ratios, has been recommended as a justifiable mixture risk approximation in order to estimate in a first tier approach whether there is a potential risk for an exposed ecosystem (Backhaus and Karlsson, 2014; Petersen et al, 2013; Backhaus and Faust 2012). In order to evaluate the risk for soil living organisms such as earthworm, the measured concentration (MEC) of the contaminants in pooled soil samples was compared to the PNEC for soil ecosystem for the specific contaminants. The potential mixture effects was assessed by summing up the MEC/PNECsoil ratios for each locations. For terrestrial predators feeding on lower trophic levels, the MEC values of earthworm and fieldfare eggs were compared to predicted no-effect concentration for oral intake (PNECpred). PNEC values were adopted from previously assessed and reported values (Andersen et al., 2012) and literature search. The single MEC/PNEC was calculated and summed up to assess if the sum exceeded 1 or not. The methodology was applied with the presumption that the available PNEC values were protective and assessed for the most sensitive species, in accordance to the guidelines for deriving PNEC values (ECHA, 2008).

3. Results

Of the 109 compounds that were analysed in all samples, 78 could be detected. 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 (means, medians, maximums and minimums) and individual data can be found in the Appendix. The number of cases (N) in all tables denotes the number of samples with detectable levels.

In general, the most compounds and highest concentrations of halogenated organic pollutants were found in sparrowhawk eggs. PCBs and PBDEs were highest in sparrowhawk, while PFAS levels were high in both sparrowhawk, tawny owl and earthworms. Mercury was found in highest concentrations in red fox, sparrowhawk and earthworm. Lead was highest in red fox and earthworms. Siloxanes and SCCP were detected in all sample matrices, with highest concentrations found in rat and sparrowhawk.

3.1 PCBs

3.1.1 Soil

Soil was sampled for the first time within this project. SumPCB concentrations varied between 0.8 and 4 ng/g dw, with a median of 1.92 ng/g dw (Table 3). The highest sumPCB concentrations were measured in Maridalen followed by Slottsparken. 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 (TA-2553/2009). None of the samples analysed in this study exceeded this threshold value.

Table 3. Average PCB concentrations in soil in ng/g dw; N: number of detected and analysed samples

	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180	SumPCB
N	5/ 5	5/ 5	5/ 5	5/ 5	5/ 5	5/ 5	5/ 5	5
Mean	0.03	0.06	0.29	0.29	0.62	0.68	0.37	2.33
Median	0.03	0.06	0.24	0.21	0.50	0.56	0.33	1.93
Minimum	0.02	0.03	0.08	0.10	0.23	0.23	0.13	0.83
Maximum	0.04	0.10	0.51	0.54	1.09	1.17	0.56	3.90

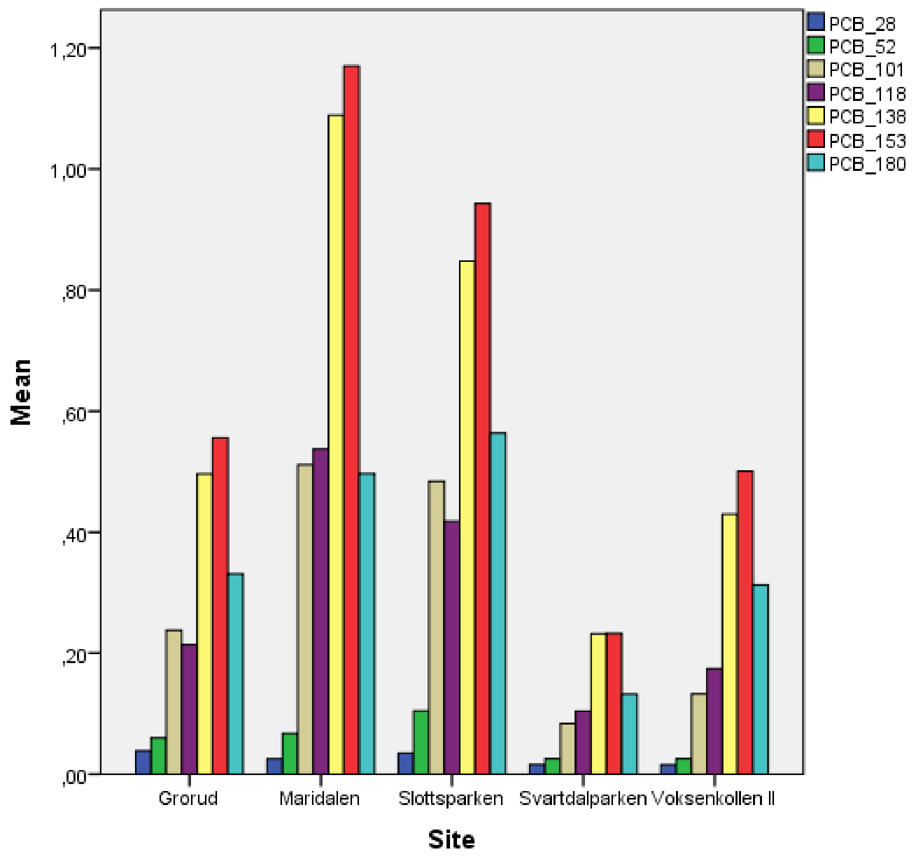


Figure 3. PCB congeners in soil from different sampling sites in Oslo (ng/g dw)

3.1.2 Earthworms

SumPCB concentrations in Earthworms ranged from 0.8 ng/g ww to 3.8 ng/g ww. The median sumPCB concentration was 1.16 ng/g ww, comparable with 2014 data (1.11 ng/g ww in Oslo). The detailed results are shown in Table 4. PCB 138 and 153 were the dominating PCBs measured.

Table 4: PCB concentrations in earthworms in ng/g ww (<LOD: not detected); N: number of detected and analysed samples

	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180	SumPCB
N	2/ 5	4/ 5	5/ 5	5/ 5	5/ 5	5/ 5	5/ 5	5
Mean	<LOD	0.08	0.22	0.15	0.34	0.65	0.16	1.60
Median	<LOD	0.04	0.13	0.10	0.21	0.50	0.14	1.04
Minimum	<LOD	<LOD	0.06	0.07	0.18	0.34	0.07	0.81
Maximum	0.05	0.19	0.65	0.37	0.85	1.38	0.30	3.79

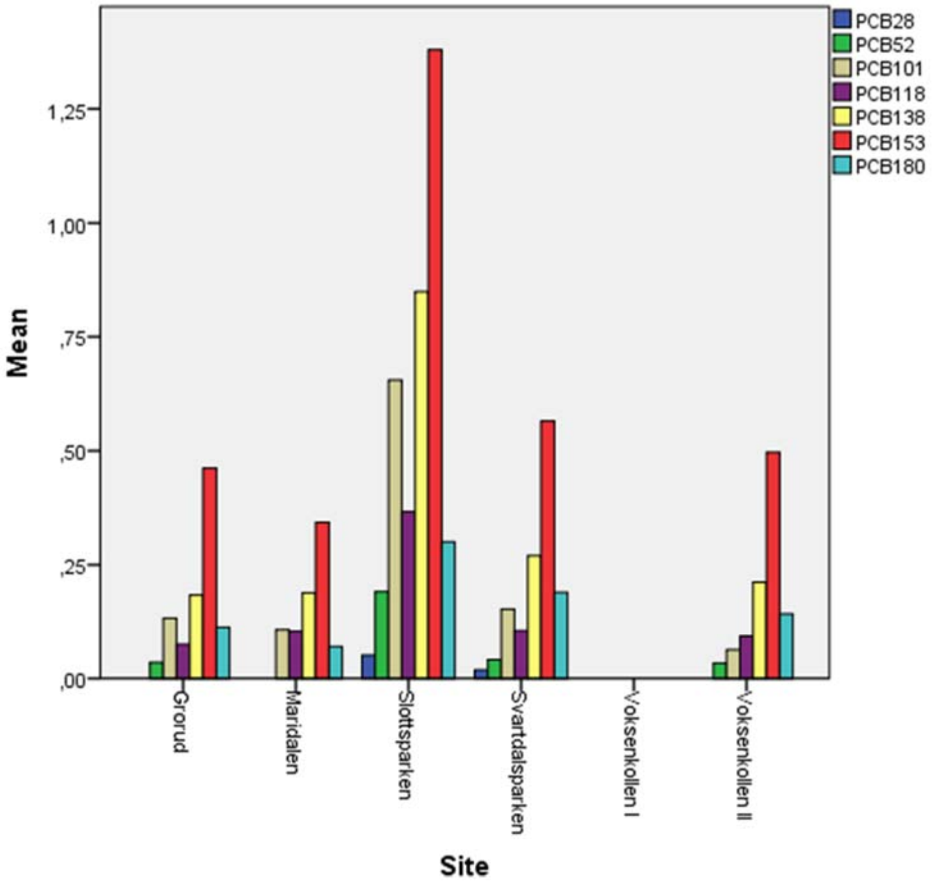


Figure 4: PCB concentrations in earthworms at the different sampling sites in ng/g ww. (No data from Voksenkollen I).

3.1.3 Fieldfare

SumPCB concentrations varied between 9.7 and 40 ng/g fw, with an average of 19, only slightly higher than the concentrations reported from Norwegian rural areas in 2015 (11.1 ng/g ww sumPCB) (Herzke et al., 2015). A summary of values are given in Table 5. PCB 138, 153 and 180 dominate the PCB pattern (Figure 4).

Table 5: PCB congener concentrations in fieldfare eggs from 2015 in ng/g fw.; N: Number of detected and measured samples

	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180	SumPCB
N	4/ 10	10/ 10	10/ 10	10/ 10	10/ 10	10/ 10	10/ 10	10
Mean	0.03	0.26	1.54	0.88	4.57	8.07	3.40	18.7
Median	<LOD	0.16	1.12	0.59	3.69	6.46	2.67	14.9
Minimum	<LOD	0.08	0.64	0.31	2.38	4.39	1.42	9.74
Maximum	0.05	1.15	5.13	3.15	9.49	15.5	8.03	39.7

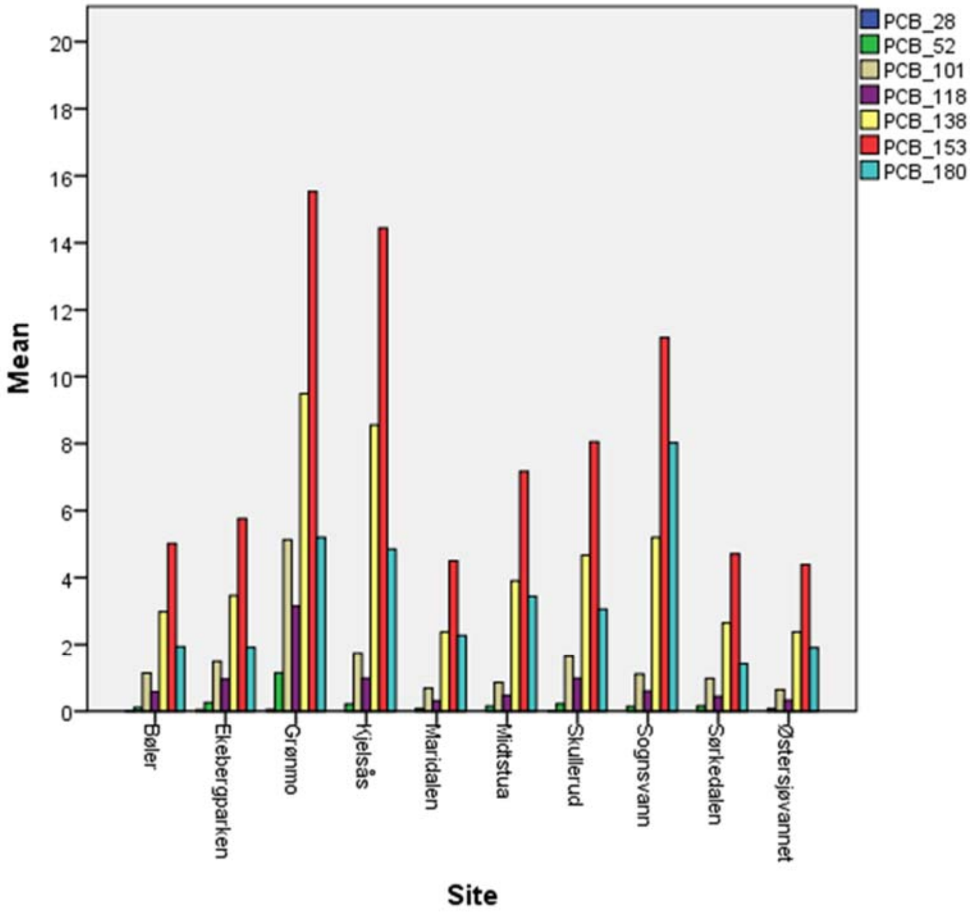


Figure 5: Concentrations of PCB congeners at different sampling sites in fieldfare eggs (ng/g fw).

3.1.4 Sparrowhawk

Ten eggs were available for analysis, all from the Oslo area. The detailed results are shown in Table 6.

In Figure 6, the median PCB concentrations by sampling location and congeners are shown. Elevated PCB concentrations were found in a number of eggs, with a maximum concentration of sumPCB of 1500 ng/g fw (fresh weight) in one sample from Oslo. The average sumPCB concentration for Oslo was 672 ng/g fw, which was slightly lower than in the previous year (750 ng/g fw). PCB 138 and 153 were the dominating PCB congeners.

Table 6: Concentrations of PCB congeners in sparrowhawk eggs in ng/g fw. N: Number of detected and measured samples

	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180	SumPCB
N	10/ 10	10/ 10	10/ 10	10/ 10	10/ 10	10/ 10	10/ 10	10
Mean	1.52	1.37	13.1	28.5	109	350	168	672
Median	0.98	0.94	10.1	26.3	109	270	171	699
Minimum	0.12	0.12	2.03	12.3	41.6	97.4	68.5	237
Maximum	7.64	4.57	34.1	65.1	194	1041	262	1500

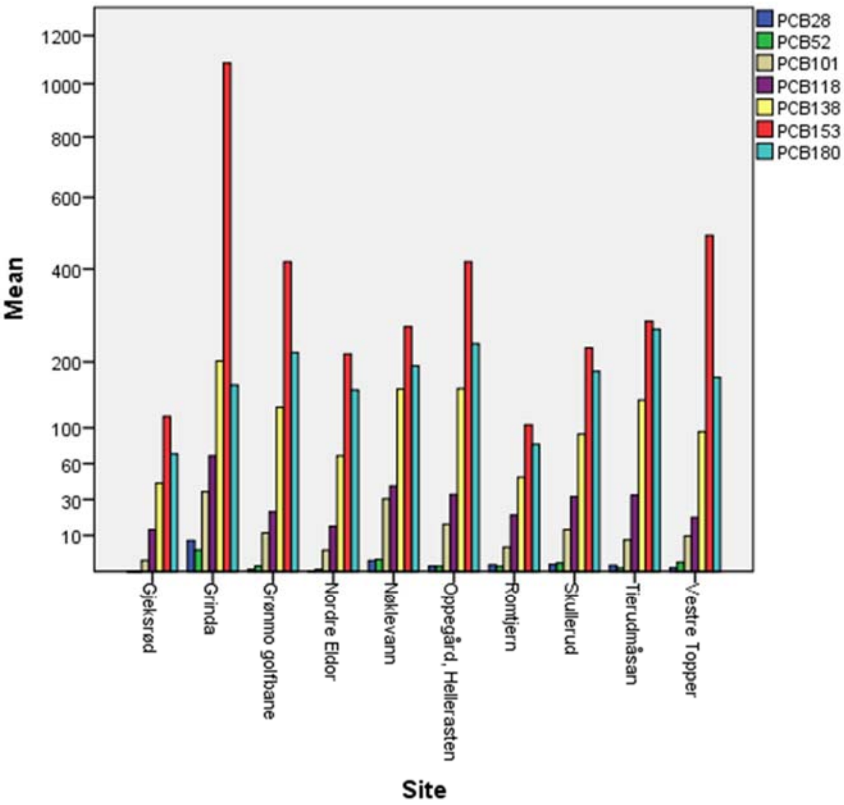


Figure 6: Main PCB congener distribution by location of sampling in eggs of sparrowhawk (ng/g fw).

3.1.5 Tawny owl

Tawny owl eggs were sampled for the first time within this project. The median sumPCB concentration of 26.4 ng/g fw was clearly lower than for the sparrowhawk. PCB 153 and 180 dominated the PCB pattern, similar to the sparrowhawk. SumPCB concentrations varied between 12.9 and 51.8 ng/g fw. For comparison, Bustnens et al., (2011), found a six times higher median (193 ng/g ww) in tawny owl eggs collected 2009 in Trøndelag, Norway.

Table 7. Concentrations of PCB congeners in tawny owl eggs in ng/g fw. N: Number of detected and measured samples

	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180	SumPCB
N	6/ 10	4/ 10	9/ 10	10/ 10	10/ 10	10/ 10	10/ 10	10
Mean	0.18	0.03	0.15	1.68	5.36	12.4	8.07	27.8
Median	0.12	<LOD	0.15	1.40	4.85	11.4	7.70	26.4
Minimum	<LOD	<LOD	<LOD	0.86	2.13	6.18	3.43	12.9
Maximum	0.51	0.04	0.26	3.43	9.74	23.2	15.0	51.7

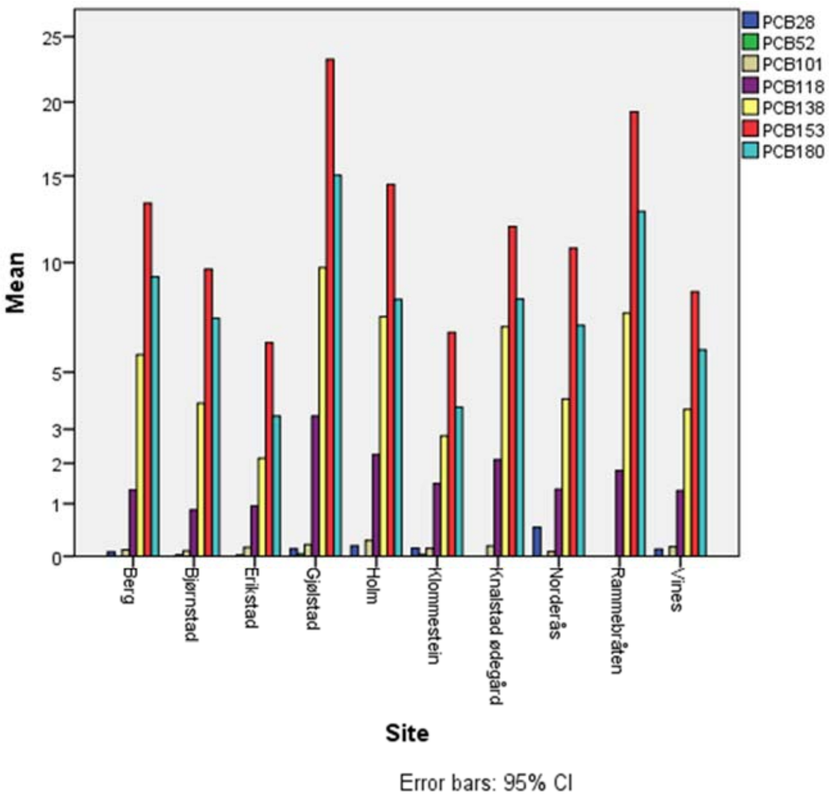


Figure 7: Main PCB congener distribution by location of sampling in tawny owl eggs (ng/g fw).

3.1.6 Rats

PCBs were found in all rat samples. SumPCB varied between 1.36 and 39.9 ng/g ww with PCB 153, 138 and 180 dominating the PCB pattern. SumPCB were comparable to sumPBDE concentrations.

Table 8: Concentrations of PCB congeners in brown rat livers in ng/g ww. N: Number of detected and measured samples

	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180	SumPCB
N	10/ 10	10/ 10	10/ 10	10/ 10	10/ 10	10/ 10	10/ 10	10
Mean	0.09	0.05	0.45	0.36	3.99	5.49	3.59	14,0
Median	0.03	0.06	0.29	0.37	2.69	4.30	2.49	11.1
Minimum	0.01	0.03	0.19	0.01	0.33	0.42	0.22	1.36
Maximum	0.33	0.08	1.29	0.87	13.7	15.0	9.47	40.0

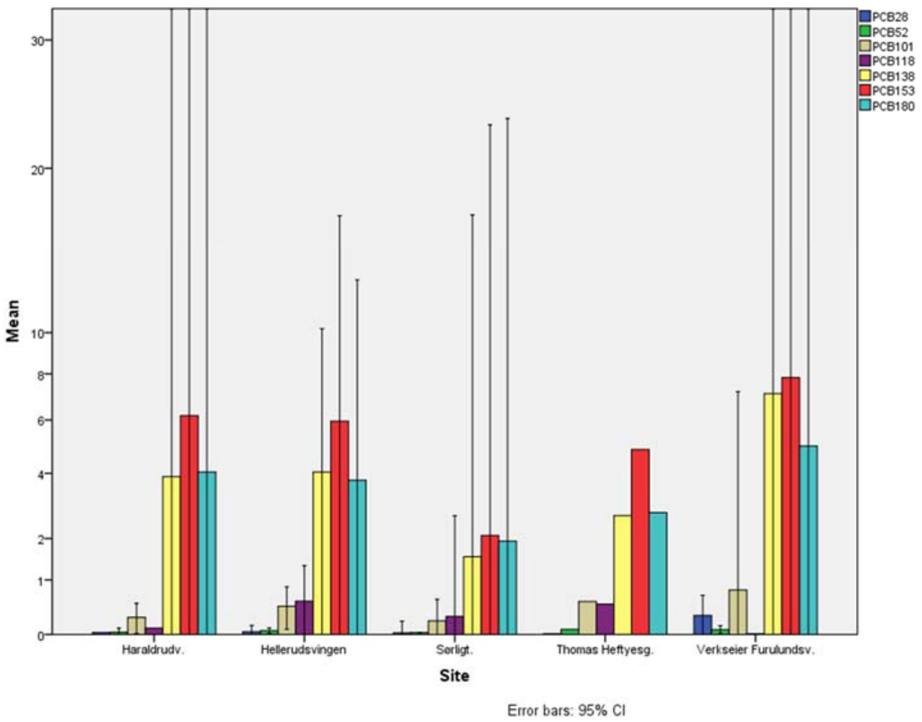


Figure 8: Main PCB congener distribution by location of sampling in rat livers (ng/g ww). Errorbars show the 95% confidence limits.

3.1.7 Red fox

In total, 10 livers of foxes all from the Oslo area, including Nittedal, were analysed for PCBs.

PCB 153 and 180 were the dominant congeners (Figure 9). The observed sumPCB concentration ranged between 1.2 and 121 ng/g ww, with a median of 6.8 ng/g ww in Oslo, similar to that observed in 2014 (6.5 ng/g ww). A summary of values are given in (Table 9).

Table 9: PCB concentrations in red fox livers from the Oslo area in (ng/g ww), N: Number of detected and measured samples

	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180	SumPCB
N	5/ 10	8/ 10	10/ 10	10/ 10	10/ 10	10/ 10	10/ 10	10
Mean	0.01	0.02	0.04	0.47	0.94	5.85	12.9	20.2
Median	0.01	0.02	0.03	0.05	0.31	2.04	5.54	6.80
Minimum	<LOD	<LOD	0.01	0.02	0.05	0.36	0.61	1.21
Maximum	0.02	0.04	0.18	4.04	6.69	41.7	68.2	121

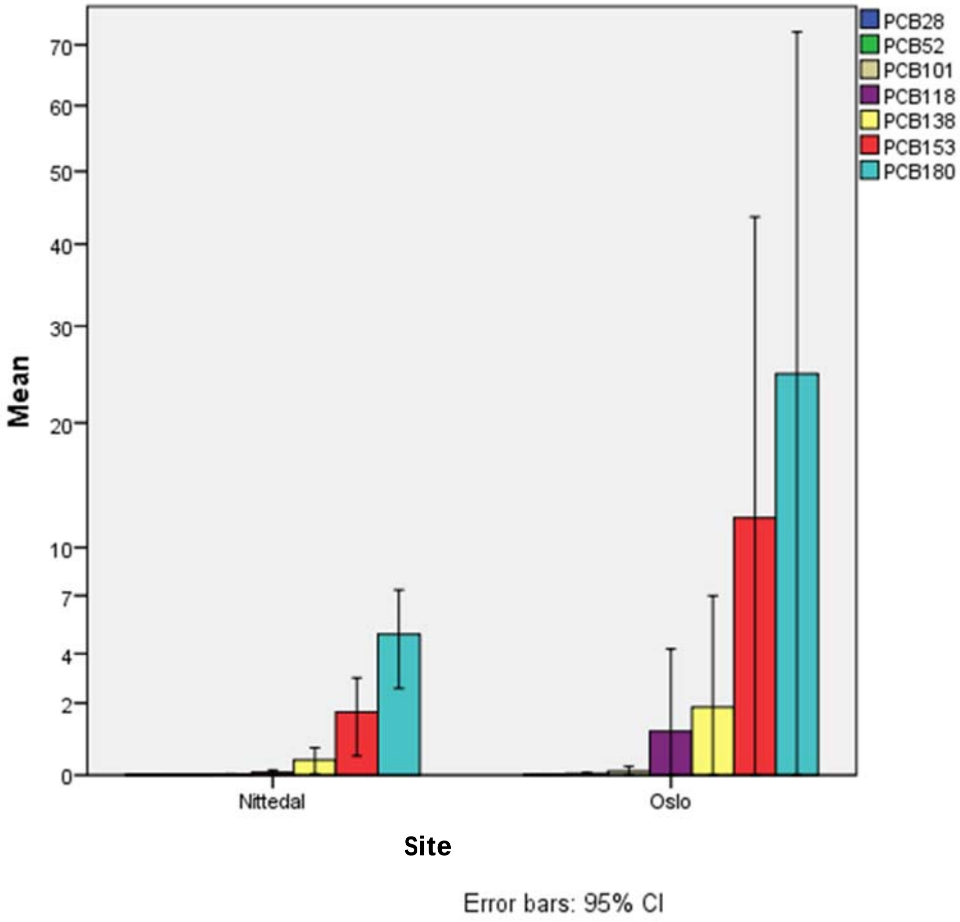


Figure 9: Average PCB congener concentrations in the Oslo area (n=10) in fox livers in ng/g ww. Errorbars show the 95% confidence limits.

For comparison, Andersen et al. reported in Arctic fox liver from Svalbard, Norway, a median sumPCB of 342 ng/g ww, more than ten times higher due to their marine diet (Andersen et al., 2015). Red fox livers from Spain reported in 2012, had median sumPCB concentrations of 1262 ng/g ww. The Spanish fox livers had therefore almost 50 times higher concentrations of PCBs compared to foxes from Oslo (Mateo et al., 2012).

3.2 PBDEs and DBDPE

3.2.1 Soil

PBDEs were found in all soil samples collected. PBDE 209 dominated in the soil, followed by PBDE 47 and 99. The highest sumPBDE concentrations were found at Grorud and Voksenkollen with 0.77 and 0.69 ng/g dw. No DBDPE was found. According to the Norwegian guidelines on classification of environmental quality of soil (normverdi), 80 ng/g dw PBDE 99 and 2 ng/g dw PBDE 209 represent the threshold for clean soil (TA-2553/2009). None of the samples analysed in this study exceeded this threshold value.

Table 10: PBDE in soil samples from Osls in ng/g dw. N: Number of detected and measured samples

	PBDE47	PBDE99	PBDE100	PBDE191	PBDE206	PBDE207	PBDE209	SumPBDE
N	5/ 5	5/ 5	2/ 5	1/ 5	3/ 5	3/ 5	5/ 5	5
Mean	0.08	0.05	<LOD	<LOD	0.02	0.01	0.33	0.49
Median	0.08	0.05	<LOD	<LOD	0.01	0.01	0.26	0.40
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.11	0.21
Maximum	0.10	0.07	0.01	0.01	0.03	0.02	0.54	0.77

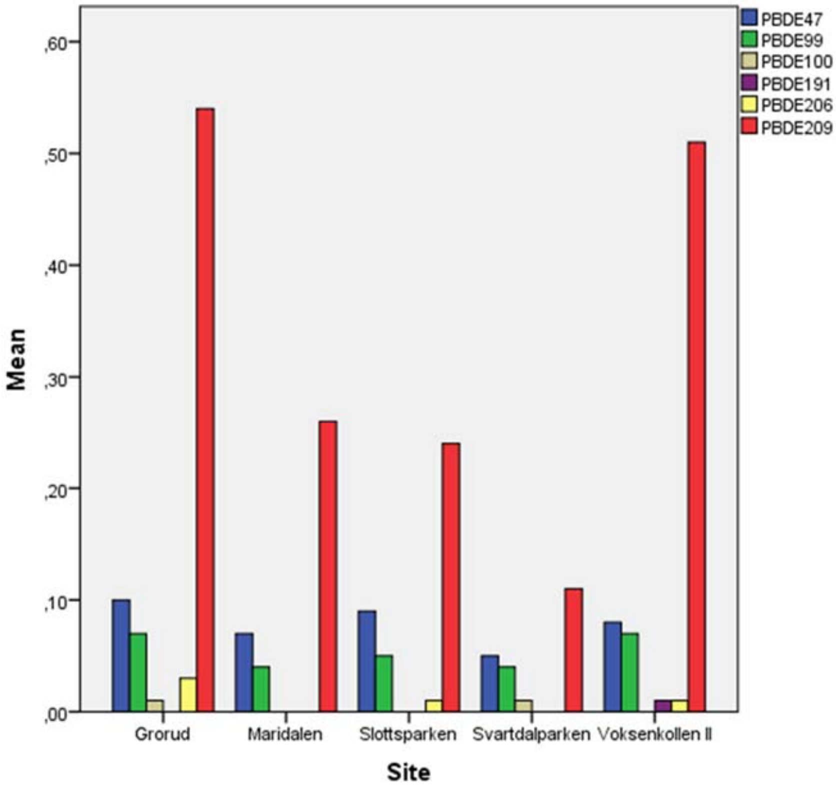


Figure 10. PBDEs in soil at the different sampling sites (ng/g, dw)

3.2.2 Earthworms

In the sampled Oslo area, the sumPBDE concentration levels ranged from <LOD in Grorud, Maridalen and Slottsparken, to 0.26 ng/g ww in Svartdalparken. In contrast to the 2014 samples, PBDE 47 and 99 dominated when detected. In 2014, the sumPBDE concentration levels ranged from 0.20 to 0.97 ng/ g ww (mean 0.55). In 2015, PBDEs were detected only in Svartdalsparken and at Voksenkollen (Figure 11).

Table 11. Average values of detected individual congeners of PBDE and sum PBDEs in earthworms combined (ng/g ww). N: Number of detected and measured samples

	PBDE47	PBDE99	PBDE100	PBDE153	PBDE154	SumPBDE
N	1/ 5	2/ 5	1/ 5	1/ 5	1/ 5	
Mean	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Median	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Maximum	0.13	0.09	0.02	0.01	0.01	0.26

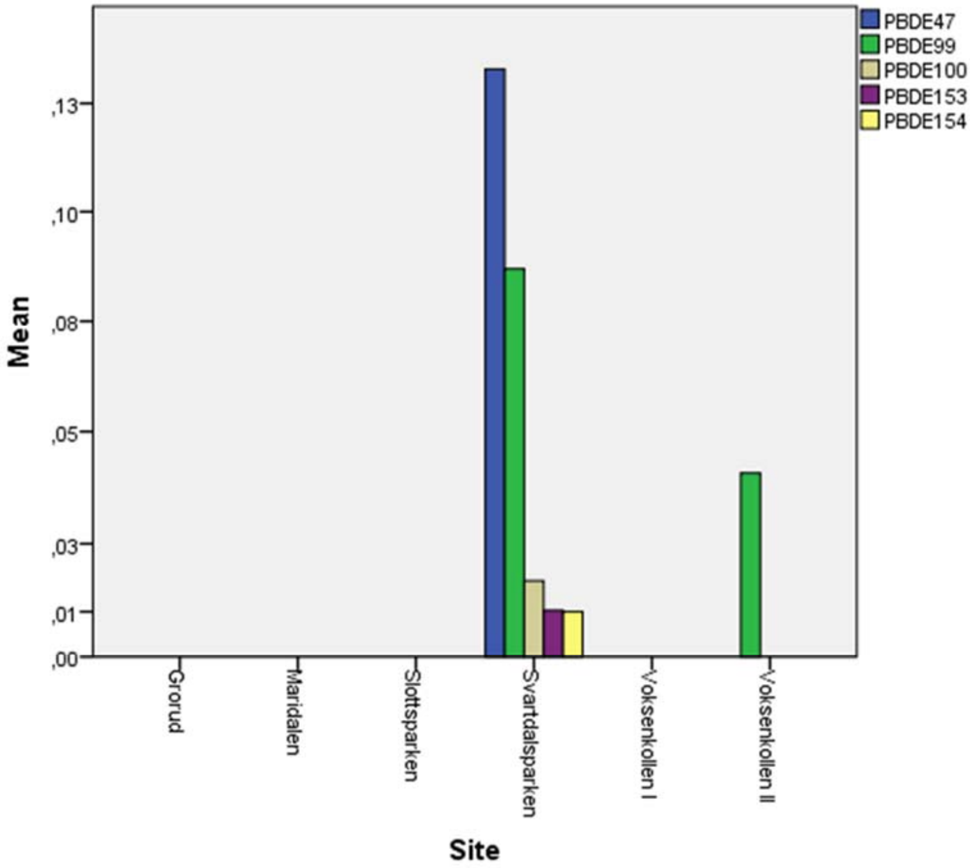


Figure 11: Average concentrations of individual congeners of PBDE in earthworms in Oslo (ng/g ww).

3.2.3 Fieldfare

For the first time, fieldfare samples from the Oslo area were available for PBDE determination. The concentrations of the PBDEs detected were in general low (median sumPBDE 2.3) and highes in PBDE 47 and 99 (Table 12, Figure 8). One sample from Bøler showed elevated levels with sumPBDE of 20.1 ng/g. No PBDE 209 was detected in any of the fieldfare eggs. On average, sumPBDE concentrations in fieldfare eggs were almost 10 times lower than the sumPBDE concentrations found in sparrowhawk eggs. DBDPE was found in three locations, in Skullerud, Grønmo and Bøler with 21.9, 7.9 and 3.58 ng/g ww

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

	PBDE47	PBDE99	PBDE100	PBDE153	PBDE154	PBDE183	PBDE191	PBDE202	PBDE206	PBDE207	Sum PBDE
N	10/ 10	107 10	10/ 10	10/ 10	10/ 10	10/ 10	3/ 10	6/ 10	3/ 10	7/ 10	10
Mean	1.05	1.73	0.50	0.36	0.27	0.07	0.09	0.36	0.09	0.06	4.28
Median	0.84	0.82	0.25	0.13	0.14	0.04	<LOD	0.04	<LOD	0.03	2.31
Minimum	0.29	0.27	0.08	0.05	0.04	0.02	<LOD	<LOD	<LOD	<LOD	0.75
Maximum	3.40	8.52	2.40	2.09	1.11	0.22	0.20	1.92	0.20	0.10	20.1

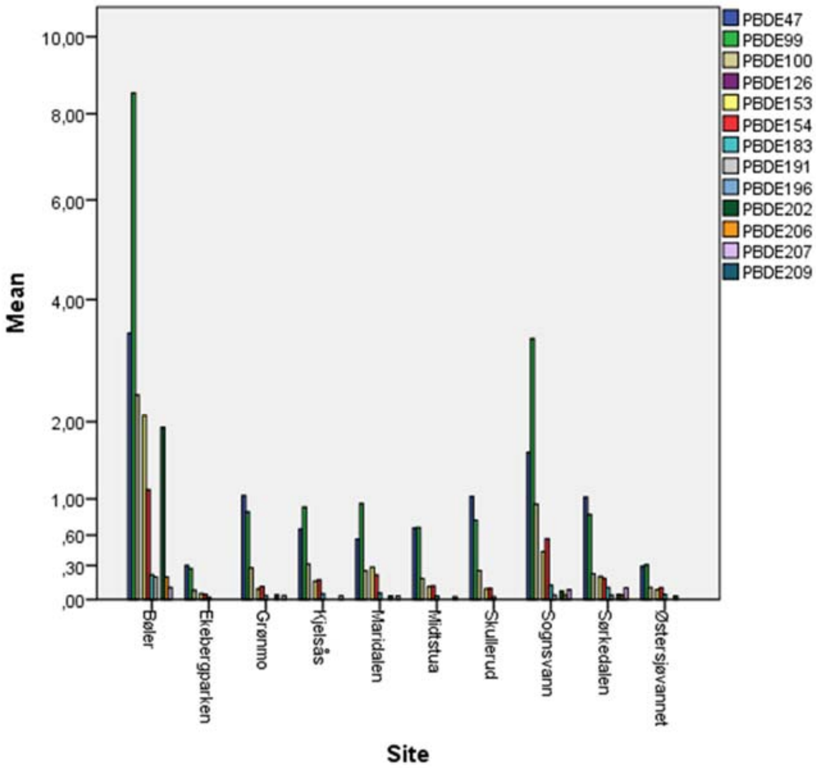


Figure 12: PBDE concentrations in eggs of fieldfare at the different sampling sites in ng/g fw.

3.2.4 Sparrowhawk

As in 2014, the dominating PBDE congener was PBDE 99, followed by PBDE 153 and PBDE 47 (Table 13). SumPBDE concentrations ranged from 9 to 59 ng/g fw fw). Compared to 2014, concentrations were lower in 2015 (56 ng/g fw in Oslo and 37 ng/g reference samples from Aust-Agder and Telemark). PBDE 209 was only detected in one egg with 2.2 ng/g fw, while the nona-PBDEs 206 and 207 were detected in almost all eggs. Figure 13 shows the average PBDE concentration of the measured congeners. For comparison sumPBDE concentrations ranging from 6-14 ng/g ww were found in eggs of the terrestrial passerine birds from the

Pearl River Delta, South China, a highly industrialised area, indicating a relatively high PBDE exposure in Oslo (Sun et al., 2014).

Table 13: PBDE congener values in sparrowhawk eggs in ng/g fw. N: Number of detected and measured samples

	PBDE47	PBDE99	PBDE100	PBDE126	PBDE153	PBDE154	PBDE183	PBDE191	PBDE202	PBDE206	PBDE207	PBDE209	SumPBDE	DBDPE
N	10/ 10	10/ 10	10/ 10	7/ 10	10/ 10	10/ 10	10/ 10	10/ 10	10/ 10	10/ 10	9/ 10	1/ 10	10	9/ 10
Mean	5.15	10.3	3.12	0.03	4.26	2.06	0.75	0.21	0.21	0.21	0.23	<LOD	26.7	22.5
Median	5.48	11.6	3.43	0.02	3.15	1.17	0.81	0.18	0.12	0.18	0.08	<LOD	26.5	4.35
Minimum	2.12	3.87	0.88	<LOD	1.25	0.36	0.27	0.09	0.06	0.09	<LOD	<LOD	9.21	<LOD
Maximum	8.40	18.5	6.60	0.08	12.9	10.1	1.67	0.37	0.79	0.37	0.89	2.16	59.1	155

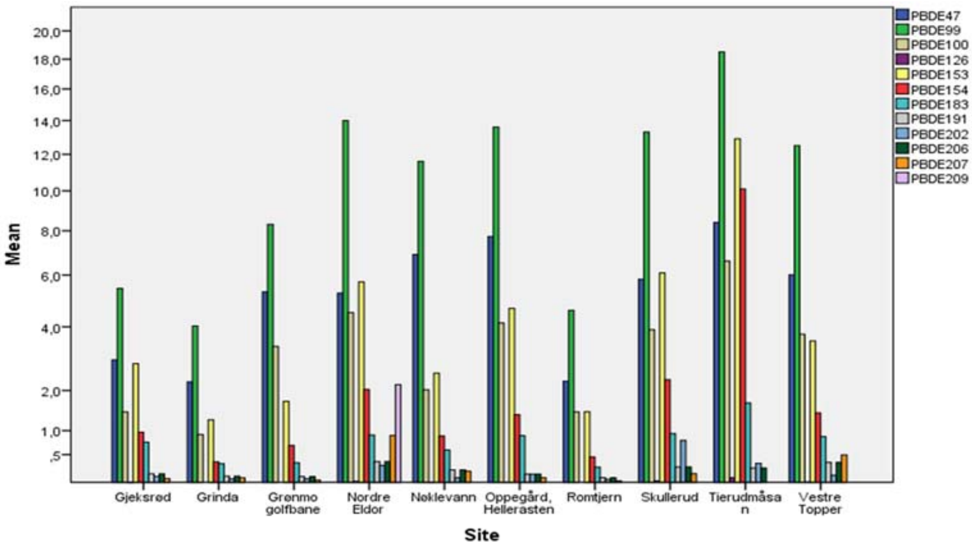


Figure 13: Average concentrations of different PBDEs in eggs of sparrowhawk (ng/g fw).

Unlike PBDE 209, DBDPE was found in 9 of 10 sparrowhawk eggs. The concentrations varied between <LOD and 155 ng/g ww, with a median concentration of 4.35 ng/g ww. Comparable DBDPE concentrations were found in eggs of the terrestrial passerine birds from the Pearl River Delta, South China, a highly industrialised area (Sun et al., 2014).

3.2.5 Tawny owl

Tawny owl eggs were sampled for the first time within this project. With median sumPBDE concentrations of 1.15 ng/g ww, clearly lower concentrations than for the sparrowhawk, but similar to that of the fieldfare. PBDE 47, 99 and 153 dominated the PBDE pattern, similar to the sparrowhawk. SumPBDE concentrations varied between 0.68 ng/g ww and 36.7 ng/g ww (median 1.2 ng/g ww). PBDE 209 was not detected in the tawny owl eggs. For comparison, Bustnes et al, 2011, reported a more than five times higher median of sumPBDE in tawny owl eggs collected in Trondheim (63.42 N, 10.23 E) in Sør-Trøndelag County, Central Norway in 2009. DBDPE was found in 8 of 10 samples, varying between 3.47 and 11.4 ng/g ww (median 5.58 ng/g ww). Comparable DBDPE concentrations were found in eggs of the terrestrial passerine bird Light-vented bulbul (Pycnonotus sinensis) from the Pearl River Delta, South China, a highly industrialised area (Sun et al., 2014).

Table 14. Detected PBDEs in tawny owl egg from the Oslo area, ng/g fw. N: Number of detected and measured samples

	PBDE47	PBDE99	PBDE100	PBDE126	PBDE153	PBDE154	PBDE183	PBDE191	PBDE202	PBDE206	PBDE207	Sum PBDE	DBDPE
N	10/ 10	9/ 10	10/ 10	2/ 10	10/ 10	10/ 10	10/ 10	3/ 10	5/ 10	3/ 10	5/ 10	10	8/ 10
Mean	1.28	2.34	0.48	<LOD	0.71	0.24	0.05	0.02	0.03	0.02	0.04	4.91	6.35
Median	0.25	0.37	0.12	<LOD	0.38	0.05	0.05	<LOD	0.03	<LOD	0.03	1.15	5.58
Minimum	0.13	<LOD	0.06	<LOD	0.16	0.02	0.02	<LOD	<LOD	<LOD	<LOD	0.68	3.47
Maximum	10.4	16.8	3.70	0.02	3.68	1.93	0.11	0.02	0.03	0.02	0.07	36.7	11.4

3.2.6 Brown rat

PBDEs in brown rat displayed a large variation. SumPBDE concentrations varied between 0.07 ng/g and 22 ng/g. PBDE 209 (detection frequency 70%) dominated in most cases followed by PBDE 47 and 153, indicating a different exposure than that of the other observed species. Median sumPBDE concentration was 1.98 ng/g ww, and the mean was 5.38. DBDPE was not found in rat liver.

Table 15: detected PBDE concentrations in liver of brown rat from Oslo in ng/g; N: Number of detected and measured samples

	PBDE47	PBDE99	PBDE100	PBDE153	PBDE154	PBDE183	PBDE196	PBDE202	PBDE206	PBDE207	PBDE 209	SumPBDE
N	6/ 10	8/ 10	9/ 10	9/ 10	1/ 10	6/ 10	3/ 10	3/ 10	3/ 10	8/ 10	7/ 10	10
Mean	0.41	0.10	0.08	0.29	<LOD	0.10	0.22	0.08	0.22	1.16	5.11	5.38
Median	0.28	0.06	0.03	0.16	<LOD	0.08	<LOD	<LOD	<LOD	0.22	1.98	1.89
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.07
Maximum	1.00	0.34	0.30	0.84	0.01	0.24	0.44	0.13	0.44	4.48	16.4	21.9

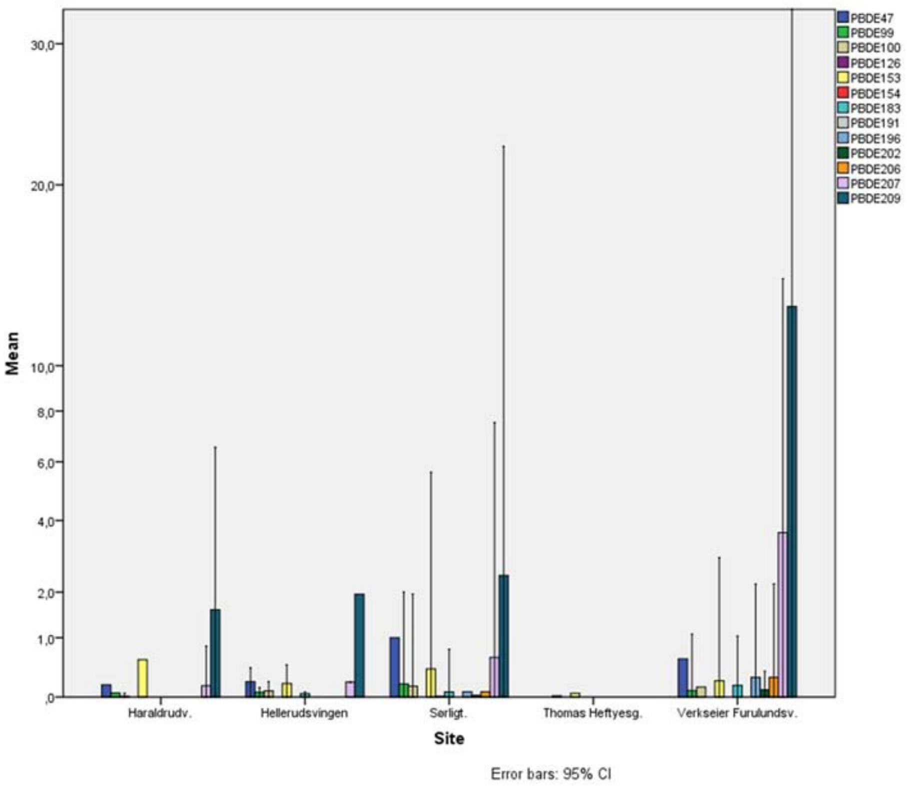


Figure 14: Average concentrations of different PBDEs in rat livers (ng/g ww). Errorbars show the 95% confidence limits.

3.2.7 Red fox

In red fox, sumPBDE ranged from <LOD to 0.44 ng/g ww in Oslo. PBDE 209 was not found in any of the samples. PBDE 47 dominated in the fox livers (Table 16, Figure 15), with a median of 0.16. For comparison, in 2014 a median of 0.03 for PBDE 47 and 0.53 ng/g for PBDE 153 ww was found in fox livers from Oslo, with a median Sum PBDE of 0.53, indicating a large variability in exposure within years and locations within a city as Olso. Also, Andersen et al. reported in Arctic fox liver from Svalbard, Norway, comparable median PBDE 47 and 153 concentrations of 0.16 and 0.08 ng/g ww respectively (Andersen et al., 2015).

Table 16. Values of individual congeners of PBDE and sum PBDEs in red fox livers in the Oslo area 2015 (ng/g ww). N: Number of detected and measured samples

	PBDE47	PBDE99	PBDE100	PBDE153	PBDE207	SumPBDE
N	3/ 10	2/ 10	2/ 10	4/ 10	1/ 10	5
Mean	0.20	<LOD	<LOD	0.06	<LOD	0.22
Median	0.16	<LOD	<LOD	0.05	<LOD	0.19
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	0.06
Maximum	0.30	0.06	0.04	0.11	0.10	0.44

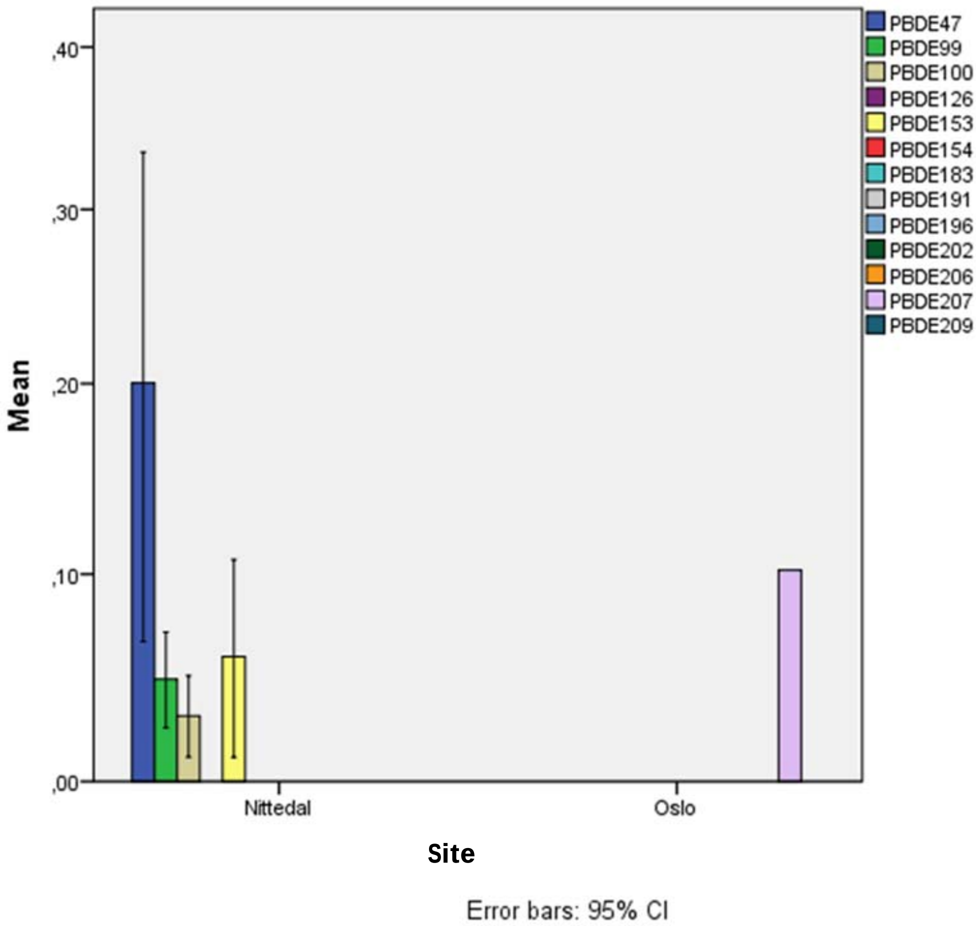


Figure 15: Average concentrations of different PBDEs in red fox livers in Oslo and Nittedal (ng/g ww). Errorbars show the 95% confidence limits.

DBDPE was not found in any of the fox liver samples.

3.3 Per-and polyfluoroalkyl substances (PFASs)

3.3.1 Soil

The five sampled locations showed both a varying PFAS composition as well as abundancy. Of the measured PFAS, PFOS, PFHxA, PFOA, PFNA and PFDcA were found in all soils. PFOS dominated the sumPFAS pattern in Svartdalparken and Voksenkollen, while PFOA dominated in the other locations. Voksenkollen was sampled twice, one sample close to the ski track (Voksenkollen II) and one closer to the metro station (Voksenkollen I). SumPFAS was highest at Grorud and Voksenkollen I with 3.6 and 4.9 ng/g dw respectively, followed by Voksenkollen

II with 1.04 ng/g dw. Local sources are therefore not probable sources compared to long range transport. No PFTeA was found in soil. 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, (TA-2553/2009). None of the samples analysed in this study exceeded this threshold value.

Table 17. PFAS in soil of the Oslo collection sites (ng/g dw).; N: Number of detected and measured samples

	PFBS	PFHxS	PFOS	PFHxA	PFHpA	PFOA	PFNA	PFDcA	PFUnA	PFDoA	PFTriA	Sum PFAS
N	1/ 10	1/ 10	6/ 10	6/ 10	5/ 10	6/ 10	6/ 10	6/ 10	3/ 10	3/ 10	1/ 10	
Mean	<LOD	<LOD	0.41	0.20	0.29	0.73	0.12	0.12	0.00	0.01	<LOD	1.83
Median	<LOD	<LOD	0.19	0.04	0.13	0.40	0.06	0.04	0.00	0.01	<LOD	0.83
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.38
Maximum	0.003	<LOD	1.77	0.68	0.71	2.17	0.32	0.55	0.01	0.01	0.01	4.96

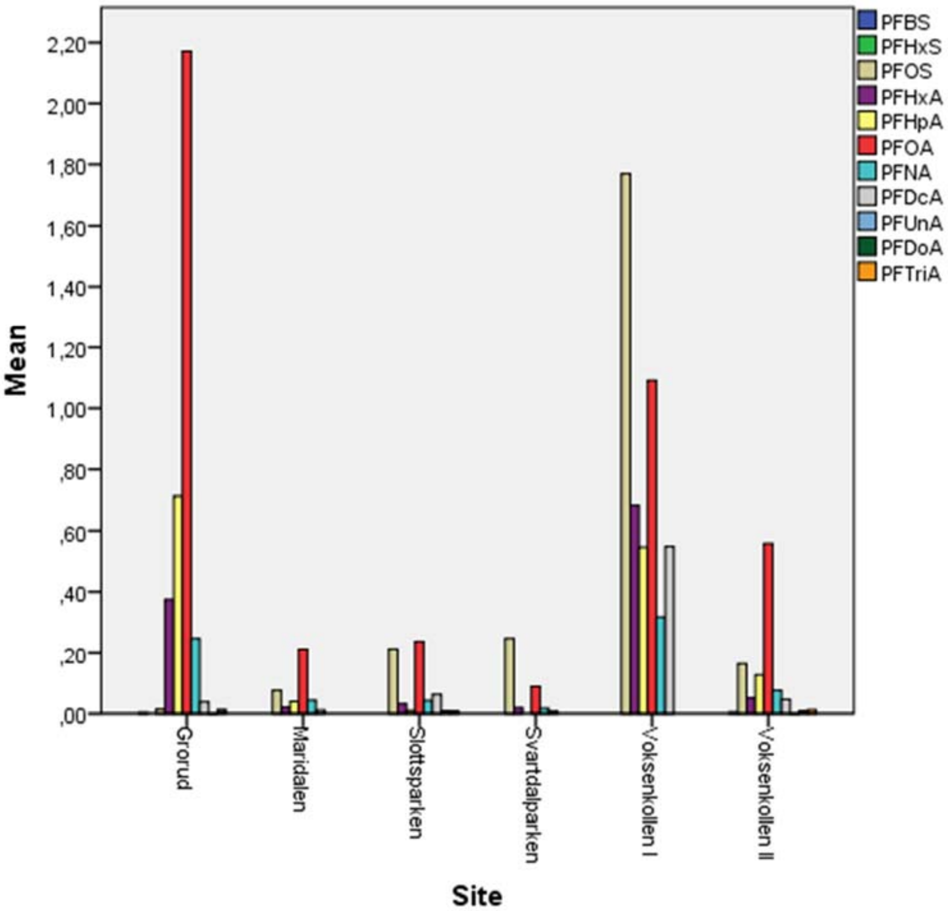


Figure 16. PFAS in soil at the different sampling sites in Oslo (ng/g dw).

3.3.2 Earthworms

As shown in Table 18, PFASs were present in every sample. The sumPFAS concentrations ranged from 5.3 to 157 ng/g ww (maximum value in in one sample from Voksenkollen I, Oslo), the median value was 21.6 ng/g ww. Both Voksenkollen sites were clearly elevated in sumPFAS compared with the other four sites. Similar concentrations as found in 2014 were detected (Herzke, et al., 2015). PFOS was dominating in all locations except Grorud and Voksenkollen, were PFOA was the major contributor. In general, variations within the sampling location are considerable, confirming the need of sampling several subsamples in one location as done in this study. In contrast to soil, PFTrA and PFTeA were found in the majority of worm samples, illustrating the bioavailability of these compounds. Rich et al. reported in 2015 that BSAFs and BAFs increased with increasing chain length for PFCAs and decreased with increasing chain length for the PFSAs, being in agreement with our findings (Rich et al., 2015).

When comparing soil and worm PFAS concentrations, only the site at Voksenkollen I showed a high sumPFAS in both soil and worms. In contrast, at Grorud, high sumPFAS in soil did not lead to high sumPFAS in worms, and high sumPFAS in worms from Voksenkollen II were not reflected in high sumPFAS concentrations in soil. However, it is known that PFAS retention in soil as well as bioavalability is governed by the carbon chain length of the respective PFAS as well as the composition of the soil. Very sandy soil will thus retain PFAS to a much lesser extent than very humic 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 longchained PFAS and an efficient drainage by water of the short chained PFAS. PFOS and PFNA contain both 8 carbons in their alkane chain, ensuring both good soil retention as well still being sufficiently water soluble to be bioavailable. For these two compounds a positive soil-worm relationship can be found with r^2 of 0.85 and 0.48 respectively. Wen et al. reported bioaccumulation factors (BAFs) of PFOS and PFOA ranging between 1.54–4.12 for soil and 0.52–1.34 g for worm. PFOS and PFOA concentrations exhibited positive influence and organic matter contents showed the negative influence on the accumulation of PFOS and PFOA in earthworms, indicating that sandy soils support the bioavailability of PFOS and PFOA into earthworms. Soil pH and clay contents played relatively unimportant roles in PFOS and PFOA bioavailability (Wen et al., 2015).

Table 18: PFAS concentrations in soil from Oslo in ng/g dw).; N: number of detected and measured samples

	PFBS	PFHxS	PFOS	PFHxA	PFHpA	PFOA	PFNA	PFDcA	PFUnA	PFDoA	PFTriA	PFTeA	Sum PFAS
N	5/ 6	6/ 6	6/ 6	6/ 6	6/ 6	6/ 6	6/ 6	6/ 6	6/ 6	6/ 6	5/ 6	5/ 6	6
Mean	0.75	1.52	20.5 9	3.04	6.73	2.95	0.87	1.74	0.58	7.44	1.43	1.89	48.8
Median	0.94	1.51	9.64	0.80	1.56	3.32	0.43	0.69	0.51	1.59	1.12	0.68	21.6
Minimum	0.13	1.11	0.55	0.35	0.59	0.34	0.02	0.01	0.02	0.03	0.71	0.24	5.31
Maximum	1.10	1.99	70.5	8.35	27.3	5.30	2.87	4.95	1.29	33.6	3.00	6.26	157

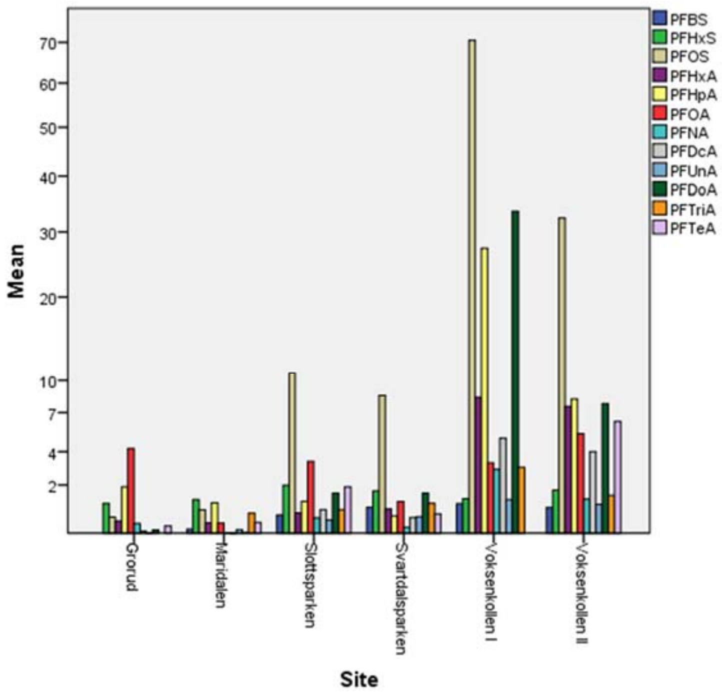


Figure 17. PFAS in earthworms at the different sampling sites (ng/g ww).

3.3.3 Fieldfare

PFAS were detected in all fieldfare eggs. With the exception of one sample, PFOS dominated in all eggs in contrast to earlier findings for the reference site, sampled in the year before. SumPFAS concentrations ranged from 3.2 ng/g ww in Maridalen to 87.1 ng/g ww in Grønmo. At Grønmo, a waste dump and recycling station is found, a possible PFAS source. The sample with the distinguished PFAS pattern PFTeA > PFTrA > PFDoA > PFOS was collected in Midtstua (sumPFAS: 19.3 ng/g ww), which also is known for it's ski jumping and cross country facilities close by (also close to the Voksenkollen site). The other three locations with elevated PFAS concentrations (Kjelsås, Sørkedalen and Ostersjøvannet) are either surrounded by buildings or industry, with ski tracks in close vicinity (less than 1 km), all possible diffuse PFAS sources.

Table 19. PFAS in eggs of fieldfare, ng/g fw. N: number of detected and measured samples

	PFHxS	PFHPS	PFOS	PFNS	PFDcS	PFHxA	PFOA	PFNA	PFDcA	PFUnA	PFDoA	PFTriA	PFTeA	PFOSA	SumPFAS
N	10/ 10	9/ 10	10/ 10	1/ 10	7/ 10	2/ 10	10/ 10	10/ 10	10/ 10	10/ 10	10/ 10	10/ 10	10/ 10	2/ 10	10
Mean	0.06	0.13	15.3	<LOD	1.40	<LOD	0.19	0.17	0.51	0.72	1.71	1.99	3.11	<LOD	24.9
Median	0.05	0.05	5.89	<LOD	0.15	<LOD	0.11	0.12	0.34	0.52	1.09	1.23	1.36	<LOD	17.3
Minimum	0.01	<LOD	1.13	<LOD	<LOD	<LOD	0.02	0.04	0.09	0.25	0.37	0.62	0.52	<LOD	3.15
Maximum	0.17	0.53	68.6	0.06	8.74	0.01	0.62	0.44	1.29	1.96	7.33	8.80	19.3	0.10	87.1

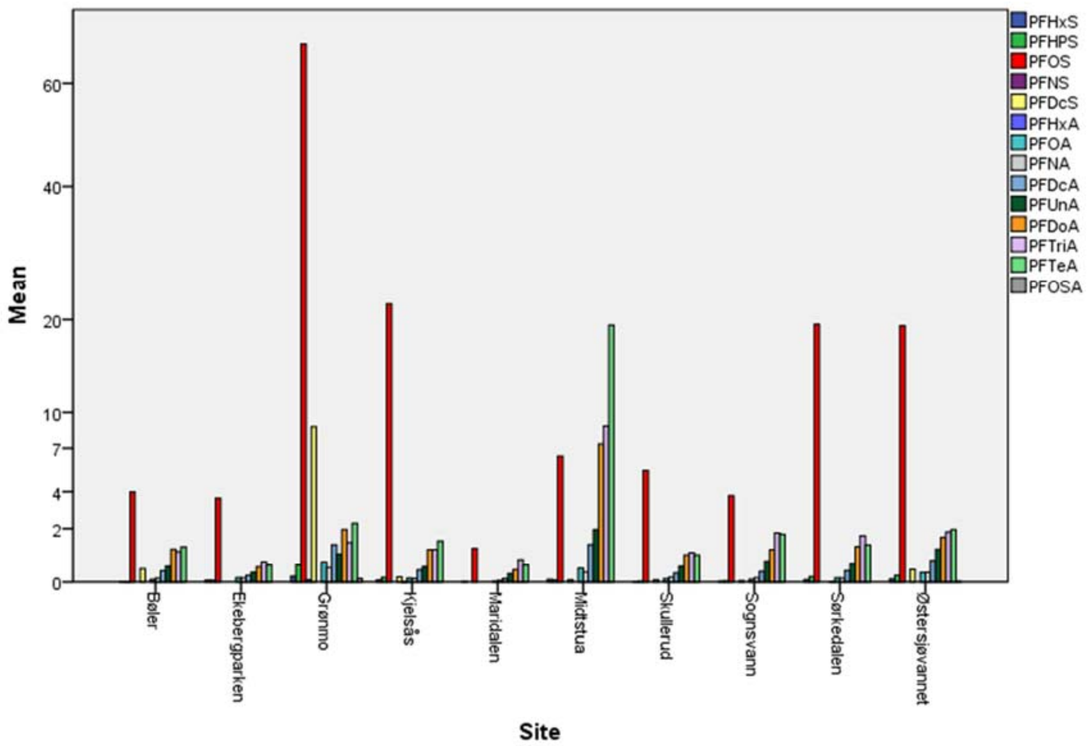


Figure 18: Average concentrations of detectable PFAS compounds in fieldfare eggs, ng/g fw.

3.3.4 Sparrowhawk

The highest sumPFAS concentration of 26 ng/g fw was found in one egg from Ås. Average sumPFAS concentrations ranged from 7.8 to 26 ng/g fw. The detailed results of detected PFAS are shown in Table 20.

Table 20: Detected PFAS congener concentrations in sparrowhawk eggs in ng/g fw. N: Number of detected and measured samples

	PFHxS	PFHPS	PFOS	PFNS	PFDcS	PFHxA	PFOA	PFNA	PFDcA	PFUnA	PFDoA	PFTriA	PFTeA	PFOSA	SumPFAS
N	10/ 10	10/ 10	10/ 10	1/ 10	9/ 10	6/ 10	10/ 10	10/ 10	10/ 10	10/ 10	10/ 10	10/ 10	10/ 10	8/ 10	10
Mean	0.10	0.12	8.62	<LOD	0.36	0.001	0.19	0.22	0.48	0.75	1.35	2.10	1.84	0.04	16.1
Median	0.09	0.09	8.21	<LOD	0.34	0.001	0.14	0.22	0.44	0.74	1.49	2.19	1.74	0.02	16.0
Minimum	0.02	0.01	3.12	<LOD	<LOD	<LOD	0.08	0.13	0.30	0.36	0.78	1.01	1.01	<LOD	7.70
Maximum	0.19	0.32	13.99	0.12	0.84	0.003	0.42	0.35	0.86	1.61	1.96	4.02	3.11	0.22	26.1

PFOS is the dominating compound in all egg samples, however there is also a considerable contribution of the long chain carboxylic acids (PFNA to PFTeA), with longer chained PFCAs dominating the PFCA pattern. That is an uncommon pattern, deviating from the more often found pattern in biota of PFOS > PFNA > PFUnA > PFTrA (Bustnes *et al.*, 2013, Jaspers *et al.*, 2013, Taniyasu *et al.*, 2013, Vestergren *et al.*, 2013). In contrast to recent years, in the ongoing study PFOA was detected in all samples.

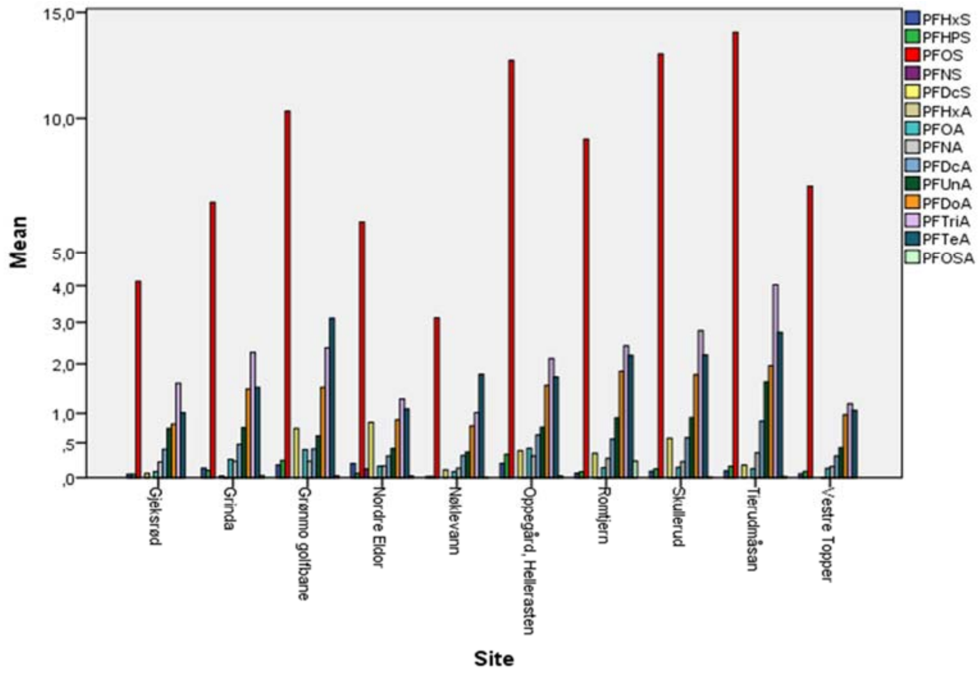


Figure 19: PFAS concentrations (ng/g fw) in eggs of sparrowhawk.

3.3.5 Tawny owl

SumPFAS concentrations in tawny owl eggs varied between 1.2 and 5.3 ng/g fw, with one extreme sample with sum concentrations of 24.9 ng/g fw, comparable with findings in sparrowhawk. PFOS dominated in all samples ranging between 0.6 and 19.6 ng/g ww (median 2.12 ng/ g fw). For comparison, 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., 2012).

Table 21. PFAS in eggs of tawny owl in the Oslo district (ng/g fw). N: Number of detected and measured samples

	PFHxS	PFHPS	PFOS	PFDcS	PFHxA	PFOA	PFNA	PFDcA	PFUnA	PFDoA	PFTriA	PFTeA	SumPFAS
N	2/ 10	4/ 10	10/ 10	5/ 10	1/ 10	10/ 10	10/ 10	10/ 10	10/ 10	10/ 10	10/ 10	10/ 10	10
Mean	<LOD	0.03	3.81	0.08	<LOD	0.01	0.03	0.14	0.20	0.35	0.39	0.30	5.28
Median	<LOD	0.02	2.12	0.08	<LOD	0.00	0.02	0.07	0.14	0.18	0.25	0.19	3.29
Minimum	<LOD	<LOD	0.55	<LOD	<LOD	<LOD	0.01	0.05	0.07	0.08	0.18	0.09	1.15
Maximum	0.02	0.05	19.6	0.14	<LOD	0.03	0.09	0.65	0.61	1.72	1.07	1.13	24.9

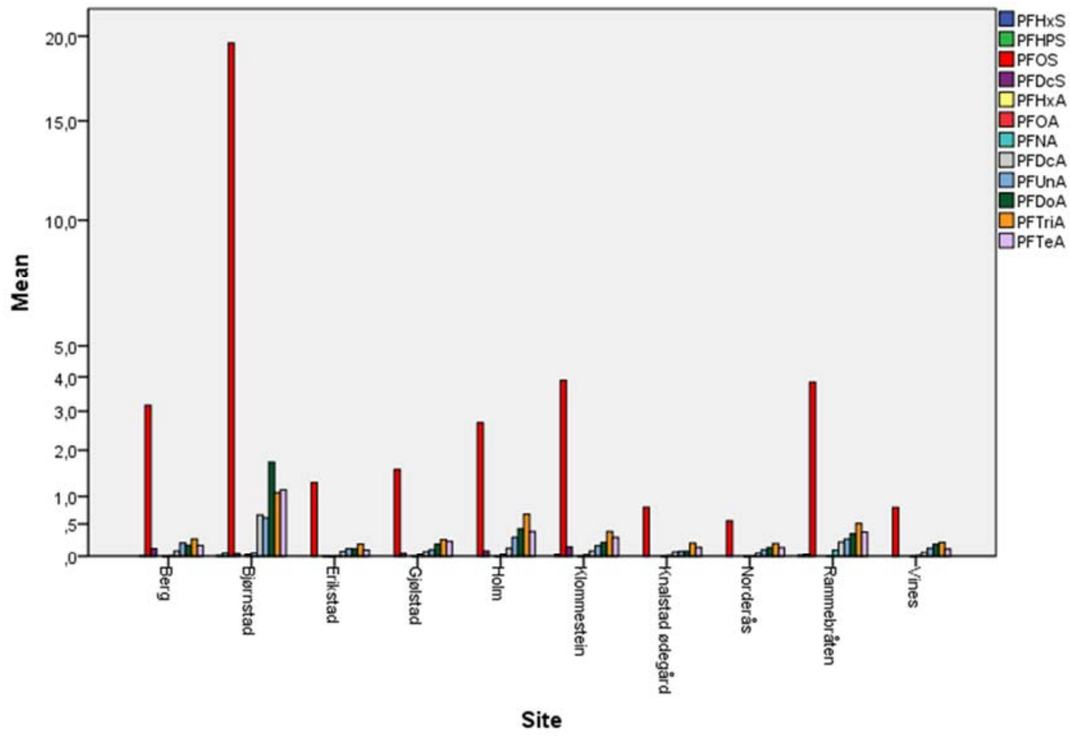


Figure 20. PFAS in eggs of tawny owl, collected at different sites in the Oslo area (ng/g, fw)

3.3.6 Brown rat

As seen for other pollutants, PFAS in rats varied considerably between individuals. SumPFAS ranged between 3.1 and 72 ng/g ww, with PFOS being the dominating contributor in all samples. The highest PFOS concentrations measured were 60.2 ng/g and 25.6 ng/g ww in two male rats, both collected in Hellerudsvingen, located in an area with private housing, close to the ski tracks. High PFCA concentrations could be found in a number of rats as well, with a varying pattern.

Table 22: PFAS in liver of brown rat, Oslo, in ng/g; N: Number of detected and measured samples

	PFOSA	PFHxS	PFHpS	PFOS	PFDcS	PFOA	PFNA	PFDcA	PFUnA	PFDoA	PFTriA	PFTeA	SumPFAS
N	10/ 10	2/ 10	6/ 10	10/ 10	8/ 10	7/ 10	10/ 10	10/ 10	10/ 10	10/ 10	10/ 10	8/ 10	10
Mean	0.06	<LOD	0.18	13.4	0.43	0.50	0.66	0.89	0.44	0.66	0.22	0.08	17.3
Median	0.04	<LOD	0.04	7.31	0.15	0.27	0.35	0.58	0.37	0.62	0.24	0.07	9.35
Minimum	0.02	<LOD	<LOD	1.39	<LOD	<LOD	0.04	0.31	0.19	0.19	0.01	<LOD	3.12
Maximum	0.18	0.32	0.63	60.2	2.13	1.40	3.39	2.98	0.95	1.36	0.46	0.16	71.8

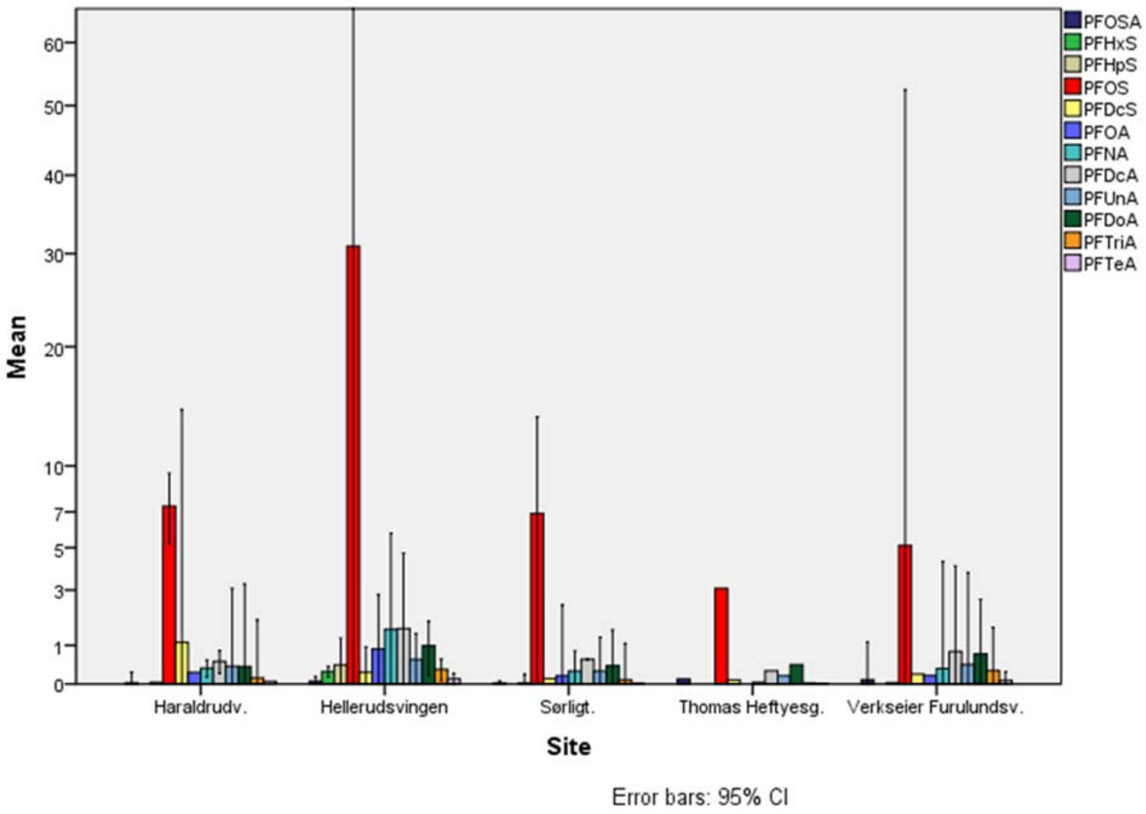


Figure 21. PFAS in Brown rat livers (ng/g ww) by site of collection. Errorbars show the 95% confidence limits.

3.3.7 Red fox

PFAS could be detected in all fox liver samples (Table 23, Figure 22). SumPFAS concentrations were higher than reported in 2014, ranging from 2.26 to 43.5 ng/g ww in 2015 compared to 0.8 to 5.9 ng/g ww in 2014. Linear PFOS was the dominating PFAS in all samples, followed by PFDcA and PFNA (Table 23).

Table 23. Concentrations of detected PFAS compounds in red fox livers (ng/g ww). N: number of detected and measured samples

	PFOSA	PFHxS	PFHpS	PFOS	PFDcS	PFHxA	PFHpA	PFOA	PFNA	PFDcA	PFUnA	PFDoA	PFTriA	PFTeA	SumPFAS
N	2/ 10	3/ 10	1/ 10	10/ 10	2/ 10	2/ 10	7/ 10	8/ 10	9/ 10	9/ 10	10/ 10	1/ 10	7/ 10	5/ 10	10
Mean	<LOD	0.51	<LOD	13.1	<LOD	<LOD	0.17	0.25	0.89	1.14	0.59	<LOD	0.45	0.07	16.3
Median	<LOD	0.61	<LOD	10.7	<LOD	<LOD	0.17	0.17	0.68	0.80	0.52	<LOD	0.32	0.04	14.8
Minimum	<LOD	<LOD	<LOD	1.35	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.03	<LOD	<LOD	<LOD	2.26
Maximum	1.08	0.64	0.29	32.8	0.28	1.44	0.33	0.55	2.23	3.53	1.56	0.55	1.02	0.13	43.5

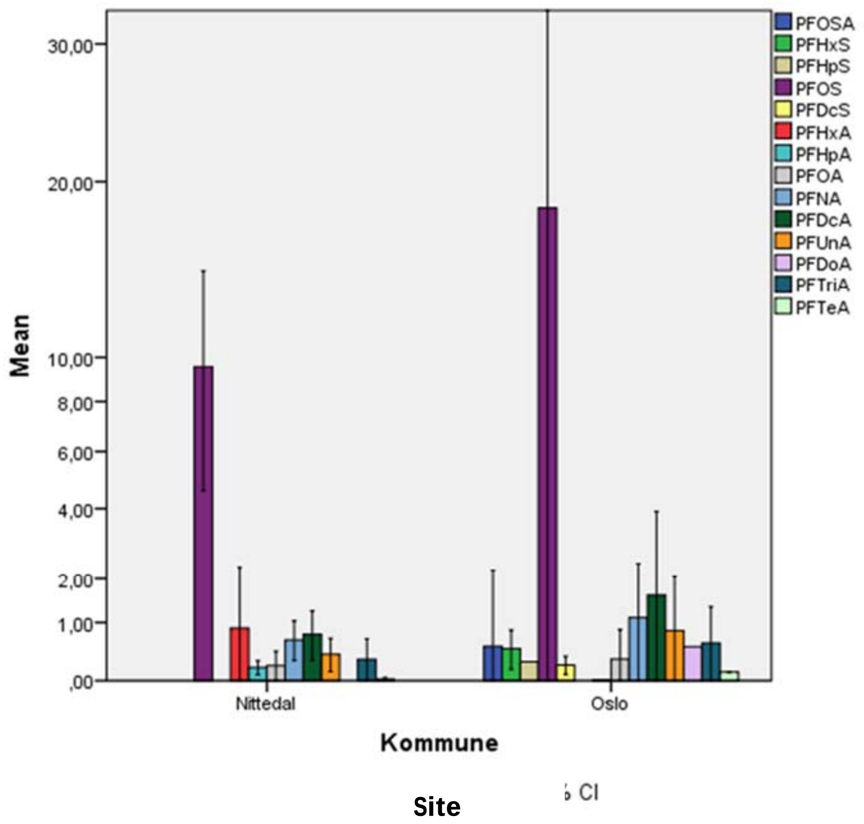


Figure 22: Average concentrations of detected PFAS compounds in the analysed fox livers (ng/g, ww).

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 where the dominating metals in all soils, except for Maridalen and Voksenkollen II, were lead was the main contributor. The sumMetals concentrations ranged from 190 000 ng/g dw in Svartdalparken to 1.525.000 ng/g dw in Voksenkollen I. Silver, mercury and cadmium were found only at low concentrations of less than 500 ng/g g dw. 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. These thresholds were exceeded for Pb in Maridalen (165 700 ng/g dw) and Voksenkollen (164 800 ng/g dw). For Cr, all locations except Svartdal parken and Voksenkollen exceeded the threshold (TA-2553/2009). For Arsenic, Slottsparken and Maridalen exceeded the guideline threshold. 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 found in Oslo. The authors calculated a bioaccumulation factor (BAF) of 49% for lead and and 10% for chrome, indicating a high 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 considerable higher than in Oslo soils (Madrid, 2008).

Table 24: Metals soil from Oslo, in ng/g dw.

	Hg	Ag	Cd	Pb	Cu	Zn	Cr	Ni	As
N	3/ 3	3/3	3/3	3/3	3/3	3/3	3/3	3/3	3/3
Mean	224	326	361	43883	28389	110846	60745	23212	7865
Minimum	56.5	127	202	15239	22313	58859	18529	6520	5272
Maximum	319	441	1734	165691	129611	180867	77669	37259	9187

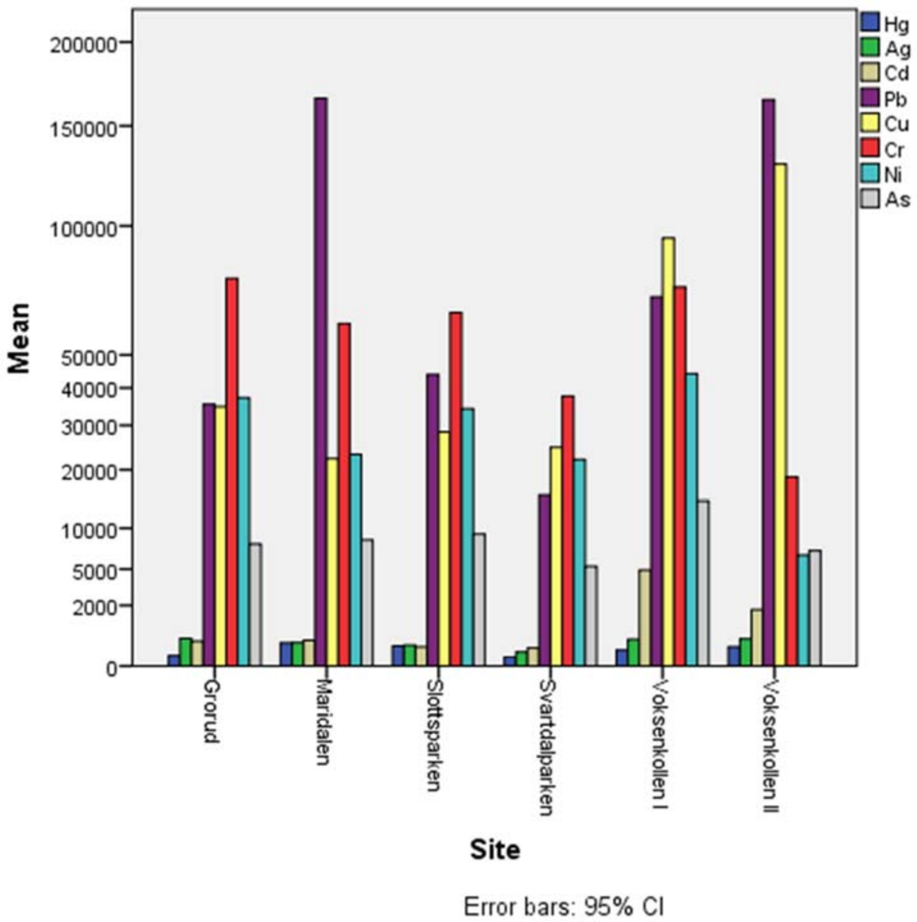


Figure 23. Metal concentrations in soil samples at the different sites in Oslo (ng/g dw)

3.4.2 Earthworm

Only worm samples from three locations were available for metal analyses (Grorud, Slottsparken and Voksenkollen II). Zink was the dominating metal, followed by copper, lead, cadmium and chrome. SumMetal concentrations ranged from 127 µg/g to 245 µg/g ww.

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. Due to a limited number of earthworms available for metal analyses, no soil-worm relationship can be established. Sunil et al. observed that copper and cadmium were toxic for the worms at 1 500 000 ng/g and 100 000 ng/g in soil respectively. Cadmium is the most toxic metal, followed by copper (Kumar et al.,2008). None of these concentrations were reached in soils from Oslo.

Table 25: Metals in pooled earthworms from Oslo, in ng/g ww.

	Hg	Ag	Cd	Pb	Cu	Zn	Cr	Ni	As
N	3/ 3	3/3	3/3	3/3	3/3	3/3	3/3	3/3	3/3
Mean	167	31	2012	8425	2993	175182	1019	669	865
Median	146	26	1257	1222	2850	192699	842	681	782
Minimum	100	22	862	886	2740	120144	392	344	723
Maximum	253	46	3917	23168	3390	212701	1823	982	1090

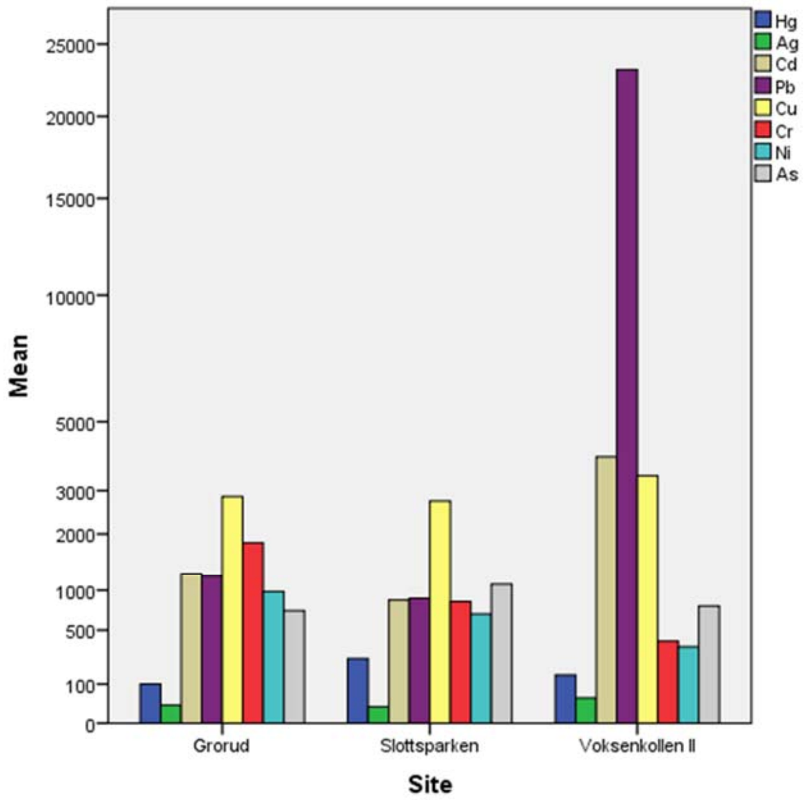


Figure 24. Metal concentrations in earthworms at the different sampling-sites in Oslo (ng/g ww).

When comparing the different urban locations where earthworm were collected, Pb varies the most between the sites, with highest concentrations found in Voksenkollen. Cd was also higher in this location, but not as distinct.

In contrast to the other investigated species, Cu was not following Zn as second in concentration order. Pb and Cr on the other hand, were found in highest concentrations in Oslo (median of 1222 and 842 ng/g). Zn and Cu are physiologically regulated (Lukkari et al. 2004).

3.4.3 Fieldfare

No fieldfare eggs were available for metal analyses.

3.4.4 Sparrowhawk

Zn, Cu and total-Hg dominated in the sparrowhawk eggs. 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 detected in seven of the analysed egg samples. Pb, Ni, Cd and As were only found at low concentrations.

Table 26. The concentrations of the detected metals in the sparrowhawk eggs (ng/g fw).; N: Number of detected and measured samples

	Pb	Hg	Ag	Cd	Cu	Zn	Cr	Ni	As
N	10/10	10/10	7/10	10/10	10/10	10/10	10/10	10/10	5/10
Mean	8.0	146	0.08	0.14	587	7649	5.1	4.2	1.13
Median	3.5	154	0.05	0.12	521	7747	4.8	5.1	0.94
Minimum	0.9	66	<LOD	0.08	439	3971	2.8	1.1	<LOD
Maximum	46.6	196	0.22	0.27	1001	10320	9.3	6.9	2.69

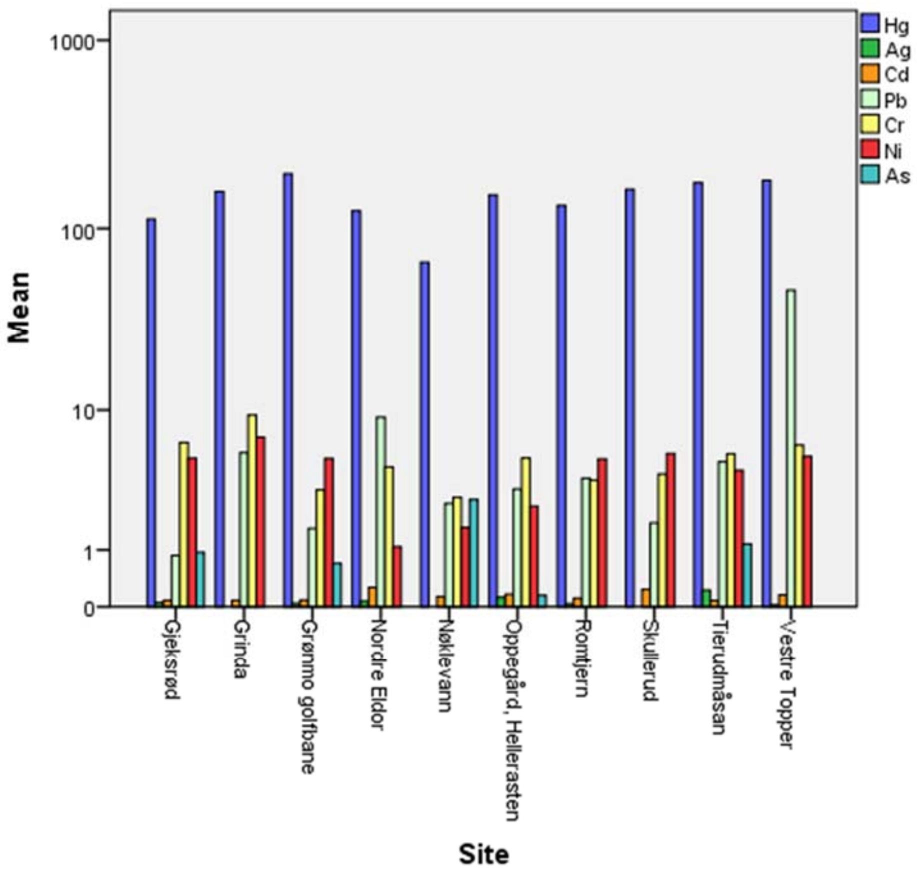


Figure 25: The concentration of different metals in the sparrowhawk eggs at the different sites (Cu and Zn omitted) (ng/g ww).

Pb and Hg are neurotoxins that cause cognitive and behavior deficits as well as decreased survival, growth, learning, and metabolism (Carvalho et al., 2008, Khadeim, 2015). In birds, Pb levels as low as 400 ng/g can cause negative effects on behavior, thermoregulation, and locomotion. The highest levels in the present study for eggs were about ten times lower than these levels. For MeHg, 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 2015, 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).

3.4.5 Tawny owl

Copper was, with a median of 895 ng/g ww, the second most important metal found after zink. All other metals were only present in very low concentrations (median Hg was 15.5 ng/g, for Pb 10.4, Ag 0.6, Cd 0.2, Ni 5.9 and As 1.1 ng/g ww). Elevated nickel concentrations were found in one egg from Bjørnstad, with 340 ng/g ww. All eggs were above the reported concentration for induced motor impairments of 1.5 ng/g ww Hg and seven eggs were above the effect Hg concentration for the increased basal activity of the cerebellar antioxidant system of 15 ng/ww (Carvalho et al., 2008).

Table 26: Metal concentrations in tawny owl eggs in ng/g ww; N: Number of detected and measured samples

	Pb	Hg	Ag	Cd	Cu	Zn	Cr	Ni	As
N	10/10	10/10	10/10	9/10	10/10	10/10	10/10	10/10	6/10
Mean	13.3	16.2	0.8	0.2	1011	10893	30.5	40.5	1.1
Median	10.4	15.5	0.6	0.2	895	12877	8.5	5.9	1.1
Minimum	0.9	7.6	0.3	<LOD	624	3468	2.4	0.8	<LOD
Maximum	47.1	25.1	1.8	0.5	1841	15007	106	340	2.1

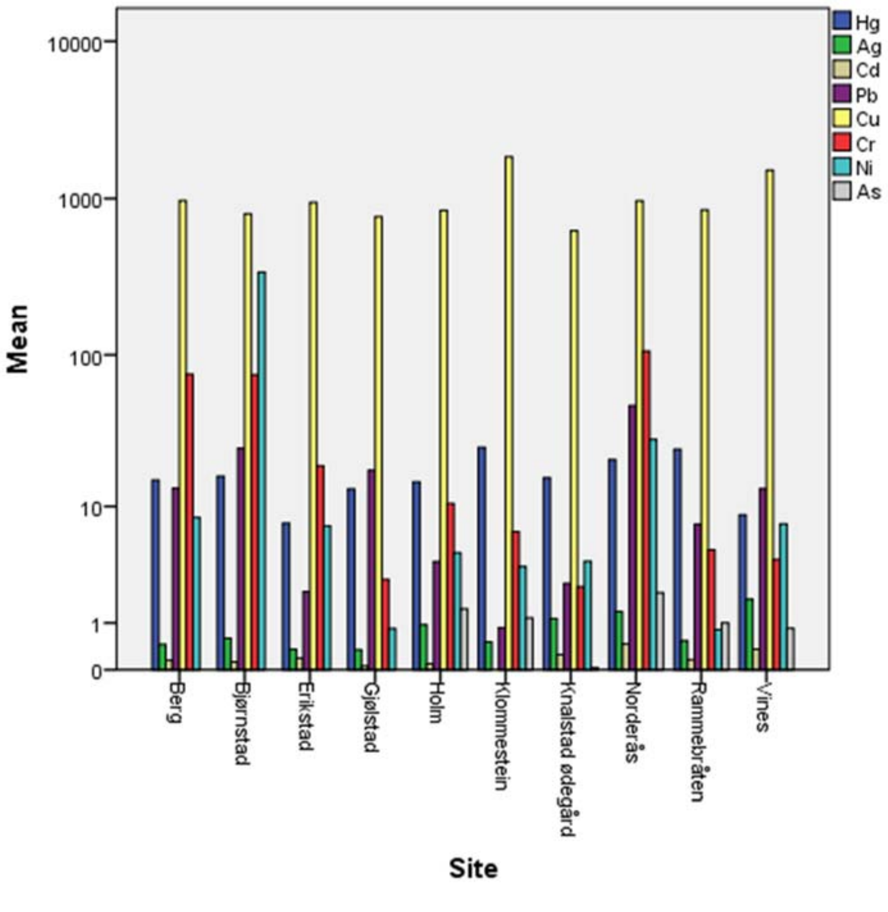


Figure 26. Metal levels (except Zn) in eggs of Tawny owls from the different sampling-sites in the Oslo area (ng/g ww).

3.4.6 Brown Rat

Metals in rat liver were mostly represented by high levels of zink (median of 25 195 ng/g ww) followed by copper and arsenic (median of 3696 and 1959 ng/g respectively). Rat showed the highest levels of arsenic in all observed species.

Table 27. Metal concentrations in brown rat livers from Oslo (ng/g ww). N: Number of detected and measured samples

	Pb	Hg	Ag	Cd	Cu	Zn	Cr	Ni	As
N	10/10	10/10	10/10	10/10	10/10	10/10	10/10	10/10	10/10
Mean	139	11.7	0.5	84	3909	27106	365	169	3516
Median	86	6.2	0.4	20	3696	25195	227	103	1959
Minimum	19	3.0	0.1	11	2227	18888	44	20	1243
Maximum	366	39.9	1.6	290	6232	45687	1759	894	8642

3.4.7 Red fox

Zn was the dominating metal detected in fox liver with concentrations varying from 34 000 ng/g to 84 000 ng/g, followed by Cu with concentrations ranging from 4 700 to 46 000 ng/g ww. Of the other elements determined, only Hg, Cr, Cd and Pb were found in concentrations above 100 ng/g ww. One fox liver contained 2929 ng/g arsenic.

Table 28. Concentrations of metals in livers of red fox from Oslo in ng/g ww. N: Number of detected and measured samples

	Pb	Hg	Ag	Cd	Cu	Zn	Cr	Ni	As
N	10/10	10/10	10/10	10/10	10/10	10/10	10/10	10/10	8/10
Mean	3995	130	15.4	223	14386	50597	447	194	462
Median	77	71	5.4	93	10735	50635	165	59	24
Minimum	21	17	0.4	27	4701	33937	61	9	<LOD
Maximum	38521	605	101	863	45841	84088	1795	851	2929

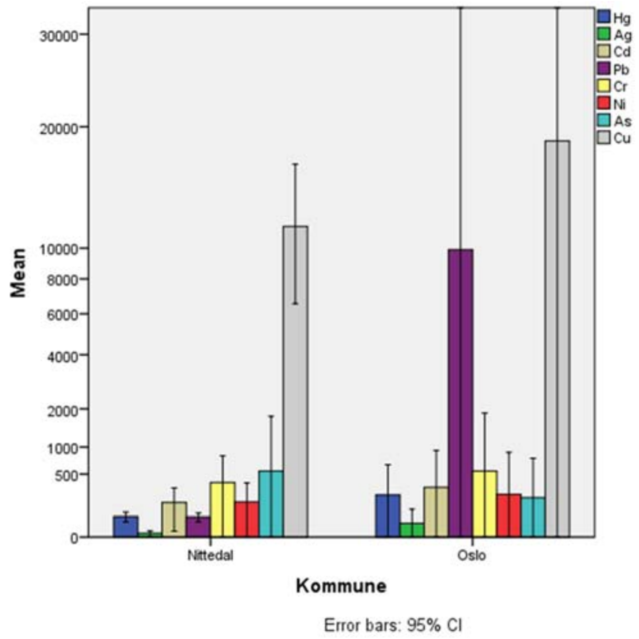


Figure 27. Metals in livers of red fox by municipality (ng/g ww). Errorbars show the 95% confidence limits.

Similar to last years findings, one individual exceeded with 38 521 ng/g ww the 1000 ng/g threshold for clinical lead poisoning by a factor of almost 40. It is unclear if the high levels found in this individual is attributed to the use of lead ammunition. However, 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, Cd levels of 94 ng/g were found (Dip et al., 2001), quite comparable to our findings of a median of 313 ng/g ww. Copper was slightly lower in Oslo, compared to Zurich with 11 200 ng/ g compared to 16 000 ng/g found in Zurich. Also zink and lead showed comparable median values to those of Zurich, both cities being of similar size in terms of inhabitants.

3.5 Cyclic Siloxanes and chlorinated paraffin's

3.5.1 Soil

MCCPs could be detected in all soil samples, opposite to SCCP which could not be found at all in soil. MCCP concentrations varied between 5.6 and 89 ng/g dw, with highest concentrations found in Grorud. 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 similar to those 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).

Of the three different cyclic siloxanes, only D4 and D5 was found in Oslo. Svartdalen showed the highest concentrations with 21.4 and 18.6 ng/g dw for D4 and D5 respectively.

Table 29. Siloxanes and paraffins found in soil samples in Oslo (ng/g dw). N: Number of detected and measured samples

	Siloxane D4	Siloxane D5	Siloxane D6	SCCP	MCCP
N	3/5	4/5	0/5	0/5	5/5
Mean	10.0	7.8	<LOD	<LOD	26.4
Median	5.2	5.2	<LOD	<LOD	14.0
Minimum	<LOD	<LOD	<LOD	<LOD	5.6
Maximum	21.5	18.6	<LOD	<LOD	89.0

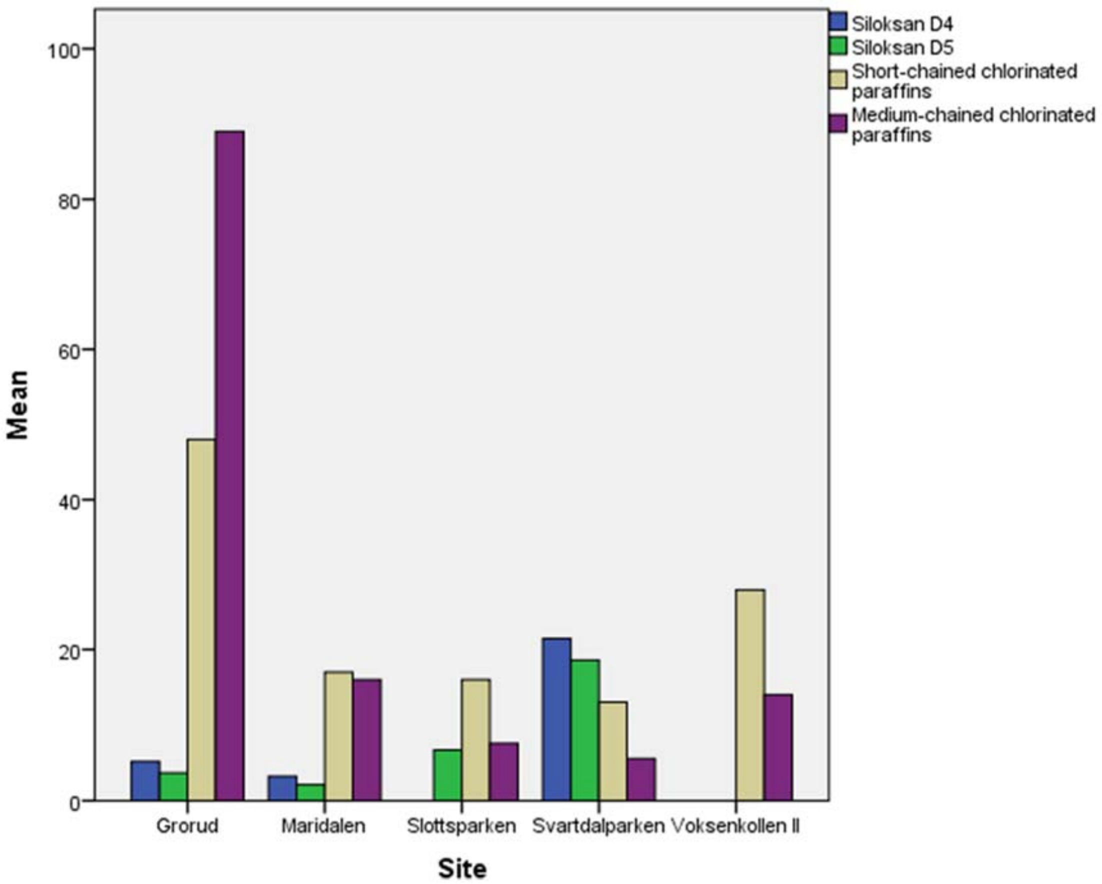


Figure 28. Siloxanes and chlorinated paraffins in soil at the different sampling sites in Oslo (ng/g dw).

3.5.2 Earthworms

Both SCCPs and MCCPs were found in earthworms from Oslo. Concentrations varied for SCCP between 5 and 48 ng/g ww and for MCCP between 1 and 9.5 ng/g ww. Concentrations in worms from Grorud did not reflect the elevated MCCP levels found in soil, indicating a low biomagnification potential. Slottsparken showed the highest concentrations of chlorinated paraffins with 57.5 ng/g ww sumCPs.

Table 30. Siloxanes and chlorinated paraffins found in earthworms in Oslo (ng/g ww). N: Number of detected and measured samples

	Siloxane D4	Siloxane D5	Siloxane D6	SCCP	MCCP
N	1/5	3/5	2/5	5/5	5/5
Mean	<LOD	1.1	<LOD	16.0	6.1
Median	<LOD	0.9	<LOD	8.7	8.0
Minimum	<LOD	<LOD	<LOD	5.0	1.0
Maximum	1.6	1.5	1.9	48.0	9.5

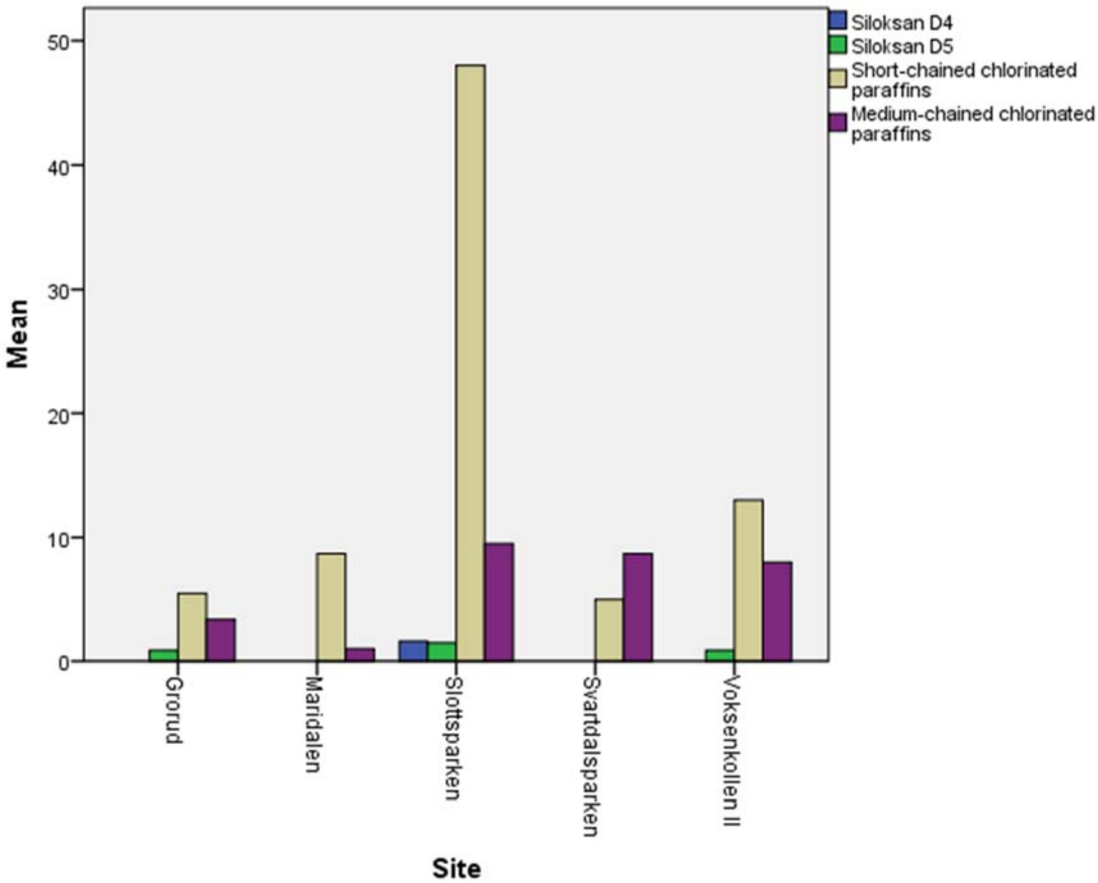


Figure 29. Siloxanes and chlorinated paraffins in earthworms at the different sampling-sites in Oslo (ng/g ww).

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), considerably 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 lower in the soil samples reported here. This indicates that the present level of CPs in soil poses no significant ecological risk for soil organisms

3.5.3 Fieldfare

Both SCCPs and MCCPs were found in fieldfare eggs. In general SCCP concentrations were higher than MCCP (median SCCP 18 ng/g ww and MCCP 3.65 ng/g ww). Little information is available on CPs in bird eggs. In an earlier report by NILU on CPs in seabird eggs, similar concentrations were found (Huber et al.,2015)

Regarding siloxanes, D4 and D6 were detected in most samples, while D5 was affected by high detection limits.

Table 31. Siloxanes and chlorinated paraffins found in eggs of fieldfare in Oslo (ng/g ww). N: Number of detected and measured samples

	Siloxane D4	Siloxane D5	Siloxane D6	SCCP	MCCP
N	8/10	0/10	10/10	10/10	8/10
Mean	2.15	<LOD	2.3	18.7	4.39
Median	1.93	<LOD	1.87	18.0	3.65
Minimum	<LOD	<LOD	1.48	10.0	<LOD
Maximum	2.8	<LOD	5.08	30.0	9.90

3.5.4 Sparrowhawk

SCCPs and MCCPs were found in sparrowhawk eggs, ranging between 3.9 and 140 ng/g ww for SCCP and 0.5 and 5.3 ng/g for MCCP (median 12.7 and 3.3 ng/g respectively). SCCPs was in general more abundant than the MCCPs. S/MCCP data for herring gull eggs from Oslo reported by the Environmental Directorate in 2014, were in the same order of magnitude (Ruus et al., 2015).

Considering the siloxanes, D5 was found at higher concentrations than D6 and D4. D5 concentrations ranged from 4.1 to 11 ng/g ww, more than twice the concentrations of D4 and D6. Maximum concentrations of D5 found in Herring gull eggs from Oslo in 2014, were with 163 ng/g ww more than ten-times higher compared to the sparrowhawk eggs.

Table 32: Cyclic siloxanes and chlorinated paraffins in sparrowhawk eggs (ng/g ww). N: Number of detected and measured samples.

	Siloxsane D4	Siloxane D5	Siloxane D6	SCCPs	MCCPs
N	3	10	10	10	10
Mean	4.3	6.1	2.6	28.9	3.0
Median	3.6	5.0	2.5	12.7	3.3
Minimum	3.6	4.1	2.2	3.9	0.5
Maximum	5.6	11.0	3.6	140.0	5.3

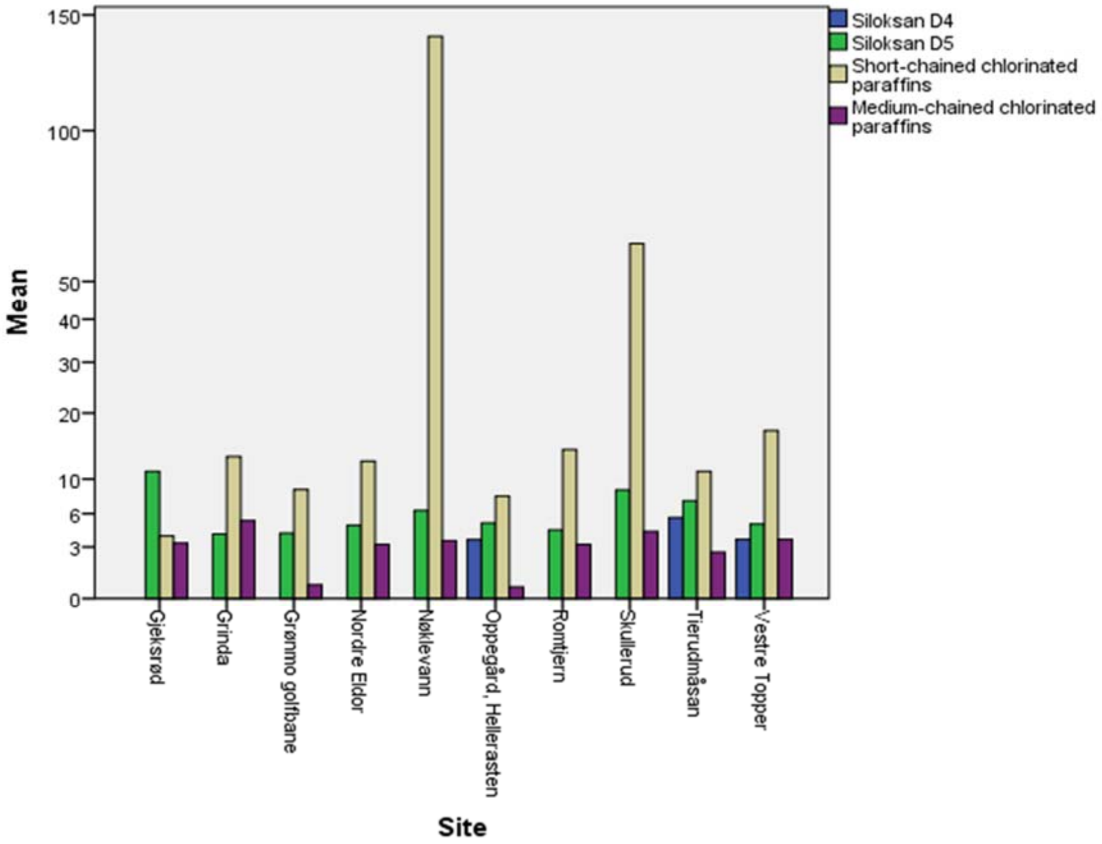


Figure 30. Siloxanes and chlorinated paraffins in sparrowhawk eggs (ng/g fw).

3.5.5 Tawny owl

S/MCCPs were found in all tawny owl eggs. Similar SCCP and MCCP median concentrations compared to the sparrowhawk could be found (12.0 and 2.8 ng/g fw). The highest SCCP measured was 20 ng/g fw.

D4 was found in all eggs, with a median of 3.5 ng/g fw. D5 showed a median of 3.1 ng/g fw, again comparable with findings in sparrowhawk eggs, but lower than herring gull eggs. Due to high detection limits, D5 was only quantifyable in 5 out of 10 samples. One egg contained the maximum concentration of 27.7 ng/g fw of D4 and 7.4 ng/g fw of D5.

Table 33. Siloxanes and chlorinated paraffins in tawny owl eggs (ng/g fw). N: Number of detected and measured samples.

	Siloxane D4	Siloxane D5	Siloxane D6	SCCP	MCCP
N	10/10	5/10	9/10	10/10	10/10
Mean	5.5	4.4	2.1	12.5	2.5
Median	3.5	3.1	1.9	12.0	2.8
Minimum	1.7	<LOD	<LOD	1.0	0.3
Maximum	27.7	7.4	3.1	20.0	3.9

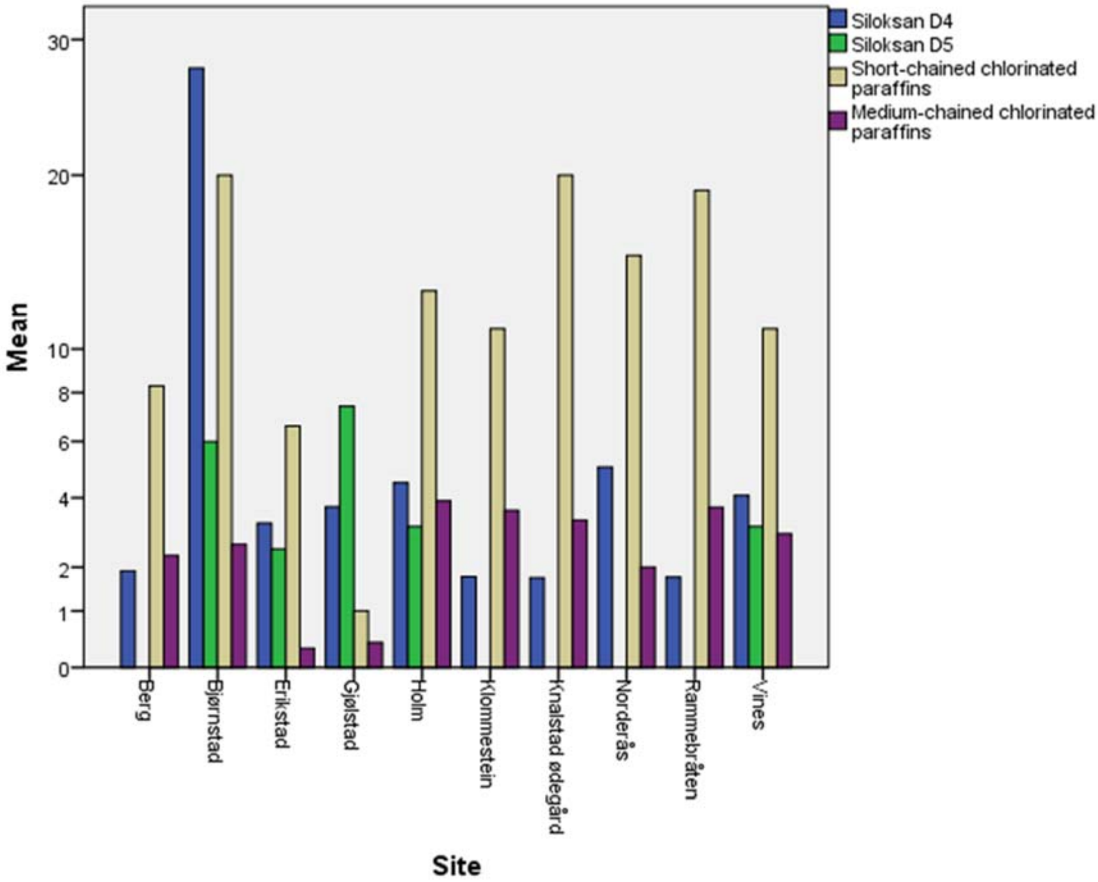


Figure 31. Siloxanes and chlorinated paraffins in tawny owl eggs (ng/g fw).

3.5.6 Brown Rats

No SCCPs was found in rat liver and only limited amounts of MCCPs was detected (in two of ten samples with maximum concentrations of 1.6 ng/g ww).

Siloxanes could be found in the majority of rats, with D4 and D5 concentrations in similar levels (median D4 15.9 ng/g, and D5 15.8 ng/g). D6 ranged between <LOD and 33 ng/g.

Table 34: Siloxanes and chlorinated paraffins in rat livers (ng/g ww). N: Number of detected and measured samples

	Siloxane D4	Siloxane D5	Siloxane D6	SCCP	MCCP
N	8/10	10/10	4/10	0/10	2/10
Mean	16.1	16.0	28.7	<LOD	1.5
Median	15.9	15.8	29.7	<LOD	1.5
Minimum	<LOD	4.1	<LOD	<LOD	<LOD
Maximum	28.8	30.0	33.2	<LOD	1.6

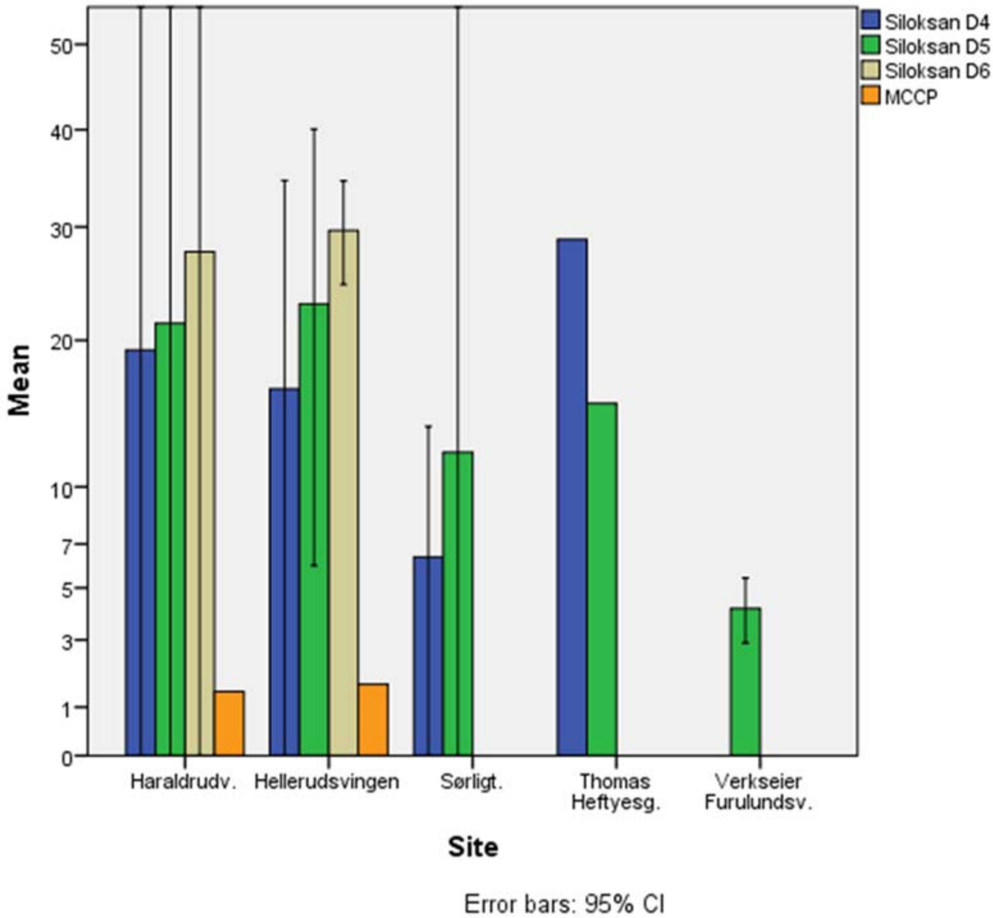


Figure 32. Siloxanes and chlorinated paraffins in rat livers (ng/g ww). SCCP were not detected. Errorbars show the 95% confidence limits.

3.5.7 Red fox

In fox liver, mostly SCCP could be detected, ranging between <LOD and 11.7 ng/g ww. MCCPs were present in 30% of all samples, ranging between <LOD and 19.8 ng/g ww. Both SCCPs and MCCPs were more frequently found in the foxes from Oslo, compared to the ones from Nittedal. Cyclic siloxanes were present in all fox samples with D5 dominating the siloxane

pattern (median of 8.9, 10.2 and 8.6 ng/g ww for D4, D5 and D6 respectively). The highest concentrations found were 11.7, 23.8 and 19.7 for D4, D5 and D6 respectively in one individual from Oslo.

Table 35: Siloxanes and chlorinated paraffins in red fox livers (ng/g ww). N: Number of detected and measured samples

	Siloxane D4	Siloxane D5	Siloxane D6	SCCP	MCCP
N	8/10	5/10	7/10	10/10	3/10
Mean	9.3	12.8	10.3	12.3	3.3
Median	8.9	10.2	8.6	10.2	4.1
Minimum	<LOD	<LOD	<LOD	3.2	<LOD
Maximum	11.7	23.8	19.7	29.7	5.0

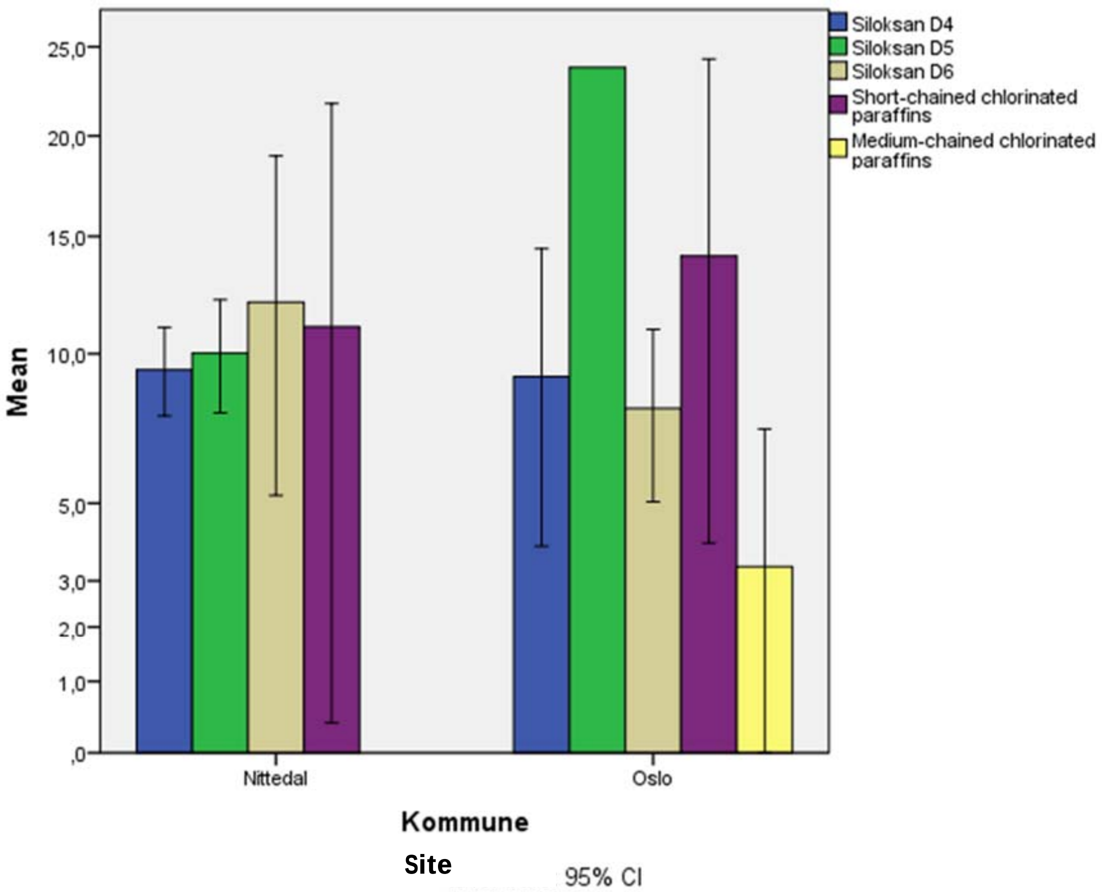


Figure 33. Siloxanes and chlorinated paraffins in red fox livers (ng/g ww). Errorbars show the 95% confidence limits.

3.6 Organic phosphorous flame retardants

3.6.1 Soil

Fourteen different OPFRs were measured within this project. Of the here reported OPFR, three belong to the chlorinated OPFR (TCEP, TCPP, TDCPP). In the analysed soil samples, only TCEP, TPP, TCP and TEHP could be found in more than one sample. TCPP was found only in Grorud, but at high concentration of 284 ng/g dw. Grorud is also the site with the highest sumOPFR concentrations, ranging between 5 and 325 ng/g dw, potentially due to the close location of a waste recirculation facility.

Table 36. OPFRs in soil samples from Oslo (ng/g dw). N: Number of detected and measured samples

	TEP	TCEP	TCPP	TPP	TnBP	TCP	EHDP	TEHP	SumOPFR
N	1/10	3/10	1/10	4/10	1/10	4/10	1/10	3/10	5/10
Mean	<LOD	3.1	<LOD	4.7	<LOD	4.2	<LOD	12.1	77.6
Median	<LOD	1.9	<LOD	4.8	<LOD	3.2	<LOD	6.6	16.8
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	5.5
Maximum	4.2	6.9	284	8.3	14.7	9.1	3.6	27.0	325

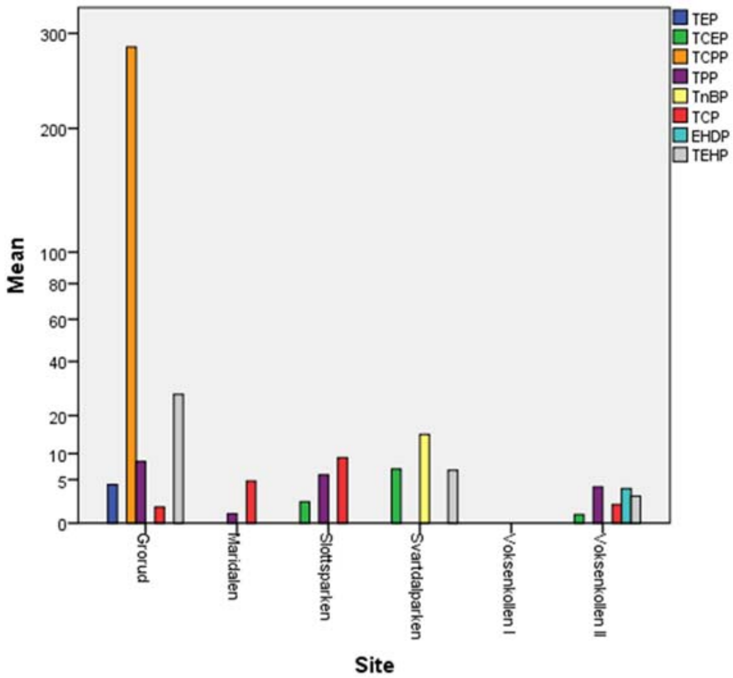


Figure 34. OPFRs in soil samples from the different sites in Oslo (ng/g dw).

3.6.2 Earthworms

OPFR were only detected in a few samples, mostly in Svartdalsparken with maximum sumOPFR concentration of 16.3 ng/g ww. TPP, TCP, EHDP and TEHP were found in most worms, but at low concentrations < 1.5 ng/g ww. The dominating OPFR in worms was TiBP with concentrations ranging between <LOD and 3.2 ng/g ww, similar to observations in Herring gull eggs from Oslo in 2015 (M-375).

Table 37. OPFRs in earthworm samples from Oslo (ng/g ww). N: Number of detected and measured samples

	TCPP	TiBP	TPP	TDCPP	TBEP	TCP	EHDP	TEHP	SumOPFR
N	1/5	4/5	5/5	3/5	2/5	4/5	4/5	5/5	5/5
Mean	<LOD	2.4	0.2	2.4	5.0	0.1	0.4	0.5	6.9
Median	<LOD	2.4	0.2	2.0	5.0	<LOD	0.4	0.3	5.9
Minimum	<LOD	<LOD	0.1	<LOD	<LOD	<LOD	<LOD	0.1	0.9
Maximum	2.6	3.2	0.2	4.0	6.4	0.2	0.5	1.5	16.3

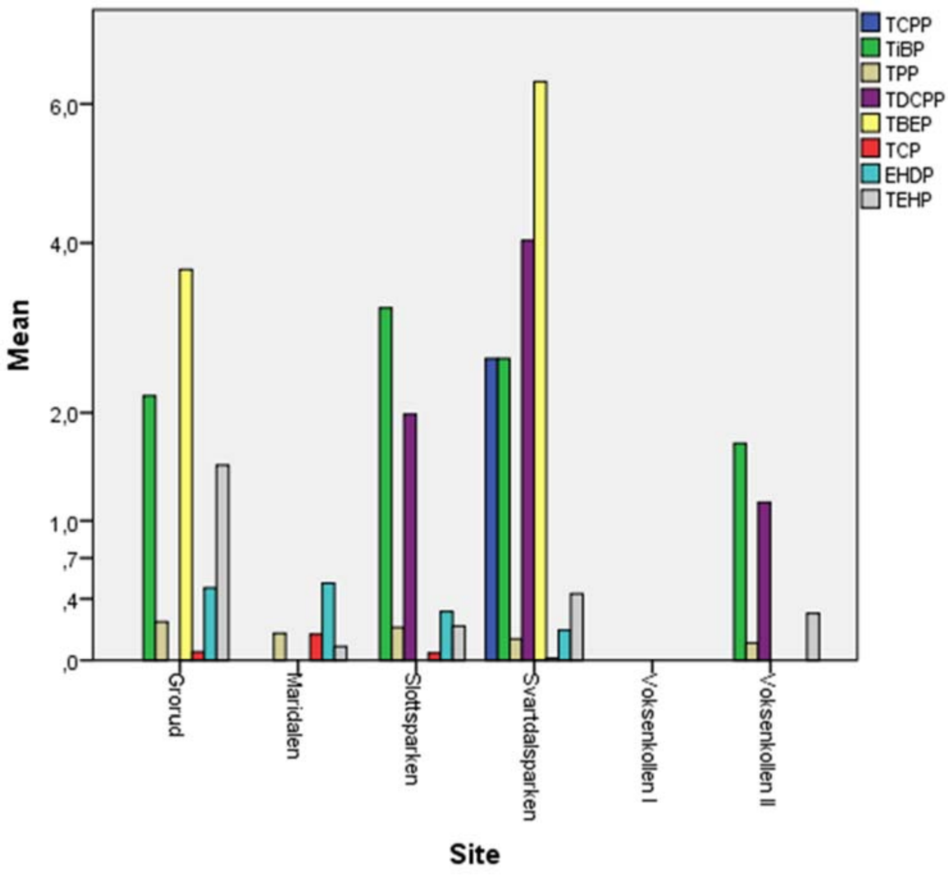


Figure 35. OPFRs in earthworm samples from the different sites in Oslo (ng/g ww).

3.6.3 Fieldfare

In fieldfare eggs, OPFR were only found sporadically and at low concentrations. SumOPFR ranged between <LOD and 7.6 ng/g ww. One elevated concentration of TBEP (7.5 ng/g ww) was found in one egg collected at the Østersjøvannet lake.

Table 38. OPFRs in fieldfare eggs from the Oslo area (ng/g ww). N: Number of detected and measured samples

	TEP	DBPhP	TBEP	TEHP	SumOPFR
N	5/10	1/10	1/10	2/10	7/10
Mean	0.82	<LOD	<LOD	<LOD	1.71
Median	0.90	<LOD	<LOD	<LOD	0.90
Minimum	0.43	<LOD	<LOD	<LOD	0.10
Maximum	1.19	0.10	7.49	0.14	7.63

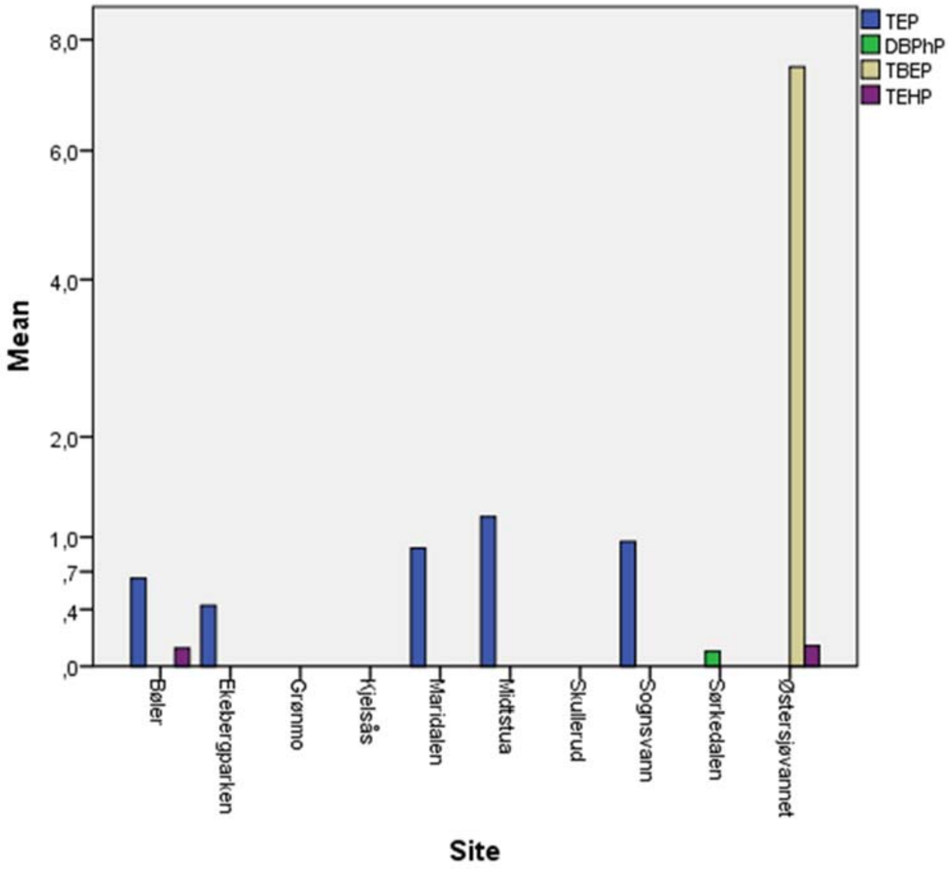


Figure 36. OPFRs in fieldfare eggs from the different sites in Oslo (ng/g ww).

3.6.4 Sparrowhawk

With sumOPFR concentrations ranging between <LOD and 0.7 ng/g ww, overall OPFR concentrations were rather low. The most detected OPFR was TEHP (detection frequency of 6%, concentration ranging between <LOD and 0.3 ng/g ww).

Table 39. OPFRs in sparrowhawk eggs from the Oslo area (ng/g fw). N: Number of detected and measured samples

	TEP	TPP	TEHP	SumOPFR
N	1/10	1/10	6/10	7/10
Mean	<LOD	<LOD	0.2	0.3
Median	<LOD	<LOD	0.2	0.3
Minimum	<LOD	<LOD	<LOD	<LOD
Maximum	0.6	0.3	0.3	0.7

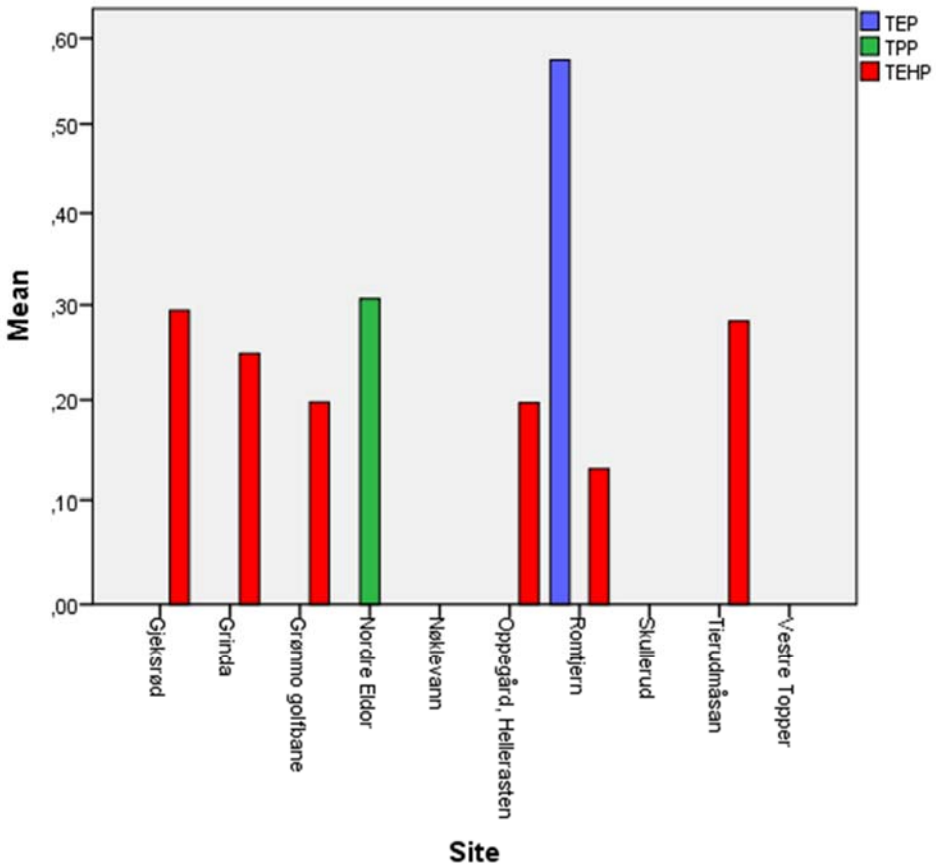


Figure 37. OPFRs in sparrowhawk eggs from the different sites in Oslo (ng/g fw).

3.6.5 Tawny owl

Similar to sparrowhawk, only little OPFR could be found. SumOPFR concentrations ranged between <LOD and 3.7 ng/g ww (median <LOD). TBEP was measured in one extreme case with 3.7 ng/g ww.

Table 40. OPFRs in tawny owl eggs in the Oslo area (ng/g fw). N: Number of detected and measured samples

	TBEP	EHDP	TEHP	SumOPFR
N	1/10	1/10	2/10	4/10
Mean	<LOD	<LOD	<LOD	1.22
Median	<LOD	<LOD	<LOD	0.48
Minimum	<LOD	<LOD	<LOD	<LOD
Maximum	3.70	0.67	0.28	3.70

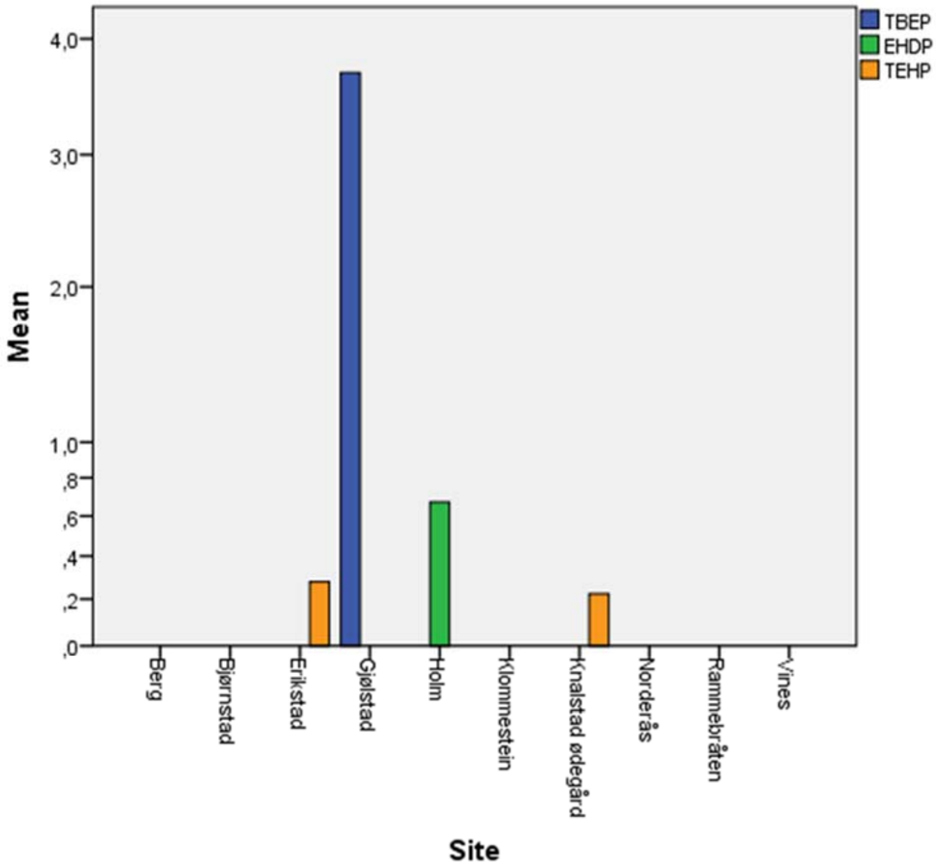


Figure 38. OPFRs in tawny owl eggs at different sites in the Oslo area(ng/g fw).

3.6.6 Brown Rats

In rats, OPFRs were found in nine out of ten samples, with TCPP and EHDP being the most abundant ones (median 0.49 and 0.67 ng/g ww respectively). TiBP and TnBP were detected in 70% of all samples, but at low concentrations. SumOPFR varied between 1.2 and 33.1 ng/g ww (median 2.92 ng/g ww). Two incidents of extreme concentrations were found, 15.9 ng/g ww of EHDP and 27.9 ng/g ww of TCPP (Haraldrudveien and Furulundsveien, respectively).

Table 41: OPFRs in rat livers in the Oslo area (ng/g ww). N: Number of detected and measured samples

	TEP	TCEP	TCPP	TiBP	TPP	TnBP	TDCPP	TBEP	EHDP	TEHP	SumOPFR
N	1/10	3/10	9/10	7/10	6/10	7/10	2/10	7/10	7/10	2/10	
Mean	<LOD	1.42	3.65	0.61	1.31	0.10	<LOD	0.44	2.77	<LOD	8.22
Median	<LOD	0.41	0.49	0.21	0.27	0.08	<LOD	0.42	0.67	<LOD	2.92
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Maximum	0.23	3.46	27.9	1.86	6.74	0.15	0.71	0.58	15.98	0.15	33.0

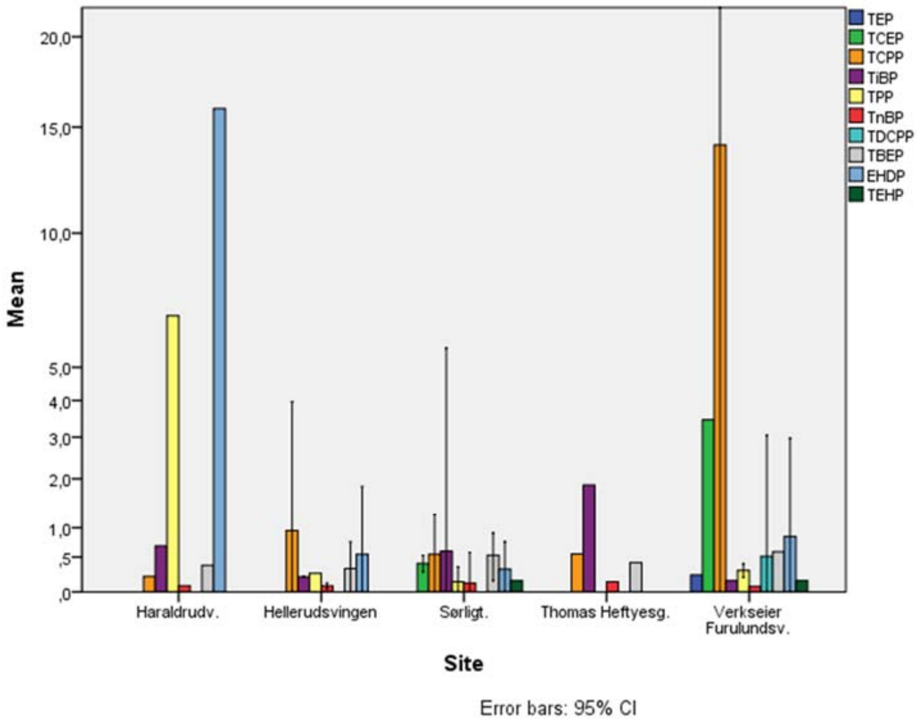


Figure 39. OPFRs in rat livers at different sites in the Oslo area (ng/g ww). Errorbars show the 95% confidence limits.

3.6.7 Red fox

EDHP, TBEP, TCPP and TPP were the most frequently detected OPFRs in fox liver ranging from 0.3 to 3.3 ng/g. TEP, TiBP, DBPhP, TnBP, and TEHP were also detected, but in few of the samples. SumOPFR ranged between 0.7 and 9.5 ng/g ww. Generally, the levels were higher in Nittedal than in Oslo (Figure 40).

Table 42. OPFRs in red fox livers in the Oslo area (ng/g ww). N: Number of detected and measured samples

	TEP	TCEP	TCPP	TiBP	TPP	DBPhP	TnBP	TBEP	TCP	EHDP	TEHP	SumOPFR
N	2/10	1/10	10/10	2/10	7/10	2/10	2/10	4/10	1/10	7/10	4/10	
Mean	<LOD	<LOD	1.06	<LOD	0.29	<LOD	<LOD	1.22	<LOD	1.46	<LOD	1.54
Median	<LOD	<LOD	0.92	<LOD	0.25	<LOD	<LOD	<LOD	<LOD	0.96	<LOD	1.56
Minimum	<LOD	<LOD	0.30	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.55	<LOD	<LOD
Maximum	3.64	1.06	2.52	0.50	0.61	0.59	1.19	3.13	0.02	3.32	0.17	2.35

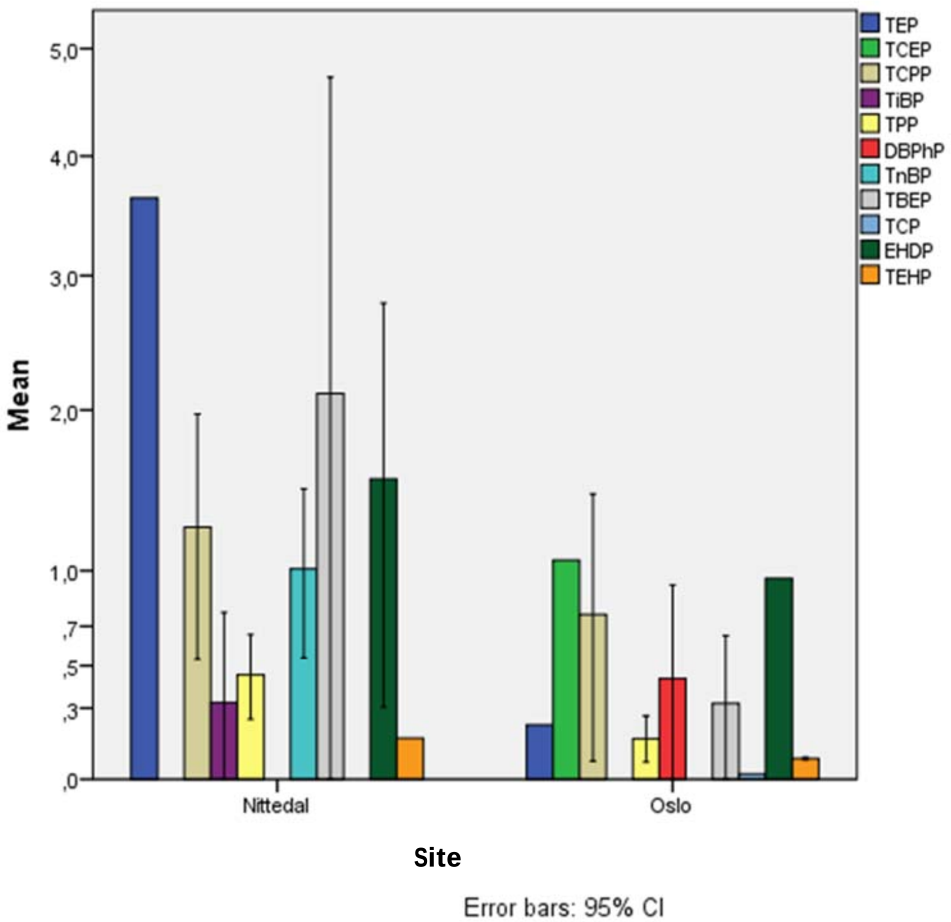


Figure 40. OPFRs in red fox livers in the Oslo area (ng/g ww). Errorbars show the 95% confidence limits.

3.7 Phenolic compounds

Due to the sporadic detection of phenolic compounds, results are discussed in the text below without illustration by figures. Detailed information regarding concentrations can be found in the Appendix.

3.7.1 Soil

Of the main phenolic compounds found in biological samples, BPA concentrations were low (<0.55 ng/g dw to 117 ng/g dw). Bisphenol S was randomly detected in all the samples at relatively low levels. In experiments that have involved spiking compounds into soil samples, degradation half lives have been reported of 1–17 d for 4-nonylphenol (Topp and Starratt, 2000 and Roberts et al., 2006), approximately 5 d for 4-t-octylphenol (Ying and Kookana, 2005), 1-7 d for bisphenol A (Ying and Kookana, 2005 and Xu et al., 2009), pointing to a relatively short residence time in soil after single emissions. However, if emissions are of a rather continuous nature, as for example diffuse urban sources, these half-lives can cause an increase in soil over time. Important sources of phenolic compounds in soil are for example emissions from degradation products of surfactants, UV stabilisers and plasticisers of plastic materials. It has been indicated that the most important source for octylphenol in Sweden was the possible abrasion from car tires with a yearly emission of about 800 kg to surface waters and 8000 kg to land in Sweden, although with high uncertainty in the calculations (COHIBA, 2012).

Table 43. Phenolic compounds in soil in the Oslo area (ng/g dw). N: Number of detected and measured samples.

	Bisphenol A	Bisphenol S	Bisphenol F	Nonylphenol	Octylphenol	TBBPA	SumPhenols
N	5/6	1/6	6/6	4/6	4/6	1/5	6/6
Median	18.0	<LOD	3.77	4.4	12.0	<LOD	38.2
Minimum	<LOD	<LOD	2.39	<LOD	<LOD	<LOD	2.4
Maximum	117.1	1.1	12.1	36.7	24.9	4.82	197

3.7.2 Earthworms

In this study bisphenol A (BPA) was the most abundant of all bisphenols found in earthworms. Detected concentrations ranged between 5600 and 9800 ng/g ww, indicating biomagnification from the soil. 4-t-octylphenol (4-t-OP) was another dominant compound found in earthworms (326 to 465 ng/ng ww). Bisphenol S was detected in two out of three samples at relatively low levels. OSPAR concluded in 2006 that octylphenol only fulfills the P and T criteria of PBT in the marine ecosystem, since endocrine disrupting properties have been shown (OSPAR, 2006).

Table 44. Phenolic compounds in earthworms from the Oslo area (ng/g ww). N: Number of detected and measured samples

	Bisphenol A	Bisphenol S	Bisphenol F	Nonylphenol	Octylphenol	TBBPA	SumPhenols
N	3/3	2/3	3/3	0/3	3/3	0/3	3/3
Median	6298	3.6	48.6	<LOD	3.32	<LOD	6353
Minimum	5631	<LOD	40.2	<LOD	3.19	<LOD	5674
Maximum	9757	4.9	50.2	<LOD	5.78	<LOD	9818

3.7.3 Fieldfare

Phenolic compounds were not measured in fieldfare eggs due to limited sample material available.

3.7.4 Sparrowhawk

Phenolic compounds were much lower in sparrowhawks than in earthworms. BPA was found in low levels (<LOD-35.4 ng/g ww). Octyl- and nonyphenol levels were similar to those reported in eggs of marine birds in Norway (Ruus et al., 2015). Bisphenol S and F were hardly detected in the samples. For comparison, Huber et al., reported sum concentrations of alkylphenols in herring gull eggs from Sklinna, Norway, ranging between 8.2 and 254 ng/g ww (Huber, 2015). TBBP A was only found in 20% of the samples at low concentrations of 1.6 ng/g ww. For comparison, Herzke et al. reported in 2005, lower TBBP A concentrations varying between lower than the quantification limit and 13 pg/ g ww in a limited number of eggs from four different birds of prey species (Herzke et al., 2005).

Table 45. Phenolic compounds in eggs of sparrowhawks from the Oslo area (ng/g ww). N: Number of detected and measured samples

	Bisphenol A	Bisphenol S	Bisphenol F	Nonylphenol	Octylphenol	TBBPA	SumPhenols
N	5/10	1/10	3/10	5/10	10/10	2/10	
Median	4.0	<LOD	<LOD	77.1	5.68	<LOD	86.8
Minimum	<LOD	<LOD	<LOD	<LOD	5.4	<LOD	5.4
Maximum	35.4	1.0	2.7	92.7	6.4	1.6	140

3.7.5 Tawny owl

Phenolic compounds were not abundant in the tawny owl eggs. Only 4-tert-octylphenol was present in appreciable levels. BPA was either not detected (<LOD) or observed at very low concentrations.

Table 46. Phenolic compounds in eggs of tawny owls from the Oslo area (ng/g ww). N: Number of detected and measured samples

	Bisphenol A	Bisphenol S	Bisphenol F	Nonylphenol	Octylphenol	TBBPA	SumPhenols
N	2/10	1/10	0/10	2/10	3/10	1/10	4/10
Median	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Maximum	3.0	3.5	<LOD	8.5	1.1	1.87	18.0

3.7.6 Red Fox

Bisphenol F was found at the highest levels in the liver of red fox (<LOD to 911 ng/g ww). BPA was either not detected (<LOD) or observed at very low concentrations. Bisphenol S was randomly detected in all the samples at relatively low levels. No TBBP A was detected in red fox livers.

Table 47. Phenolic compounds in liver of red fox from the Oslo area (ng/g ww). N: Number of detected and measured samples

	Bisphenol A	Bisphenol S	Bisphenol F	Nonylphenol	Octylphenol	TBBPA	SumPhenols
N	3/10	2/10	2/10	0/10	4/10	0/10	
Median	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Maximum	13.6	4.0	912	<LOD	27.0	<LOD	957

3.7.7 Brown rats

BPA was found in 50% of all samples ranging between <LOD and 61 ng/g ww. Bisphenol F was found in low concentrations below 2.3 ng/g ww. Bisphenol S was randomly detected in some of the samples at levels below 24 ng/g ww. No TBBP A was detected.

Table 48. Phenolic compounds in liver of brown rats from the Oslo area (ng/g ww). N: Number of detected and measured samples

	Bisphenol A	Bisphenol S	Bisphenol F	Nonylphenol	Octylphenol	TBBPA	SumPhenols
N	5/10	3/10	4/10	0/10	1/10	0/10	
Median	24.7	<LOD	<LOD	<LOD	<LOD	<LOD	24.7
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Maximum	60.8	24.0	2.3	<LOD	6.2	<LOD	93.3

3.8 UV compounds

Due to the sporadic detection of phenolic compounds, results are discussed in the text below without further illustration by figures and tables. Information regarding concentrations can be found in the Appendix.

3.8.1 Soil

All soil samples had values below detection limits (< 5ng/g dw)

3.8.2 Earthworms

All samples had values below detection limits (< 3 ng/g dw)

3.8.3 Fieldfare

UV compounds were not analysed for in the fieldfare egg samples due to limited availability of sample.

3.8.4 Sparrowhawk

All egg samples had values below detection limits (< 3 ng/g dw)

3.8.5 Tawny owl

All egg samples had values below detection limits (< 3 ng/g dw)

3.8.6 Red fox

All liver samples had values below detection limits (<1 -< 3 ng/g dw)

3.8.7 Rats

UV-328 was found in two brown rat liver samples, with values of 5.2 and 7.4 ng/g ww.

3.9 Pesticides, DDTs and biocides

In the following, we discuss the results for pesticide and biocide measurements. The pesticides HCB, HCHs, chlordanes, oxy-chlodane and mirex are grouped together in the sumPest value, while the DDTs are grouped together as sumDDTs.

3.9.1 Soil

Besides *trans*-nonachlor and HCB, only limited amounts of pesticides were detected. *Trans*-nonachlor ranged between 0.03 and 0.07 ng/g dw and HCB ranged between 0.12 and 17.4 ng/g dw. The one extreme HCB concentration of 17.4 ng/g dw was found in Grorud. Bromadiolone was not detected in any soil sample.

DDTs were not analysed for in soil.

Table 49. Pesticides in soil samples in Oslo (ng/g dw). N: Number of detected and measured samples

	HCB	Trans-chlordane	Cis-chlordane	Trans-nonachlor	Cis-nonachlor	Sum Chlordanes
N	6/10	1/10	1/10	6/10	5/10	6/10
Mean	3.14	<LOD	<LOD	0.05	0.02	0.07
Median	0.28	<LOD	<LOD	0.05	0.02	0.07
Minimum	0.12	<LOD	<LOD	<LOD	<LOD	<LOD
Maximum	17.40	0.02	0.03	0.07	0.02	0.11

3.9.2 Earthworms

Earthworms showed low levels of chlordanes and HCB, they were in the same order of magnitude as in soil, with HCB and *trans*-nonachlor being the most prevalent pesticides. The highest HCB concentration of 2.35 ng/g ww was found in earthworms from Grorud. SumPesticide concentrations varied between 0.12 and 2.4 ng/g ww. Bromadiolone was not detected in any worm sample.

DDTs were not analysed for in worms.

3.9.3 Fieldfare

HCB, *trans*-nonachlor and *oxy*-chlordane belonged to the most detected pesticides in fieldfare eggs, contributing most to the sumPest concentration. SumPest concentrations varied between 1.8 and 7.4 ng/g ww (median 4.3 ng/g ww).

Mirex also showed up in low concentrations. In general, levels of pesticides were of one order of magnitude higher than in earthworms.

Table 50. Pesticides in fieldfare eggs from the Oslo area (ng/g ww). N: Number of detected and measured samples

	HCB	Mirex	Trans-chlordane	Oxychlordane	Trans-nonachlor	Cis-nonachlor	Sum Chlordanes
N	10/10	10/10	1/10	9/10	10/10	10/10	
Mean	2.85	0.07	<LOD	0.75	0.75	0.14	1.56
Median	3.12	0.06	<LOD	0.53	0.55	0.10	1.27
Minimum	1.20	0.04	<LOD	<LOD	0.37	0.07	0.56
Maximum	5.43	0.13	0.01	1.95	1.57	0.31	3.83

DDTs and bromadiolone were not analysed for in fieldfare eggs.

3.9.4 Sparrowhawk

A similar pattern of the non-DDT pesticides compared with the fieldfare was found in sparrowhawk, but at much higher levels. Some additional pesticides were also detected in all samples, mirex, *cis*-chlordane and *cis*-nonachlor. HCB dominated the non-DDT pesticides pattern, followed by Oxychlordane,*trans*-nonachlor and Mirex.

Table 51. Pesticides other that DDTs in eggs of sparrowhawks (ng/g fw). N: Number of detected and measured samples

	HCB	Mirex	Trans-chlordane	Cis-chlordane	Oxychlordane	Trans-nonachlor	Cis-nonachlor	Sum Chlordanes
N	10/10	10/10	4/10	8/10	10/10	10/10	10/10	10/10
Mean	18.3	2.3	0.02	0.07	13.7	10.8	2.47	26.9
Median	13.2	1.92	<LOD	0.07	8.08	7.17	1.44	16.1
Minimum	5.54	0.67	<LOD	<LOD	4.13	2.73	0.64	7.52
Maximum	57.6	7.09	0.02	0.14	42.5	24.4	6.57	73.6

Of the measured DDTs, *p,p'*-DDE dominated the DDT pattern with a median of 874 ng/g ww, followed by *p,p'*-DDT with a median of 11 ng/g ww. SumDDTs ranged between 368 and 4255 ng/g fw (median 920 ng/g fw).

Table 52. DDTs in eggs of sparrowhawks from the Oslo area (ng/g fw). N: Number of detected and measured samples

	o,p'-DDE	o,p'-DDD	p,p'-DDD	o,p'-DDT	p,p'-DDT	p,p'-DDE	sumDDTs
N	7/10	5/10	10/10	3/10	10/10	10/10	10/10
Mean	0.08	0.05	16.9	0.09	15.4	1215	1248
Median	0.05	0.04	11.4	<LOD	10.6	874	920
Minimum	<LOD	<LOD	3.6	<LOD	2.0	344	369
Maximum	0.15	0.12	42.4	0.17	42.2	4174	4256

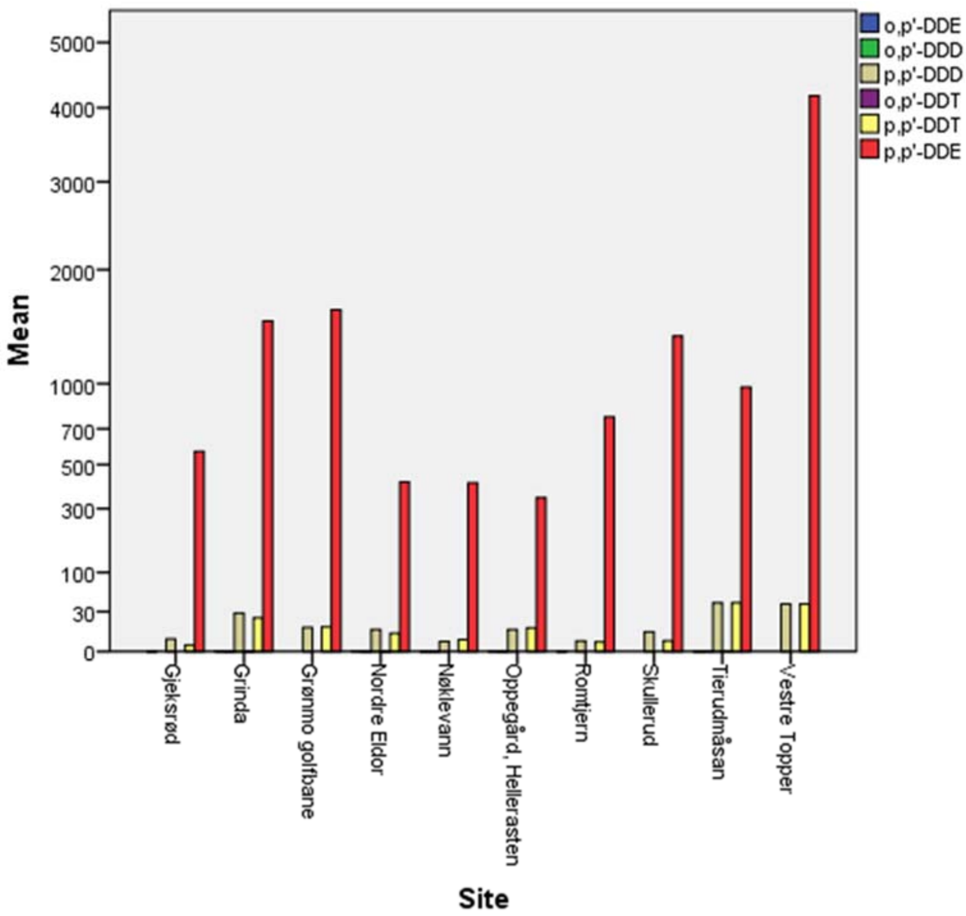


Figure 41. DDTs in eggs of sparrowhawks from the different sampling sites in the Oslo area(ng/g fw).

3.9.5 Tawny owl

As seen for the other bird eggs, oxy-chlordane and HCB were the major non-DDT pesticides with a median of 8.1 and 13.25 ng/g ww respectively. Sum non-DDT Pesticides ranged between 2.8 and 13.6 ng/g ww with a median of 6.1 ng/g ww. Bromadiolone was not detected in any tawny owl sample.

Table 53. Pesticides except DDTs in eggs of tawny owl from the Oslo area (ng/g, fw). N: Number of detected and measured samples

	Trans-chlordane	Cis-chlordane	Oxychlordane	Trans-nonachlor	Cis-nonachlor	Sum Chlordanes	HCB	Mirex
N	1/10	2/10	10/10	10/10	10/10	10/10	10/10	10/10
Mean	<LOD	<LOD	3.12	0.59	0.16	3.88	2.87	0.21
Median	<LOD	<LOD	3.07	0.51	0.16	3.75	2.18	0.17
Minimum	<LOD	<LOD	1.16	0.19	0.05	1.41	1.22	0.11
Maximum	0.02	0.05	4.99	1.20	0.26	6.27	6.95	0.53

As for the sparrowhawk, p,p'-DDE was the major contributor of the DDT compunds, but at more than one order of magnitude lower levels.

Table 54. DDTs in eggs of tawny owl from the Oslo area (ng/g, fw). N: Number of detected and measured samples

	p,p'-DDD	p,p'-DDT	p,p'-DDE	sumDDTs
N	10/10	10/10	10/10	10/10
Mean	0.48	0.63	66.4	67.5
Median	0.43	0.47	32.8	34.6
Minimum	0.05	0.12	16.6	16.9
Maximum	1.13	1.44	219	220

For comparison, 16 tawny owl eggs were collected in Sør-Trøndelag County, Central Norway, 2009 showing a median of 66 ng/g ww, higher levels than the eggs collected in 2015 in Oslo (median of 34 ng/g ww) (Bustnes et al., 2011). The highest *p,p'*-DDE concentration measured in the Oslo area in 2015 was 220 ng/g ww. *P,p'*-DDT and *p,p'*-DDD were also found in all eggs but at low concentrations of <1.5 ng/g ww.

3.9.6 Red fox

Oxy-chlordane was by far the dominating pesticide in fox livers, ranging between 1.2 and 318 ng/g ww (median 11.9 ng/g ww). Sum non-DTT pesticides ranged between 1.5 ng/g ww and 330 ng/g ww (median of 12.6 ng/g ww). All other measured pesticides showed low median concentrations of < 0.4 ng/g ww. Andersen et al., reported a tenfold higher oxy-chlordane concentrations with a median of 180 ng/g ww in liver of arctic fox from Svalbard (Andersen, et al., 2015), mainly caused by their marine diet. The highest bromadiolone concentrations within this study were found in fox liver with a median of 415.5 ng/g ww. The concentrations found ranged between 69 and 4940 ng/g ww, illustrating high individual variability. Using the reported biological effects threshold in foxes for bromadiolone of 200 ng/g, and the toxicity threshold of 2000 ng/g (Berny et al., 1997), four out of ten foxes exceeded the effect threshold and three the toxicity threshold.

Table 55. Pesticides except DDTs in livers of red fox from the Oslo area (ng/g, ww). N: Number of detected and measured samples

	Trans-chlordane	Cis-chlordane	Oxychlordane	Trans-nonachlor	Cis-nonachlor	Sum Chlordanes	HCB	Mirex	SumPesticides	Bromdiolone
N	8/10	2/10	10/10	3/10	1/10	10/10	10/10	9/10	10/10	7/10
Mean	0.21	<LOD	40.6	2.12	<LOD	41.4	0.65	0.36	42.4	1832
Median	0.21	<LOD	11.9	<LOD	<LOD	12.2	0.32	0.13	12.6	416
Minimum	<LOD	<LOD	1.20	<LOD	<LOD	1.34	0.12	<LOD	1.46	<LOD
Maximum	0.48	0.03	318	6.00	0.03	324	3.71	2.37	330	4940

DDTs were not analysed for in fox livers.

3.9.7 Brown rats

HCB and oxy-chlordane were the most abundant pesticides in rat livers, ranging from <LOD to 2.8 ng/g ww for HCB and <LOD and 0.8 ng/g ww for oxy-chlordane. The median of SumPesticide of 0.43 ng/g ww was 30 times lower compared to fox livers. Median bromadiolone concentration were 302 ng/g ww, and high maximum level were found at 6820 ng/g ww. Using the reported biological effects threshold in foxes for bromadiolone of 200 ng/g, and the toxicity threshold of 2000 ng/g (Berny et al., 1997), three out of ten rats exceeded the effect threshold and two the toxicity threshold.

Table 56. Pesticides except DDTs in livers of brown rats from the Oslo area (ng/g, ww). N: Number of detected and measured samples

	Oxychlordane	Trans-nonachlor	Sum Chlordanes	HCB	Mirex	SumPesticides	Bromdiolone
N	2/10	2/10	3/10	8/10	2/10	9/10	6/10
Mean	<LOD	<LOD	<LOD	0.80	<LOD	0.88	1632
Median	<LOD	<LOD	<LOD	0.60	<LOD	0.43	302
Minimum	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Maximum	0.80	0.12	0.92	2.79	0.09	2.88	6820

DDTs were not analysed for in rat livers.

3.10 Discussion and interspecies comparison

In the following chapter we will assess the overall exposure of all measured pollutants in the species investigated in this study. The main aim is to compare the contribution of the investigated pollutants per species to be able to identify the main contributors to contamination. In addition, we will assess the correlation between pollutant groups to better understand exposure routes. Interspecies comparison will be discussed as well, improving the understanding of uptake and accumulation of pollutants in urban terrestrial environments.

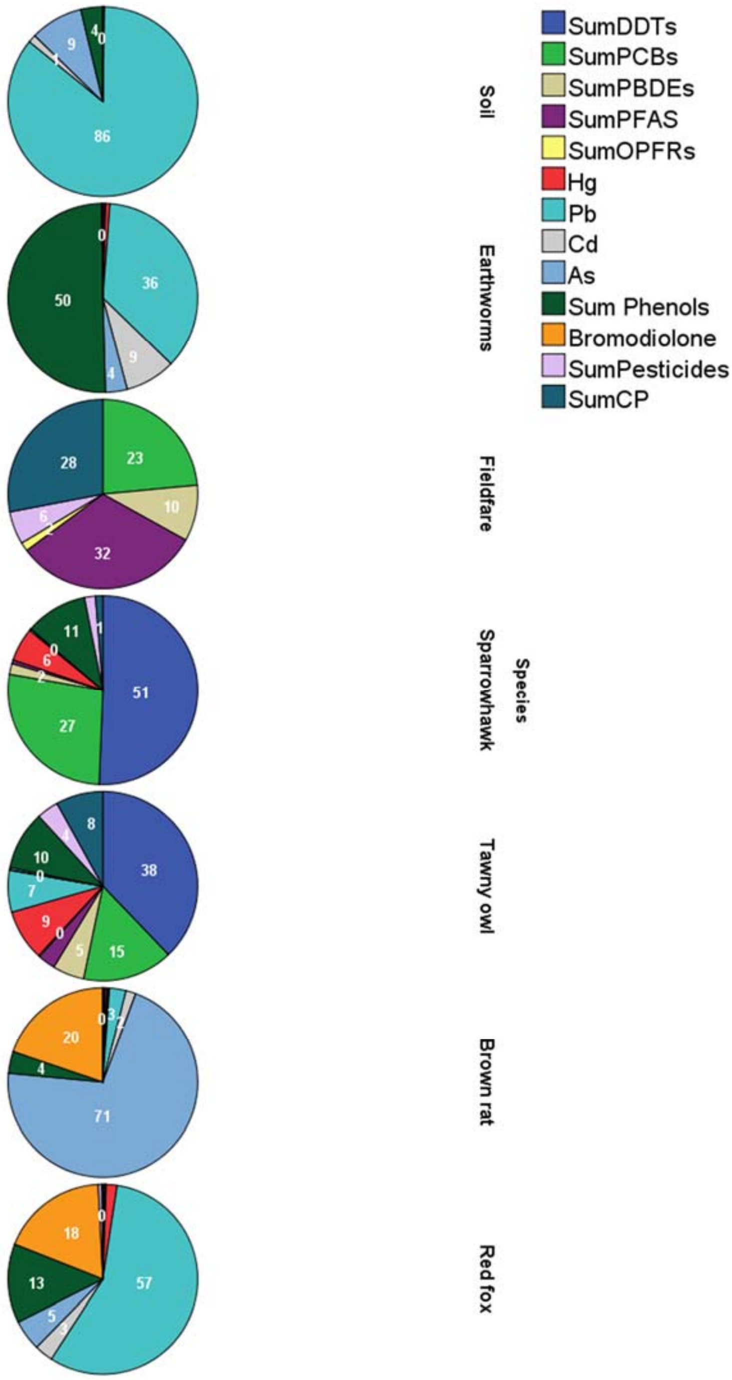


Figure 42: Relative contribution in % of major pollutants to the observed species calculated on a ww basis (dw for soil).

Mostly sum parameters of the investigated pollutants will be discussed, information for single compounds can be found in the chapters above. Only the metals Hg, Pb, Cd and As are known to be toxic at concentrations that can be found in the environments and are therefore included in the combined exposure assessment. The prediction of risk based on predicted no effect concentrations (PNEC) of the individual contaminants and in combination, can be found in chapter 4. Note that SumDDTs were only measured in sparrowhawk and Tawny owl, and that metal were not analysed in fieldfare.

In soil, the main contributors to the overall pollution are metals (where lead alone stood for 88% of the total load, followed by phenolic compounds (4 %). POPs play only a small role of the overall contamination, in contrast to worms (see below)

Earthworms
Ca 50 % of the overall pollutant load in earthworms consisted of phenols. Bisphenol A, G and E belonged to the most dominating phenols detected in earthworms. Very few data exist for BPA in terrestrial animals. A recent review on BPA (Corrales et al, 2015) stated that the only terrestrial organisms for which field BPA accumulation data are available, is for the earthworm (Eisenia fetida). BPA in the referred study was measured in tissue from adult earthworms collected from sewage percolating beds and domestic gardens (Markman et al, 2007) and the levels (< 5 ng/g ww) were much lower than concentrations found in earthworm from Oslo area (the present study). Chen et al., 2002, found that BPS and BPF was acutely toxic in Daphnia magna (EC50, 76mg/L for 24hrs) and showed estrogenic activity, but no mutagenic activity in vitro. Yamasaki et al. (Yamasaki et al. 2004) found BPS binding to estrogen receptor. In another study, exposure of zebrafish to BPS resulted in decreases in gonad weights, alteration in plasma estrogen and testosterone (Ji et al. 2013) and increased female to male sex ratio, decreased body length, altered testosterone and estradiol (Naderi et al. 2014). A number of studies showed that BPF was estrogenic, androgenic, and thyroidogenic, while nineteen *in vitro* studies showed estrogenic, androgenic, and other physiological/biochemical effects (Rochester & Bolden 2015).
In another study (Rosenmai et al. 2014) the authors used several assays to assess steroidogenic activity, as well as teratogenicity, genotoxicity, carcinogenicity, and metabolic effects of BPA, BPS and BPF. It has been found that BPS and BPF had estrogen receptor binding, estrogenic activity, and antiandrogenic activity similar to those of BPA, with BPS being the least potent. However, BPS and BPF exhibited the greatest steroidogenic (i.e., progesterone) activity, increasing levels of 17α-hydroxyprogesterone and progesterone levels, whereas BPA did not (Rosenmai et al. 2014).

Of the metals, Cadmium and lead were the dominating pollutants (average of 2011 and 8425 ng/g ww, respectively). 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 in Oslo. 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).

The average sumPFAS concentration in Lumbricidae/earthworm varied between the different sites, but were the dominating organic pollutant group in all cases when compared to PCBs and PBDEs. The lowest concentration was reported for Østmarkssetra, but all urban sites were higher than the reference sites from 2014 (except one site in Gjerstad). The highest concentration of PFAS was found in Voksenkollen, which is a popular skiing area (potential impact of ski wax depositions). The majority of the samples had a PFAS profile dominated by

PFOS followed by PFTrA. There are a number of studies where PFAS concentrations in earthworms have been reported, however often these studies have been investigating contamination from the use of fire-fighting foam and leakage to soil and do not represent background concentrations. Studies have shown that high concentrations of PFASs in soil can have a negative effect on the earthworm's reproductive ability (SFT, 2006). High PFOS concentrations in soil can also cause DNA damage and induce oxidative stress (Xu et al. 2013). Even though earthworm accumulate long chain (C>9) PFAS, to a greater degree than short chain, the concentrations reported in the present study are not within the range of reported toxic effect concentrations. However, this study shows that PFASs are ubiquitously present in the urban environment, reaching elevated concentrations in some locations. 151 ng/g ww was found in Voksenkollen, which is even more than what was observed in 2013, where the highest sumPFAS level found was about five times lower (31 ng/g ww in Grorud).

Fieldfare

Fieldfare eggs show a very complex pollutant pattern, with PFAS (31%) chlorinated parafins (27%), sumPCBs (23%) as the most important ones. Please note that phenols, DDTs and metals were not measured in fieldfare eggs. No data for organic pollutants and metals could be found for fieldfare eggs or other matrices in the literature. For improved interspecies comparability, lipid related concentrations are used (lw). Data for great tits (Parus major) were available and will be used for comparison purposes. In our study, 654 ng/g lw sumPCB were detected in the fieldfare eggs, about a tenth of that found in eggs of great tits in Belgium (average $sumPCB_{21}$ concentrations of 4110 ng/g lw) (Voorspoels et al., 2007), but more than reported in our report from 2015 (427 ng/g lw sumPCB) (Herzke et al., 2015). PBDEs were found in eggs of great tits averaging with 220 ng/g lw. In our study 458 ng/g lw were found (compared to 143 ng/g lw in 2015), twice as much as the Belgian data. In a second study, 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, suburban close to Oslo. The PCBs concentrations of 1000 ng/g lw in that study were twice as high as found in the here presented study, but the PBDEs concentrations of 25 ng/g lw were about 20 times lower. Since samples were collected in 2006, changes over time in PBDE exposure as well as dietary differences can explain the observed differences. A more recent study on starling eggs (Sturnus vulgaris), sampled worldwide, with one Norwegian rural location in Nord Trøndelag, showed less than 500 ng/g lw sumPCBs and less than 50 ng/g lw sumPBDEs, (Eens et al. 2013), similar and ten times lower than observed in our fieldfare eggs from 2015. The detection of considerable concentrations of chlorinated paraffin's (CP) have not been reported before and should be followed up. Lipid based CP concentration were highest in fieldfare eggs, compared to sparrowhawk and tawny owl (962, 638 and 447 ng/g lw). This might be linked to elevated levels found in soil and worm, similar to observations of PFAS.

Sparrowhawk

In sparrowhawk eggs, DDTs and PCBs are the major contributors with respective 50% and 26% relative contribution. The highest sumPCB contamination found in Norway in any bird of prey, was in peregrine falcon eggs from 1976 in Rogaland, with 110 000 ng/g ww (Nygård, 1983). During the 1970's, average PCB values of more than 23 000 ng/g ww and DDE values of more than 38 000 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 & Polder 2012). However, pollutant concentrations have decreased considerably in Norwegian sparrowhawks since then. One sparrowhawk egg from the period 2005-2010 had an average value of 229 ng/g PCBs and 509 ng/g DDE (Nygård and Polder 2012). In the present material, an average of 692 ng/g ww PCBs was found, compared to 410 ng/g ww reported in 2015 (Herzke et al., 2015. Its food choice, feeding on other birds (Hagen et al. 1952), makes it vulnerable to trophic magnification of pollutants, but one must expect large variations in pollutant levels, due to variations in local prey species. *P,p'*-DDE was found with a median of 1293 ng/g ww, also higher than observed in Nygård & Polder (2012). The evidence of non-declining concentrations for traditional POPs in sparrowhawks, emphasize the need of continuous monitoring and for the identification of local urban sources. There are good reasons to believe that eggs reflect the local ecosystem quite well, rather than the wintering grounds, as the eggs are formed in the body after reaching the breeding-grounds in the spring. That leads to the question whether we still have local PCB and DDT sources close to cities like Oslo, or, alternatvely in addition to diffuse widespread pollution from multiple sources. An exposure by feeding on migrating birds coming from polluted wintering grounds is also a source which should be accounted for.

The median levels of other major organic pollutants were low(ng/g fw); SumPBDEs: 26.5, Sum Chlordanes: 15.6, HCB: 12.8, Mirex: 1.9).

The median concentration of sumPFAS in this study was 16 ng/g fw, comparable to 19 ng/g fw reported in 2014 (Report 2015). 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 fw, 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.

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 cadmium (Cd) and lead (Pb) (Furness, 1996 and Spahn and Sherry, 1999). As, Hg, and Pb belong to the non-essential metals whilst Cu and Zn belong to the essential metals. Cu, Zn and Cd have been shown to significantly bioconcentrate from soils to invertebrates, but biodilute from invertebrates to birds (Hargreaves et al., 2011). Cu, Zn and Fe are essential macro elements with many important biological functions, and internal concentrations are usually well-regulated. When comparing with earlier data, sparrowhawk eggs collected in a period between 2005 and 2010 showed a similar Hg concentration of 175 ng/g ww, as found in our study with 148 ng/g fw (median) in the Oslo area, but the low sample sizes precludes any comparison over time (Nygård & Polder 2012). The concentration of Zn found in sparrowhawk eggs where in the range of values found in Audouins's gull Larus audouinii (Morera 1997), and Cory's shearwater Calonectris diomedea (Renzoni et al. 1986). Cu concentrations found where in agreement with results obtained for Larus audouinii (Morera 1997). Since Cu and Zn are physiologically regulated in birds (Richards and Steele 1987), of the here measured metals mostly Hg, Pb, Cd and As can prove toxic at concentrations that can be found in the environment (Depledge et al. 1998). For mercury, concentrations of 500 ng/g to 2000 ng/g in eggs are sufficient to reduce egg viability, hatchability, embryo survival and chick survival in nonmarine birds (Thompson 1996; Mierzykowski, 2005). Embryo deformities may occur in bird eggs containing about 1000 ng Hg/g, 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 endpoint 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). In the case of the sparrowhawk from this study, the found median concentration of 148 ng/g fw as well as the maximum concentration found of 196 ng/g ww are well below these thresholds.

The other toxic metals, Cd, Pb and As, were detected in very low levels; 0.12, 3.5 and 0.9 ng/g ww, respectively.

Of the new emerging pollutants included in this study, a number of phenolic compounds were present with high abundancy (4-nonylphenol, and a number of bisphenols). So far, only little information exist on the toxic effects on birds of prey caused by these compounds.

Tawny owl

In tawny owl eggs, sum phenols contribute the most followed by DDTs and PCBs. Little is know 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. 4-tert-octylphenol was the most dominating phenol observed in the phenol group. Little SumPFAS was found in the eggs.

Brown Rat

Rat liver showed a very distinct major contribution by arsenic (median 1959 ng/g ww) and bromadiolone (302 ng/g ww), (71% and 11%, respectively), both potentially applied in rodenticide and also used for wood treatment (As). The median concentration of sumPFAS was with 9.4 ng/g ww twice the amount found in rat liver collected in Oslo in 2013 (average 5.2 ng/g ww sumPFAS), which is comparable with what was found in red foxes from Oslo in this study. The rodenticide bromadiolone is the most abundand organic pollutant in this species, causing a potential risk also to other species feeding on rats (e.g. cats, birds of prey). High levels of arsenic poses an additional secondary poisoning threat.
In addition, a high siloxane concentration of 86 ng/g ww indicate exposure to waste. Conventional POPs are only minor contributors to the overall exposure.

Red fox

Phenols and bromadiolone are the main contributors in fox liver. The foxes collected in Oslo were contaminated with a median level of 15 ng/g ww sumPFAS, compared to 2014 with 3.8 ng/g ww. PFOS contributed about 70% to that load (10.7 ng/g ww). In polar fox liver from Svalbard, PFOS concentrations ranging between 10 and 220 ng/g ww were found, up to 20 times higher caused by the partly marine diet of polar foxes (Aas et al., 2014).
In respect to the PCBs and PBDEs found in red fox, Voorspoels et al. (2007) reported means of sumPBDE of 9.2 ng/g lw and sumPCBs of 300 ng/g lw in rodents from Belgium, which can be compared with 10 ng/g lw sumPBDE and 145 ng/g lw sumPCB in the red fox liver samples from our study. In a second study by Mateo et al., 2012, sumPCB concentrations of 1262 ng/g ww are reported in fox liver samples from a Natural reserve in south west Andalusia in Southern Spain, more than 250 times more than what we found in samples from the urban site in Oslo.

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. Levels of organic pollutants, especially PCBs, are much higher in the top predator (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, and thus behaves differently in biota compared to the “classic” organic pollutants such as PCBs, apparently show little to no apparent biomagnification among the studied species. In fact, earthworms from Oslo show the highest average values, ca. three times higher than the red fox, and almost double of the sparrowhawk.

When comparing the average sum concentrations of the analysed pollutants in the six observed species, interesting species related differences can be observed (Figure 43 and 44).

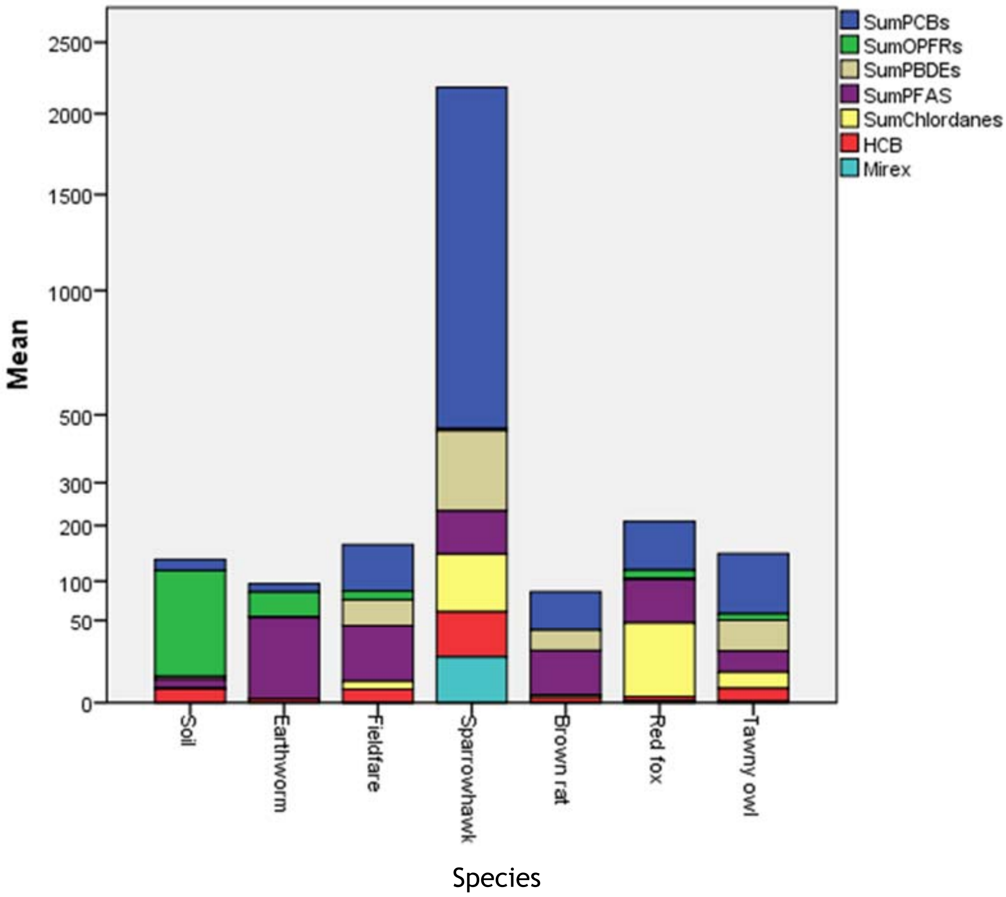


Figure 43. Sum of persistent organic pollutants in the different sample types in the Oslo area in 2015 (ng/g ww). DDTs were only analysed in Sparrowhawk and Tawny owl, so they are not shown.

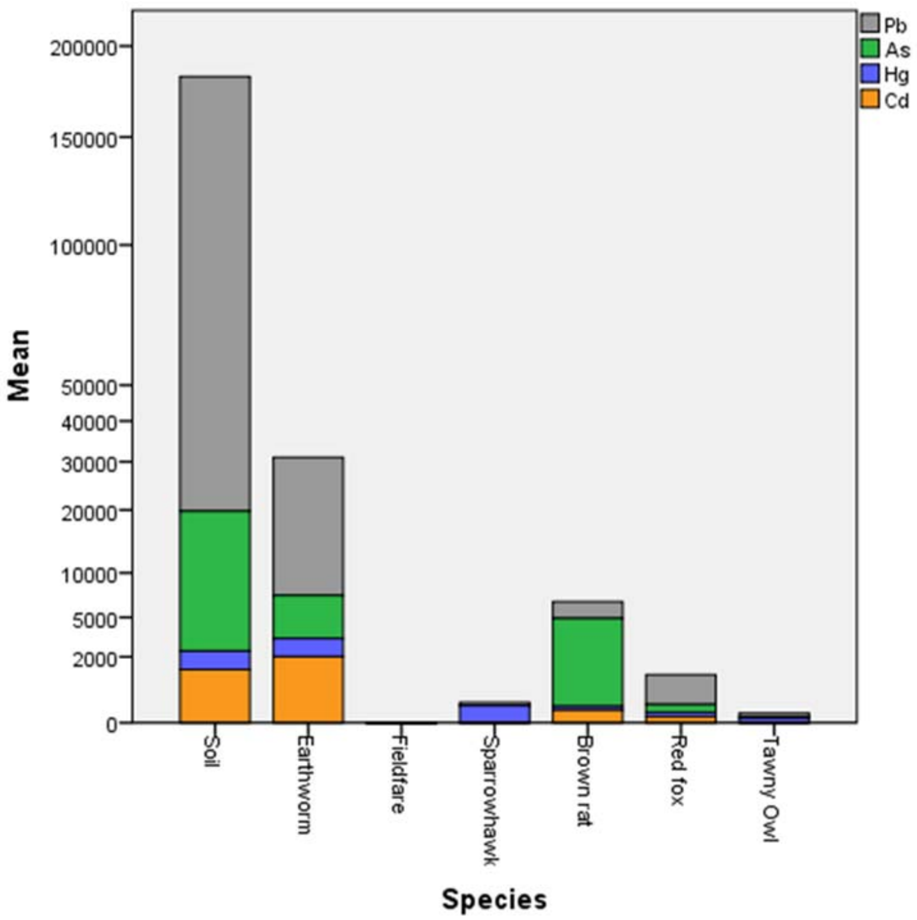


Figure 44. Concentrations of metals having known poisonous effects in the different sample types (ng/g ww for biota, ng/g dw for soil).

Figure 43 shows the relative PCB concentrations, with sparrowhawk showing up to more than 25 higher concentrations than the other species observed on a ww basis (median 946 ng/g fw). Tawny owl, red fox fieldfare and brown rat, on the other hand, showed quite comparable sumPCB concentrations (in the range between 14 and 28 ng/g ww).

The prevalence of highly chlorinated PCB congeners seems to be connected to higher position in the food-chain (Figure 45). When assessing the contribution of the analysed PCB congeners in the observed species, a trend to higher chlorinated PCBs from soil to fox and from worms to sparrowhawk becomes obvious. PCB 180 contributed majorly to the sumPCB load in fox liver, in contrast to sparrowhawk and fieldfare eggs, where PCB 153 and 138 were the dominating congeners. In earthworms, the lower chlorinated PCBs were more abundant.

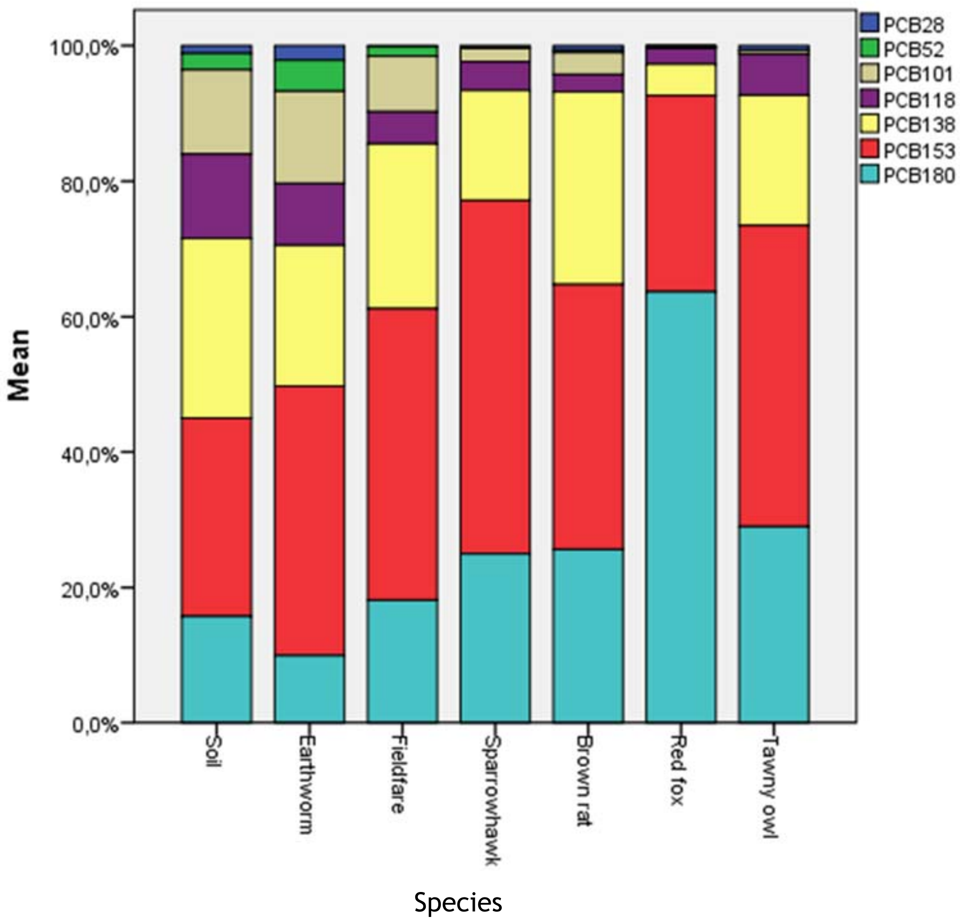


Figure 45: Comparison of relative concentrations of PCB congeners in all sample matrices

For PBDEs, a similar trend as for the PCBs can be found (Figure 46). The contribution of the different PBDE congeners to the sumPBDE load varies between species. SumPBDE is dominated by the lower brominated PBDE 99 in sparrowhawk-, tawny owl and fieldfare eggs, while it is dominated by higher brominated congeners 207 in fox liver, and by 207 and 209 in brown rat (Figure 46). In soil, PBDE 209 was dominating.

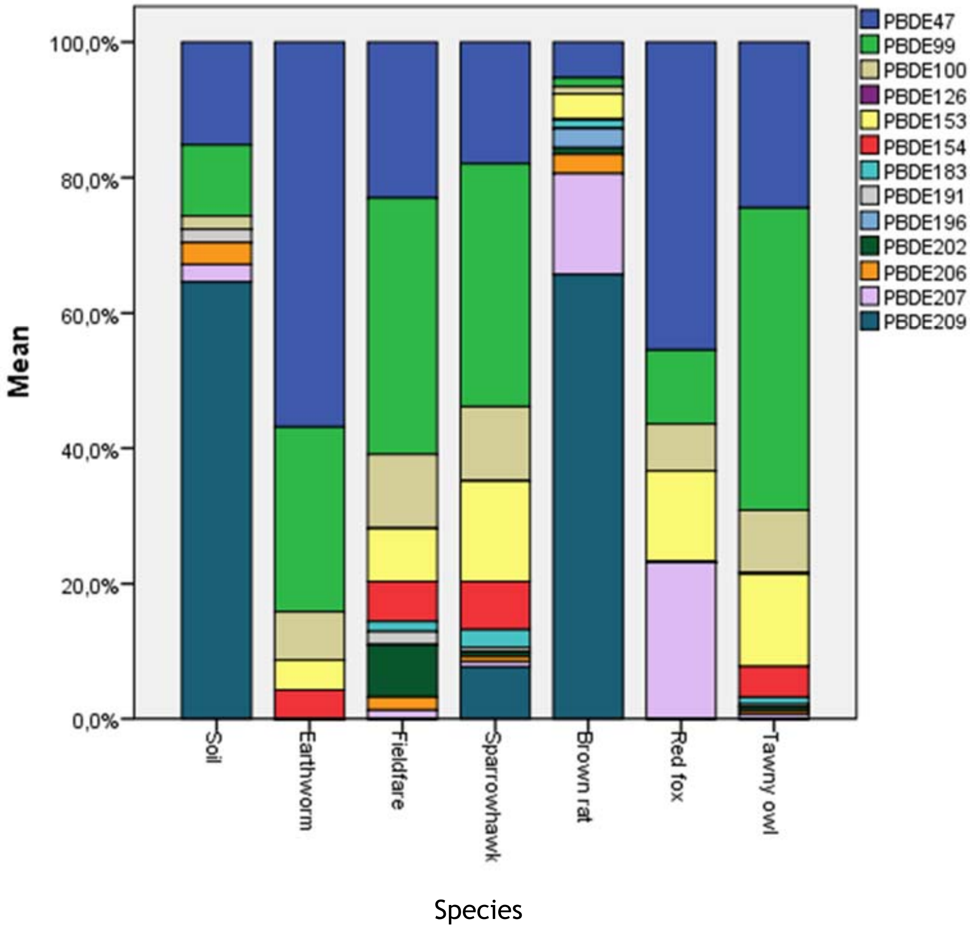


Figure 46: Comparison of relative concentrations of PBDE congeners in all species included in this study.

When assessing non-DTT pesticides, *oxy*-chlordane shows a high interspecies variability, with increasing relative contribution from fieldfare to fox (> 90%). SumPesticides is found in following order Sparrowhawk > fox > fieldfare = tawny owl on a lipid weight basis.

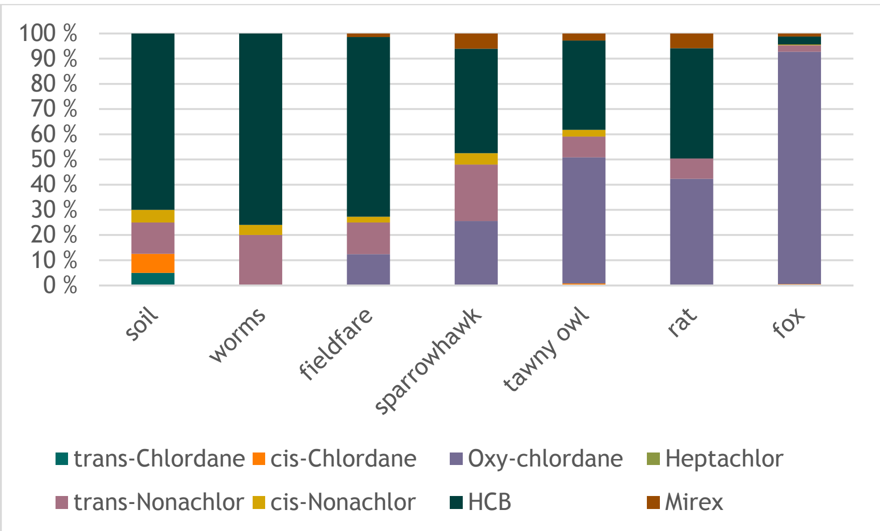
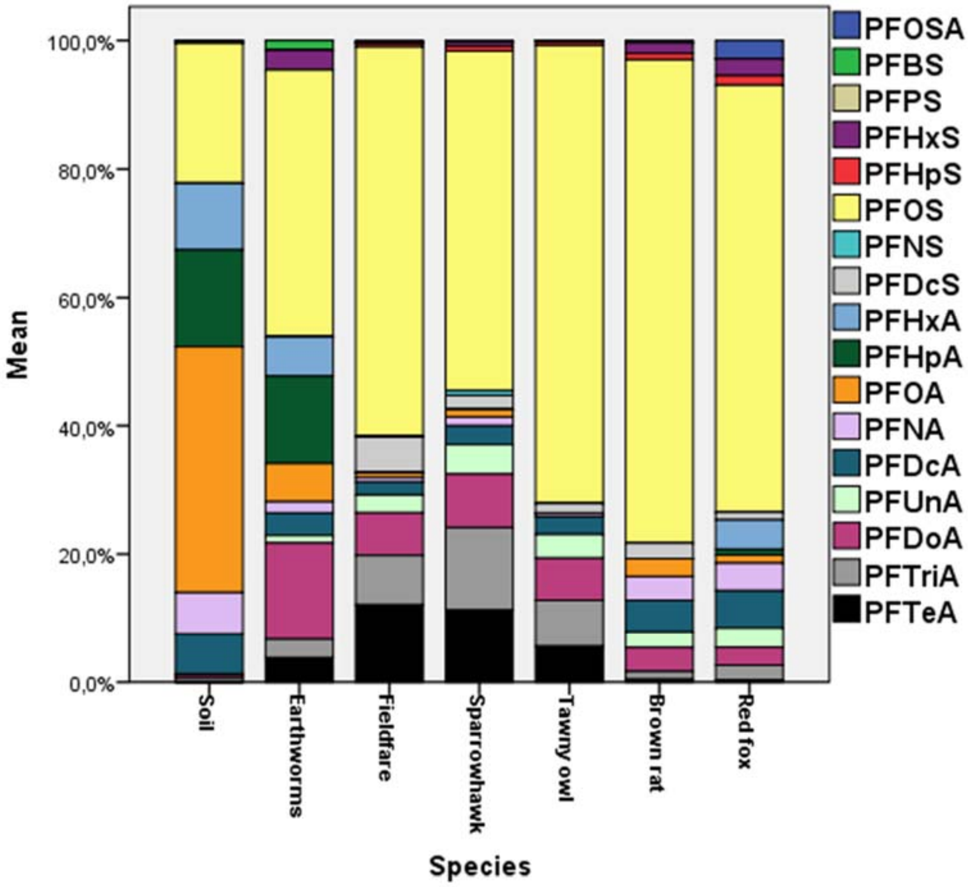


Figure 47: Relative concentrations of pesticides in different samples from Oslo.

Figure 48: relative distribution of PFAS in different samples from Oslo

For PFAS a different picture was found, with less distinct interspecies differences (Figure 48). PFOS is the overall dominating compound, but in soil PFOA dominates. PFTriA and PFTeA contribute more in higher levels of the food-chains (fieldfare, sparrowhawk and tawny owl).



The rodenticide bromadiolone was mostly found in rats and foxes. Figure 49 shows the comparison, illustrating the more than 5 times higher concentrations found in rat livers compared to foxes.

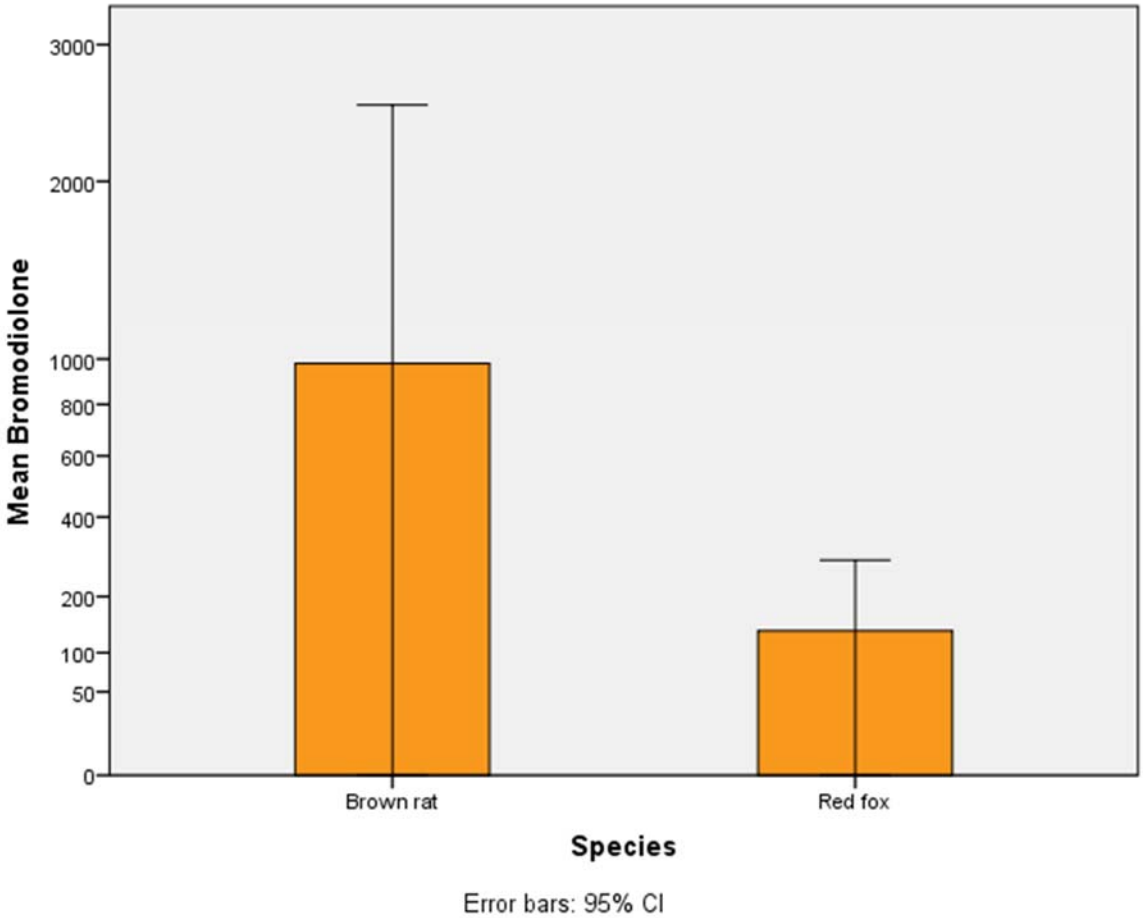


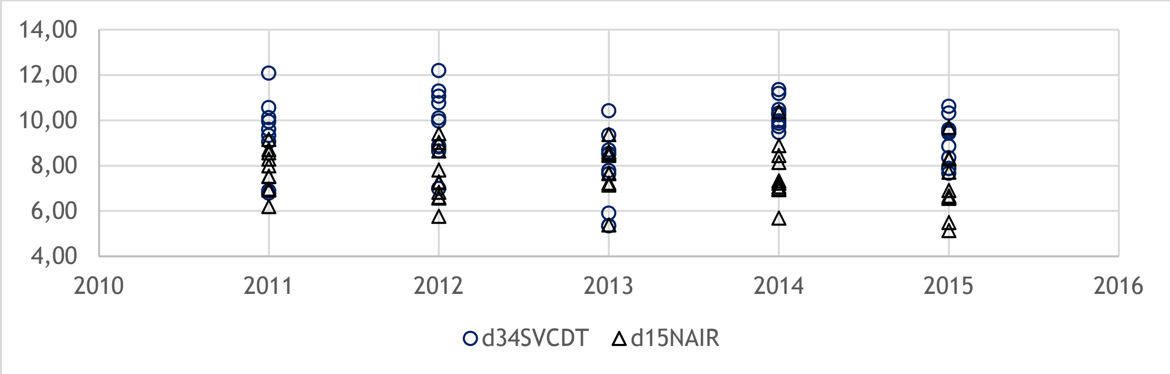
Figure 49. Levels of bromdiolone in rats and red fox in the Oslo area in 2015 (ng/g ww). Errorbars show the 95% confidence limits.

Limited detection rates for the other pollutants groups disabled a similar interspecies comparison.

3.11 Time trend of organic pollutants in fox liver

In order to assess changes over time in exposure to several pollutant groups, red fox liver was sampled in a period of 5 years, 2011 – 2015, separately to the ones discussed above. 25 males and 25 females were selected, the age ranging between 1 and 9 years (average age 4.2 years). Average weight was 6121 g. All individuals were captured in Lierne, a municipality in Nord-Trøndelag county, Norway.

Ten individuals per year (5 males and 5 females) were collected and analysed subsequently for OPFR, PFAS, PCB and PBDE as well as stable isotopes. For OPFR, individual samples were analysed (10 samples per year), in contrast to PFAS, where two samples per year were pooled, and for PCB/ PBDE, 5 samples per year were pooled. Stable isotopes were also measured in all 50 samples. Figure 50 illustrates the stable isotopes in all samples, indicating no change in dietary intake in the sampling period.



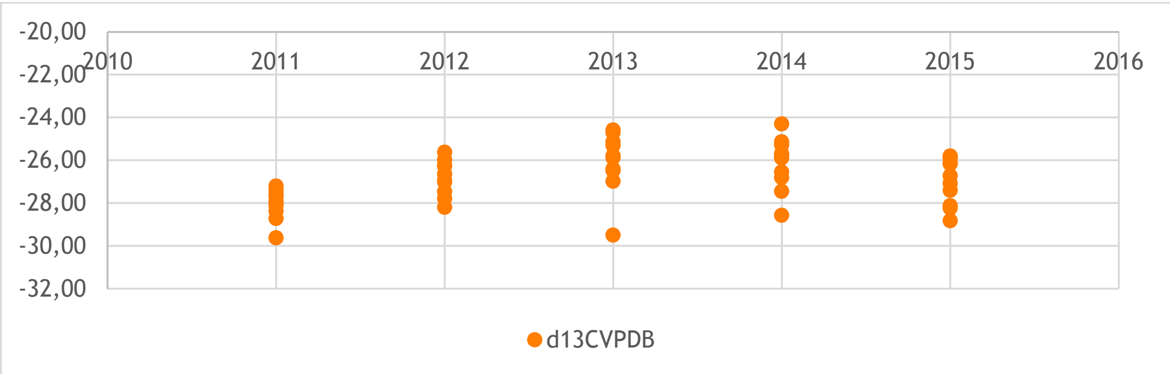


Figure 50: Stable isotopes in fox liver

Of the measured 14 OPFR, none could be measured in more than 18% of all samples. TEP, TCEP, TPRP, PIBP, BDPHP, DBPHP, TNBP, TDCPP AND EHDB could not be detected in any of the samples. TCPP, TPP, TBEP, TCP and TEHP could be found very sporadically at low concentrations. When detected, TCPP was the OPFR with the highest concentrations between 3 and 13.4 ng/g ww. On the basis of the low detection frequency of OPFR in red fox liver, no time trend can be established.

PCBs and PBDEs were measured in pooled samples (n=5). Overall, PCB 28 and 52 were not or only once detected. PCB 101 was detected in 60 % of all samples, and 118 in 90% with the remaining PCB 138, 153 and 180 detected in all samples. Concentrations vary considerably between years, mostly visible for PCB 180 (Figure 52). PCB 180 is changing between 200 ng/lw and 800 ng/g lw with 2011 and 2013, with a drop observed again in 2014 and 2015. The next major PCB, the PCB 153 follows a similar trend, but on a lower scale (increase from 100 to 200 ng/g lw between 2011 and 2013). PCB 118 and 138 do not express a similar change over time. Even if the data for stable isotopes do not point to a changing food source in these years, a switch between prey items in 2011 and 2013, residing on a similar trophic level, could explain the here reported findings. Compared to the data for fox liver from Oslo, PCB levels were in same order of magnitude for all years (Figure 51).

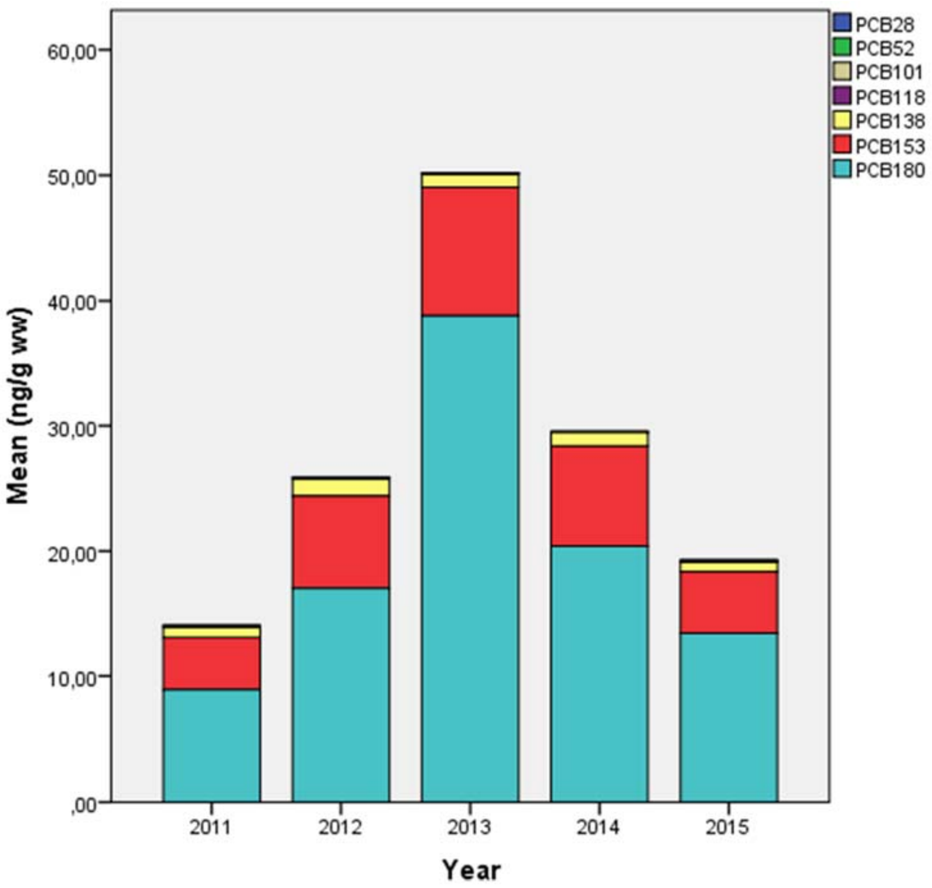


Figure 51. PCBs in fox livers from Lierne municipality 2011-2015 (ng/g ww).

PBDE levels were generally low in both cases, but the pattern differed with dominating PBDE 47 in the fox livers from Oslo to dominating PBDE 153 and 209 in Lierne. If only considering fox livers from the Lierne municipality, the elevated levels in 2014 and 2015 is in line with what was observed for PCBs, and probably have the same cause (Figure 52). In general, the available period of 5 years is too short to establish changes over times, but it can rather be used to assess inter-year variations.

PFAS were measured in pooled samples, comprising of two samples, resulting in five samples per year. PFOS was the dominating PFAS measured (median 1.14 ng/ g ww) followed by PFNA; PFUnA, PFDcA and PFHxS (respective medians 0.6, 0.47, 0.42 and 0.35 ng/g ww). The maximum concentration of PFOS measured was 4.78 ng/g in a sample from 2015 (5 year old males). SumPFAS ranged between 0.02 and 8.8 ng/g ww (median 3.2 ng/g ww)(Figure 53a). For none of the detected PFAS could a significant change of concentrations be observed. Figure 53b illustrates the mean concentrations in fox liver of the major PFASs in liver of red foxes from Lierne. In order to elucidate the effect of the PFOS ban in Europe, samples from a period before the intervention are needed. For comparison, fox liver concentrations from the Oslo area, reported here, was clearly higher with a median of 10.7 ng/g ww for PFOS. An opposite trend compared to PCBs and PBDEs were observed in PFAS, in that the concentrations of PFAS seemed to be lower in 2013 and 2014. One suspects that this also may be connected to a change in diet during these years.

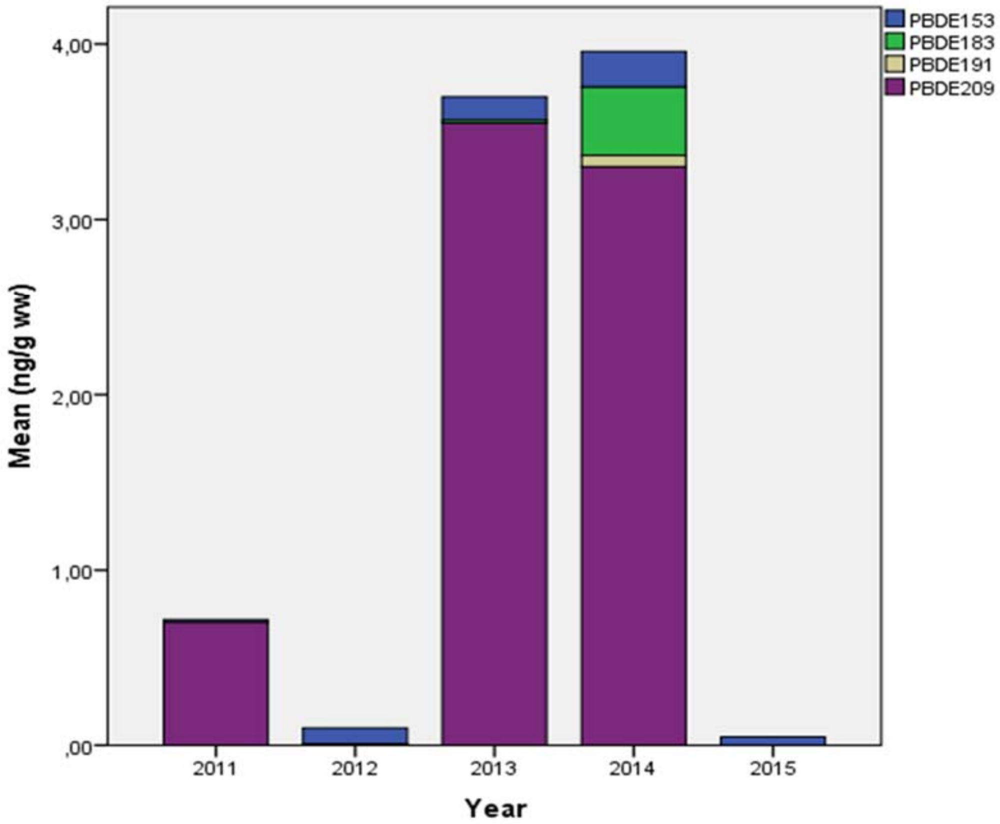


Figure 52. PBDEs in fox livers from Lierne municipality 2011-2015 (ng/g ww).

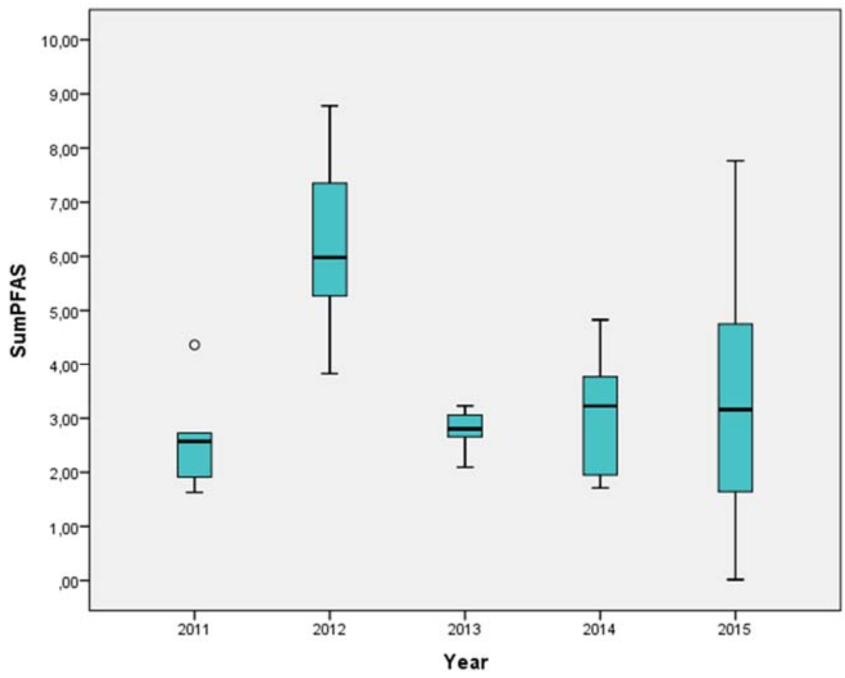


Figure 53a. SumPFASs in fox livers from Lierne municipality 2011-2015 (ng/g ww).

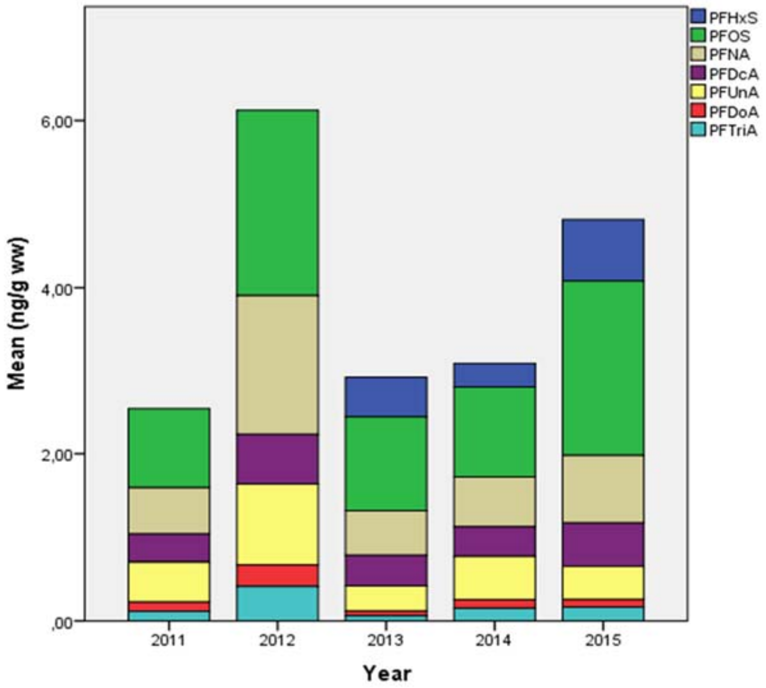


Figure 53b. PFASs in fox livers from Lierne municipality 2011-2015 (ng/g ww).

3.12 Effect related measurements

3.12.1 Egg shell thickness

It is a well documented fact that DDT, or more precisely *p,p'*-DDE, a breakdown product of DDT, causes eggshell thinning (Miller et al. 1976, Ratcliffe 1960, Ratcliffe 1970), and many bird species in different parts of the world had lowered reproduction, severely reduced populations or driven close to extinction by this (Blus et al. 1979, Lindén et al. 1984, Newton & Bogan 1974, Newton et al. 1989, Nisbet 1988, Nygård 1983, Peakall & Kiff 1985). Even though this insecticide has been banned for outdoor use in Norway since 1972, it still exists in the environments, some brought to us by long-range transport by precipitation, ocean currents and air masses, and some is still present in our environment due to previous use. In addition, migrating birds are exposed in other countries during winter.

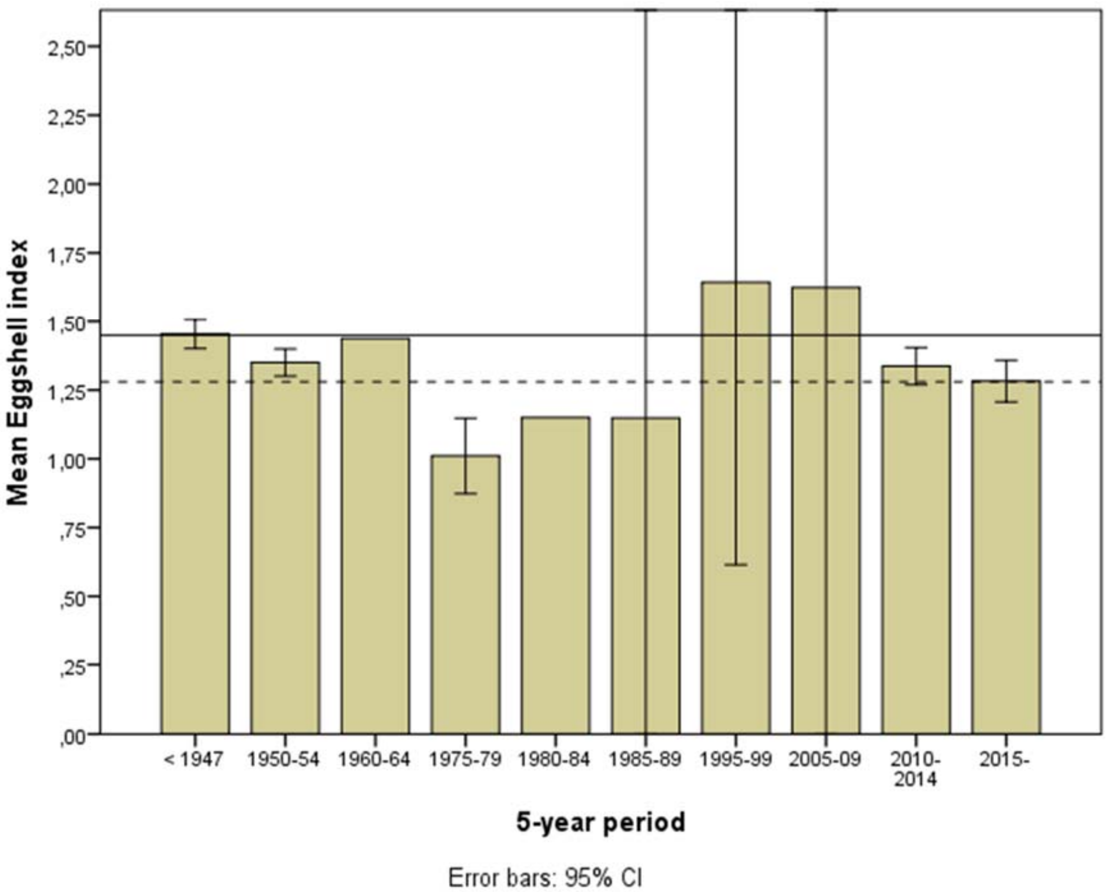


Figure 54. Eggshell index of sparrowhawk eggs in Norway by 5-year periods since 1947. The solid line represents the pre-1947 average, and the dotted line the 2015 average. Errorbars show the 95% confidence limits.

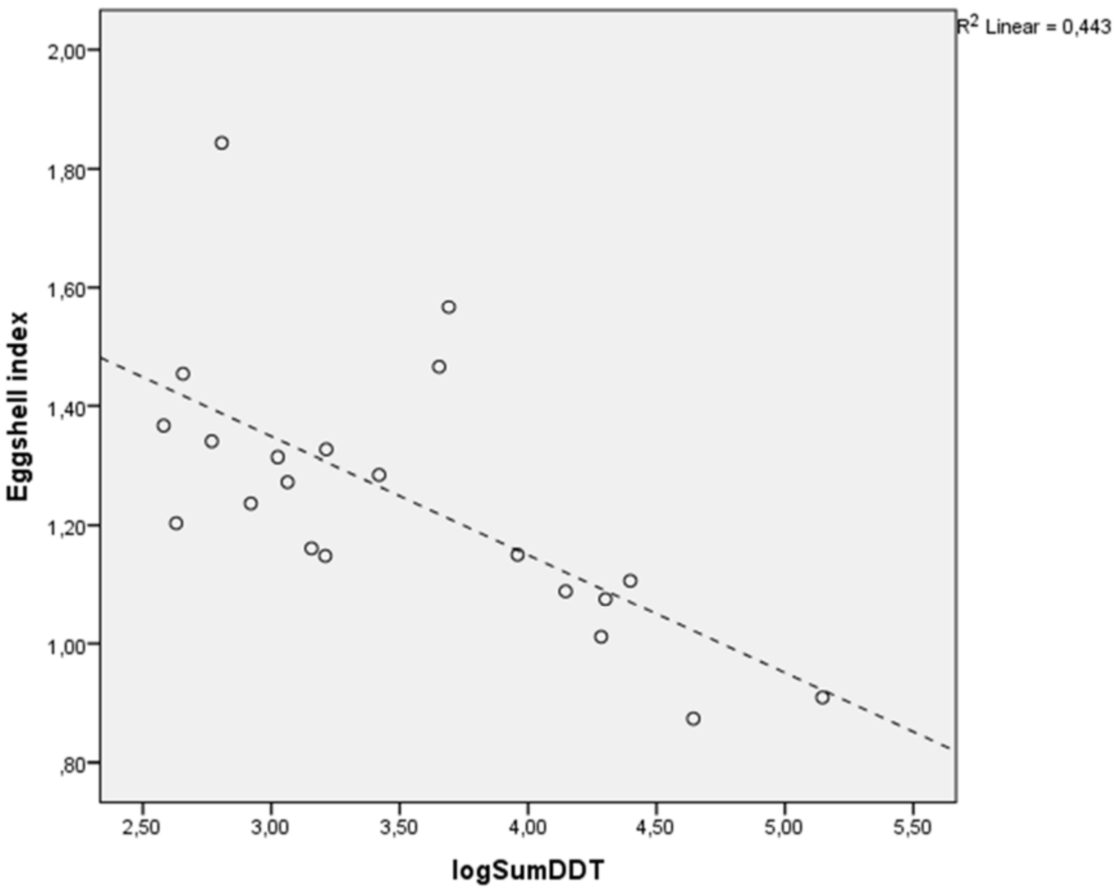


Fig. 55. The relation between eggshell index and log SumDDT levels in sparrowhawk eggs in Norway, the present material included. (Older eggs: T. Nygård, personal data).

The average eggshell index in 2015 in the Oslo area was 12% lower than pre-DDT levels (<1947); 1.28 vs 1.45 (11.7%) (Figure 54). The relation between DDT levels and shell thinning has been long established, and is in general linear in relation to log DDT levels (Blus et al. 1972). This holds also for sparrowhawk eggs from Norway (R = -0,67, P = 0.001) (Figure 55). Also, other POPs such as PCB and PBDEs have been shown to negatively influence egg shell thickness. Eggshell thinning above 16 to 18% has been associated with declining bird populations (Miljeteig et al., 2012). In white-tailed eagles (*Haliaeetus albicilla*) eggshell thinning became obvious when DDE levels exceeded 50 000 ng/g lw, and a 18% reduction in eggshell thickness was associated with a DDE level of 720 000 ng/g lw in the eggs (Helander et al., 2002). Furthermore, a lowest observed effect level (LOEL) for embryo mortality in white-tailed eagles of about 120 000 ng/g lw, was suggested (Helander et al., 2002). In the here reported sparrowhawk eggs, a median *p,p'*-DDE of 35 000 ng/g lw and a maximum concentration of 176 00 ng/g lw was found, both close to and above suggested thresholds, indicating possible harmful effects on the population.

3.12.2 Ano-genital distance (AGD) in rats

Anogenital distance (AGD) is an endpoint that was recently added to the U.S. EPA testing guidelines for reproductive toxicity studies. This endpoint is sensitive to hormonal effects of chemicals. In two cases liver samples needed to be pooled in order to be able to retrieve enough sample material for the required analyses. For these cases no AGD can be evaluated. The samples available for consideration consisted of 4 female and 4 male individuals. The AGD ranged between 10 and 16.5 mm in females and between 18.5 and 30 mm in males (standard deviation 2.1 and 2.6 respectively). Too few data points per sex were available to establish a correlation between AGD and pollutant concentration in rat liver. Literature data refer mostly to AGD data from newborn laboratory rats, further challenging any comparison. The most frequently observed adverse effect on the AGD is a reduced distance in males. Differences of 5% or greater are generally indicators of reproductive toxicity (using at least 20 litters for the evaluation) (Hood, 2016).

3.13 Bioaccumulation and biomagnification

As part of the sampling campaign, the following species representing a terrestrial food chain were sampled: Soil, earthworms, fieldfare eggs and sparrowhawk eggs. In our case, we use fieldfare eggs as representants of fieldfare chicks, which are potential prey items of sparrowhawks. 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. In the case of soil and earthworm, bioconcentration factors could be calculated as well.

3.13.1 Results from stable nitrogen and carbon isotope analyses

$\delta^{15}N$ data 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. In general, more lipophilic chemicals show stronger relationships between measured tissue concentrations and trophic position.

Table 57. $\delta^{15}N$, $\delta^{13}C$ and $\delta^{34}S$ in the different sample types from the Oslo area.

Species		δ13C	δ15N	δ34S
Sparrowhawk	N	10	10	10
	Mean	-24,89	7,39	6,43
	Median	-24,86	7,09	6,43
	Minimum	-26,99	5,78	5,46
	Maximum	-23,51	9,73	7,37
Tawny owl	N	10	10	10
	Mean	-28,74	7,88	5,42
	Median	-28,71	7,93	5,87
	Minimum	-29,56	6,51	2,31
	Maximum	-27,87	9,28	7,18
Fieldfare	N	10	10	10
	Mean	-27,12	7,20	2,03
	Median	-27,05	7,25	1,87
	Minimum	-27,91	5,96	-1,21
	Maximum	-26,37	8,64	5,95
Red fox	N	3	3	3
	Mean	-24,93	9,31	6,64
	Median	-25,08	8,39	5,60
	Minimum	-25,56	6,43	4,84
	Maximum	-24,14	13,12	9,49
Brown rat	N	10	10	10
	Mean	-24,66	8,36	5,61
	Median	-24,61	8,64	5,72
	Minimum	-25,48	6,85	4,11
	Maximum	-24,03	9,19	7,43
Earthworm	N	5	5	5
	Mean	-26,04	4,99	5,78
	Median	-25,86	4,72	6,61
	Minimum	-27,45	3,67	0,17
	Maximum	-25,00	6,81	9,37
Soil	N	5	5	4
	Mean	-28,08	-8,70	3,19
	Median	-27,62	-7,80	3,37
	Minimum	-29,50	-17,54	1,43
	Maximum	-27,19	-2,89	4,59

According to the measured $\delta^{15}N$ data, the organisms included in this monitoring cover different trophic levels. Earthworms showed the lowest $\delta^{15}N$ which indicates 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 in between.

Figure 56 shows the $\delta^{15}N$ signature of the four investigated species. Differences between soil and earthworms to the other species are quite considerable, with no further $\delta^{15}N$ enrichment happening further up the food web.

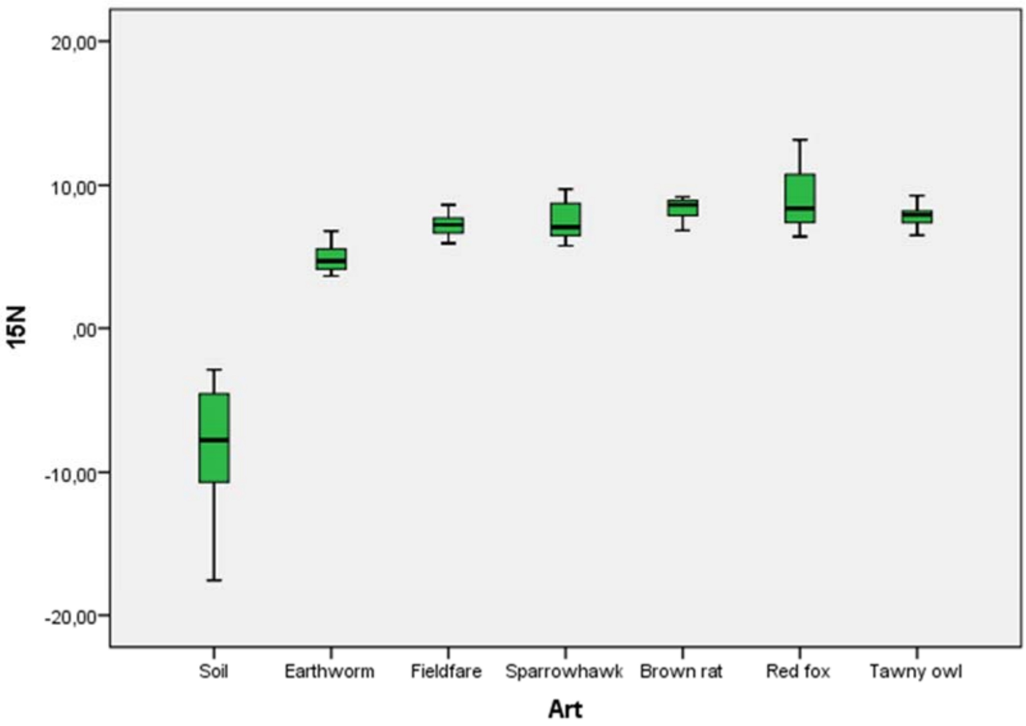


Figure 56: $\delta^{15}N$ concentrations in all species analysed (‰)

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 (median of 8.64 and 8.39 respectively), followed by tawny owl (7.9), sparrowhawk (7.09), fieldfare (7.25) and earthworms (4.72). Soil showed a negative $\delta^{15}N$ of -7.8 as a median. In literature, $\delta^{15}N$ were reported for polar fox, varying between 10 and 12 ‰ (Andersen et al., 2015). Similar to the 2014 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 more likely to be caused by the fact that the prey of the sparrowhawk is almost purely terrestrial (Hagen 1952). Also similar to the 2014 findings, the fieldfare is considered to be a secondary consumer, feeding on insects and earthworms. Since some insect species can be carnivorous also, they might reside on a equally high TL as the prey of sparrowhawk and thus causing similarly high $\delta^{15}N$ concentration in fieldfare compared to sparrowhawks. 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).

As the distribution of $\delta^{15}N$ concentrations in sparrowhawk eggs found in this study illustrates, the $\delta^{15}N$ varies only little, indicating that the sparrowhawk has a narrow food source, consisting of a limited variety of species. Between-species differences were found for sparrowhawk *vs*. all other species, and fieldfare *vs*. earthworms. No other inter-specific differences were found (Mann-Whitney U tests).

$\delta^{13}C$ 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, eggs from marine locations are expected to show a less negative $\delta^{13}C$ value than eggs from terrestrial locations. However, direct comparison of the data presented in this report should be done with care, since different tissues were analysed for the different species in the study (eggs, liver, whole individuals). Different tissues may have different $\delta^{13}C$ turnover rates and may reflect the dietary exposure differently and in an optimal study design only data from the same tissue type should be compared (optimally muscle tissue due to slow turnover rates).

The differences in $\delta^{13}C$ concentrations found in sparrowhawk eggs ranged between -23.5 and -27 (Table 58, Figure 57), but with a median of -24.9. 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), indicating that little food of marine origin is present in the food of the sparrowhawk. Tawny owl eggs showed the lowest $\delta^{13}C$ of all biota samples, indicating a very distinct $\delta^{13}C$ depleted food source (rodents). 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 this study (median -27.05).

Red fox and brown rat as well as earthworms showed similar concentrations, averaging at -25.1, -24.6 and -25.9 ‰ respectively (Figure 57), indicating that all selected species are part of a similar food chain, feeding on terrestrial food items. Tawny owl showed most negative $\delta^{13}C$ concentrations with a median of -28.7 ‰, indicating a more distinguished food source. Between-species differences were found for sparrowhawk *vs*. all other species, and fieldfare *vs*. earthworms. No other inter-specific differences were found (Mann-Whitney U tests).

Table 58. $\delta^{13}C$ levels in the different sample types.

Species	N	Mean	Median	Minimum	Maximum
Soil	5		-27.6	-29.5	-27.2
Earthworm	5		-25.9	-27.4	-25.0
Fieldfare	10		-27.0	-27.9	-25.0
Sparrowhawk	10		-24.9	-27.0	-23.5
Brown rat	10		-24.6	25.5	-24.0
Tawny owl	10		-28.7	-29.6	-27.9
Red fox	10		-25.8	-26.3	-24.1

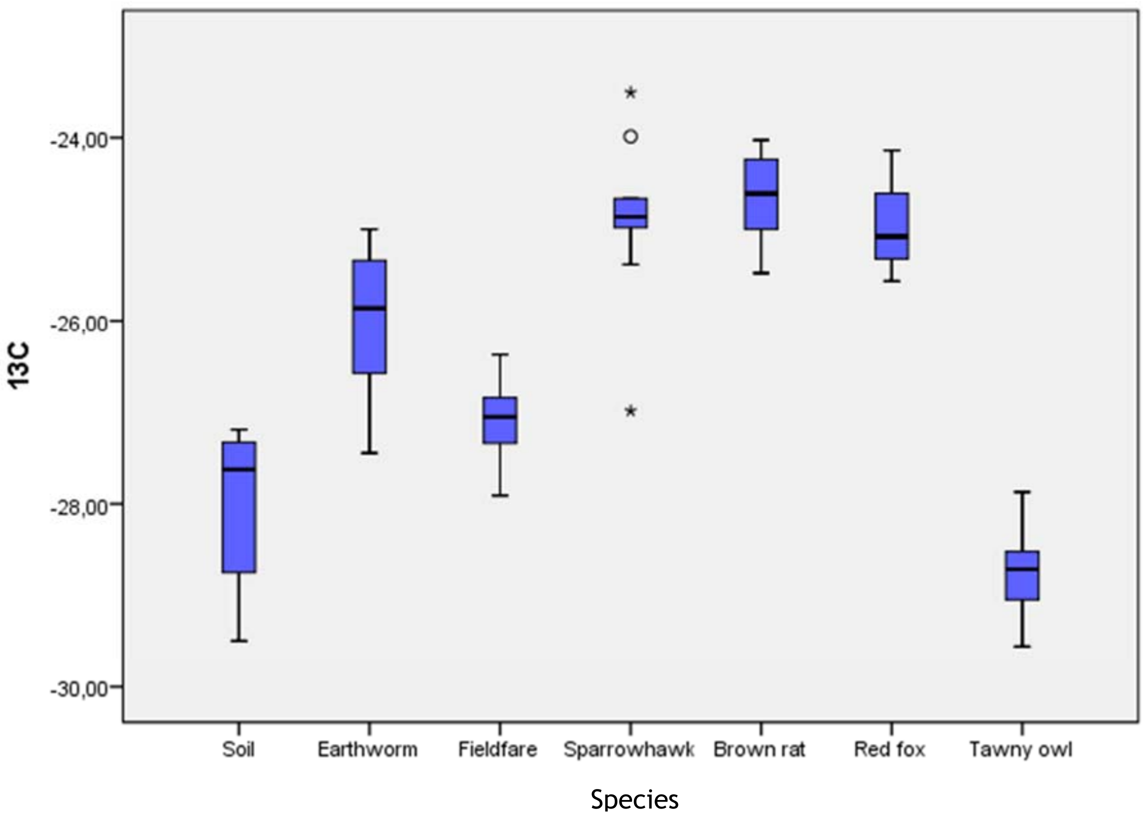


Figure 57: Boxplot of δ^{13} C concentrations in the different species analysed.

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

Figure 58a 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.

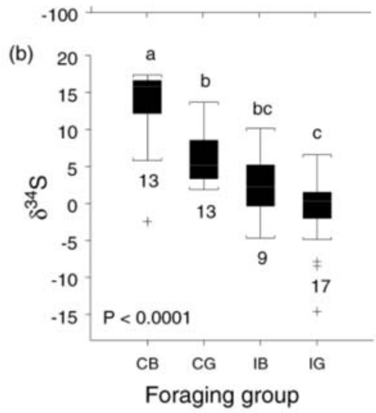


Fig. 2 Box plot showing the central 50% (*boxes*) and range (*lines*) of a δD_{f-p} and b $\delta^{34}S$ for four foraging groups of raptors: coastal bird-eaters (*CB*), coastal generalists (*CG*), inland bird-eaters (*IB*), and inland generalists (*IG*). Letters above boxes indicate group membership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

Figure 58a: Boxplot illustrating $\delta^{34}S$ relationships in respect to foraging strategies in raptors, taken from (Lott et al., 2003).

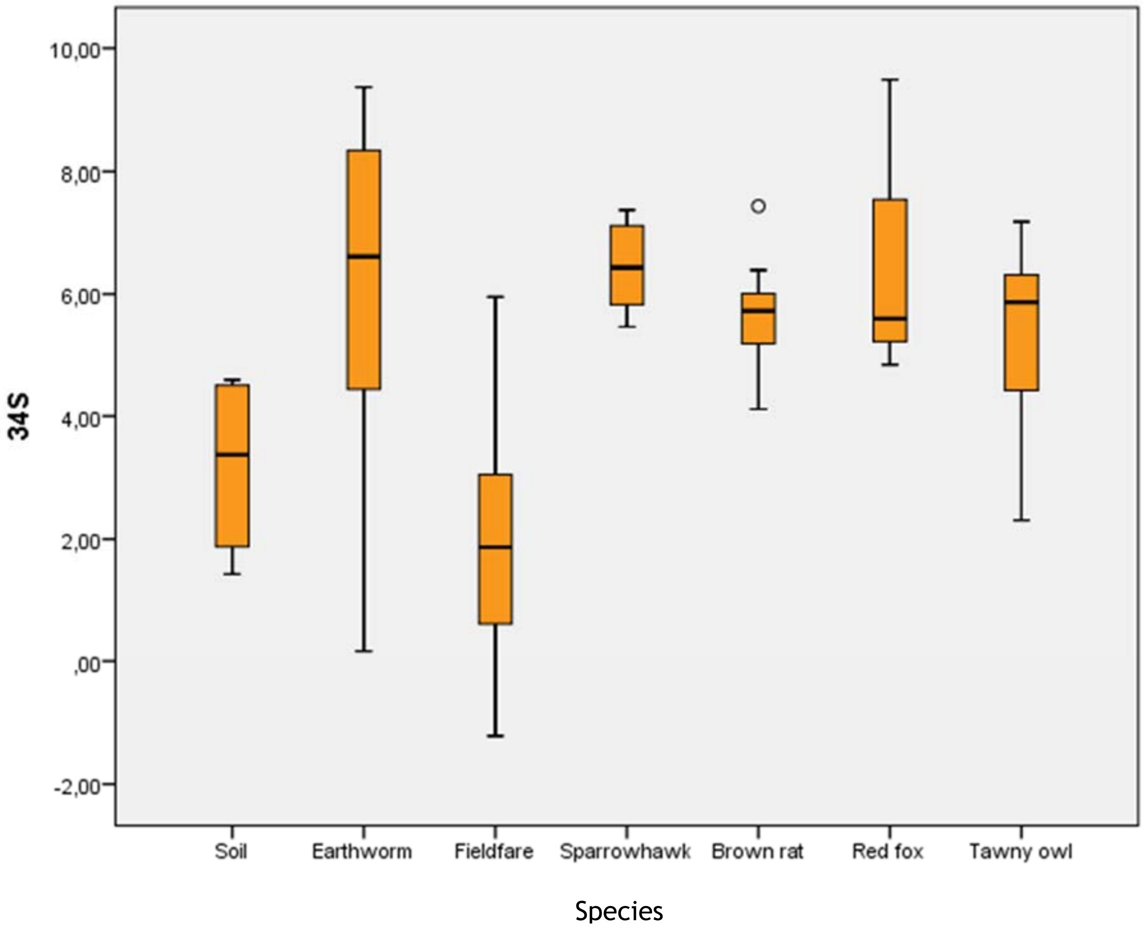


Figure 58b: $\delta^{34}S$ data measured in the urban terrestrial environment

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 terrestrialomnivore (seeds, berries worms and insects), on the other hand, shows a clear distinction to the other bird species and also the worms, indicating an additional prey species besides worms. Since fieldfare data overlap strongly with the soil data, we can assume that fieldfare feeds on local food items, opposite to tawny owl and sparrowhawk, which are clearly distinguished from the soil 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 59). The omnivores, rat and fox are also overlapping with sparrowhawk, complicating the relationships. In general, little stable isotope data exist from terrestrial food chains similar to the one sampled here. 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 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. The range of values was least for the fieldfare, which may be caused by the fact that the eggs of this species was sampled from one single site. Foxes and sparrowhawk showed a large spread of values, probably caused by the fact they feed on a wide range of species and food items.

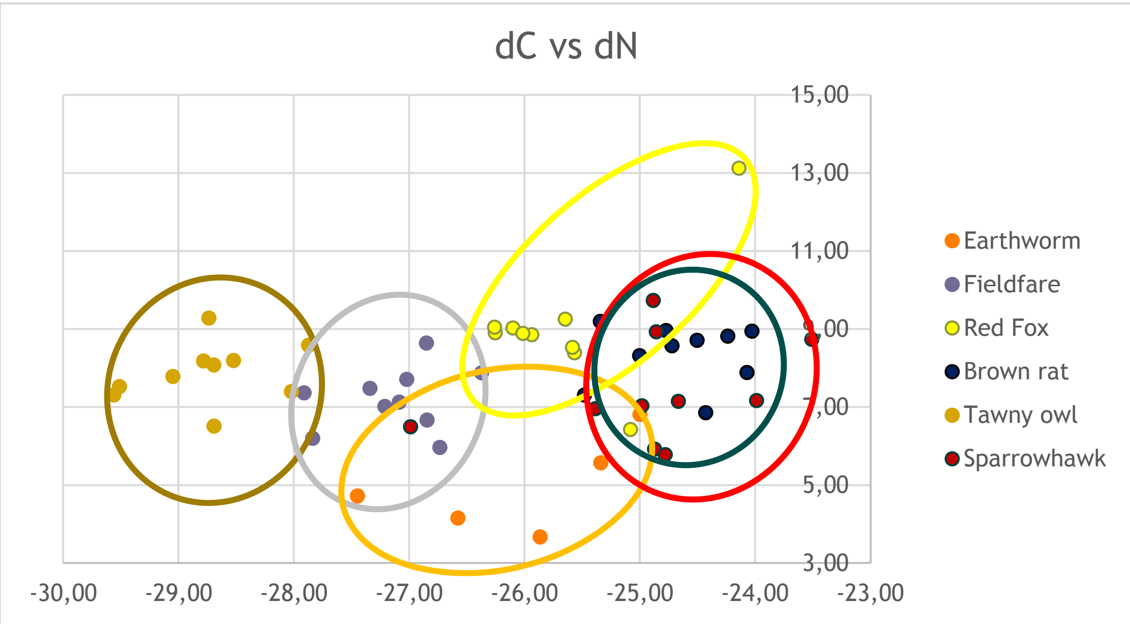
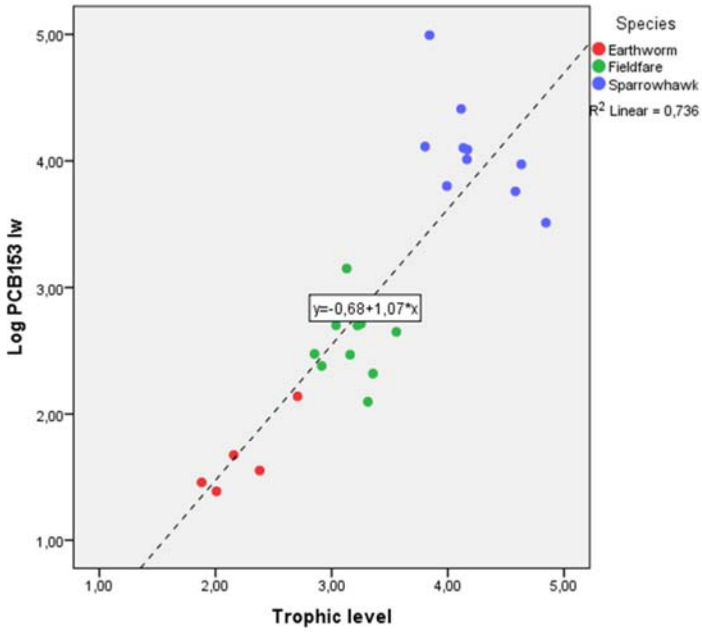
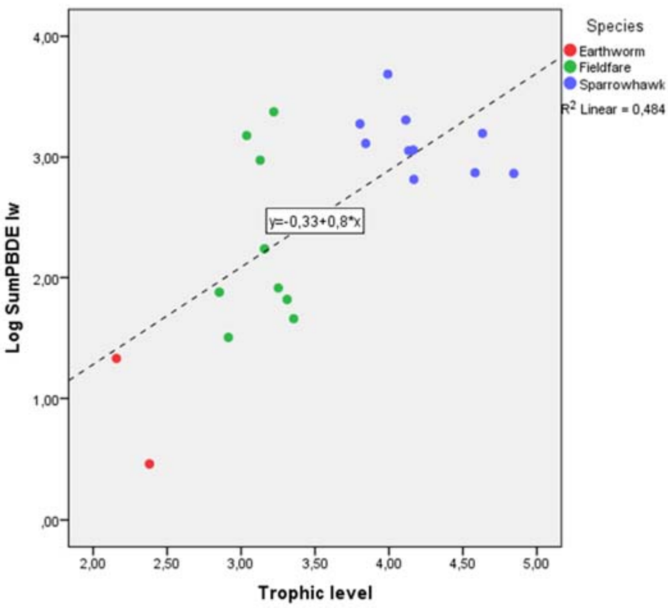


Figure 59: Relationship between the dietary descriptors δ^{15}N and δ^{13}C in biota from urban terrestrial environments

3.13.2 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 PFOS) 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 61). Within the frame of this study, the foodchain earthworm – fieldfare – sparrowhawk was included, enabling the estimation of the TMF.





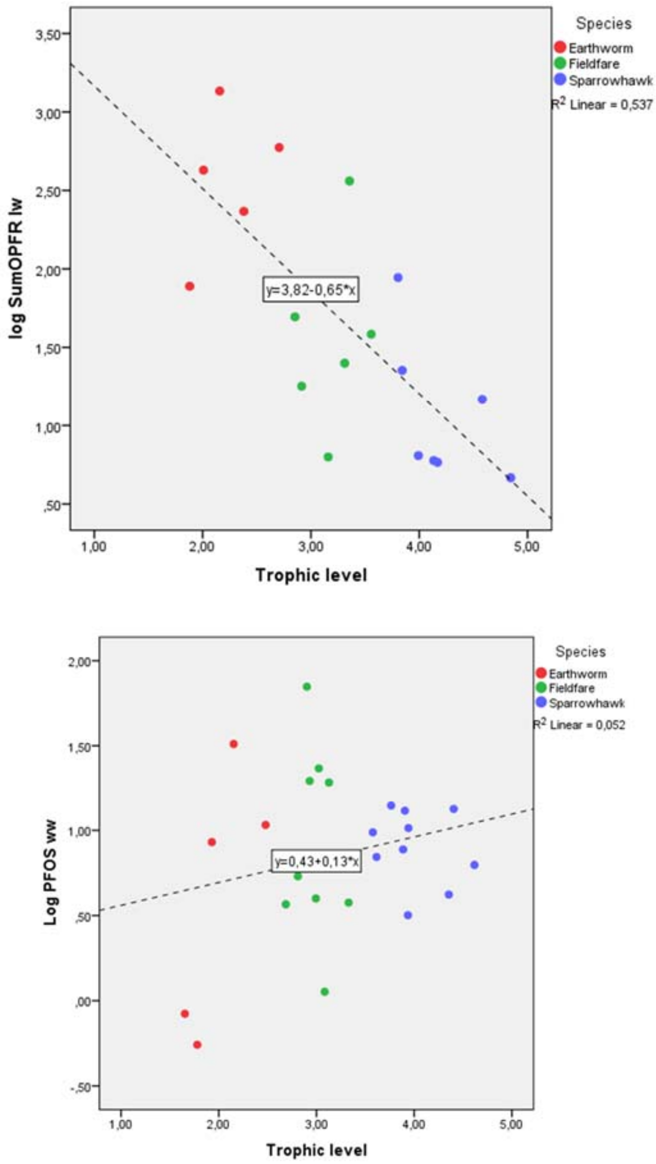


Figure 60: Relationship between trophic level and log PCB153, sumPBDE, sumOPFR and PFOS concentrations in ng/g lw or ww

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, using the equation Log [compound] = a + *b*TL, and TMF = 10^b :

PCB 153:	11.7
SumPCBs:	11.5
SumPBDEs:	6.3
SumOPFR:	0.2
PFOS:	1.3
PFTrA:	1.5
D4:	2.3
D5:	3.0

All other investigated compounds did not show any linear relationship between trophic level and concentrations.

TMFs >1 indicate biomagnification of these compounds in the terrestrial foodchain. In respect to these criteria, PFOS seems not to bioaccumulate in the observed foodchain, opposite to PFTrA, which shows some evidence of bioaccumulating similar to the siloxanes D4 and D5 along with the PCBs and PBDEs.

For comparison with data reported in the report from 2015, the following TMFs were found for a reference location in Norway and a similar food chain (Herzke et al., 2015):

SumPCBs: 10.2, SumPBDEs: 6.0, and for sumPFAS 1.4

resulting in TMFs >1 in comparable orders of magnitude for all organic compound groups investigated, indicating biomagnification of these compounds in the terrestrial foodchain also in remote locations.

4. Prediction of combined risk for soil living organisms and predators

In the natural environment, living organisms are not only exposed to one single pollutant, but to a variety of different contaminants. The exposure to the mixture of chemicals is first and foremost through food (prey), but also from water and the environment they live in. Component-based approaches are suitable methods for evaluating risk of mixtures when exposure data (i.e. concentrations) in addition to toxicity endpoints or similar toxicity reference values exist for the individual chemical components. (Altenburger et al., 2014). Within the European regulation of chemicals i.e., Registration, Evaluation, Authorisation and Restriction of Chemicals [REACH]) enacted in 2007, guidance exists on how to quantitatively assess the effects of a substance on the environment by determining the concentration of the substance below which adverse effects are not expected to occur in the environment. This concentration is known as Predicted No-Effect Concentrations (PNECs) (ECHA, 2008). A PNEC is obtained through the application of an assessment factor to ecotoxicological endpoints (EC50 or NOECs) using organisms with different sensitivities for any type of chemical. The size of the assessment factor depends on duration of the test (acute or chronic), the number of trophic concentrations tested and the general uncertainties in predicting ecosystem effects from laboratory data. In order to derive risk of contaminants for soil living organisms, such as plants, microorganisms and earthworm, $PNEC_{soil}$ should be determined (Andersen et al 2012). The evaluation of risk for soil living organisms is performed by comparing predicted or measured concentrations in soil with the derived $PNEC_{soil}$. To avoid risk for terrestrial soil ecosystem the measured environmental concentration (MEC) should not exceed the PNEC level for the specific substance.
Risk of contaminants for wildlife as higher member of the food chain has to consider and include bioaccumulative properties of the contaminants, which is a highly relevant property of several persistent organic pollutants. Biomagnification is defined as accumulation and

transfer of chemicals via the food chain, resulting in an increase of the internal concentration in organisms at higher levels in the trophic chain. Secondary poisoning is a concern for toxic effects in the higher members of the food chain of the terrestrial environment, which result from ingestion of organisms from lower trophic levels that contain accumulated substances. In order to estimate risk for wildlife and predators due to oral intake from lower trophic levels of bioaccumulative contaminants, $PNEC_{oral}$ should be determined (Mayfield et al., 2014). $PNEC_{oral}$ values represent dietary predicted no effect concentrations, below which food concentrations are not expected to pose a risk to birds or mammals (ECHA 2008). Results from long-term laboratory studies are strongly preferred, such as NOECs for mortality, reproduction or growth. If a chronic NOEC for both birds and mammals is available, the lower of the resulting PNECs may be used as the secondary poisoning assessment to represent all predatory organisms (ECHA, 2008). To avoid risk for wildlife, the PEC or MEC in feed should not exceed the $PNEC_{oral}$ levels for the specific chemical or chemical group; i.e. the MEC/PNEC ratio, the risk quotient (RQ)should not exceed 1.

The component-based method of summing up PEC/PNEC or MEC/PNEC ratios (i.e risk quotient, RQ) has been recommended as a justifiable mixture risk approximation (Backhaus and Faust 2012; Kortenkamp et al., 2014) in order to estimate in a first tier whether there is a potential risk for an exposed ecosystem; i.e. if the sum of MEC/PNEC exceed 1. This approach has been used in the present study in order to evaluate the risk for combined effects for soil ecosystem through the use of $PNEC_{soil}$ and $PNEC_{pred}$ (=$PNEC_{oral}$) for predators where earthworm, fieldfare eggs/chick could be a substantial part of the diet. $PNEC_{soil}$ and $PNEC_{pred}$ were adopted from a previous Norwegian study (Andersen et al. 2012) in addition to literature search including EU risk assessment reports (EU RAR), Environment Agency risk evaluation reports (EA ERAR) and European Chemicals Agency, http://echa.europe.eu. The PNEC values from Andersen et al. 2012, and risk assessment reports by EU and EA were considered as first choice references and in addition compared to other sources.

4.1 Prediction of risk for soil living organisms

The detected levels of the contaminants in soil from the various Oslo areas are shown in Table 59 with respective PNEC values. The single $MEC/PNEC_{soil}$ (RQsoil) values (Table 60) characterizes the risk for each chemical and the $\Sigma MEC/PNEC_{soil}$ (RQmix-soil) were calculated in order to predict mixture effects by the concentration addition approach. In the case of unavailable PNEC values per dry weight (dw), wet weight (ww) PNEC values were used together with MEC in ww.

Table 59: Measured concentrations (MEC) of pooled ***soil*** *samples from Maridalen, Slottsparken, Svartdalparken, Grorud and Voksenpollen II. All concentrations are given as ng/g dw, except for BDE209, SCCP, MCCP, D4 and D5 since PNECsoil is given in ng/g ww.*

Components	**Maridalen MEC**	**Slottsparken MEC**	**Svartdalparken MEC**	**Grorud MEC**	**Voksenkollen II MEC**	$PNEC_{soil}$ dw	$PNEC_{soil}$ ww
PFOS	0.075	0.21	0.25	0.01	0.16	373	
PFOA	0.21	0.24	0.09	2.17	0.56	160	
SumPCB7	3.90	3.40	0.83	1.93	1.59	10	

PentaBDE	0.11	0.14	0.10	0.18	0.15	380	
BDE209 (ww)	0.11	0.04	0.01	0.19	0.34		98000
MCCP (ww)	6.9	1.2	0.5	32.0	10.6		10600
BPA	18	5.6	12	20.8		3200	
TBBPA			4.8			12	
4-nonylphenol	4.5		1.2	4.3	24.9	300	
4-octylphenol	13.6		5.5			6.7	
TCEP		1.92	6.86		0.65	386	
TCPP				284		1700	
TDCP/TDCPP						330	
TBEP				48.3		810	
EHDPP (ww)					2.39		302
TCP	4.76	9.10		1.36	1.62	2.7	
TBP/TnBP			14.66			5300	
TIBP						640	
D4 (ww)	1.39		1.78	1.88			160
D5 (ww)	0.91	1.08	1.54	1.33			4800
Cr	60745	64632	37682	77669	18530	62000	
Ni	23212	34243	22136	37259	6520	50000	
Cu	22314	28390	24786	34806	129612	89600	
Zn	136932	110847	84532	180867	58859	26000	
Cd	386	225	202	361	1735	1150	
Pb	165691	43883	15239	35422	164832	166000	
Hg	320	248	56	74	224	300	

Table 60: RQsoil (MEC/PNECsoil) values of contaminants for soil samples from Maridalen, Slottsparken, Svartdalparken, Grorud and Voksenpollen II.

Components	**Maridalen RQsoil**	**Slottsparken RQsoil**	**Svartdalparken RQsoil**	**Grorud RQsoil**	**Voksenkollen II RQsoil**	$PNEC_{soil}$ dw	$PNEC_{soil}$ ww
PFOS	2E-04	6E-04	7E-04	4E-05	4E-04	373	
PFOA	1E-03	1E-03	6E-04	0.0136	3E-03	160	
SumPCB7	0.39	0.34	0.083	0.193	0.159	10	
PentaBDE	3E-04	4E-04	3E-04	5E-04	4E-04	380	
BDE209 (ww)	1E-06	4E-07	9E-08	2E-06	3E-06		98000
MCCP (ww)	6E-04	1E-04	4E-05	3E-03	1E-03		10600
BPA	6E-03	2E-03	4E-03	7E-03		3200	
TBBPA			0.4			12	
4-octylphenol	2.03		0.82		3.72	6.7	
4-nonylphenol	0.015		4E-03	0.014	4E-04	300	
TCEP		5E-03	0.018		2E-03	386	
TCPP				0.17		1700	
TBEP				0.06		810	
TCP	1.76	3.37		0.503	0.599	2.7	
TBP/TnBP			0.003			5300	
EHDP					0.008		
D4 (ww)	0.020		0.134	0.033			160
D5 (ww)	4E-04	1E-03	4E-03	8E-04			4800
Cr	0.98	1.04	0.61	1.25	0.30	62000	
Ni	0.46	0.68	0.44	0.75	0.13	50000	
Cu	0.25	0.32	0.28	0.39	1.45	89600	
Zn	5.3	4.3	3.3	7.0	2.3	26000	
Cd	0.3	0.2	0.2	0.3	1.5	1150	
Pb	1.00	0.26	0.09	0.21	0.99	166000	
Hg	1.07	0.83	0.19	0.25	0.7	300	

Prediction of risk from mixture of contaminants in soil ecosystem at the various sites, given as sum of the respective RQ, RQmix-soil:

	Maridalen	Slottsparken	Svartdalparken	Grorud	Voksen-kollen II
RQmix-soil	14	11	7	11	12

All sites show RQmix-soil above 1. The compounds contributing most to the sum were mainly the metals, 4-octylphenol and TCP. Among the metals, Zn shows the highest risk quotients. Of the organic pollutants, octylphenol and TCP are among the most contributing pollutants. It should be noted that the PNECsoil of 0.0067 mg/dw for octylphenols (Andersen et al 2012) is most probable based on studies performed on the isomer 4-tert-octylphenol (cas.no. 140-66-9).

Order of most important RQsoil contributions to the RQmix-soil at the sampling locations:

Maridalen:	Zn> 4-octylphenol>TCP> Hg~Pb
Slottsparken:	Zn>TCP>Cr>Hg
Svartdalparken:	Zn>4-octylphenol >Cr
Grorud	Zn>Cr>Ni>TCP
Voksenkollen II:	4-octylphenol >Zn> Cd> Cu

Zn has an important physiological function in all organisms, and it is uncertain if the high concentration in soil is of high risk to soil living organisms. The Norwegian normative value for soil has been set to 200 mg/kg and only Voksenkollen I exceeds this concentration. However, in accordance to the available PNEC value used and the ECHA PNECsoil value of 35.6 mg/kg soil dw, the MEC/$PNEC_{soil}$ is above 1 at all sites, indicating reason for concern. Cr concentrations in soil at three sites (Maridalen, Slottsparken and Grorud) revealed concentrations above the normative value of 50 mg/kg (TA2553, 2009).

The sum of risk quotients for metals as a group is above 1 for all sites, also if Zn is not included. The sum of the RQ for the known most toxic metals (Hg, Cd and Pb) is above 1 at the sites Maridalen, Slottsparken and Voksenkollen II. The concentrations of Pb in soil from Maridalen and Voksenkollen of 165 and 164 mg/kg dw, respectively, are much higher than the normative value of 60 mg/kg (TA 2553, 2009) and can be classified as condition class 3 (Moderate polluted). The other sites have Pb levels comparable with median concentrations in soils from several Norwegian cities (Nygard, 2014). Cd and Hg levels in the present study are also comparable with the reported median concentrations in soils from Hamar, Oslo and other cities (Nygard, 2014). Hg concentrations are below the normative value of 1.5 mg/kg. Most sites revealed Cd concentrations below the normative value of 1.5 mg/kg, except for soil from Voksenkollen II.

Although one of the alkylphenols, the isomer 4-tert-octylphenol, was not part of the assignment of the project, we have included it in the discussion for soil ecosystem since the reported PNECsoil is low and since we detected much higher concentrations compared to 4-n-octylphenol. 4-tert-octylphenol is included in the REACH candidate list with the scope of environmental concern. The basis for the proposal is the degradation of octylphenol ethoxylates to octylphenols, which has endocrine disrupting properties in the environment

(Danish EPA, 2013). It should be noted that 4-tert-octylphenol (CAS no 140-66-9) revealed high soil concentrations at all Oslo sites in in the range of 154-1303 ng/g ww. The RQsoil values were not included in this table due to an expected uncertainty in the provisional $PNEC_{soil}$ value of 5.8 ng/g ww based on the PNEC value for surface water and equilibrium partitioning (Environment Agency Risk Evaluation Report 4-tert-octylphenol 2005), see also Annex $PNEC_{soil}$ values. The calculated RQsoil values from the Oslo sites were in the range of 2-57 using this PNECsoil value. It should be mentioned that the ECHA web site reported a $PNEC_{soil}$ value of 2.3 mg/kg dw. Using this PNEC value resulted in risk ratios in the range of 0.01-0.06, indicating very low risk.

In a previous risk evaluation by VKM (2009), it was concluded that there were low risks of octylphenols and nonylphenols since these substances are rapidly degradable with $t_{1/2}$ in soil = 8-10 days (VKM, 2009; Danish EPA, 2013). If the situation is a more or less continuous input to these soil areas from external sources or as degradation product of octylphenol ethoxylates of 4-tert-octylphenols, this can potentially result in a risk for soil living organisms.

4.2 Prediction of combined risk for predators by oral intake

4.2.1 Earthworm as prey

Detected concentrations of the various contaminants in pooled earthworm samples from the various locations are listed below in table 61 together with PNECpred values. The risk for oral intake of earthworm for predators of single compounds was evaluated by the calculation of MEC/PNECpred (RQpred), table 62. Potential risk from mixture of contaminants were assessed by summing up the single RQpred values (RQmix-pred). Species feeding on earthworms are a broad range of birds as well as small mammals (voles), which can consume up to 50 worms per day.

Table 61: Measured concentrations (MEC) of pooled ***earthworm*** *samples from Maridalen Slottsparken, Svartdalparken, Grorud and Voksenkollen II. All concentrations are given as ng/g ww.*

Components	**Maridalen MEC**	**Slottsparken MEC**	**Svartdalparken MEC**	**Grorud MEC**	**VoksenkollenII MEC**	$PNECpred_l$
PFOS	0.84	10.8	8.5	0.55	32.4	37
HCB	0.08	0.18	0.19	2.4	0.28	16.7
PCB153	0.34	1.38	0.57	0.46	0.50	670
PentaBDE	<LOD	<LOD	0.2	<LOD	0.04	1000
SCCP	8.7	48.0	5.0	5.5	13.0	5500
MCCP	1.0	9.5	8.7	3.4	8.0	10000
BPA	na	5631	na	9758	6298	2670
4-octylphenol	na	5.8	na	3.3	3.2	10000
4-t-octylphenol	na	465.1	na	332.8	326.4	10000

TCPP	< 1.8	< 1.8	2.6	<1.8	< 1.8	11600
TDCP/TDCPP	< 0.18	2.0	4.0	< 0.18	1.2	3300
TBEP	< 2.1	< 2.1	6.4	3.7	< 2.1	4400
EHDPP	0.51	0.31	0.19	0.48	< 0.02	1100
TCP	0.16	0.05	0.01	0.05	< 0.01	1700
D4	na	1.6	na	< LOQ	< LOQ	41000
D5	na	1.5	na	0.87	0.87	13000
D6	na	1.9	na	1.2	< LOQ	66700
Ni	na	681	na	982	344	8500
Cd	na	862	na	1257	3917	160
Pb	na	886	na	1222	23168	3600
Hg	na	253	na	100	146	400

The concentrations of metals are more or less in accordance with 2013 and 2014 data from the Oslo area. PFOS data is also comparable to previous years when excluding the Voksenkollen II concentrations.
Since Cu and Zn are physiologically regulated in birds (Richards and Steele 1987), mostly Hg, Pb, Cd and As can prove toxic at concentrations that can be found in the environment (Depledge et al. 1998).

Table 62: Single (RQpred) values of contaminants in earthworm from Maridalen,, Slottsparken, Svartdalparken, Grorud and Voksenpollen II. Predicted combined risk is given as Sum RQmix-pred for each site.

Components	**Maridalen RQpred**	**Slottsparken RQpred**	**Svartdalparken RQpred**	**Grorud RQpred**	**Voksenkollen II RQpred**	PNECpred$_{l}$
PFOS	0.02	0.29	0.23	0.01	0.88	37
HCB	4.8E-03	0.01	0.01	0.14	0.02	16.7
PCB153	5.1E-04	2.1E-03	8.4E-04	6.9E-04	7.4E-04	670
PentaBDE			2.4E-04		4.1E-05	1000
SCCP	1.6E-03	8.7E-03	9.1E-04	1.0E-03	2.4E-03	5500
MCCP	1.0E-04	9.5E-04	8.7E-04	3.4E-04	8.0E-04	10000
BPA		2.1		3.7	2.4	2670
4-octylphenol		5.8E-04		3.3E-04	3.2E-04	10000
4-t-octylphenol		0.05		0.03	0.03	10000
TCPP			2.2E-04			11600
TDCP/TDCPP		6.0E-04	1.2E-03		3.5E-04	3300
TBEP			1.4E-03	8.3E-04		4400
EHDPP	4.6E-04	2.8E-04	1.7E-04	4.3E-04		1100
TCP	9.6E-05	2.7E-05	8.4E-06	3.1E-05		1700
D4		3.9E-05				41000
D5		1.1E-04		6.7E-05	6.7E-05	13000
D6		2.9E-05		1.8E-05		66700
Ni		0.08		0.12	0.04	8500
Cd		5.39		7.86	24.48	160
Pb		0.25		0.34	6.44	3600
Hg		0.63		0.25	0.37	400

Prediction of risk from mixture of contaminants in earthworm as prey at the various sites, given as sum of the respective RQ, RQmix-pred:

	Maridalen	Slottsparken	Svartdalparken	Grorud	Voksenkollen II
RQmix-pred	0.03	9	0.3	12	35

As can be seen from the table above, BPA, PFOS, Cd and other metals contributed with the highest single risk quotients to the RQmix-pred for the sites with detected concentrations above LOD.

Very few data exist for BPA in terrestrial animals. A recent review on BPA (Corrales et al, 2015) stated that the only terrestrial organisms for which field BPA accumulation data are available, is for the earthworm (Eisenia fetida). BPA in the referred study was measured in tissue from adult earthworms collected from sewage percolating beds and domestic gardens (Markman et al, 2007) and the levels (< 5 ng/g ww) were much lower than concentrations found in earthworm from Oslo area, the present study . BPA was not measured in fieldfare so no clear conclusion to potential biomagnification and risk can be assessed, although BPA was measured and detected in sparrowhawk, but three order of magnitude less than concentrations found in earthworm.

Order of main $MEC/PNEC_{pred}$ contribution to the $Sum(MEC/PNEC_{pred})$; i.e. RQmix-pred at the sampling locations:

Grorud :	Cd> BPA> Pb>Hg>HCB> Ni
Svartdalparken:	PFOS>HCB
Maridalen:	PFOS
Slottsparken:	Cd>BPA>>Hg>PFOS
Voksenkollen II:	Cd>Pb> >BPA>PFOS

PFOS risk quotients were highest at Voksenkollen II and BPA risk ratios were comparable at the three sites with detected concentrations (Grorud, Slottsparken and Voksenkollen II). The same three sites revealed high metal ratios contributing to the sum, although Voksenkollen II had a very high ratio for Cd (24.5) as well.

When comparing with the 2014 data, a similar high contribution by Cd to the sum followed by Pb, Hg and PFOS was found (Herzke et al., 2015). Cd had also highest contribution to the sum of risk quotients in the 2013 data and was followed by PFOS and Pb or Hg at the various sites.

Although quite high levels of 4-t-octylphenol were found at three of the sites, the risk ratio MEC/PNEC does not contribute substantially to the RQmix-pred for predators of earthworm using the EA RER 2005 PNEC of 10 mg/kg food. The ECHA web site reported a lower PNEC value of 2.36 mg/kg food for 4-t-octylphenol. Using this value resulted in risk quotients in the range of 0.14-0.20. In contrast, BPA was one of the compounds with the highest concentration in earthworm at three sites and resulted in a rather high risk contribution for predators of earthworm.

4.2.2 Fieldfare as prey

Since fieldfare are characterised by a high individual variation in pollutant load, median and 90^{th} percentile concentrations across sites were used in the calculation of risk quotients, table 63. The risk assessment is not direct, as the normal prey of the sparrowhawk would be fieldfare chicks (and adults) , not eggs, even though som maternal transfer from mother to eggs is to be expected. After the chicks grow older, the effect of meaternal transfer will be diluted, and the values measured in their bodies will more reflect those of the environment (the food given to them, where earthworms will form a major part, thus making the evaluation of thophic transfer strong).

Metals and phenols were not analysed in the fieldfare samples in the present project. The concentration data for metals of fieldfare samples from reference site (Åmotsdalen) with known PNECpred was collected from last year's report (Herzke et al., 2015). Cadmium as evaluated with the highest risk for predators of earthworm in this year study, was below LOD or not analysed in the fieldfare samples from report M-354. BPA with a rather high concentration in earthworm, and high risk ratio for predators of earthworm, was not analysed in the fieldfare samples. We therefore cannot rule out that BPA might pose a potential risk for fieldfare if BPA bioaccumulates. However, BPA is found in much lower concentrations in sparrowhawk than in earthworm. PFOS was found to constitute a potential risk for predators of earthworm at some sampling locations, and PFOS was detected in the fieldfare samples.

Table 63: Measured median and 90th percentile concentrations (MEC) of fieldfare egg samples. All concentrations and PNEC$_{pred}$ are given as ng/g ww in food.

Components	Median MEC	90th percentile MEC	PNECpred
PFOS	5.89	27.97	37
HCB	3.115	4.197	16.7
PCB153	6.463	14.550	670
PentaBDE	1.965	6.680	1000
OctaBDE	0.36	1.80	67000
SCCP	18.00	25.50	5500
MCCP	3.65	7.17	10000
TBEP(n=1)	7.49	7.49	4400
D4	1.93	2.8	41000
D6	1.87	3.12	66700
Ni (2014 data)	1.5	7.3	8500
Hg (2014 data)	3.6	12.7	400

Table 64: Single (RQpred) values of contaminants in fieldfare egg based on median and 90th percentile concentrations. Predicted combined risk is given as Sum RQmix-pred for each site below the table.

Components	Median RQpred	90th percentile RQpred	PNECpred
PFOS	0.16	0.76	37
HCB	0.19	0.25	16.7
PCB153	0.010	0.022	670
PentaBDE	1.97E-03	6.68E-03	1000
OctaBDE	5.33E-06	2.68E-05	67000
SCCP	3.27E-03	4.64E-03	5500
MCCP	3.65E-04	7.17E-04	10000
TBEP(n=1)	1.70E-03	1.70E-03	4400

D4	4.71E-05	6.76E-05	41000
D6	2.81E-05	4.68E-05	66700
Ni (2014 data)	1.76E-04	8.59E-04	8500
Hg (2014 data)	0.01	0.03	400

Prediction of risk from mixture of contaminants for predators of fieldfare eggs/chicks, given as sum of the respective RQ, RQmix-pred:

	Median concentrations	90th percentile concentrations
RQmix-pred	0.4	1.1

RQpred contribution to the RQmix-pred:

Median concentrations: HCB~PFOS>Hg
90^{th} percentile concentrations: PFOS>HCB>PCB153~Hg

PFOS and HCB contribute the most to the sum of the risk ratios for predators of fieldfare egg/chicks, and it is only the 90^{th} percentile concentration that results in a sum of risk ratios above 1. Fieldfare chicks may be part of the diet of sparrowhawks and other birds of prey as well as mammals (cats, foxes). From our rather small dataset and available PNEC values for oral intake, the median data do not indicate a high risk for predators feeding on fieldfare chicks. Compared to the 2014 data of fieldfare in the Oslo area, the present PFOS concentrations are higher. However, since the chosen and most probably more reliable PNECpred value is higher in this year's report, the RQ for PFOS is lower.

5. Conclusions and Recommendations

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

- Soil:	Mercury > Toxic metals > SumPhenols
- Earthworms:	SumPhenols >>Toxic metals >> sumPFAS
- Fieldfare*:	Chlorinated paraffins > sumPCB > sumPFAS ~ sumPBDE
- Sparrowhawk:	SumDDT > sumPCB > SumPhenols > Mercury
- Tawny owl:	SumPhenols > sumDDT > sumPCB
- Red fox:	Phenols > Bromadiolone > Toxic metals
- Brown rat:	Arsen >> Bromadiolone > SumPhenols

*Phenols and metals were not measured in fieldfare

Of all the organisms and tissues measured in the study, earthworms had the highest average concentration of the sum of all organic pollutants measured, followed by sparrowhawk and red fox. When only focusing on the toxic metals mercury, cadmium, lead and arsenic, soil was the highest contaminated compartment followed by worm and rats.

An estimation of the trophic magnification was possible for the foodchain earthworm - fieldfare - sparrowhawk. In order to assess the bioaccumulation potential, trophic magnification factors (TMF) were calculated. The TMF calculations indicated trophic biomagnification for PCBs, PBDEs, Pesticides (without DDTs), the siloxanes D5 and D4, PFTrA and PFOS in decreasing order.

The combined risk of the measured pollutants was evaluated with a first tier conservative concentration addition (CA) approach using predicted no effect concentration for predators ($PNEC_{soil}$) as reference values. For the first time soil was included in the estimation of combined risk. The Sum($MEC/PNEC_{pred}$) ranged between 6 and 47, above the threshold of 1 in all locations. The earthworms from the five sampled sites in Oslo area showed a Sum($MEC/PNEC_{pred}$) ranging between 0.1 and 36 respectively, indicating a risk for predators with earthworm as an important food item in three out of five locations. Toxic metals and phenolic compounds were important contributors to the Sum($MEC/PNEC_{soil}$) in soil compared to PFOS and HCB as additional contributors in earthworms. Fieldfare eggs showed a low Sum($MEC/PNEC_{pred}$) of 0.7 for predators, mostly caused by PFOS and HCB.

As a successful campaign for collecting sparrowhawk egg was conducted in 2014 and 2015, we recommend to carry on using this species as a true trophic level 4 reperesentative for long-term studies. Small rodent species are suggested to be included in the study in order to assess prey items of the tawny owl as well. The analyses of phenolic compounds and metals in fieldfare eggs is suggested to be included in the program, to enable the assesment of bioaccumulation and dietary uptake of these compounds from the earthworms. The inclusion of selenium to the metal analytes is also recommended in order to improve the assessment of the toxic potential of mercury.

With the addition of air samples from the same locations as the soil samples to the program, we would be able to assess sources of the urban environment in comparison with long-range transported pollutant loads. 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.

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8. Appendix

PCB, PBDE, CPs

Nr. of samples		52	53	54	55	56	57	58	59	60	61
Customer:		Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:		15/1881	15/1882	15/1883	15/1884	15/1885	15/1886	15/1887	15/1888	15/1889	15/1890
Individual:											
Location		2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Sample type:		Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Concentration units:		Egg, Sparrowhawk	Egg, Sparrowhawk	Egg, Sparrowhawk	Egg, Sparrowhawk	Egg, Sparrowhawk	Egg, Sparrowhawk	Egg, Sparrowhawk	Egg, Sparrowhawk	Egg, Sparrowhawk	Egg, Sparrowhawk
		ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:											
2,2',4,4'-TetBDE	47	2,240	2,260	2,900	6,010	8,400	5,260	6,910	5,830	5,310	7,730
2,2',4,4',5-PenBDE	99	4,030	4,600	5,450	12,500	18,500	14,000	11,600	13,300	8,310	13,600
2,2',4,4',6-PenBDE	100	0,913	1,440	1,440	3,740	6,600	4,520	2,020	3,900	3,330	4,140
3,3',4,4',5-PenBDE	126	<LOD	<LOD	0,010	0,019	0,083	0,027	0,011	0,036	<LOD	0,015
2,2',4,4',5,5'-HexBDE	153	1,300	1,540	2,830	3,720	12,900	5,950	2,540	6,290	1,710	4,830
2,2',4,4',5,6'-HexBDE	154	0,378	0,484	0,980	1,500	10,100	2,110	0,900	2,380	0,683	1,420
2,2',3,4,4',5',6-HepBDE	183	0,343	0,284	0,761	0,921	1,670	0,939	0,602	0,966	0,347	0,920
2,3,3',4,4',5',6-HepBDE	191	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2,2',3,3',4,4',5,6'-OctBDE	196	0,116	0,091	0,154	0,372	0,249	0,381	0,222	0,277	0,104	0,152
2,2',3,3',5,5',6,6'-OctBDE	202	0,068	0,063	0,108	0,135	0,333	0,307	0,084	0,813	0,067	0,148
2,2',3,3',4,4',5,5',6-NonBDE	206	0,116	0,091	0,154	0,372	0,249	0,381	0,222	0,277	0,104	0,152

2,2',3,3',4,4',5,6,6'-NonBDE	207	0,085	0,036	0,072	0,523	<LOD	0,931	0,197	0,158	0,046	0,087
DecaBDE	209	<LOD	<LOD	<LOD	<LOD	<LOD	2,250	<LOD	<LOD	<LOD	<LOD
2,4,4'-TriCB	28	7,96	1,14	0,12	0,67	1,08	0,19	2,01	1,24	0,39	0,92
2,2',5,5'-TetCB	52	4,76	0,90	0,12	1,68	0,64	0,40	2,25	1,53	0,98	0,92
2,2',4,5,5'-PenCB	101	35,6	5,68	2,07	9,77	8,22	4,70	30,5	12,6	11,1	15,1
2,3',4,4',5-PenCB	118	67,8	20,1	12,5	18,8	33,1	14,1	40,1	31,9	21,9	33,6
2,2',3,4,4',5'-HexCB	138	202	47,3	42,4	95,3	138	67,8	155	92,3	127	156
2,2',4,4',5,5'-HexCB	153	1 083	104	115	489	279	214	267	226	418	418
2,2',3,4,4',5,5'-HepCB	180	161	80,4	69,7	174	262	153	193	184	217	234
DBDPE		<LOD	<LOD	<LOD	8,76	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
SCCP		13,00	14,00	3,90	17,00	11,00	12,40	140,00	61,00	8,70	7,90
MCCP		5,30	3,20	3,30	3,60	2,60	3,20	3,50	4,30	0,60	0,50

<LOD Less than Limit of Quantification

PCB, PBDE, CPs

		42	43	44	45	46	47	48	49	50	51
Nr. of samples		42	43	44	45	46	47	48	49	50	51
Customer:		Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:		15/1871	15/1872	15/1873	15/1874	15/1875	15/1876	15/1877	15/1878	15/1879	15/1880
Individual:											
Sampling year		2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Location		Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:		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
Concentration units:		ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:											
2,2',4,4'-TetBDE	47	0,283	0,328	0,600	0,156	0,171	0,191	10,400	0,224	0,135	0,434
2,2',4,4',5-PenBDE	99	0,366	<LOD	1,630	0,314	0,647	0,692	16,800	0,385	0,257	0,144
2,2',4,4',6-PenBDE	100	0,100	0,140	0,188	0,105	0,188	0,160	3,700	0,064	0,056	0,120
3,3',4,4',5-PenBDE	126	<LOD	<LOD	0,017	<LOD	<LOD	<LOD	0,018	<LOD	<LOD	<LOD
2,2',4,4',5,5'-HexBDE	153	0,497	0,411	1,030	0,282	0,408	0,402	3,680	0,182	0,157	0,179
2,2',4,4',5,6'-HexBDE	154	0,035	0,093	0,080	0,042	0,065	0,053	1,930	0,024	0,030	0,046
2,2',3,4,4',5',6-HepBDE	183	0,037	0,069	0,052	0,057	0,075	0,035	0,112	0,034	0,043	0,022
2,3,3',4,4',5',6-HepBDE	191	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2,2',3,3',4,4',5,6'-OctBDE	196	<LOD	<LOD	0,024	0,023	<LOD	<LOD	<LOD	0,025	<LOD	<LOD
2,2',3,3',5,5',6,6'-OctBDE	202	<LOD	0,034	0,029	0,031	0,022	<LOD	0,029	<LOD	<LOD	<LOD

2,2',3,3',4,4',5,5',6-NonBDE	206	<LOD	<LOD	0,024	0,023	<LOD	<LOD	<LOD	0,025	<LOD	<LOD
2,2',3,3',4,4',5,6,6'-NonBDE	207	<LOD	<LOD	0,030	0,027	<LOD	0,018	0,036	0,072	<LOD	<LOD
DecaBDE	209	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2,4,4'-TriCB	28	<LOD	<LOD	0,14	0,52	0,07	<LOD	0,17	0,12	0,12	<LOD
2,2',5,5'-TetCB	52	<LOD	<LOD	0,03	<LOD	<LOD	0,02	<LOD	<LOD	0,04	0,02
2,2',4,5,5'-PenCB	101	<LOD	0,18	0,13	0,08	0,11	0,09	0,26	0,16	0,19	0,16
2,3',4,4',5-PenCB	118	1,86	2,25	1,54	1,37	1,41	0,91	2,24	1,34	3,43	1,03
2,2',3,4,4',5'-HexCB	138	7,73	7,37	2,92	4,13	6,10	4,07	7,33	3,75	9,74	2,31
2,2',4,4',5,5'-HexCB	153	19,9	12,8	6,93	11,1	14,3	10,2	14,5	8,75	23,20	6,69
2,2',3,4,4',5,5'-HepCB	180	13,2	8,73	3,90	7,15	9,94	7,65	8,13	6,06	15,04	3,71
DBDPE		<LOD	<LOD	<LOD	11,40	<LOD	7,62	<LOD	<LOD	6,37	4,72
SCCP		19,0	20,0	11,0	15,0	8,3	20,0	13,0	11,0	1,0	6,6
MCCP		3,7	3,3	3,6	2,0	2,3	2,6	3,9	2,9	0,4	0,3

<LOD Less than Limit of Quantification

PCB, PBDE, CPs

Nr. of samples		1	2	3	4	5	6	7	8	9	10
Customer:		Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir	Miljødir.
NILU sample ID:		15/1851	15/1852	15/1853	15/1854	15/1855	15/1856	15/1857	15/1858	15/1859	15/1860
Individual:		RR-0038	RR-0051	RR-0053	Furuset VI	209	210	211	212	213	214
Sampling year		2015	2015	2015							
Location		Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:		Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver
Concentration units:		ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:											
2,2',4,4'-TetBDE	47	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0,303	<LOD	0,164	0,134
2,2',4,4',5-PenBDE	99	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0,057	<LOD	0,039	<LOD
2,2',4,4',6-PenBDE	100	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0,038	<LOD	<LOD	0,023
3,3',4,4',5-PenBDE	126	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2,2',4,4',5,5'-HexBDE	153	0,02	<LOD	<LOD	<LOD	0,056	<LOD	0,038	<LOD	0,113	0,03
2,2',4,4',5,6'-HexBDE	154	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2,2',3,4,4',5',6-HepBDE	183	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2,3,3',4,4',5',6-HepBDE	191	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2,2',3,3',4,4',5,6'-OctBDE	196	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2,2',3,3',5,5',6,6'-OctBDE	202	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

2,2',3,3',4,4',5,5',6-NonBDE	206	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2,2',3,3',4,4',5,6,6'-NonBDE	207	<LOD	<LOD	<LOD	0,102	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
DecaBDE	209	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2,4,4'-TriCB	28	0,02	0,01	0,02	0,01	<LOD	<LOD	<LOD	<LOD	0,01	<LOD
2,2',5,5'-TetCB	52	0,04	0,02	0,04	0,03	<LOD	0,01	0,02	<LOD	0,02	0,01
2,2',4,5,5'-PenCB	101	0,07	0,03	0,18	0,05	0,01	0,01	0,03	0,01	0,03	0,02
2,3',4,4',5-PenCB	118	4,04	0,05	0,22	0,04	0,03	0,02	0,14	0,02	0,05	0,08
2,2',3,4,4',5'-HexCB	138	6,69	0,20	0,43	0,10	0,43	0,07	0,44	0,05	0,18	0,81
2,2',4,4',5,5'-HexCB	153	41,8	2,80	3,42	0,36	3,64	0,71	1,10	0,59	1,45	2,62
2,2',3,4,4',5,5'-HepCB	180	68,2	12,8	17,6	0,61	8,93	3,24	3,52	5,58	5,50	2,83
DBDPE		<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
SCCP		18,0	7,8	21,0	9,6	10,7	4,4	3,8	14,6	29,7	3,2
MCCP		4,1	5,0	0,9	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

<LOD Less than Limit of Quantification

PCB, PBDE, CPs

Nr. of samples		1	2	3	4	5	6	7	8	9	10
Customer:		Miljødir.	Miljødi.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:		15/1861	15/1862	15/1863	15/1864	15/1865	15/1866	15/1867	15/1868	15/1869	15/1870
Individual:		99003/16	99004/16	99005/16	99010/16	99011/16	99012/16	99013/16	99001/16 og 99023/16	99026/16	99002/16 og 99030/16
Sampling year		2015	2015	2015							
Location		Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:		Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver
Concentration units:		ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:											
2,2',4,4'-TetBDE	47	1,00	0,299	<LOD	<LOD	0,125	<LOD	<LOD	0,604	0,253	0,178
2,2',4,4',5-PenBDE	99	0,34	0,095	0,016	<LOD	0,037	<LOD	0,05	0,17	0,064	0,058
2,2',4,4',6-PenBDE	100	0,30	0,144	<LOD	0,016	0,03	0,008	0,016	0,144	0,085	0,015
3,3',4,4',5-PenBDE	126	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2,2',4,4',5,5'-HexBDE	153	0,84	0,334	0,029	0,053	0,098	<LOD	0,024	0,449	0,159	0,588
2,2',4,4',5,6'-HexBDE	154	0,01	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2,2',3,4,4',5',6-HepBDE	183	0,13	0,054	0,1	<LOD	<LOD	<LOD	0,016	0,236	0,044	<LOD
2,3,3',4,4',5',6-HepBDE	191	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

2,2',3,3',4,4',5,6'-OctBDE	196	0,08	<LOD	0,443	<LOD	<LOD	<LOD	<LOD	0,142	<LOD	<LOD
2,2',3,3',5,5',6,6'-OctBDE	202	0,03	<LOD	0,08	<LOD	<LOD	<LOD	<LOD	0,126	<LOD	<LOD
2,2',3,3',4,4',5,5',6-NonBDE	206	0,08	<LOD	0,443	<LOD	<LOD	<LOD	<LOD	0,142	<LOD	<LOD
2,2',3,3',4,4',5,6,6'-NonBDE	207	1,17	0,218	4,48	<LOD	0,221	0,111	0,085	2,78	<LOD	0,217
DecaBDE	209	4,00	<LOD	16,4	<LOD	1,95	1,2	0,833	9,42	<LOD	1,98
2,4,4'-TriCB	28	0,04	0,02	0,27	0,01	0,09	<LOD	0,01	0,33	0,02	0,03
2,2',5,5'-TetCB	52	0,03	0,07	0,07	0,08	0,04	0,04	0,03	0,08	0,07	0,03
2,2',4,5,5'-PenCB	101	0,19	0,58	0,28	0,56	0,29	0,29	0,25	1,29	0,53	0,25
2,3',4,4',5-PenCB	118	0,47	0,87	<LOD	0,51	0,26	0,1	0,1	0,01	0,56	<LOD
2,2',3,4,4',5'-HexCB	138	2,74	6,61	0,53	2,64	1,66	0,34	0,33	13,7	3,87	7,44
2,2',4,4',5,5'-HexCB	153	3,74	10,7	0,66	4,85	2,12	0,46	0,42	15	5,05	11,9
2,2',3,4,4',5,5'-HepCB	180	3,64	7,94	0,49	2,73	1,12	0,3	0,22	9,47	2,24	7,79
DBDPE		<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
SCCP		<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
MCCP		<LOD	0,9	<LOD	1,0	<LOD	<LOD	<LOD	<LOD	1,6	1,4

<LOD   Less than Limit of Quantification

PCB, PBDE, CPs

Nr. of samples		1	2	3	4	5	6	7	8	9	10
Customer:		Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:		15/1841	15/1842	15/1843	15/1844	15/1845	15/1846	15/1847	15/1848	15/1849	15/1850
Individual:		pool	pool	pool	pool	pool	pool				
Sampling year		2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Location		Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:		Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare
Concentration units:		ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:											
2,2',4,4'-TetBDE	47	0,30	0,66	0,56	1,58	0,68	1,02	0,29	3,40	1,03	1,04
2,2',4,4',5-PenBDE	99	0,27	0,91	0,95	3,31	0,68	0,82	0,31	8,52	0,76	0,85
2,2',4,4',6-PenBDE	100	0,08	0,32	0,25	0,94	0,18	0,22	0,10	2,40	0,25	0,28
3,3',4,4',5-PenBDE	126	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2,2',4,4',5,5'-HexBDE	153	0,05	0,16	0,29	0,44	0,11	0,20	0,08	2,09	0,09	0,09
2,2',4,4',5,6'-HexBDE	154	0,04	0,17	0,22	0,56	0,12	0,18	0,10	1,11	0,09	0,11
2,2',3,4,4',5',6-HepBDE	183	0,02	0,05	0,05	0,12	0,03	0,10	0,04	0,22	0,02	0,03
2,3,3',4,4',5',6-HepBDE	191	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2,2',3,3',4,4',5,6'-OctBDE	196	<LOD	<LOD	<LOD	0,04	<LOD	0,04	<LOD	0,20	<LOD	<LOD
2,2',3,3',5,5',6,6'-OctBDE	202	<LOD	<LOD	0,03	0,07	<LOD	0,04	0,03	1,92	<LOD	0,04

2,2',3,3',4,4',5,5',6-NonBDE	206	<LOD	<LOD	<LOD	0,04	<LOD	0,04	<LOD	0,20	<LOD	<LOD
2,2',3,3',4,4',5,6,6'-NonBDE	207	<LOD	0,03	0,03	0,08	0,02	0,10	<LOD	0,10	<LOD	0,03
DecaBDE	209	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2,4,4'-TriCB	28	0,04	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0,02	0,02	0,05
2,2',5,5'-TetCB	52	0,26	0,22	0,08	0,15	0,15	0,16	0,08	0,11	0,22	1,15
2,2',4,5,5'-PenCB	101	1,49	1,73	0,68	1,11	0,86	0,98	0,64	1,14	1,65	5,13
2,3',4,4',5-PenCB	118	0,95	0,98	0,31	0,60	0,48	0,44	0,33	0,58	0,98	3,15
2,2',3,4,4',5'-HexCB	138	3,46	8,56	2,38	5,20	3,91	2,65	2,38	2,98	4,67	9,49
2,2',4,4',5,5'-HexCB	153	5,76	14,44	4,50	11,16	7,17	4,71	4,39	5,02	8,05	15,53
2,2',3,4,4',5,5'-HepCB	180	1,91	4,85	2,27	8,03	3,44	1,42	1,91	1,94	3,06	5,20
DBDPE		<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	3,58	21,9	7,90
SCCP		30,00	25,00	18,00	16,00	17,00	18,00	10,00	20,00	12,00	21,00
MCCP		9,90	3,10	6,00	2,10	3,30	4,80	1,90	0,80	4,00	0,60

<LOD Less than Limit of Quantification

PCB, PBDE, CPs

Nr. of samples		1		2	3	4	5	6	7	8	10	11
Customer:			Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:			15/1831	15/1832	15/1833	15/1834	15/1835	15/1836	15/1837	15/1838	15/1839	15/1840
Individual:			pool	pool	pool	pool	pool	pool	pool	pool	pool	pool
Sampling year			2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Location			Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:			Soil pooled sample	Soil pooled sample	Soil pooled sample	Soil pooled sample	Soil pooled sample	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.
Concentration units:			ng/g dw	ng/g dw	ng/g dw	ng/g dw	ng/g dw	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:												
2,2',4,4'-TetBDE	47		0,07	0,09	0,05	0,10	0,08	<LOD	0,13	<LOD	<LOD	<LOD
2,2',4,4',5-PenBDE	99		0,04	0,05	0,04	0,07	0,07	<LOD	0,09	<LOD	<LOD	0,04
2,2',4,4',6-PenBDE	100		<LOD	<LOD	0,01	0,01	<LOD	<LOD	0,02	<LOD	<LOD	<LOD
3,3',4,4',5-PenBDE	126		<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2,2',4,4',5,5'-HexBDE	153		<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0,01	<LOD	<LOD	<LOD
2,2',4,4',5,6'-HexBDE	154		<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0,01	<LOD	<LOD	<LOD
2,2',3,4,4',5',6-HepBDE	183		<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2,3,3',4,4',5',6-HepBDE	191		<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2,2',3,3',4,4',5,6'-OctBDE	196		<LOD	<LOD	<LOD	<LOD	0,01	<LOD	<LOD	<LOD	<LOD	<LOD
2,2',3,3',5,5',6,6'-OctBDE	202		<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2,2',3,3',4,4',5,5',6-NonBDE	206		<LOD	0,01	<LOD	0,03	0,01	<LOD	<LOD	<LOD	<LOD	<LOD
2,2',3,3',4,4',5,6,6'-NonBDE	207		<LOD	0,01	<LOD	0,02	0,01	<LOD	<LOD	<LOD	<LOD	<LOD
DecaBDE	209	0,26		0,24	0,11	0,54	0,51	<LOD	<LOD	<LOD	<LOD	<LOD

2,4,4'-TriCB	28	0,03	0,03	0,02	0,04	0,02	<LOD	0,02	<LOD	0,05	<LOD
2,2',5,5'-TetCB	52	0,07	0,10	0,03	0,06	0,03	0,04	0,04	<LOD	0,19	0,03
2,2',4,5,5'-PenCB	101	0,51	0,48	0,08	0,24	0,13	0,13	0,15	0,11	0,65	0,06
2,3',4,4',5-PenCB	118	0,54	0,42	0,10	0,21	0,17	0,07	0,11	0,10	0,37	0,09
2,2',3,4,4',5'-HexCB	138	1,09	0,85	0,23	0,50	0,43	0,18	0,27	0,19	0,85	0,21
2,2',4,4',5,5'-HexCB	153	1,17	0,94	0,23	0,56	0,50	0,46	0,57	0,34	1,38	0,50
2,2',3,4,4',5,5'-HepCB	180	0,50	0,56	0,13	0,33	0,31	0,11	0,19	0,07	0,30	0,14
DBDPE		<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
SCCP		17	16	13	48	28	5,5	5	8,7	48	13
MCCP		16,0	7,6	5,6	89,0	14,0	3,4	8,7	1	9,5	8

<LOD Less than Limit of Quantification

PCB, PBDE, Cl

Nr. of samples		62	63	64	65	66	67	68	69	70	71
Customer:		Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:		15/2394	15/2399	15/2404	15/2409	15/2414	15/2419	15/2426	15/2429	15/2434	15/2439
Individual:											
Sampling year											
Location		Pooled sample 5 pieces	Pooled sample 5 pieces	Pooled sample 5 pieces	Pooled sample 5 pieces	Pooled sample 5 pieces	Pooled sample 5 pieces	Pooled sample 5 pieces	Pooled sample 5 pieces	Pooled sample 5 pieces	Pooled sample 5 pieces
Sample type:		Red fox liver opsjon 3	Red fox liver opsjon 3	Red fox liver opsjon 3	Red fox liver opsjon 3	Red fox liver opsjon 3	Red fox liver opsjon 3	Red fox liver opsjon 3	Red fox liver opsjon 3	Red fox liver opsjon 3	Red fox liver opsjon 3
Concentration units:		ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww

Compound name:											
2,2',4,4'-TetBDE	47	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0,07	0,07	<LOD
2,2',4,4',5-PenBDE	99	<LOD	<LOD	0,01	<LOD	0,01	<LOD	<LOD	0,05	0,05	<LOD
2,2',4,4',6-PenBDE	100	<LOD	<LOD	0,01	0,01	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
3,3',4,4',5-PenBDE	126	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2,2',4,4',5,5'-HexBDE	153	0,02	0,02	0,12	0,06	0,27	0,03	0,17	0,24	0,24	0,05
2,2',4,4',5,6'-HexBDE	154	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0,01	<LOD
2,2',3,4,4',5',6-HepBDE	183	<LOD	<LOD	0,01	0,01	0,02	<LOD	0,01	0,39	0,39	0,01
2,3,3',4,4',5',6-HepBDE	191	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2,2',3,3',4,4',5,6'-OctBDE	196	<LOD	<LOD	<LOD	<LOD	0,01	<LOD	<LOD	<LOD	0,07	<LOD
2,2',3,3',5,5',6,6'-OctBDE	202	<LOD	<LOD	<LOD	<LOD	0,04	<LOD	0,01	<LOD	<LOD	0,01
2,2',3,3',4,4',5,5',6-NonBDE	206	<LOD	<LOD	<LOD	<LOD	0,01	0,09	<LOD	0,07	0,07	<LOD
2,2',3,3',4,4',5,6,6'-NonBDE	207	<LOD	<LOD	0,04	0,03	0,27	0,12	0,02	0,55	0,55	0,02

DecaBDE	209	<LOD	0,70	<LOD	<LOD	3,77	3,16	<LOD	3,30	3,30	<LOD
2,4,4'-TriCB	28	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
2,2',5,5'-TetCB	52	<LOD	<LOD	<LOD	<LOD	<LOD	0,02	<LOD	<LOD	<LOD	<LOD
2,2',4,5,5'-PenCB	101	<LOD	0,03	0,05	0,03	<LOD	0,05	0,02	<LOD	<LOD	0,04
2,3',4,4',5-PenCB	118	0,08	0,15	0,17	0,10	0,04	0,14	0,06	0,07	<LOD	0,14
2,2',3,4,4',5'-HexCB	138	0,78	0,95	1,58	1,09	0,92	1,07	0,67	1,49	0,52	0,98
2,2',4,4',5,5'-HexCB	153	4,60	3,72	9,46	5,28	13,5	7,01	8,45	7,53	2,98	6,83
2,2',3,4,4',5,5'-HepCB	180	8,70	9,10	21,9	12,2	48,4	29,2	24,1	16,7	6,08	20,8

PFAS

Nr. of samples	52	53	54	55	56	57	58	59	60	61
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1881	15/1882	15/1883	15/1884	15/1885	15/1886	15/1887	15/1888	15/1889	15/1890
Sampling year:	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Location	Oslo 4732_2015	Oslo 4733_2015	Vestby 4735_2015	Vestby 4736_2015	Ås 4737_2015	Ås 4738_2015	Oslo 4739_2015	Oslo 4740_2015	Oslo 4741_2015	Oppegård 4742_2015
Sample type:	Egg, Sparrowhawk	Egg, Sparrowhawk	Egg, Sparrowhawk	Egg, Sparrowhawk	Egg, Sparrowhawk	Egg, Sparrowhawk	Egg, Sparrowhawk	Egg, Sparrowhawk	Egg, Sparrowhawk	Egg, Sparrowhawk
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
Perfluorooktansulfonamid (PFOSA)	0,029	0,239	<LOD	<LOD	0,015	0,025	0,009	0,012	0,026	0,024
Perfluorobutan sulfonat (PFBS)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Perfluoropentan sulfonat (PFPS)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Perfluorohexansulfonat (PFHxS)	0,133	0,062	0,047	0,055	0,089	0,200	0,016	0,087	0,171	0,199
Perfluoroheptansulfonat (PFHpS)	0,102	0,084	0,048	0,088	0,153	0,059	0,015	0,121	0,236	0,333
Perfluoroktan sulfonat (PFOS)	6,977	9,733	4,198	7,723	13,990	6,262	3,177	13,365	10,313	13,041
Perfluorononan sulfonat (PFNS)	<LOD	<LOD	<LOD	<LOD	<LOD	0,122	<LOD	<LOD	<LOD	<LOD
Perfluordekan sulfonat (PFDS)	0,022	0,362	0,056	<LOD	0,171	0,873	0,106	0,591	0,734	0,392

Perfluoroheksansyre (PFHxA)	0,001	<LOD	<LOD	0,001	<LOD	0,001	<LOD	0,001	<LOD	0,003
Perfluoroheptansyre (PFHpA)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Perfluoroktansyre (PFOA)	0,261	0,142	0,082	0,132	0,120	0,161	0,083	0,143	0,394	0,430
Perfluornonansyre (PFNA)	0,232	0,283	0,217	0,156	0,347	0,164	0,130	0,226	0,223	0,309
Perfluordekansyre (PFDcA)	0,494	0,597	0,406	0,317	0,858	0,313	0,311	0,600	0,406	0,647
Perfluorundecansyre (PFUnA)	0,780	0,980	0,749	0,448	1,613	0,429	0,365	0,955	0,610	0,782
Perfluordodecansyre (PFDoA)	1,531	1,961	0,821	1,032	1,961	0,921	0,793	1,824	1,502	1,590
Perfluortridecansyre (PFTrA)	2,356	2,579	1,615	1,250	4,023	1,321	1,032	2,883	2,371	2,193
Perfluortetradecansyre (PFTeA)	1,563	2,340	1,028	1,117	2,746	1,123	1,807	2,278	3,106	1,771

PFAS

Nr. of samples	42	43	44	45	46	47	48	49	50	51
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1871	15/1872	15/1873	15/1874	15/1875	15/1876	15/1877	15/1878	15/1879	15/1880
Individual:										
Sampling year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Location	Vestby 4348_2015	Vestby 4349_2015	Ås 4350_2015	Ås 4351_2015	Ås 4352_2015	Ås 4353_2015	Vestby 4354_2015	Vestby 4355_2015	Vestby 4356_2015	Vestby 4357_2015
Sample type:	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
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
Perfluorooktansulfonamid (PFOSA)	<LOD	<LOD	<LOD	<LOD	<LOD	0,576	<LOD	<LOD	<LOD	<LOD
Perfluorobutan sulfonat (PFBS)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Perfluoropentan sulfonat (PFPS)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Perfluorohexansulfonat (PFHxS)	0,017	<LOD	<LOD	<LOD	<LOD	0,013	<LOD	<LOD	<LOD	<LOD
Perfluoroheptansulfonat (PFHpS)	0,026	<LOD	0,023	<LOD	0,009	0,052	<LOD	<LOD	<LOD	<LOD
Perfluoroktan sulfonat (PFOS)	3,948	0,851	4,066	0,571	3,396	20,619	2,691	0,814	1,556	1,380
Perfluorononan sulfonat (PFNS)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Perfluordekan sulfonat (PFDS)	<LOD	<LOD	0,144	<LOD	0,120	0,042	0,078	<LOD	0,045	<LOD
Perfluoroheksansyre (PFHxA)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0,001
Perfluoroheptansyre (PFHpA)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

Perfluoroktansyre (PFOA)	0,007	0,003	0,002	0,001	0,002	0,031	0,002	0,001	0,005	0,001
Perfluornonansyre (PFNA)	0,093	0,012	0,020	0,007	0,011	0,052	0,025	0,012	0,024	0,009
Perfluordekansyre (PFDcA)	0,217	0,068	0,083	0,046	0,084	0,690	0,118	0,058	0,065	0,077
Perfluorundecansyre (PFUnA)	0,266	0,078	0,161	0,101	0,210	0,638	0,284	0,122	0,097	0,120
Perfluordodecansyre (PFDoA)	0,351	0,082	0,213	0,132	0,174	1,816	0,421	0,181	0,179	0,117
Perfluortridecansyre (PFTrA)	0,525	0,209	0,393	0,195	0,275	1,133	0,669	0,212	0,244	0,195
Perfluortetradecansyre (PFTeA)	0,379	0,139	0,296	0,131	0,171	1,192	0,376	0,112	0,221	0,101

PFAS

Nr. of samples	1	2	3	4	5	6	7	8	9	10
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1851	15/1852	15/1853	15/1854	15/1855	15/1856	15/1857	15/1858	15/1859	15/1860
Individual:	RR-0038	RR-0051	RR-0053	Furuset VI	209	210	211	212	213	214
Sampling year	2015	2015	2015		2015		2015		2015	
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
Perfluorooktansulfonamid (PFOSA)	1,08	<LOD	0,04	<LOD	<LOD	<LOD	<LOD	0,22	<LOD	0,20
Perfluorobutan sulfonat (PFBS)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Perfluoropentan sulfonat (PFPS)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Perfluorohexansulfonat (PFHxS)	0,64	0,30	0,61	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

Perfluoroheptansulfonat (PFHpS)	0,29	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Perfluoroktan sulfonat (PFOS)	32,80	27,38	11,70	1,35	5,22	15,87	9,75	5,31	6,53	14,67
Perfluorononan sulfonat (PFNS)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Perfluordekan sulfonat (PFDS)	0,19	0,28	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Perfluoroheksansyre (PFHxA)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0,36	<LOD	1,44	<LOD
Perfluoroheptansyre (PFHpA)	<LOD	<LOD	<LOD	0,01	0,03	0,15	0,25	0,33	0,27	0,17
Perfluoroktansyre (PFOA)	0,50	<LOD	<LOD	0,17	0,05	0,49	0,07	0,17	0,55	0,03
Perfluornonansyre (PFNA)	2,23	1,11	0,61	0,45	0,55	1,18	0,68	0,96	0,26	0,42
Perfluordekansyre (PFDcA)	3,53	0,85	1,82	0,19	0,30	1,41	0,65	0,73	<LOD	0,80
Perfluorundecansyre (PFUnA)	1,56	0,30	1,44	0,10	0,14	0,68	0,62	0,51	0,03	0,54
Perfluordodecansyre (PFDoA)	<LOD	<LOD	0,55	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Perfluortridecansyre (PFTrA)	0,59	0,23	1,02	<LOD	0,03	0,32	0,71	<LOD	<LOD	0,27
Perfluortetradecan syre (PFTeA)	0,13	<LOD	0,13	<LOD	<LOD	<LOD	<LOD	0,02	0,01	0,04

PFAS

NILU

Nr. of samples	1	2	3	4	5	6	7	8	9	10
Customer:	Miljødir.	Miljød	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1841	15/1842	15/1843	15/1844	15/1845	15/1846	15/1847	15/1848	15/1849	15/1850
Individual:	pool	pool	pool	pool	pool	pool				
Sampling year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Location	Ekeberg 4734_2015	4746_2015	Maridalen 4747_2015	Sognsvann 4748_2015	Midtstua 4749_2015	Sorkedalen 4750_2015	Østersjøvannet 4751_2015	Boler 4752_2015	Skullerud 4753_2015	Gronmo 4754_2015
Sample type:	Egg, Fieldfare	Egg Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
Perfluorooktansulfonamid (PFOSA)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0,02	<LOD	<LOD	0,10
Perfluorobutan sulfonat (PFBS)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Perfluoropentan sulfonat (PFPS)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Perfluorohexansulfonat (PFHxS)	0,05	0,05	0,02	0,02	0,07	0,07	0,08	0,02	0,01	0,17
Perfluoroheptansulfonat (PFHpS)	0,04	0,13	<LOD	0,03	0,05	0,16	0,20	0,01	0,03	0,54
Perfluoroktan sulfonat (PFOS)	3,68	23,27	1,13	3,76	6,41	19,61	19,22	3,98	5,38	70,33

Perfluorononan sulfonat (PFNS)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0,06
Perfluordekan sulfonat (PFDS)	<LOD	0,15	<LOD	0,04	0,06	<LOD	0,38	0,40	0,06	8,95
Perfluoroheksansyre (PFHxA)	<LOD	0,00	<LOD	<LOD	<LOD	0,01	<LOD	<LOD	<LOD	<LOD
Perfluoroheptansyre (PFHpA)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Perfluoroktansyre (PFOA)	0,12	0,12	0,02	0,08	0,41	0,12	0,27	0,07	0,09	0,63
Perfluornonansyre (PFNA)	0,12	0,11	0,04	0,12	0,29	0,11	0,28	0,11	0,14	0,45
Perfluordekansyre (PFDcA)	0,20	0,38	0,09	0,31	1,29	0,34	0,67	0,34	0,26	1,32
Perfluorundecansyre (PFUnA)	0,29	0,49	0,25	0,65	1,96	0,57	1,10	0,48	0,48	0,94
Perfluordodecansyre (PFDoA)	0,47	1,14	0,37	1,08	7,33	1,22	1,60	1,10	0,88	2,00
Perfluortridecansyre (PFTrA)	0,64	1,15	0,71	1,80	8,80	1,68	1,84	1,00	0,96	1,41
Perfluortetradecansyre (PFTeA)	0,53	1,52	0,52	1,74	19,31	1,29	1,95	1,19	0,88	2,32

PFAS

Nr. of samples	1	2	3	4	5	6	7	8	10	11
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1831	15/1832	15/1833	15/1834	15/1835	15/1836	15/1837	15/1838	15/1839	15/1840
Individual:	pool	pool	pool	pool	pool	pool	pool	pool	pool	pool
Sampling year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Location	Maridalen	Slottsparken	Svartdalparken	Grorud	Voksenk ollen II	Grorud 4898	Svartdalparken 4896	Maridalen 4900	Slottsparken 4901	Voksen II 4907
Sample type:	Soil pooled sample	Soil pooled sample	Soil pooled sample	Soil pooled sample	Soil pooled sample	Earthworm s whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
Perfluorooktansulfonamid (PFOSA)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Perfluorobutan sulfonat (PFBS)	0,001	<LOD	<LOD	0,001	<LOD	<LOD	0,94	0,13	0,63	0,94
Perfluoropentan sulfonat (PFPS)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Perfluorohexansulfonat (PFHxS)	<LOD	<LOD	<LOD	<LOD	0,003	1,11	1,70	1,28	1,99	1,74
Perfluoroheptansulfonat (PFHpS)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Perfluoroktan sulfonat (PFOS)	0,032	0,034	0,020	0,005	0,108	0,55	8,53	0,84	10,76	32,39
Perfluorononan sulfonat (PFNS)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Perfluordekan sulfonat (PFDS)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

Perfluoroheksansyre (PFHxA)	0,009	0,005	0,002	0,135	0,034	0,41	0,87	0,35	0,72	7,53
Perfluoroheptansyre (PFHpA)	0,017	0,002	<LOD	0,256	0,084	1,91	0,59	1,14	1,20	8,21
Perfluoroktansyre (PFOA)	0,091	0,038	0,007	0,782	0,369	4,22	1,20	0,34	3,37	5,30
Perfluornonansyre (PFNA)	0,018	0,007	0,001	0,089	0,050	0,33	0,19	0,02	0,53	1,31
Perfluordekansyre (PFDcA)	0,005	0,010	0,001	0,013	0,030	0,07	0,53	0,01	0,85	4,00
Perfluorundecansyre (PFUnA)	<LOD	0,001	<LOD	<LOD	0,001	0,02	0,57	0,11	0,44	1,07
Perfluordodecansyre (PFDoA)	<LOD	0,001	<LOD	0,004	0,005	0,11	1,59	0,03	1,59	7,78
Perfluortridecansyre (PFTrA)	<LOD	<LOD	<LOD	<LOD	0,007	<LOD	1,12	0,71	0,85	1,48
Perfluortetradecansyre (PFTeA)	<LOD	<LOD	<LOD	<LOD	<LOD	0,24	0,68	0,36	1,90	6,26

PFAS

Nr. of samples				62	63	64	65	66	67	68
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/2394	15/2396	15/2398	15/2400	15/2402	15/2404	15/2406	15/2408	15/2410	15/2412
Individual:										
Sampling year	2011	2011	2011	2011	2011	2012	2012	2012	2012	2012
Location										
Sample type:	Red fox liver opsjon 3	Red fox liver opsjon 3	Red fox liver opsjon 3	Red fox liver opsjon 3	Red fox liver opsjon 3	Red fox liver opsjon 3	Red fox liver opsjon 3	Red fox liver opsjon 3	Red fox liver opsjon 3	Red fox liver opsjon 3
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
Perfluorooktansulfonamid (PFOSA)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Perfluorobutan sulfonat (PFBS)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Perfluoropentan sulfonat (PFPS)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Perfluorohexansulfonat (PFHxS)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Perfluoroheptansulfonat (PFHpS)	<LOD	<LOD	0,01	0,01	0,03	<LOD	0,05	0,01	<LOD	0,02
Perfluoroktan sulfonat (PFOS)	0,66	0,99	0,96	0,73	1,41	3,00	2,98	2,20	0,97	1,95
Perfluorononan sulfonat (PFNS)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

Perfluordekan sulfonat (PFDS)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Perfluoroheksansyre (PFHxA)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Perfluoroheptansyre (PFHpA)	0,02	0,27	<LOD	<LOD	0,08	0,13	<LOD	<LOD	<LOD	0,04
Perfluoroktansyre (PFOA)	0,01	0,01	0,01	<LOD	0,05	0,03	0,09	0,07	0,04	0,03
Perfluornonansyre (PFNA)	0,42	0,37	0,52	0,22	1,26	3,69	0,65	1,84	1,14	1,04
Perfluordekansyre (PFDcA)	0,30	0,35	0,30	0,26	0,45	0,69	0,44	0,50	0,53	0,82
Perfluorundecansyre (PFUnA)	0,36	0,46	0,48	0,31	0,79	0,86	0,58	0,96	0,81	1,61
Perfluordodecansyre (PFDoA)	0,07	0,10	0,12	0,07	0,20	0,17	0,19	0,20	0,16	0,56
Perfluortridecansyre (PFTrA)	0,07	0,17	0,18	0,03	0,12	0,21	0,29	0,20	0,18	1,20
Perfluortetradecansyre (PFTeA)	0,01	0,00	0,01	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0,09

Metalls

Nr. of samples	52	53	54	55	56	57	58	59	60	61
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1881	15/1882	15/1883	15/1884	15/1885	15/1886	15/1887	15/1888	15/1889	15/1890
Year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	Egg, Sparrowhawk	Egg, Sparrowhawk	Egg, Sparrowhawk	Egg, Sparrowhawk	Egg, Sparrowhawk	Egg, Sparrowhawk	Egg, Sparrowhawk	Egg, Sparrowhawk	Egg, Sparrowhawk	Egg, Sparrowhawk
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
52 Cr	9,34	3,68	6,40	6,16	5,46	4,49	2,78	4,04	3,15	5,12
60 Ni	6,90	5,06	5,11	5,25	4,28	1,08	1,63	5,48	5,08	2,40
63 Cu	458,92	688,57	1000,61	607,61	501,93	642,85	522,67	438,92	518,77	485,76
66 Zn	10165,34	6125,06	3970,76	8678,26	8278,65	9107,82	6179,21	7215,03	6454,72	10320,04
75 As	0,00	0,00	0,94	0,00	1,15	0,00	2,69	0,00	0,69	0,15
107 Ag	0,00	0,04	0,05	0,02	0,22	0,07	0,00	0,00	0,04	0,12
111 Cd	0,08	0,11	0,08	0,16	0,08	0,27	0,13	0,23	0,09	0,17
208 Pb	5,54	3,79	0,87	46,56	4,85	9,08	2,52	1,78	1,60	3,20
201 Hg	157,22	132,68	112,35	180,72	175,28	124,04	65,96	161,78	195,67	151,04

Metalls

Nr. of samples	42	43	44	45	46	47	48	49	50	51
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1871	15/1872	15/1873	15/1874	15/1875	15/1876	15/1877	15/1878	15/1879	15/1880
Individual:										
Sampling year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	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
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
52 Cr	4,83	2,39	6,60	105,70	75,09	74,38	10,47	4,05	2,78	18,93
60 Ni	0,81	3,91	3,55	28,26	8,34	339,83	4,59	7,51	0,84	7,27
63 Cu	846,38	624,23	1840,55	967,97	969,91	800,39	839,81	1513,64	766,86	943,38
66 Zn	13722,56	9744,53	3467,75	15006,77	13709,62	8240,88	13860,27	13420,16	5427,16	12334,57
75 As	1,00	0,03	1,15	2,11	0,00	0,00	1,46	0,85	0,00	0,00
107 Ag	0,53	1,13	0,50	1,36	0,45	0,59	0,95	1,82	0,34	0,35
111 Cd	0,16	0,25	0,00	0,46	0,15	0,12	0,09	0,35	0,06	0,19
208 Pb	7,48	2,57	0,87	47,07	13,32	24,75	3,91	13,23	17,63	2,17
201 Hg	24,39	15,71	25,11	20,82	15,19	16,12	14,73	8,73	13,22	7,60

Metalls

NILU

Nr. of samples	1	2	3	4	5	6	7	8	9	10
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1851	15/1852	15/1853	15/1854	15/1855	15/1856	15/1857	15/1858	15/1859	15/1860
Individual:	RR-0038	RR-0051	RR-0053	Furuset VI	209	210	211	212	213	214
Sampling year	2015	2015	2015							
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
52 Cr	199	68	131	1795	1105	61	619	346	70	77
60 Ni	28	9,11	65	851	521	24	270	99	21	52
63 Cu	11211	12831	45841	4701	11354	20921	9950	9241	10258	7555
66 Zn	37714	54332	84088	44221	42094	55926	49191	52395	33937	52078
75 As	381	<LOD	<LOD	26	9,50	2929	23	13	7,3	304
107 Ag	9,9	15,3	101,3	0,7	1,7	11,5	2,4	4,0	0,4	6,8
111 Cd	313	27	863	67	76	381	297	109	59	33
208 Pb	38521	205	696	174	53	78	76	59	69	21
201 Hg	605	71	233	16,9	58,5	69,9	81,5	36,9	33,5	91,4

Metalls

NILU

Nr. of samples	1	2	3	4	5	6	7	8	9	10
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1861	15/1862	15/1863	15/1864	15/1865	15/1866	15/1867	15/1868	15/1869	15/1870
Individual:	99003/16	99004/16	99005/16	99010/16	99011/16	99012/16	99013/16	99001/16 og 99023/16	99026/16	99002/16 og 99030/16
Sampling year	2015	2015	2015							
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
52 Cr	261,4	76,3	44,1	86,8	192,8	411,0	46,3	1759,4	320,7	448,0
60 Ni	128,9	21,1	19,7	25,2	77,0	181,9	23,3	893,6	130,3	186,8
63 Cu	3244	4966	4406	3855	3394	3537	2227	3898	3329	6232
66 Zn	25434	45687	24214	24579	19680	27546	18888	28899	24956	31179
75 As	1410	1485	4815	1244	1974	8642	4261	8140	1243	1944
107 Ag	0,55	0,52	0,18	0,10	0,72	0,19	0,26	0,85	0,24	1,63
111 Cd	14,3	18,2	123,4	14,6	14,4	167,1	22,2	290	11,4	167
208 Pb	151,4	48,2	366,5	54,9	72,1	99,9	239,5	299	18,9	43,8
201 Hg	6,7	4,7	5,5	5,8	3,0	39,9	7,0	32,2	3,9	8,6

Metalls

NILU

Nr. of samples	1	2	3	4	5	6	7	8	10	11
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1831	15/1832	15/1833	15/1834	15/1835	15/1836	15/1837	15/1838	15/1839	15/1840
Individual:	pool	pool	pool	pool	pool	pool	pool	pool	pool	pool
Sampling year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	Soil pooled sample	Soil pooled sample	Soil pooled sample	Soil pooled sample	Soil pooled sample	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
52 Cr	60745	64632	37682	77669	18530	1823			3,1	5,1
60 Ni	23212	34243	22136	37259	6520	982			5,1	2,4
63 Cu	22314	28390	24786	34806	129612	2850			519	486
66 Zn	136932	110847	84532	180867	58859	192699			6455	10320
75 As	8397	9188	5273	7866	7046	723			0,69	0,15
107 Ag	326	262	127	441	432	26			0,04	0,12
111 Cd	386	225	202	361	1735	1257			0,09	0,17
208 Pb	165691	43883	15239	35442	164832	1222			1,60	3,20
201 Hg	320	248	56	74	224	100			196	151

DDTs and pesticides

Nr. of samples	52	53	54	55	56	57	58	59	60	61
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1881	15/1882	15/1883	15/1884	15/1885	15/1886	15/1887	15/1888	15/1889	15/1890
Individual:										
Location	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Sample type:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Concentration units:	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
	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
trans-Chlordane	<LOD	0,02	<LOD	0,02	<LOD	0,02	0,02	<LOD	<LOD	<LOD
cis-Chlordane	0,03	0,14	<LOD	0,04	0,07	0,09	0,05	0,06	<LOD	0,11
Oxy-chlordane	4,13	4,93	10,3	4,65	42,5	27,7	4,15	12,1	5,81	20,3
Heptachlor	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
trans-Nonachlor	2,73	7,43	6,91	4,56	24,4	22,8	4,47	17,3	4,54	12,6
cis-Nonachlor	0,64	1,59	0,94	0,85	6,57	5,09	1,28	3,68	0,69	3,41
HCB	57,6	5,54	6,96	11,0	32,7	14,1	7,30	12,4	16,1	18,9
Mirex	3,01	0,71	2,32	1,07	7,09	2,98	0,67	1,52	0,92	2,72

o.p'-DDE	0,107	0,0209	0,0525		0,0517	0,161	0,0417			0,126
p,p'-DDE	1570	825	579		975	432	418			356
o,p'-DDD	0,0443	<LOD	<LOD		0,116	0,0362	0,0211			0,0538
p,p'-DDD	29,1	4,04	4,99		42,4	11,9	3,71			11,7
o,p'-DDT	0,0655	<LOD	<LOD		0,172	0,0449	<LOD			<LOD
p,p'-DDT	23,5	3,66	2,06		42,2	8,87	4,61			13,1

DDTs and pesticides

Nr. of samples	42	43	44	45	46	47	48	49	50	51
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1871	15/1872	15/1873	15/1874	15/1875	15/1876	15/1877	15/1878	15/1879	15/1880
Individual:										
Sampling year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	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
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
trans-Chlordane	<LOD	<LOD	0,02	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
cis-Chlordane	<LOD	<LOD	0,05	<LOD	<LOD	0,01	<LOD	<LOD	<LOD	<LOD
Oxy-chlordane	3,31	4,65	4,99	1,88	2,84	1,16	1,98	4,51	4,29	1,59
Heptachlor	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
trans-Nonachlor	0,50	1,20	0,99	0,27	0,51	0,19	0,72	0,80	0,46	0,26
cis-Nonachlor	0,16	0,26	0,23	0,07	0,16	0,05	0,18	0,22	0,12	0,16
HCB	1,45	6,95	5,08	2,46	1,75	1,22	3,46	2,74	1,90	1,66
Mirex	0,15	0,53	0,20	0,12	0,19	0,21	0,28	0,12	0,15	0,11

o.p'-DDE	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
p,p'-DDE	52,6	36,7	20,8	226	207	57,1	31,3	17,1	24,3	21,3
o,p'-DDD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
p,p'-DDD	0,684	0,545	0,108	0,544	1,21	0,371	1,04	0,171	0,241	0,0536
o,p'-DDT	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
p,p'-DDT	0,936	0,954	0,154	0,464	1,54	0,512	1,3	0,147	0,39	0,131

Pesticide
s

NILU

Nr. of samples	1	2	3	4	5	6	7	8	9	10
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1851	15/1852	15/1853	15/1854	15/1855	15/1856	15/1857	15/1858	15/1859	15/1860
Individual:	RR-0038	RR-0051	RR-0053	Furuset VI	209	210	211	212	213	214
Sampling year	2015	2015	2015							
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
trans-Chlordane	0,03	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
cis-Chlordane	0,03	<LOD	0,03	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Oxy-chlordane	318	4,89	10,7	1,2	13,1	16,4	5,04	14,1	18,1	4,16
Heptachlor	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
trans-Nonachlor	6,00	0,06	0,3	0,14	0,23	0,33	0,19	0,08	0,22	0,48
cis-Nonachlor	0,03	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
HCB	3,71	0,32	0,37	0,12	0,18	0,31	0,25	0,39	0,28	0,54
Mirex	2,37	0,1	0,14	<LOD	0,06	0,13	0,06	0,18	0,14	0,08

Pesticides

Nr. of samples	1	2	3	4	5	6	7	8	9	10
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1861	15/1862	15/1863	15/1864	15/1865	15/1866	15/1867	15/1868	15/1869	15/1870
Individual:	99003/16	99004/16	99005/16	99010/16	99011/16	99012/16	99013/16	99001/16 og 99023/16	99026/16	99002/16 og 99030/16
Sampling year	2015	2015	2015							
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
trans-Chlordane	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
cis-Chlordane	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Oxy-chlordane	0,8	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0,36	<LOD
Heptachlor	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
trans-Nonachlor	0,1	<LOD	<LOD	<LOD	<LOD	<LOD	0,12	<LOD	<LOD	<LOD
cis-Nonachlor	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
HCB	1,13	2,79	0,05	0,43	0,77	0,2	<LOD	0,07	0,92	<LOD
Mirex	0,07	0,09	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

Pesticides

Nr. of samples	1	2	3	4	5	6	7	8	9	10
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1841	15/1842	15/1843	15/1844	15/1845	15/1846	15/1847	15/1848	15/1849	15/1850
Individual:	pool	pool	pool	pool	pool	pool				
Sampling year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
trans-Chlordane	0,010	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
cis-Chlordane	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Oxy-chlordane	0,470	0,52	0,52	1,95	0,65	<LOD	0,73	0,53	0,45	0,94
Heptachlor	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
trans-Nonachlor	0,64	0,37	0,57	1,57	0,53	0,46	0,53	1,25	0,4	1,14
cis-Nonachlor	0,15	0,1	0,1	0,31	0,09	0,1	0,07	0,15	0,07	0,22
HCB	4,06	1,48	1,72	3,32	1,21	1,2	3,29	5,43	2,94	3,82
Mirex	0,13	0,05	0,05	0,07	0,04	0,07	0,05	0,05	0,07	0,12

Pesticides

Nr. of samples	1	2	3	4	5	6	7	8	10	11
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1831	15/1832	15/1833	15/1834	15/1835	15/1836	15/1837	15/1838	15/1839	15/1840
Individual:	pool	pool	pool	pool	pool	pool	pool	pool	pool	pool
Sampling year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	Soil pooled sample	Soil pooled sample	Soil pooled sample	Soil pooled sample	Soil pooled sample	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.
Concentration units:	ng/g dw	ng/g dw	ng/g dw	ng/g dw	ng/g dw	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
trans-Chlordane	<LOD	<LOD	0,02	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
cis-Chlordane	0,03	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Oxy-chlordane	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Heptachlor	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
trans-Nonachlor	0,05	0,03	0,07	0,05	0,04	0,05	0,08	0,04	0,06	0,03
cis-Nonachlor	0,02	0,00	0,02	0,02	0,02	<LOD	<LOD	<LOD	0,01	<LOD
HCB	0,28	0,12	0,13	17,40	0,27	2,35	0,19	0,08	0,18	0,28
Mirex	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

OPFR

Nr. of samples	52	53	54	55	56	57	58	59	60	61
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1881	15/1882	15/1883	15/1884	15/1885	15/1886	15/1887	15/1888	15/1889	15/1890
Individual:										
Location	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Sample type:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Concentration units:	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
	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
TEP	< 0.52	0,57	< 0.52	< 0.52	< 0.52	< 0.52	< 0.52	< 0.52	< 0.52	< 0.52
TCEP	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29
TPrP	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
TCPP	< 1.38	< 1.38	< 1.38	< 1.38	< 1.38	< 1.38	< 1.38	< 1.38	< 1.38	< 1.38
TiBP	< 1.08	< 1.08	< 1.08	< 1.08	< 1.08	< 1.08	< 1.08	< 1.08	< 1.08	< 1.08
BdPhP	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
TPP	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	0,31	< 0.20	< 0.20	< 0.20	< 0.20

DBPhP	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07
TnBP	< 3.31	< 3.31	< 3.31	< 3.31	< 3.31	< 3.31	< 3.31	< 3.31	< 3.31	< 3.31
TDCPP	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
TBEP	< 3.33	< 3.13	< 3.33	< 3.33	< 3.33	< 3.33	< 3.33	< 3.33	< 3.33	< 3.33
TCP	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07
EHDP	< 0.62	< 0.62	< 0.62	< 0.62	< 0.62	< 0.62	< 0.62	< 0.62	< 0.62	< 0.62
TEHP	0,25	0,13	0,29	< 0.11	0,28	< 0.11	< 0.11	< 0.11	0,20	0,20

OPFR

NILU

Nr. of samples	42	43	44	45	46	47	48	49	50	51
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1871	15/1872	15/1873	15/1874	15/1875	15/1876	15/1877	15/1878	15/1879	15/1880
Individual:										
Sampling year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	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
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
TEP	< 0.52	< 0.52	< 0.52	< 0.52	< 0.52	< 0.52	< 0.52	< 0.52	< 0.52	< 0.52
TCEP	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29
TPrP	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
TCPP	< 1.38	< 1.38	< 1.38	< 1.38	< 1.38	< 1.38	< 1.38	< 1.38	< 1.38	< 1.38
TiBP	< 1.08	< 1.08	< 1.08	< 1.08	< 1.08	< 1.08	< 1.08	< 1.08	< 1.08	< 1.08
BdPhP	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
TPP	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
DBPhP	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07
TnBP	< 3.31	< 3.31	< 3.31	< 3.31	< 3.31	< 3.31	< 3.31	< 3.31	< 3.31	< 3.31
TDCPP	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
TBEP	< 3.33	< 3.33	< 3.33	< 3.33	< 3.33	< 3.33	< 3.13	< 3.33	3,70	< 3.33
TCP	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07
EHDP	< 0.62	< 0.62	< 0.62	< 0.62	< 0.62	< 0.62	0,67	< 0.62	< 0.62	< 0.62
TEHP	< 0.11	0,22	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11	0,28

OPFR

Nr. of samples	1	2	3	4	5	6	7	8	9	10
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1851	15/1852	15/1853	15/1854	15/1855	15/1856	15/1857	15/1858	15/1859	15/1860
Individual:	RR-0038	RR-0051	RR-0053	Furuset VI	209	210	211	212	213	214
Sampling year	2015	2015	2015							
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
TEP	< 0.08	0,23	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08	3,64
TCEP	< 0.2	< 0.2	< 0.2	1,06	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
TPrP	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
TCPP	0,30	1,25	0,52	0,99	1,27	0,68	0,86	0,76	2,52	1,43
TiBP	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0,50	0,15	< 0.1	< 0.1
BdPhP	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
TPP	0,10	0,19	0,25	0,14	< 0.01	< 0.01	0,37	< 0.01	0,38	0,61
DBPhP	< 0.01	0,59	0,29	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
TnBP	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	1,19	0,83	< 0.2	< 0.2
TDCPP	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TBEP	0,22	< 0.2	0,43	< 0.2	< 0.2	< 0.2	3,13	1,10	< 0.2	< 0.2
TCP	< 0.01	0,02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
EHDP	< 0.03	< 0.03	< 0.03	0,96	2,74	0,85	3,32	1,14	0,55	0,66
TEHP	0,08	0,08	0,09	<0.05	<0.05	<0.05	0,17	<0.05	<0.05	<0.05

OPFR

NILU

Nr. of samples	1	2	3	4	5	6	7	8	9	10
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1861	15/1862	15/1863	15/1864	15/1865	15/1866	15/1867	15/1868	15/1869	15/1870
Individual:	99003/16	99004/16	99005/16	99010/16	99011/16	99012/16	99013/16	99001/16 og 99023/16	99026/16	99002/16 og 99030/16
Sampling year	2015	2015	2015							
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
TEP	< 0.08	< 0.08	0,23	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08
TCEP	0,39	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0,41	3,46	< 0.2	< 0.2
TPrP	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
TCPP	0,49	0,20	0,20	0,55	0,29	0,21	0,60	27,98	2,35	4,20
TiBP	0,99	0,21	0,15	1,86	0,20	0,68	0,20	< 0.1	< 0.1	< 0.1
BdPhP	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
TPP	0,12	0,25	0,30	< 0.01	< 0.01	6,74	0,15	0,29	< 0.01	<0.10
DBPhP	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
TnBP	0,15	0,09	0,07	0,13	0,07	0,08	0,08	< 0.2	< 0.2	< 0.2

TDCPP	< 0.1	< 0.1	0,71	< 0.1	< 0.1	< 0.1	< 0.1	0,31	< 0.1	< 0.1
TBEP	0,50	0,22	0,58	0,41	0,42	0,37	0,56	< 0.2	< 0.2	< 0.2
TCP	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
EHDP	0,28	0,84	0,67	< 0.03	0,25	15,98	0,35	1,01	< 0.03	< 0.03
TEHP	<0.05	<0.05	0,15	<0.05	<0.05	<0.05	0,15	<0.05	<0.05	<0.05

OPFR

Nr. of samples	1	2	3	4	5	6	7	8	9	10
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1861	15/1862	15/1863	15/1864	15/1865	15/1866	15/1867	15/1868	15/1869	15/1870
Individual:	99003/16	99004/16	99005/16	99010/16	99011/16	99012/16	99013/16	99001/16 og 99023/16	99026/16	99002/16 og 99030/16
Sampling year	2015	2015	2015							
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
TEP	< 0.08	< 0.08	0,23	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08
TCEP	0,39	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0,41	3,46	< 0.2	< 0.2
TPrP	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
TCPP	0,49	0,20	0,20	0,55	0,29	0,21	0,60	27,98	2,35	4,20
TiBP	0,99	0,21	0,15	1,86	0,20	0,68	0,20	< 0.1	< 0.1	< 0.1
BdPhP	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
TPP	0,12	0,25	0,30	< 0.01	< 0.01	6,74	0,15	0,29	< 0.01	<0.10
DBPhP	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

TnBP	0,15	0,09	0,07	0,13	0,07	0,08	0,08	< 0.2	< 0.2	< 0.2
TDCPP	< 0.1	< 0.1	0,71	< 0.1	< 0.1	< 0.1	< 0.1	0,31	< 0.1	< 0.1
TBEP	0,50	0,22	0,58	0,41	0,42	0,37	0,56	< 0.2	< 0.2	< 0.2
TCP	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
EHDP	0,28	0,84	0,67	< 0.03	0,25	15,98	0,35	1,01	< 0.03	< 0.03
TEHP	<0.05	<0.05	0,15	<0.05	<0.05	<0.05	0,15	<0.05	<0.05	<0.05

OPFR

Nr. of samples	1	2	3	4	5	6	7	8	10	11
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1831	15/1832	15/1833	15/1834	15/1835	15/1836	15/1837	15/1838	15/1839	5/1840
Individual:	pool	pool	pool	pool	pool	pool	pool	pool	pool	ool
Sampling year	2015	2015	2015	2015	2015	2015	2015	2015	2015	015
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	slo
Sample type:	Soil pooled sample	Soil pooled sample	Soil pooled sample	Soil pooled sample	Soil pooled sample	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	g/g ww
Compound name:										
TEP	< 0.52	< 0.52	< 0.52	1,52	< 0.52	< 0.18	< 0.18	< 0.18	< 0.18	< 0.18
TCEP	< 0.15	0,31	0,57	< 0.15	0,43	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08
TPrP	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
TCPP	< 1.93	< 1.93	< 1.93	102,4	< 1.93	1,60	2,58	< 1.8	< 1.8	< 1.8
TiBP	< 1.53	< 1.53	< 1.53	< 1.53	< 1.53	2,2	2,6	< 1.0	3,2	1,7

BdPhP	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
TPP	0,31	0,93	< 0.18	3,00	2,55	0,24	0,13	0,17	0,21	0,11
DBPhP	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
TnBP	< 0.26	< 0.26	1,22	< 0.26	< 0.26	< 6.2	< 6.2	< 6.2	< 6.2	< 6.2
TDCPP	< 2.89	< 2.89	< 2.89	< 2.89	< 2.89	< 0.18	4,0	< 0.18	2,0	1,2
TBEP	< 7.8	< 7.8	< 7.8	17,39	< 7.8	3,7	6,4	< 2.1	< 2.1	< 2.1
TCP	2,05	1,46	< 0.18	0,49	1,07	0,05	0,01	0,16	0,05	< 0.01
EHDP	< 1.51	< 1.51	< 1.51	< 1.51	2,39	0,48	0,19	0,51	0,31	< 0.02
TEHP	< 0.09	< 0.09	0,55	9,73	1,72	1,49	0,44	0,09	0,22	0,30

Cyclic siloxanes

Nr. of samples	52	53	54	55	56	57	58	59	60	61
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1881	15/188 2	15/1883	15/1884	15/1885	15/1886	15/1887	15/1888	15/1889	15/1890
Individual:										
Location	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Sample type:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
	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
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
D4	< LOQ	< LOQ	< LOQ	3,61	5,59	< LOQ	< LOQ	< LOQ	< LOQ	3,59
D5	4,06	4,43	10,99	4,98	7,37	4,87	6,32	8,63	4,14	5,07
D6	2,74	2,52	2,27	2,19	2,32	2,70	2,56	3,58	2,51	2,94

Cyclic siloxanes

Nr. of samples	42	43	44	45	46	47	48	49	50	51
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1871	15/1872	15/1873	15/1874	15/1875	15/1876	15/1877	15/1878	15/1879	15/1880
Individual:										
Sampling year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	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
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
D4	1,76	1,74	1,77	5,05	1,91	27,74	4,50	4,08	3,71	3,21
D5	< LOQ	< LOQ	< LOQ	< LOQ	< LOQ	5,99	3,11	3,11	7,41	2,47
D6	1,78	1,22	1,44	< LOQ	1,85	2,91	2,77	2,47	3,09	1,81

Cyclic siloxanes

Nr. of samples	1	2	3	4	5	6	7	8	9	10
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1861	15/1862	15/1863	15/1864	15/1865	15/1866	15/1867	15/1868	15/1869	15/1870
Individual:	99003/16	99004/16	99005/16	99010/16	99011/16	99012/16	99013/16	99001/16 og 99023/16	99026/16	99002/16 og 99030/16
Sampling year	2015	2015	2015							
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
D4	5,8	8,2	< LOQ	28,8	22,6	13,7	7,0	< LOQ	18,1	24,8
D5	6,1	16,2	4,1	15,3	22,9	15,3	18,1	4,3	30,0	27,6
D6	< LOD	< LOD	< LOD	< LOD	28,5	22,1	< LOQ	< LOQ	30,8	33,2

Cyclic siloxanes

Nr. of samples	1	2	3	4	5	6	7	8	9	10
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1861	15/1862	15/1863	15/1864	15/1865	15/1866	15/1867	15/1868	15/1869	15/1870
Individual:	99003/16	99004/16	99005/16	99010/16	99011/16	99012/16	99013/16	99001/16 og 99023/16	99026/16	99002/16 og 99030/16
Sampling year	2015	2015	2015							
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
D4	7,5	< LOQ	< LOQ	10,8	8,51	7,50	8,63	11,7	10,8	9,19
D5	23,8	< LOD	< LOD	<LOD	<LOD	<LOD	8,39	12,3	9,18	10,2
D6	9,8	6,7	7,5	<LOD	<LOD	<LOD	8,23	19,7	8,6	11,9

Cyclic siloxanes

Nr. of samples	1	2	3	4	5	6	7	8	9	
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1841	15/1842	15/1843	15/1844	15/1845	15/1846	15/1847	15/1848	15/1849	15/1850
Individual:	pool	pool	pool	pool	pool	pool				
Sampling year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
D4	2,38	2,79	1,85	1,76	< LOQ	2,76	< LOQ	1,81	1,96	1,90
D5	< LOQ	< LOQ	< LOQ	< LOQ	< LOQ	< LOQ	< LOQ	< LOQ	< LOQ	< LOQ
D6	2,12	1,48	1,49	2,90	2,84	1,77	1,57	5,08	1,84	1,90

Cyclic siloxanes

Nr. of samples	1	2	3	4	5	6	7	8	10	11
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1831	15/1832	15/1833	15/1834	15/1835	15/1836	15/1837	15/1838	15/1839	15/1840
Individual:	pool	pool	pool	pool	pool	pool	pool	pool	pool	pool
Sampling year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	Soil pooled sample	Soil pooled sample	Soil pooled sample	Soil pooled sample	Soil pooled sample	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
D4	1,39	< LOQ	1,78	1,88	< LOQ	< LOQ		1,61	< LOQ	
D5	0,91	1,08	1,54	1,33	< LOQ	0,87		1,47	0,87	
D6	< LOQ	< LOQ	< LOQ	< LOQ	< LOQ	1,22		1,93	< LOQ	

Stabile Isotoper & Lipid %

Nr. of samples	52	53	54	55	56	57	58	59	60	61
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1881	15/1882	15/1883	15/1884	15/1885	15/1886	15/1887	15/1888	15/1889	15/1890
Individual:										
Location	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Sample type:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Concentration units:	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
	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
$\delta^{34}S_{VCDT}$	5,56	6,70	7,33	7,37	6,82	7,12	5,83	6,00	5,46	6,17
$\delta^{13}C_{VPDB}$	-24,87	-24,78	-23,51	-25,38	-26,99	-24,88	-24,66	-24,86	-23,99	-24,98
$\delta^{15}N_{AIR}$	5,93	5,78	8,74	6,96	6,49	9,73	7,15	8,93	7,17	7,03
lipid%	1,1	0,8	2	1,9	4,4	6,6	2,6	2,4	3,4	3,3

Stabile Isotoper & Lipid %

Nr. of samples	42	43	44	45	46	47	48	49	50	51
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1871	15/1872	15/1873	15/1874	15/1875	15/1876	15/1877	15/1878	15/1879	15/1880
Individual:										
Location	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Sample type:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
	Egg,	Egg,	Egg,	Egg,	Egg,	Egg,	Egg,	Egg,	Egg,	Egg,
Concentration units:	Tawny owl	Tawny owl	Tawny owl	Tawny owl	Tawny owl	Tawny owl	Tawny owl	Tawny owl	Tawny owl	Tawny owl
	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
$\delta^{34}S_{VCDT}$										
$\delta^{13}C_{VPDB}$	4,42	6,51	5,07	6,31	5,92	7,18	6,24	2,31	4,39	5,81
$\delta^{15}N_{AIR}$	-28,02	-28,69	-29,56	-28,73	-28,78	-29,05	-27,87	-28,52	-28,69	-29,51
	7,40	8,08	7,31	9,28	8,18	7,78	8,58	8,19	6,51	7,52
lipid%	2,2	3,3	5,7	3,3	2,8	2,6	4,2	4,2	3	4,1

Stabile Isotoper

Nr. of samples	1	2	3	4	5	6	7	8	9	10
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1851	15/1852	15/1853	15/1854	15/1855	15/1856	15/1857	15/1858	15/1859	15/1860
Individual:	RR-0038	RR-0051	RR-0053	Furuset VI	209	210	211	212	213	214
Sampling year	2015	2015	2015							
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
$\delta^{34}S_{VCDT}$	9,49	5,60	4,84	3,81	3,65	5,30	2,67	3,42	3,14	1,96
$\delta^{13}C_{VPDB}$	-24,14	-25,56	-25,08	-25,58	-26,25	-25,64	-26,26	-25,93	-26,10	-26,01
$\delta^{15}N_{AIR}$	13,12	8,39	6,43	8,53	8,90	9,25	9,05	8,85	9,03	8,89

Stabile Isotoper

Nr. of samples	1	2	3	4	5	6	7	8	9	10
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1851	15/1852	15/1853	15/1854	15/1855	15/1856	15/1857	15/1858	15/1859	15/1860
Individual:	RR-0038	RR-0051	RR-0053	Furuset VI	209	210	211	212	213	214
Sampling year	2015	2015	2015							
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
$\delta^{34}S_{VCDT}$	9,49	5,60	4,84	3,81	3,65	5,30	2,67	3,42	3,14	1,96
$\delta^{13}C_{VPDB}$	-24,14	-25,56	-25,08	-25,58	-26,25	-25,64	-26,26	-25,93	-26,10	-26,01
$\delta^{15}N_{AIR}$	13,12	8,39	6,43	8,53	8,90	9,25	9,05	8,85	9,03	8,89

Stabile Isotoper & Lipid %

NILU

Nr. of samples	1	2	3	4	5	6	7	8	9	10
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1841	15/1842	15/1843	15/1844	15/1845	15/1846	15/1847	15/1848	15/1849	15/1850
Individual:	pool	pool	pool	pool	pool	pool				
Sampling year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare	Egg, Fieldfare
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
$\delta^{34}S_{VCDT}$	3,53	3,04	5,95	0,56	2,81	0,61	2,13	1,61	1,22	-1,21
$\delta^{13}C_{VPDB}$	-27,83	-27,34	-27,02	-26,85	-26,73	-27,08	-26,37	-27,91	-26,84	-27,21
$\delta^{15}N_{AIR}$	6,20	7,48	7,71	8,64	5,96	7,13	7,88	7,37	6,67	7,02
lipid%	2,4	2,8	3,6	2,5	2,4	1,6	2,1	1	1,6	1,1

Stabile Isotoper & Lipid %

NILU

Nr. of samples	1	2	3	4	5	6	7	8	10	11
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1831	15/1832	15/1833	15/1834	15/1835	15/1836	15/1837	15/1838	15/1839	15/1840
Individual:	pool	pool	pool	pool	pool	pool	pool	pool	pool	pool
Sampling year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	Soil pooled sample	Soil pooled sample	Soil pooled sample	Soil pooled sample	Soil pooled sample	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
$\delta^{34}S_{VCDT}$	4,41	1,43	For lite	2,32	4,59	4,44	9,37	8,33	6,61	0,17
$\delta^{13}C_{VPDB}$	-27,19	-27,62	-29,50	-28,75	-27,33	-26,58	-27,45	-25,86	-25,00	-25,34
$\delta^{15}N_{AIR}$	-7,80	-10,68	-17,54	-4,58	-2,89	4,15	4,72	3,67	6,81	5,57
lipid%						1,9	1,2	1,2	1	1,4

UV and biocides

Nr. of samples	52	53	54	55	56	57	58	59	60	61
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1881	15/1882	15/1883	15/1884	15/1885	15/1886	15/1887	15/1888	15/1889	15/1890
Individual:										
Location	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Sample type:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Concentration units:	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
	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
BP3	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6
EHMC	<9	<9	<4	<4	<4	<9	<4	<4	<4	<4
UV-329	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6
OC	<4	<4	<4	<4	<4	<5	<4	<4	<4	<4
UV-328	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
UV-327	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Bromodiolone	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

UV and biocides

NILU

Nr. of samples	42	43	44	45	46	47	48	49	50	51
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1871	15/1872	15/1873	15/1874	15/1875	15/1876	15/1877	15/1878	15/1879	15/1880
Individual:										
Sampling year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	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
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
BP3	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6
EHMC	<10	<45	<11	<48	<44	<79	<4	<4	<4	<4
UV-329	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6
OC	<4	4	<4	<4	<4	<4	<4	<4	<4	<4
UV-328	<3	<3	<3	<3	<3	<3	<4	<3	<3	<3
UV-327	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Bromodiolone	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

UV and biocides

NILU

Nr. of samples	1	2	3	4	5	6	7	8	9	10
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1851	15/1852	15/1853	15/1854	15/1855	15/1856	15/1857	15/1858	15/1859	15/1860
Individual:	RR-0038	RR-0051	RR-0053	Furuset VI	209	210	211	212	213	214
Sampling year	2015	2015	2015							
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
BP3	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6
EHMC	<12	24,0	<12	<21	<21	<21	<21	<21	<21	<21
UV-329	<8	<3	<3	<2	<2	<3	<2	<2	<2	<2
OC	18,3	<14	<14	<16	<16	<16	<16	<16	<16	<16
UV-328	<3	<3	<3	<1	<1	<1	<1	<1	<1	<1
UV-327	<3	<3	<3	<2	<1	<1	<1	<2	<3	<2
Bromodiolone	4940	<5	<5	<5	68,6	4396	415,5	104,8	142,8	2756

UV and biocides

Nr. of samples	1	2	3	4	5	6	7	8	10	11
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1831	15/1832	15/1833	15/1834	15/1835	15/1836	15/1837	15/1838	15/1839	15/1840
Individual:	pool	pool	pool	pool	pool	pool	pool	pool	pool	pool
Sampling year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	Soil pooled sample	Soil pooled sample	Soil pooled sample	Soil pooled sample	Soil pooled sample	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.
Concentration units:	ng/g dw	ng/g dw	ng/g dw	ng/g dw	ng/g dw	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
BP3	<50	<50	<50	<50	<100	<3	na	na	5	<3
EHMC	12	<10	<10	17	40	8	na	na	<6	<6
UV-329	<5	<5	<5	<5	<10	<3	na	na	<3	<3
OC	<10	<10	<10	<10	33	<5	na	na	<5	<3
UV-328	<5	<5	<5	<5	<10	<5	na	na	<5	<5
UV-327	<5	<5	<5	<5	<10	<3	na	na	<3	<3
Bromodiolone	<100	<100	<100	<100	<100	<1	na	na	<1	<1

Phenolic compounds incl. TBBPA

Nr. of samples	52	53	54	55	56	57	58	59	60	61
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1881	15/1882	15/1883	15/1884	15/1885	15/1886	15/1887	15/1888	15/1889	15/1890
Individual:										
Location	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Sample type:	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Concentration units:	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
	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
bisphenol A	<0.55	<0.55	<0.55	<0.55	<0.55	4,9	35,4	2,2	3,5	4,8
tetrabromobisphenol A	1,6	<1	<1	<1	<1	<1	<1	1,6	<1	<1
4,4-bisphenol F	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
2,2-bisphenol F	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
bisphenol BP	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
bisphenol S	1,0	<1	<1	<1	<1	<1	<1	<1	<1	<1
4-nonylphenol	78,4	92,8	20,9	77,1	<1	<1	<1	<1	<1	2,7
4-octylphenol	5,7	6,0	5,5	6,1	6,4	5,4	5,6	5,8	5,5	5,4

Phenolic compounds incl. TBBPA

Nr. of samples	42	43	44	45	46	47	48	49	50	51
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1871	15/1872	15/1873	15/1874	15/1875	15/1876	15/1877	15/1878	15/1879	15/1880
Individual:										
Sampling year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	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
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
bisphenol A	1,5	<5	<5	<5	<0.55	3,0	<0.55	<5	<5	<5
tetrabromobisphenol A	1,9	<5	<5	<5	<1	<1	<1	<5	<5	<5
4,4-bisphenol F	<1	<5	<5	<5	<1	<1	<1	<5	<5	<5
2,2-bisphenol F	<1	<5	<5	<5	<1	<1	<1	<5	<5	<5
bisphenol BP	<1	<5	<5	<5	<1	<1	<1	<5	<5	<5
bisphenol S	3,5	<5	<5	<5	<1	<1	<1	<5	<5	<5
4-nonylphenol	<1	<5	<5	<5	8,5	<1	2,3	<5	<5	<5
4-octylphenol	3,5	<5	<5	<5	1,1	1,0	<1	<5	<5	<5

Phenolic compounds incl. TBBPA

Nr. of samples	1	2	3	4	5	6	7	8	9	10
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1851	15/1852	15/1853	15/1854	15/1855	15/1856	15/1857	15/1858	15/1859	15/1860
Individual:	RR-0038	RR-0051	RR-0053	Furuset VI	209	210	211	212	213	214
Sampling year	2015	2015	2015							
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver	Red fox liver
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
bisphenol A	<10	<10	<10	10,0	13,6	9,9	<100	<100	<100	<100
tetrabromobisphenol A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
4,4-bisphenol F	312,2	10,8	1781,4	<5	<5	<5	<5	<5	<5	10,4
2,2-bisphenol F	345,8	<1	911,8	1,9	<1	<1	<1	<1	<LOD	<LOD
bisphenol BP	<1	<1	<1	<2	<2	<2	1,0	<LOD	<LOD	<LOD
bisphenol S	<1	<1	<1	3,7	<2	<2	3,0	<LOD	<LOD	<LOD
4-nonylphenol	<1	<1	<1	<100	<100	<100	<LOD	<LOD	<LOD	<LOD
4-octylphenol	<1	<1	10,8	<50	<50	<50	21,4	26,9	<LOD	20,2

Phenolic compounds incl. TBBPA

Nr. of samples	1	2	3	4	5	6	7	8	9	10
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1861	15/1862	15/1863	15/1864	15/1865	15/1866	15/1867	15/1868	15/1869	15/1870
Individual:	99003/16	99004/16	99005/16	99010/16	99011/16	99012/16	99013/16	99001/16 og 99023/16	99026/16	99002/16 og 99030/16
Sampling year	2015	2015	2015							
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver	Brown rat liver
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww

Compound name:										
bisphenol A	<5	<5	<5	28,0	23,7	<LOD	60,8	24,4	24,7	<LOD
tetrabromobisphenol A	<5	<5	<5	<1	<1	<1	<1	<1	<1	<1
4,4-bisphenol F	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
2,2-bisphenol F	<5	<5	<5	<1	<1	2,2	1,9	2,3	1,8	<1
bisphenol BP	<5	<5	<5	<2	<2	<2	<2	<2	<2	<2
bisphenol S	<5	<5	<5	<2	<2	4,9	<2	3,6	<2	24,0
4-nonylphenol	<5	<5	<5	<100	<100	<100	<100	<100	<100	<100
4-octylphenol	<5	<5	<5	<50	<50	<50	<50	<50	<50	<50

Phenolic compounds incl. TBBPA

Nr. of samples	1	2	3	4	5	6	7	8	10	11
Customer:	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.	Miljødir.
NILU sample ID:	15/1831	15/1832	15/1833	15/1834	15/1835	15/1836	15/1837	15/1838	15/1839	15/1840
Individual:	pool	pool	pool	pool	pool	pool	pool	pool	pool	pool
Sampling year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Location	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo	Oslo
Sample type:	Soil pooled sample	Soil pooled sample	Soil pooled sample	Soil pooled sample	Soil pooled sample	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.	Earthworms whole indiv.
Concentration units:	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww	ng/g ww
Compound name:										
bisphenol A	18,0	5,6	12,0	20,8	<0.55	<10	na	na	<10	<10
tetrabromobisphenol A	<1	<1	4,82	<1	<1	<1	na	na	<1	<1
4,4-bisphenol F	14,6	7,3	<1	4,1	<1	312,2	na	na	10,8	1781,4
2,2-bisphenol F	5,2	2,7	2,4	3,8	12,1	345,8	na	na	<1	911,8
bisphenol BP	4,0	2,2	1,3	2,0	7,6	<1	na	na	<1	<1
bisphenol S	1,1	<1	<1	<1	<1	<1	na	na	<1	<1
4-nonylphenol	4,5	<1	1,2	4,3	<1	<1	na	na	<1	<1
4-octylphenol	13,6	<1	5,5	<1	24,9	<1	na	na	<1	10,8

PNEC values

PNEC values for soil ecosystem with references. Most data adopted from Andersen et al 2012, EU risk assessment reports (EU RAR), Environment Agency risk evaluation reports (EA ERAR) and European Chemicals Agency, http://echa.europe.eu. Entries with font coloured in grey are not used in the calculations.

Compound	$PNEC_{soil}$	Unit	Reference	Safety factor	Endpoint
BPA	3.2	mg/kg dw	EU RAR BPA	10	Calculated from PNECaquatic –D. magna
TBBPA	0.012	mg/kg dw	EU draft RAR TBBPA	10	Earthworm reproduction
PentaBDE	0.38	mg/kg dw	TA-2625	50	
OctaBDE	20.9	mg/kg ww	EU RAR 2003	50	Phytotoxicity
DecaBDE	98	mg/kg ww	EU RAR 2002	50	
HexBDE	1.2	mg/kg ww	EU RAR 2003	50	Phytotoxicity
TriBDE	20.9	mg/kg ww	Using Octa BDE value	50	Phytotoxicity
TetraBDE	20.9	mg/kg ww	Using Octa BDE value*	50	Phytotoxicity
HeptaBDE	20.9	mg/kg ww	Using Octa BDE value	50	Phytotoxicity
NonaBDE	20.9	mg/kg ww	Using Octa BDE value	50	Phytotoxicity
Siloksan (D4)	0.16	mg/kg ww	EA ERA 2009 Octamethylcyclotetra-siloxane		PNEC for water, equilibrium partitioning method
Siloksan (D4)	0.15	mg/kg dw	European Chemicals Agency, http://echa.europa.eu/		partition coefficient
Siloksan (D5)	4.8	mg/kg ww	EA ERA 2009 Decamethylcyclo-pentasiloxane		PNEC for water, equilibrium partitioning method
Siloksan (D5)	3.77	mg/kg dw	European Chemicals Agency, http://echa.europa.eu/	100	
Nonylphenols	0.3	mg/kg dw	European Chemicals Bureau, 2002	10	Earthworm reproduction
Octylphenols	0.0067	mg/kg dw	Environmental Agency (UK) 2005	10	Calculated from PNECaquatic-mysid M. bahia
4-tert-octylphenol	0.0059	*mg/kg ww*	EA RER 2005 4-tert-octylphenol	Large uncertainty	PNEC surface water and equilibrium partitioning
4-tert-octylphenol	2.3	mg/kg dw	European Chemicals Agency, http://echa.europa.eu/	10	
MCCP	11.9	mg/kg dw	European Chemicals Agency, http://echa.europa.eu/	10	
SCCP	5.95	mg/kg dw	European Chemicals Agency, http://echa.europa.eu/	20	
MCCP	10.6	mg/kg ww	EU RAR addendum 2007	**10**	Earthworm reproduction
SCCP	1.76	mg/kg ww	EU RAR addendum 2008	**0**	LogKow estimation- no safety factor
PFOA	0.16	mg/kg dw	TA-2444/2008	100	Worm reproductivity

PFOS	0.373	mg/kg dw	pfos.uk.risk.eval.report.2004	1000	Worm toxicity
$SumPCB_7$	0.01	mg/kg dw	Aquateam rapport nr 06-039	50	Calculated from aquatic data
TCEP	0.386	mg/kg dw	EURAS, 2009	50	Folsomia candida 28 d exposure
TCPP	1.7	mg/kg dw	EU RAR TCPP	10	Spiring Lactuca sativa
TDCP/TDCPP	0.33	mg/kg dw	EU RAR 2008	10	57d NOEC reproduction toxicity E.foetida
TBEP	0.81	mg/kg dw	TA-2784	EqP	Calculated
EHDPP	0.302	mg/kg ww	Environmental Agency (UK), 2009	10	Estimated from aquatic data
TCP	0.0027	mg/kg dw	EU-RER	10	Spiring Lactuca sativa
TBP/TnBP	5.3	mg/kg dw	TA-2784	EqP	Based on LogKow
TBP/TnBP	0.64	mg/kg dw	ECHA-Registration dossier		
TIBP	0.64	mg/kg dw	TA-2784	EqP	Based on LogKow
Other organo-phosphates	1.06	mg/kg dw	Average value for organophosphates	Not PNEC	
Cd	1.15	mg/kg dw	European chemicals Bureau, 2007	2	*SSD: species sensitivity distribution*
Cd	0.9	mg/kg dw	European Chemicals Agency, http://echa.europa.eu/		
Cr	62	mg/kg dw	European chemicals Bureau, 2005	3	Estimated from aquatic data
Cu	89.6	mg/kg dw	European chemicals Bureau, 2008	2	SSD
Cu	65	mg/kg dw	European Chemicals Agency, http://echa.europa.eu/		
Hg	0.3	mg/kg dw	Euro-chlor, Voluntary risk assessment, Mercury, 2004	1000	Background value soil
Hg	0.022	mg/kg dw	European Chemicals Agency, http://echa.europa.eu/		
Ni	50	mg/kg dw	VKM report 2009	2	SSD
Pb	166	mg/kg dw	EURAS, 2008	2	SSD
Pb	147-212	mg/kg dw	European Chemicals Agency, http://echa.europa.eu/		
Zn	26	mg/kg dw	VROM, 2008	2	SSD
Zn	35.6	mg/kg dw	European Chemicals Agency, http://echa.europa.eu/		

$PNEC_{pred}$ values (mg/kg in food) for secondary poisoning with references. Most data adopted from Andersen et al 2012, EU risk assessment reports (EU RAR), Environment Agency risk evaluation reports (EA ERAR) and European Chemicals Agency, http://echa.europe.eu. Entries with font coloured in grey are not used in the calculations.[1]

Compound	$PNEC_{pred}$ mg/kg	Reference	Safety factor	Endpoint
BPA	2.67	EU RAR BPA add	30	Three generation feeding study of rats
TBBPA	667	(mammalian) EU RAR TBBPA	30	2-generation rat reproduction study
PentaBDE	1	EU Risk assessment-Diphenyl Ether, Pentabromo derivative Final Report, August 2000	10	30 day oral rat study-liver effects
OctaBDE	6.7	EU Risk assessment-Diphenyl Ether, Octabromo derivative Final Report, August 2003	10	Rabbit phetotoxicity
DecaBDE	833	DecaBDE, EA-ENvRA-2009	30	Rat, two years carcinogenicity study
PFOS	0.067	Brooke et al. 2004 http://www.environment-agency.gov.uk/	30	Rat liver effects, chronic study NOEC 2mg/kg
PFOS	0.017	Brooke et al. 2004	30	Rat liver effects, chronic study Lowest no effect 0.5 ppm
PFOS	0.037	RIVM 2010 http://www.rivm.nl/dsresource?objectid=rivmp:15878&type=org&disposition=inline&ns_nc=1	90	NOAEL of 0.1 mg/kgbw/d for maternal weight gain from a teratogenicity study
PFOS	0.33	Newsted et al 2007, in Appendix 3, RIVM 2010	30	21 weeks, bodyweight, reproduction, NOEC, northern bobwhite quail
HCB	0.0167	Science Dossier http://www.eurochlor.org/media/90477/sd16-hcbaquaticra-final.pdf	30	NOEC mink 0.5 mg/kg
Siloxane (D4)	1.7	EA ERAR 2009 Octamethylcyclotetra-siloxane	300	Rat liver effects
Siloxane (D4)	41	Source: European Chemicals Agency, http://echa.europa.eu/	90	
Siloxane (D5)	13	EA ERAR 2009 Decamethylcyclopenta-Siloxane,	30	Repeated exposure, liver effects
Siloxane (D5)	16	Source: European Chemicals Agency, http://echa.europa.eu/	90	
Siloxane (D6)	66.7	Source: European Chemicals Agency, http://echa.europa.eu/	300	

Compound	$PNEC_{pred}$ mg/kg	Reference	Safety factor	Endpoint
Siloxane (D6)	50-100	EA ERAR 2009	300	Reproduction NOAEL rat
Nonylphenols	10	EU RAR nonylphenol	10	Rat multi-generation study, reproduction effect
Octylphenols	10	Environmental Agency (UK) 2005	30	Rat, two-generation study, systemic and postnatal toxicity
4-tert-octylphenol	10	EA RER 2005 4-tert-octylphenol	30	
4-tert-octylphenol	2.36	Source: European Chemicals Agency, http://echa.europa.eu/	30	
MCCP	10	EU RAR addendum 2007	30	Rat, 90 days study, kidney effects
SCCP	5.5	EU RAR addendum 2008	30	Reproduction effects on wild duck
TDCP	3.3	EU RAR 2008	30	Two-years carcinogenicity rat study
EHDPP	1.1	Environmental Agency (UK) 2009	90	Rat 90 d oral exposure
TCP	1.7	EA RER 2009 (1330-78-5)	30	Two-years reproduction mouse study
TCPP	11.6	EU RAR TCPP 2008	90	Rat, 13 weeks study, liver effects
PCB153	0.67	TemaNord 2011: 506. ISBN 978-92.893-2194-5 Using Sludge on Arable Land (Table 7)	20	RIVM (1995) Risk assessment of bioaccumulation in the food webs of two marine AMOEBE species: common tern and harbor seal. RIVM Report 719102040.
Cd	0.16	EU RAR	10	Based on 4 studies with birds and 5 studies with mammals
Hg	0.4	2009, Munoz et al.	10	NOEC 4 mg/kg food for Coturnis c. Japonica.
Ni	8.5	EU RAR Ni 2008	10	Wild duck, tremor effects observed in chickens at day 28
Pb	3.6	Lead Water Framework Directive EQS dossier 2011	15	SSD

[1]$PNEC_{pred}$ not found for PCB7
EU RAR: EU Risk Assessment report
EA RER: Environmental Agency Risk Evaluation Report

GPS locations for sampling locations

Location	UTM-zone	East Coordinates	North Coordinates
Earthworm and soil			
Voksenkollen	32V	0593098	6650289
Maridalen	32V	0598627	6649266
Grorud	32V	604630	6647194
Slottsparken	32V	596410	6643426
Svartedalsparken	32V	600272	6642101
Red fox			
15/1851	32V	Oslo	
15/1852	32V	Oslofjorden	
15/1853	32V	Oslo	
15/1854	32V	Furuset	
15/1855	32V	Nittedal kommune	
15/1856	32V	Nittedal kommune	
15/1857	32V	Nittedal kommune	
15/1858	33V	Nittedal kommune	
15/1859	33V	Nittedal kommune	
15/1860	33V	Nittedal kommune	
Brown rat			
All same location	32V	598100	6643200
Fieldfare			
15/1841	32V	599147	6640664
15/1842	32V	599802	6648805
15/1843	32V	598518	6649737
15/1844	32V	596312	6649094
15/1845	32V	593976	6648160
15/1846	32V	590505	6651088
15/1847	32V	602804	6639696
15/1848	32V	603655	6639538
15/1849	32V	603610	6638522
15/1850	32V	604003	6635151
Tawny owl and Sparrow hawk	Confidential for species protection	Confidential for species protection	Confidential for species protection

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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.