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Screening Program 2017 – AMAP Assessment Stoffer

Screening Programme 2017 – AMAP Assessment Compounds

Summary - sammendrag

This report summarizes the findings of a screening study on the occurrence of emerging substances selected by AMAP and other related substances measured earlier. The study includes selected solvents, siloxanes, flame retardants, UV compounds, pesticides, bisphenols and other PBT compounds in effluent, ambient air, biota, and marine plastic.

Denne rapporten oppsummerer resultatene av en screeningundersøkelse om forekomst av stoffer utvalgt av AMAP samt en rekke andre tidligere målte stoffer med et særlig oppfølgingsbehov. Undersøkelsen omfatter blant annet utvalgte løsemidler, siloksaner, flammehemmere, UV-stoffer, pesticider, bisfenoler og andre PBT-stoffer i avløp, uteluft, biota og marin plast.

4 emneord

Nye miljøgifter, Arktis, Luft, Biota

4 subject words

Emerging pollutants, Arctic, Air, Biota

Front page photo

Ove Hermansen

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1. Attachment 1

Summary

A recent report from the Arctic Monitoring and Assessment Programme (AMAP) identified 25 compounds with physiochemical properties that raised concerns with respect to Arctic environments. The initial selection of these compounds was based on the calculation of persistency (P), bioaccumulation (B), and long-range transport potential (LRTP). Additional selection criteria included production volume, and the lack of environmental monitoring data. These compounds, and an additional set of PFAS (perfluoroalkyl substances), current-use pesticides, UV-filters, bisphenols, chlorinated paraffins, and dechloranes, were included in the current study.

To get information on the P-, B-, and LRTP-criteria, the following samples were included: Air samples from an Arctic station, Arctic species of different trophic levels, and a few hot-spot samples to elucidate emission levels (wastewater effluent, marine plastic and urban air).

Of the 25 selected AMAP compounds, five ***volatile fluoroorganic and related compounds*** were detected in Arctic air for the first time. Several of these compounds, which are used as liquids for cooling, cleaning, and in medical applications, have not been found in environmental samples before. The detection of these compounds in Arctic air samples is a potential indication of long-range transport and persistency. In addition, these compounds have no sink in the lower atmosphere and they have a strong IR-absorbance, which together make it very likely that they can act as long-lived greenhouse gases. A follow-up study with more dedicated sampling and analysis should receive high priority.

A new ***siloxane*** compound was found in urban air, but not in the other monitored samples and a follow-up seems less relevant.

Seven of the eight selected UV-filters were found in both Arctic and urban biota samples. These findings suggest the potential to bioaccumulate, and support conclusions from previous studies. However, little is known about the effect of these compounds in birds and polar bear, which prevent a relevant environmental risk assessment.

Dacthal was the only compound of the 6 selected ***currently used pesticides*** detected in Arctic air samples from the Zeppelin Mountain. As there are no known local sources for dacthal, it can be assumed that dacthal is exposed to long range atmospheric transport.

Dechloranes and chlorinated paraffins were detected in all samples of Arctic biota. Without substantial local sources, these findings clearly show that these compounds are subject to both long-range atmospheric transport and bioaccumulation, and emphasise again the importance of international regulations of these compounds.

An important finding of the ***suspect and non-target screening*** was hexachlorobutadiene, which was ubiquitous. However, while this particular suspect and non-target analysis resulted in very few confirmed identifications, the true power of these data will be realised in the years to come. The data are archived and will be reinvestigated for new contaminants and new hypotheses in the coming years. The data are in effect a very valuable “digital” sample bank.

Sammendrag

AMAP har i en ny rapport prioritert 25 stoffer som er listet i REACH og IUR (Nord-Amerika), som kan ha POP-egenskaper og langtransporteres til Arktis, har høyt forbruk og er lite undersøkt i Arktis. For å øke datagrunnlaget og generell forståelse av miljøskjebnen, ble flere andre stoffgrupper, som allerede tidligere har vært undersøkt i prøver fra Arktis, lagt til denne studien. Dette gjelder: PFAS, UV-stoffer, bisfenoler, klorparafiner, og noen pesticider.

For å få god informasjon om egenskaper som persistens, bioakkumulering og langtransport, ble det valgt å undersøke arktiske luftprøver og arktisk biota av forskjellig trofisk nivå samt noen prøver fra hotspot-lokaliteter (luft, biota, utslippsvann og marin plast fra Tromsø).

Av de valgte 25 AMAP komponentene ble fem ***flyktige fluororganiske og beslektede stoffer*** funnet regelmessig og for første gang i arktiske luftprøver. Flere av disse stoffene, som brukes som kjøle- og rensevæske og til spesielle medisinske applikasjoner, har ikke tidligere vært påvist i miljøet. Funnet i arktisk luft er en sterk indikasjon for at stoffene langtransporteres og at de er persistente. Flere av disse stoffene absorberer infrarød stråling og kan derfor bidra til drivhuseffekten. En nøyere oppfølging av disse stoffer anbefales sterkt.

En ***siloksanforbindelse*** som tidligere ikke har vært målt, er påvist i luftprøver fra Tromsø. Stoffet ble ikke funnet i de andre undersøkte prøvetypene og en eventuell oppfølging kan ha lavere prioritet enn for andre stoffer i denne studien.

Sju av de åtte valgte ***UV-stoffene*** ble funnet i de undersøkte biotaprøvene. Dette bekrefter tidligere konklusjoner om fare for bioakkumulering av disse stoffene. Siden man vet for lite om effekter i fugler og pattedyr, er det vanskelig å vurdere betydning og risikoen av disse funnene.

Dacthal var den eneste av de valgte pesticidene som ble funnet i luftprøver fra Zeppelinstasjonen. Det er ingen kjente lokale kilder for dacthal og det må antas at stoffet er utsatt for atmosfærisk langtransport.

Dekloraner og klorerte parafiner ble funnet i alle arktiske biotaprøver. Siden det ikke er noen vesentlige lokale kilder for disse stoffene, er dette en tydelig indikasjon for langtransport og bioakkumulering og viser på nytt nødvendighet av en internasjonal regulering av disse stoffer.

Det ble også gjennomført en ***suspekt og non-target screening*** av alle prøver. I nesten alle prøvene ble det påvist heksaklorbutadien. Selv om det i dag kun ble gjort noen få sikre identifikasjoner av nye stoffer, er ikke denne screeningteknikken forgjeves. Alle rådata er lagret og det forventes en rivende utvikling av databehandlingsteknikker i tiden som kommer. Disse dataene utgjør derfor en meget verdifull digital miljøprøvebank.

1. Background and introduction

1.1 General

For part 1 of the 2017 screening programme, the Norwegian Environment Agency nominated a large and diverse group of compounds for analysis. The criteria for selection were the potential occurrence of these compounds to the Arctic environment, their potential for long-range transport, identification of possible local sources, occurrence and accumulation in Arctic biota, and the assessment of possible environmental risks. This selection is mainly based on the outcome of recent assessment of the Arctic Monitoring and Assessment Programme (AMAP) (*AMAP Assessment 2016: Chemicals of Emerging Arctic Concern*, 2017), "Chapter 4. Further contaminants of potential Arctic concern", which identified chemicals of emerging concern especially for the Arctic environment. There is a huge number of chemical substances currently in production and use. Not all of them are of environmental concern and therefore, it is prudent to narrow the potential pollutants to those with the highest likelihood to be chemicals of concern for the Arctic and other environments. This is done *in silico* by (1) screening of databases for substances in use, combining with knowledge/assumptions (2) on chemical properties similar to known pollutants and (3) on the potential for long-range atmospheric transport. Chemicals fulfilling these specifications can then be selected for possible regulation or additional study. Recent studies of databases on chemicals in Europe and North America has identified up to about 1200 substances with the potential to reach the Arctic and bio-accumulate in food webs (Howard & Muir, 2010; Rorije, Verbruggen, Hollander, Traas, & Janssen, 2011; Scheringer et al., 2012; Öberg & Iqbal, 2012).

1.2 Selected compounds

In this chapter the compounds selected for this screening study are listed, together with their acronym, CAS-number, function or use, and calculated Log KOW. Compounds from the AMAP list are emphasized by shading.

1.2.1 Volatile fluoroorganic and related compounds

Table 1: Volatile fluoroorganic and related compounds
Name, Acronym, CAS, Function, and Log K_{OW} (EPISUITE)
Shaded compounds: Selected according to AMAP report, Chapter 4 (AMAP Assessment 2016: Chemicals of Emerging Arctic Concern, 2017).

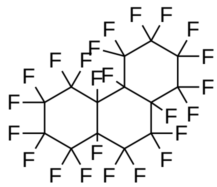
Name	Acronym	Structure	CAS	Function	Log K_{OW}
Perfluoroperhydro-phenanthrene (Vitreon, Flutec PP 11)	PFPHP		306-91-2	Solvent, blood replacement, eye surgery	9,6

Table 1: Volatile fluoroorganic and related compounds

Name, Acronym, CAS, Function, and Log K_{OW} (EPISUITE)
Shaded compounds: Selected according to AMAP report, Chapter 4 (AMAP Assessment 2016: Chemicals of Emerging Arctic Concern, 2017).

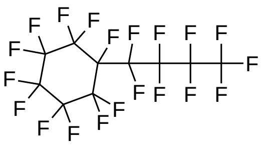
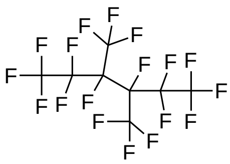
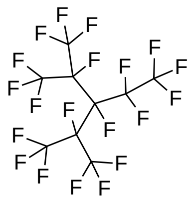
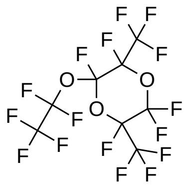
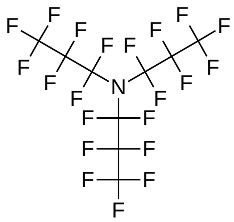
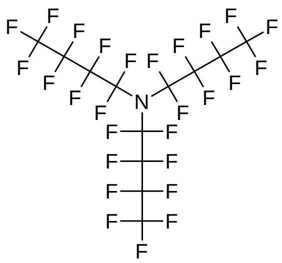
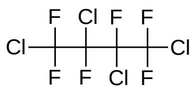
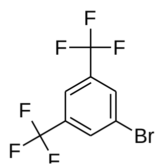
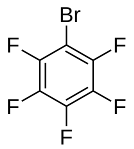
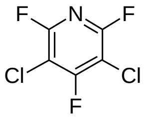
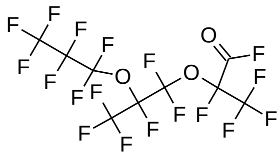
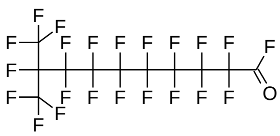
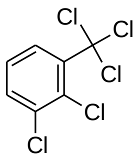
Name	Acronym	Structure	CAS	Function	Log K_{OW}
Undecafluoro-(nonafluorobutyl)-cyclohexane	PFBCH		374-60-7	Solvent, Drug carrier, Cosmetics	6,9
1,1,1,2,2,3,4,5,5,6,6,6-Dodecafluoro-3,4-bis-(trifluoromethyl)-hexane	PFDMH		1735-48-4	Solvent	6,8
Perfluoro dimethylethylpentane	PP90		50285-18-2	Solvent	6,8
2,2,3,5,6-Pentafluoro-5-(pentafluoroethoxy)-3,6-bis(trifluoromethyl)-1,4-dioxane	PFEPFD [1]		84041-66-7	Intermediate	4,8
Perfluoro-tripropylamine	PFTPA		338-83-0	Solvent	7,1
Tris(perfluorobutyl)-amine (FC-43)	PFTBA		311-89-7	Solvent	10,0
1,2,3,4-Tetrachloro-hexafluorobutane	TCHFB		375-45-1	Solvent	4,8
3,5-Bis(trifluoromethyl) bromobenzene	BTFMBB		328-70-1	Solvent	7,1

Table 1: Volatile fluoroorganic and related compounds
Name, Acronym, CAS, Function, and Log K_{OW} (EPISUITE)
Shaded compounds: Selected according to AMAP report, Chapter 4 (AMAP Assessment 2016: Chemicals of Emerging Arctic Concern, 2017).

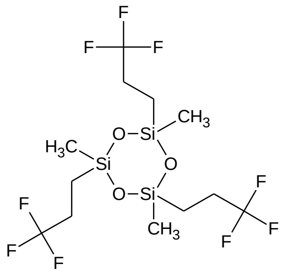
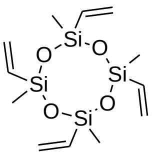
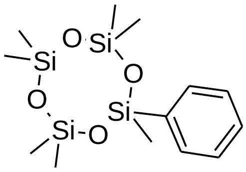
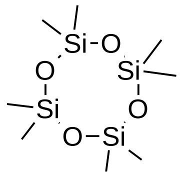
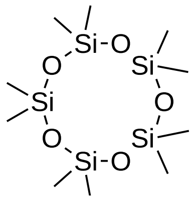
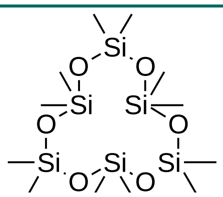
Name	Acronym	Structure	CAS	Function	Log K_{OW}
Bromopentafluoro-benzene	BPFB		344-04-7	Intermediate	3,9
3,5-Dichloro-2,4,6-trifluoro-pyridine	DCTFP		1737-93-5	Intermediate	2,7
2,3,3,3-tetrafluoro-2-[1,1,2,3,3,3-hexafluoro-2-(heptafluoropropoxy)-propoxy]-propanoyl fluoride Hexafluoropropylene Oxide Trimer	HFPO-T [2]		2641-34-1	Intermediate	5,0
Octadecafluoro-9--(trifluoromethyl) Decanoylfluoride*)	9M-PFDF [2]		15720-98-6	Intermediate	7,6
1,2-Dichloro-3-(trichloromethyl) benzene	DCTCB [3]		84613-97-8	Intermediate/ unintentional	4,4

[1]) For 2,2,3,5,6-Pentafluoro-5-(pentafluoroethoxy)-3,6-bis(trifluoromethyl)-1,4-dioxane it was not possible to find an analytical standard. It was therefore not possible to perform a standard target analysis of these substances.
[2]) HFPO-T and 9M-PFDF are fluorides of carboxylic acids, which under normal analytical treatment readily hydrolyse to the corresponding free carboxylic acid (Rayne, 2013). It was therefore not possible to perform a standard target analysis of these substances. However, this compound was analysed by non-target screening.
[3]) For 1,2-Dichloro-3-(trichloromethyl) benzene it was not possible to purchase an analytical standard. It was therefore not possible to perform a standard target analysis of these substances. However, this compound was analysed by non-target screening.

Many of these compounds are, like PFAS (per/polyfluorinated alkylated substances), fluorinated substances produced by electrochemical fluorination (ECF). In contrast to PFAS, which are substances with a hydrophobic fluorinated alkyl group and a hydrophilic group in the same molecule and often used as surfactants, the volatile fluoroorganic compounds listed in Table 1 are not surfactants. Several of these compounds are chemically inert and marketed for a wide range of industrial and medical applications. In medicine they are used as blood replacement, in eye surgery, and as drug carriers. However, little is known about the worldwide production and consumption of many of these chemicals.

1.2.2 Volatile siloxanes

Table 2: Volatile siloxanes
Name, Acronym, CAS, Function, and Log K_{OW} (EPISUITE)
Shaded compounds: Selected according to AMAP report, Chapter 4 (AMAP Assessment 2016: Chemicals of Emerging Arctic Concern, 2017).

Name	Acronym	Structure	CAS	Function	Log K_{OW}
2,4,6-Trimethyl-2,4,6-tris(3,3,3-trifluoropropyl)-cyclotrisiloxane	D3F		2374-14-3	Solvent	8,7
2,4,6,8-Tetraethenyl-2,4,6,8-tetramethyl-cyclotetrasiloxane	D4Vn		2554-06-5	Monomer	6,5
Heptamethylphenyl-cyclotetrasiloxane	D4Ph		10448-09-6	Solvent	
Octamethylcyclo-tetrasiloxane	D4		556-67-2	Solvent	6,7
Decamethylcyclo-pentasiloxane	D5		541-02-6	Solvent	8,0
Dodecamethylcyclo-hexasiloxane	D6		540-97-6	Solvent	9,1

Cyclic volatile methylsiloxanes (cVMS) are used in personal care products and other consumer products. D4Vn is a monomer used in the production of some silicone polymers.

1.2.3 Per- and polyfluorinated alkylated compounds

Table 3: PFAS
Name, Acronym, CAS, Function

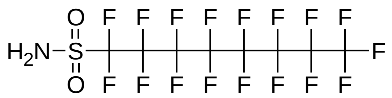
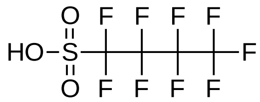
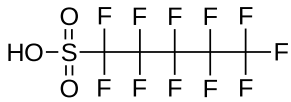
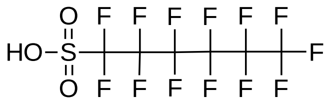
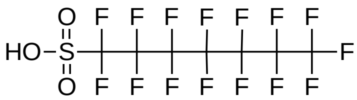
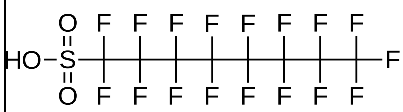
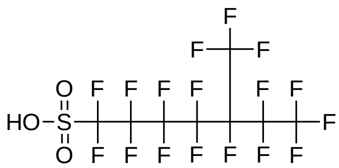
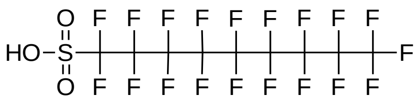
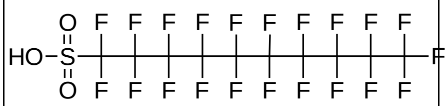
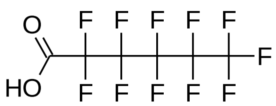
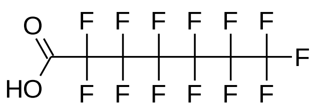
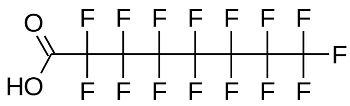
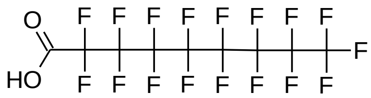
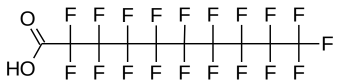
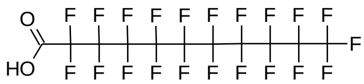
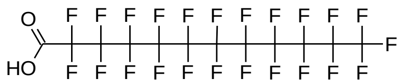
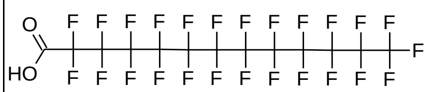
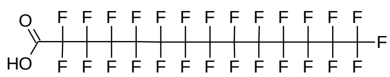
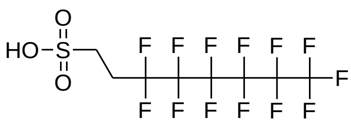
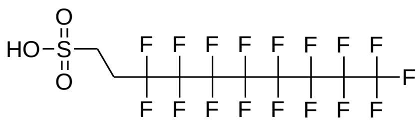
Name	Acronym	Structure	CAS
Perfluorooctane sulfonamide	PFOSA		754-91-6
Perfluorobutane sulfonic acid	PFBS		375-73-5 or 59933-66-3
Perfluoropentane sulfonic acid	PFPS		2706-91-4
Perfluorohexane sulfonic acid	PFHxS		355-46-4
Perfluoroheptane sulfonic acid	PFHpS		375-92-8
Perfluorooctansulfonate	PFOS		2795-39-3
Branched Perfluorooctan-sulfonate*	brPFOS		
Perfluorononane sulfonic acid	PFNS		474511-07-4
Perfluorodecane sulfonic acid	PFDcS		335-77-3
Perfluorohexanoic acid	PFHxA		307-24-4
Perfluoroheptanoic acid	PFHpA		375-85-9

Table 3: PFAS
Name, Acronym, CAS, Function

Name	Acronym	Structure	CAS
Perfluorooctanoic acid	PFOA		335-67-1
Perfluorononanoic acid	PFNA		375-95-1
Perfluorodecanoic acid	PFDcA		335-76-2
Perfluoroundecanoic acid	PFUnA		2058-94-8
Perfluorododecanoic acid	PFDoA		307-55-1
Perfluorotridecanoic acid	PFTriA		72629-94-8
Perfluorotetradecanoic acid	PFTeA		376-06-7
6:2 Fluorotelomer sulfonic acid	6:2FTS		27619-97-2
8:2 Fluorotelomer sulfonic acid	8:2 FTS		39108-34-4

PFAS have been in use for over 60 years for various industrial purposes such as in electronic devices, fire-fighting foam, hydraulic fluids, metal plating and textiles. In 2000, the major producer of PFOS voluntarily started to phase-out the use of this compound. Today PFOS, it's salts, and PFOSF are included in Annex B of the Stockholm Convention. On the other hand, widespread manufacturing of PFOS and related substances started in China in the first decade of this century. The other important PFAS group are the perfluoroalkyl carboxylates (PFCAs). Production and use of perfluorooctanoate (PFOA) and its homologues have been phased out in the western countries following agreements with manufacturers. Today, PFOA is selected as a candidate for the "substances of very high concern" by The European Chemicals Agency

("Candidate List of substances of very high concern for Authorisation," 2018). There are also planned restrictions under REACH, and global restriction are prepared under the Stockholm convention.

1.2.4 UV filters

Table 4: UV filters
Name, Acronym, CAS, Function, and Log K_{OW} (EPISUITE)

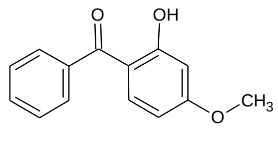
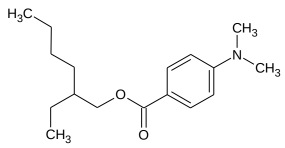
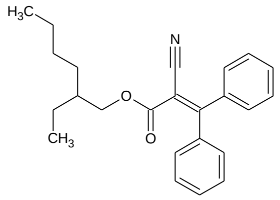
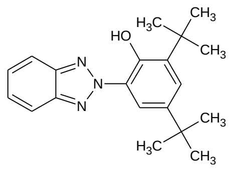
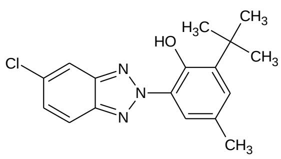
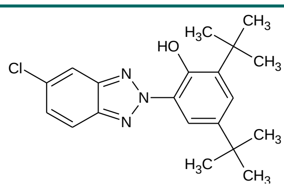
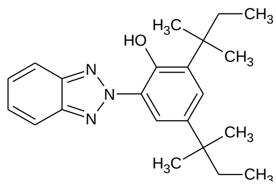
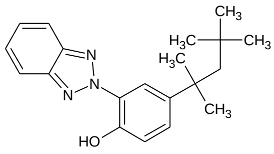
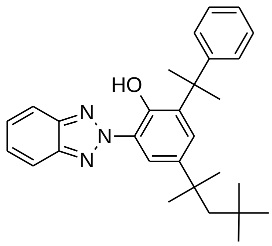
Name	Acronym	Structure	CAS	Function	Log K_{OW}
Benzophenone-3	BP3		131-57-7	UV filter	3,5
2-Ethylhexyl-4-dimethyl-aminobenzoate	ODPABA		21245-02-3	UV filter	5,8
Octocrylene	OC		6197-30-4	UV filter	6,9
	UV-320		3846-71-7	UV filter	6,3
Bumetrizole	UV-326		3896-11-5	UV filter	5,6
	UV-327		3864-99-1	UV filter	6,9
	UV-328		25973-55-1	UV filter	

Table 4: UV filters
Name, Acronym, CAS, Function, and Log K_{OW} (EPISUITE)

Name	Acronym	Structure	CAS	Function	Log K_{OW}
Octrizole	UV-329		3147-75-9	UV filter	6,2
	UV-928 [1])		73936-91-1	UV filter	8,8

[1]) For UV-928 it was possible to purchase an analytical standard. However, this compound was analysed by suspect screening.

UV filters are used in sun cream, and as additives to numerous products including plastics, paints and coatings to protect these from photodegradation.

1.2.5 Semivolatile persistent organic compounds (PBT) including current-use pesticides (CUPs)

Table 5: Semivolatile persistent organic compounds (PBT) including current-use pesticides (CUPs)
Name, Acronym, CAS, Function, and Log K_{OW} (EPISUITE)
Shaded compounds: Selected according to AMAP report, Chapter 4 (AMAP Assessment 2016: Chemicals of Emerging Arctic Concern, 2017).

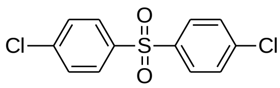
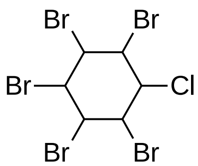
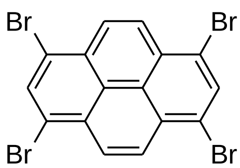
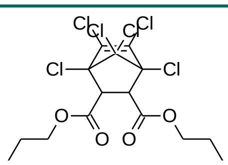
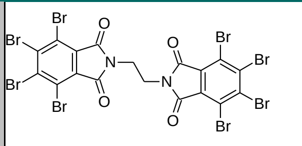
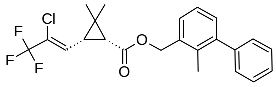
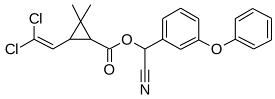
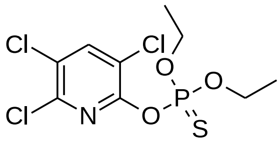
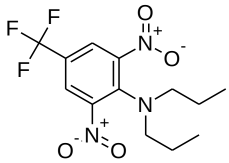
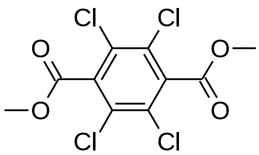
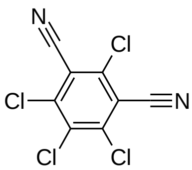
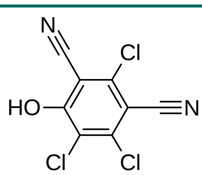
Name	Acronym	Structure	CAS	Function	Log K_{OW}
Bis (4-chlorophenyl) sulfone	BCPS		80-07-9	Monomer	3,9
1,2,3,4,5-Pentabromo-6-chlorocyclohexane	PBCCH		87-84-3	Flame retardant	4,7
1,3,6,8-Tetrabromo pyrene	TBPy [1])		128-63-2	Flame retardant	8,5
1,4,5,6,7,7-Hexachloro bicyclo[2.2.1]hept-5-ene-2,3-dicarboxylic acid dibutyl ester	DBCD		1770-80-5	Flame retardant	7,3

Table 5: Semivolatile persistent organic compounds (PBT) including current-use pesticides (CUPs)
Name, Acronym, CAS, Function, and Log K_{OW} (EPISUITE)
Shaded compounds: Selected according to AMAP report, Chapter 4 (AMAP Assessment 2016: Chemicals of Emerging Arctic Concern, 2017).

Name	Acronym	Structure	CAS	Function	Log K_{OW}
2,2'-(1,2-ethanediyl)bis[4,5,6,7-tetrabromo-1H-Isoindole-1,3(2H)-dione	EBTBP [2])		32588-76-4	Flame retardant	8.4
Bifenthrin			82657-04-3	Insecticide	8,2
Cypermethrin			52315-07-8	Insecticide	6,4
Chlorpyrifos			2921-88-2	Insecticide	4,7
Trifluralin			1582-09-8	Insecticide	5,3
Dacthal			1861-32-1	Herbicide	4,2
Chlorothalonil			1897-45-6	Fungicide	3,7
4-Hydroxy-2,5,6-trichloro-isophthalonitrile	[3])		28343-61-5	Metabolite	3,1

[1]) An analytical standard for 1,3,6,8-Tetrabromopyrene could be acquired. However, the neat standard was not soluble in solvents, which are compatible with the requirements of analytical work. It was therefore not possible to analyse this substance in this study.
[2]) An analytical standard for 2,2'-(1,2-ethanediyl)bis[4,5,6,7-tetrabromo-1H-Isoindole-1,3(2H)-dione could be acquired. However, the neat standard was not soluble in solvents, which are compatible with the requirements of analytical work. It was therefore not possible to analyse this substance in this study.

[3]) An analytical standard for 4-Hydroxy-2,5,6-trichloro-isophthalonitrile could be acquired. However, three different approaches for the clean-up and instrumental analysis did not give sufficient sensitivity for this substance. It was therefore not possible to analyse this substance during the time frame available for this study.

Bis (4-chlorophenyl) sulfone (BCPS) is used as a monomer in the production of thermostable polymers (polysulfones and polyethersulfones) and is classified as a high production volume chemical (Norström, Remberger, Kaj, Wiklund, & Brorström-Lundén, 2010).

The other compounds in this group are flame retardants and current-use pesticides (CUPs).

Table 6: Dechloranes
Name, Acronym, CAS, Function, and Log K_{OW}

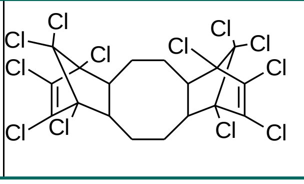
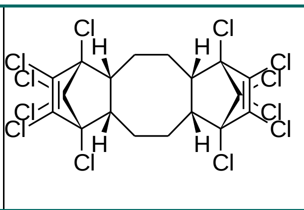
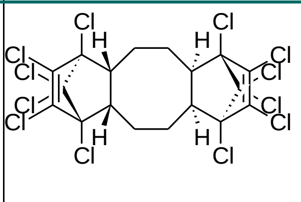
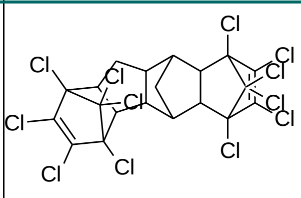
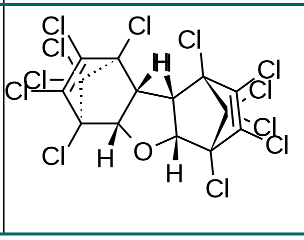
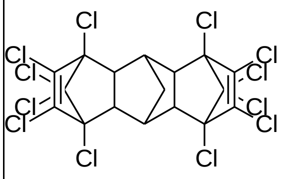
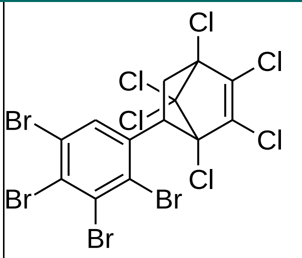
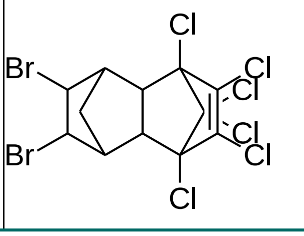
Name	Acronym	Structure	CAS	Function	Log K_{OW}
Dechlorane plus	DP		13560-89-9	Flame retardant	8.85
Dechlorane plus is existing as two different isomers, syn and anti, which are formed in the approximate ratio of 1:3:					
Dechlorane plus syn	DP syn		135821-03-3	Flame retardant	8.85
Dechlorane plus anti	DP anti		135821-74-8	Flame retardant	8.85
Dechlorane 601	Dec 601		13560-90-2	Flame retardant	9.22
Dechlorane 602	Dec 602		31107-44-5	Flame retardant	7.37

Table 6: Dechloranes
Name, Acronym, CAS, Function, and Log Kow

Name	Acronym	Structure	CAS	Function	Log Kow
Dechlorane 603	Dec 603		13560-92-4	Flame retardant	8.24
Dechlorane 604	Dec 604		34571-16-9	Flame retardant	8.84
Dibromoaldrin	DBALD		20389-65-5	Flame retardant	5.77

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

1.2.6 Bisphenols

Table 7: Bisphenols
Name, Acronym, CAS, Function, and Log Kow (EPISUITE)

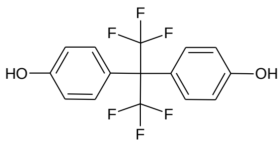
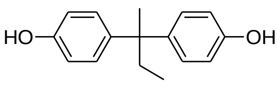
Name	Acronym	Structure	CAS	Function	Log Kow
Bisphenol AF	BPAF		1478-61-1	Monomer	
Bisphenol B	BPB		77-40-7	Monomer	4,1

Table 7: Bisphenols
Name, Acronym, CAS, Function, and Log K_{OW} (EPISUITE)

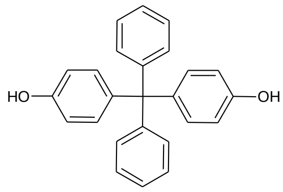
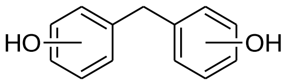
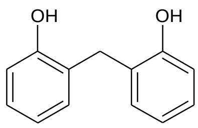
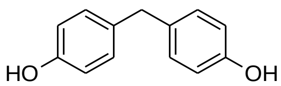
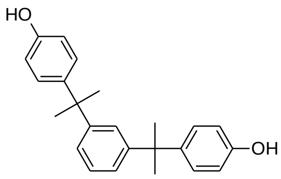
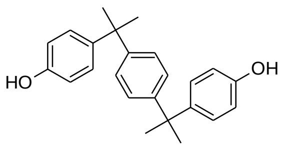
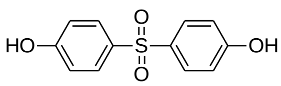
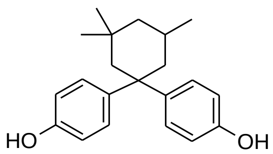
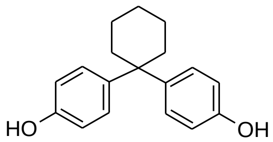
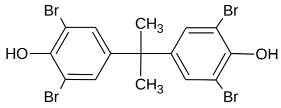
Name	Acronym	Structure	CAS	Function	Log K_{OW}
Bisphenol BP	BPBP		1844-01-5	Monomer	
Bisphenol F	BPF		1333-16-0	Monomer	
2,2'-Bisphenol F	BPF		2467-02-9	Monomer	3,1
4,4'-Bisphenol F	BPF		620-92-8	Monomer	
Bisphenol M	BPM		13595-25-0	Monomer	
Bisphenol P	BPP		2167-51-3	Monomer	6,3
Bisphenol S	BPS		80-09-1	Monomer	
Bisphenol TMC	BPTMC		129188-99-4	Monomer	6,0
Bisphenol Z	BPZ		843-55-0	Monomer	5,0

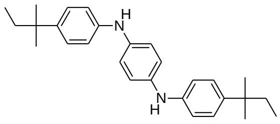
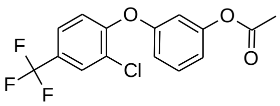
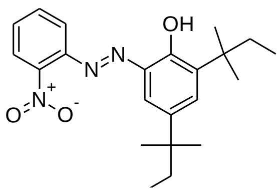
Table 7: Bisphenols
Name, Acronym, CAS, Function, and Log Kow (EPISUITE)

Name	Acronym	Structure	CAS	Function	Log K_{OW}
Tetrabromo-bisphenol A	TBBPA		79-94-7	Monomer	7,2

Bisphenols are used as monomers in the production of a long range of different polymers (plastics). Due to the endocrine-disrupting properties there is an increasing environmental and health concern about all bisphenols.

1.2.7 Other aromatic compounds

Table 8: Other aromatic compounds
Name, Acronym, CAS, Function, and Log Kow (EPISUITE)
Shaded compounds: Selected according to AMAP report, Chapter 4 (AMAP Assessment 2016: Chemicals of Emerging Arctic Concern, 2017).

Name	Acronym	Structure	CAS	Function	Log K_{OW}
N,N'-Bis[4-(2-methyl-2-butanyl)phenyl]-1,4-benzenediamine	BDBBD		5432-99-5	Antioxidant	7,7
3-[2-Chloro-4-(trifluoromethyl) phenoxy]phenyl acetate	CTFPPA		50594-77-9	Intermediate for Herbicide	4,4
6-[(2-Nitrophenyl)azo]-2,4-di-tert-pentylphenol	NPADPP		52184-19-7	Intermediate for benzotriazoles	9,5

Under the CAS number 5432-99-5 both N,N'-Bis[4-(2-methyl-2-butanyl)phenyl]-1,4-benzene-diamine (BDBBD) with molecular weight 400.599 (see Figure 1) and N,N'-Bis(4-tert-butylphenyl)benzene-1,4-diamine (BtBBD) with molecular weight 372.546 can be found in different databases. However, the Chemical Abstracts Service (CAS), who is responsible body assigning the CAS registry number, has assigned 5432-99-5 to the substance shown in Table 8, which is also the structure of the compound measured in this study.

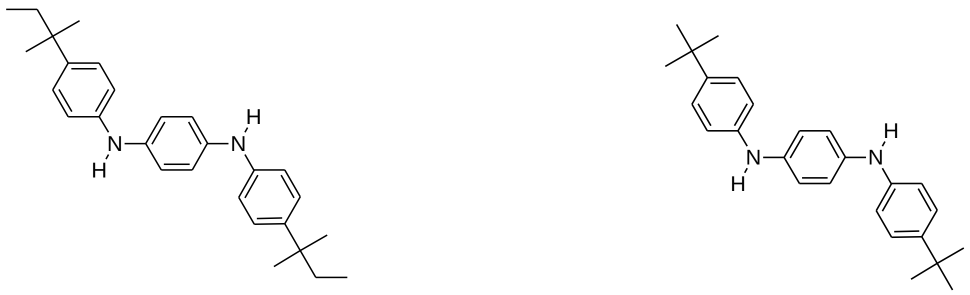


Figure 1: Structure of N,N'-Bis[4-(2-methyl-2-butanyl)phenyl]-1,4-benzene-diamine (BDBBD) to the left and N,N'-Bis(4-tert-butylphenyl)benzene-1,4-diamine (BtBBD) to the right.

2. Materials and methods

2.1 Sampling stations, sample collection and sample pre-treatment

Sample collection, transport and storage before analysis was at the responsibility of NILU, the Norwegian Institute for Nature Research (NINA), and the Norwegian Polar Institute (NPI). Different sample types were taken in the Norwegian arctic area and in Tromsø as a local hotspot area. Sample locations are shown in Figure 2 and 3.

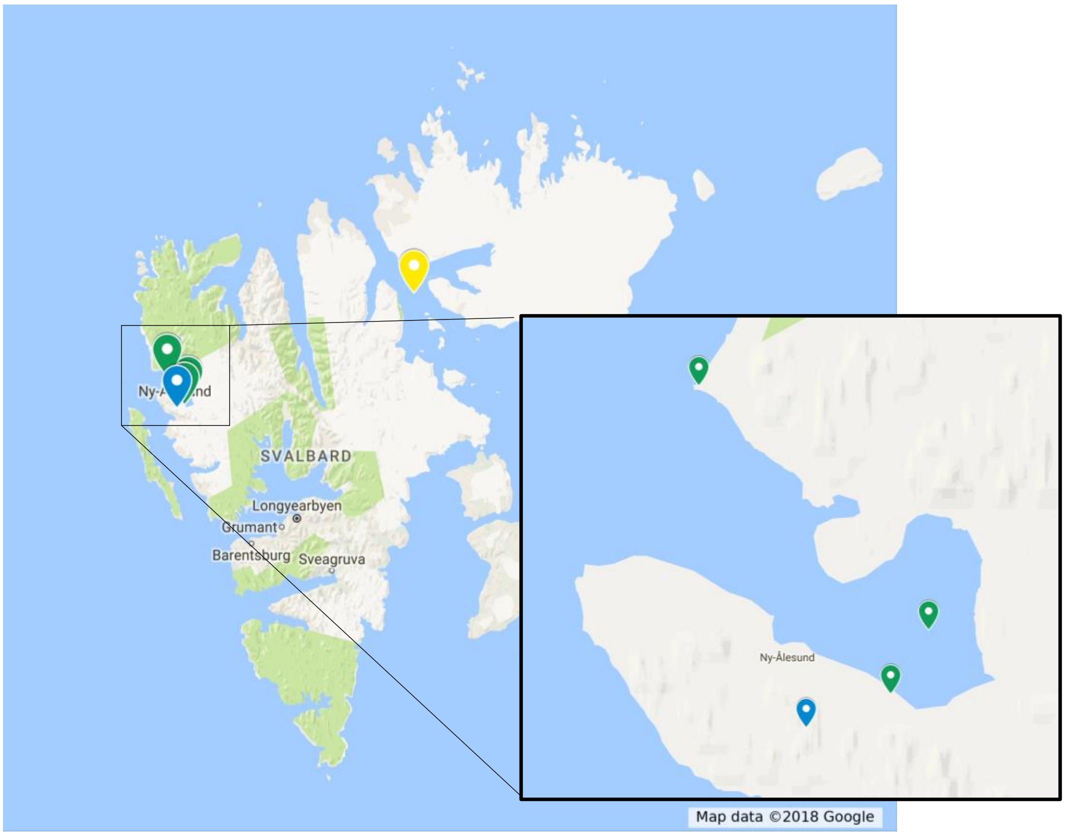


Figure 2: Sampling stations on Svalbard. Blue: Air samples (Zeppelin mountain); green: Egg samples (Kongsfjord area); and yellow: Polar bear blood samples (north-east Svalbard).

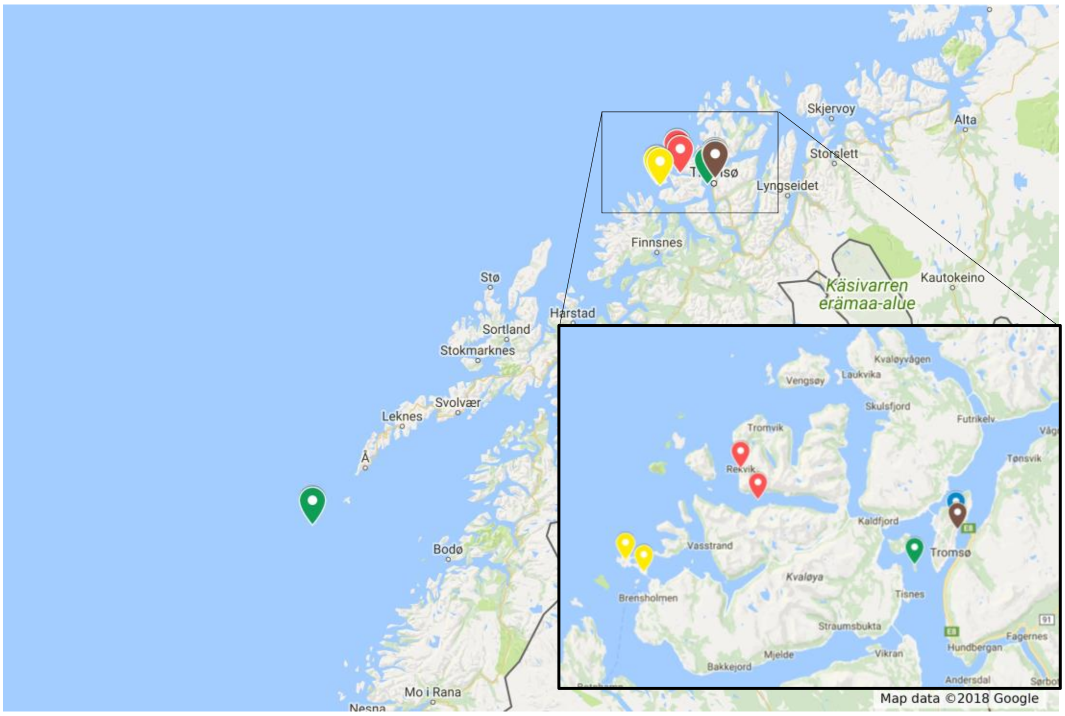


Figure 3: Sampling stations on the Norwegian mainland. Blue: Air samples (Tromsø city, different places); green: Egg samples (Røst and Grindøya); yellow: Mink samples (Hillesøy and Sommarøy); red: Marine plastic (Rekvika and Ersfjorden); and brown: Waste water effluent (Breivika).

2.1.1 Arctic air

Air samples were collected at the Arctic observatory located at 78°54'29"N 11°52'53"E, 475 m above sea level on the Zeppelin Mountain, and south of the settlement Ny-Ålesund on Svalbard. This station is part of Norway's air monitoring network, where PCBs and many other legacy POPs have been monitored for several decades. Different active air samplers were used for this study: 1) a high volume air sampler equipped with only a filter unit, 2) a high volume air sampler equipped with both a filter unit and two PU-foam plugs, and 3) two low volume samplers equipped with either an ENV-adsorbent cartridge or an ABN-adsorbent cartridge. In principle all three sampler designs consist of a pump that draws air through the samplers with an average air flow rate of either 25 m^3/hour or 0.5 m^3/hour, a filter/adsorbent unit, and a flow meter. Specification on each sampler type is given in Table 9. Flow-rate and sampling conditions were digitally monitored and documented (e.g. power failures, etc.) as an integrated part of the sampling and quality control procedure.

Air sampling of particle bound compounds and semi-volatile compounds is a well-established routine at NILU and sampling errors are typically in the same range as those from the measurement uncertainty. The adsorbent based air sampling of volatile and very volatile compounds was tested and optimized for the cyclic siloxanes (I. S. Krogseth et al., 2013). It is expected that it also will be applicable to other compounds with similar volatility. However, in this study there are also compounds with higher volatility which suffer from breakthrough.

Table 9: Parameters for air sampling at Zeppelin mountain, Ny-Ålesund						
Sampler ID	**Type**	**Volume m3**	**Flow m3/h**	**Period**	**Sample ID**	**Analyte group**
1	Filter	1826,85	25	30.06.17-03.07.17	1	Bisphenols
		816,95	25	12.07.17-13.07.17	2	
		2833,08	25	28.07.17-31.07.17	3	
		1963,74	25	09.08.17.11.08.17	4	
		2877,51	25	25.08.17-28.08.17	5	
2	Filter/PUF	2011,04	25	07.07.17-10.07.17	1	CUP+PBT
		1885,61	25	21.07.17-24.07.17	2	
		1972,61	25	04.08.17-07.08.17	3	
		2029,36	25	18.08.17-21.08.17	4	
		1952,85	25	01.09.17-04.09.17	5	
3	Filter/PUF	2003,65	25	30.06.17-03.07.17	1	UV
		1974,34	25	14.07.17-17.07.17	2	
		1667,98	25	28.07.17-31.07.17	3	
		2031,56	25	11.08.17-14.08.17	4	
		2019,39	25	25.08.17-28.08.17	5	
4	Filter	1841,2	25	05.07.17-07.07.17	1	Other aromatics
		1650,3	25	21.07.17-24.07.17	2	
		1605,82	25	02.08.17-04.08.17	3	
		2935,64	25	11.08.17-14.08.17	4	
		2143,81	25	30.08.17-01.09.17	5	
5	**ABN**	47,34	0,7	09.06.17-12.06.17	1	**All volatiles**
		50,85	0,7	30.06.17-03.07.17	2	
		37,49	0,7	21.07.17-24.07.17	3	
		40,36	0,7	11.08.17-14.08.17	4	
		50,49	0,7	01.09.17-04.09.17	5	

2.1.2 Arctic biota

The sampling of eggs was performed with authorisation from the Norwegian Environment Agency and the Governor of Svalbard. The laying-order of the eggs was not accounted for when collecting the eggs to minimise disturbances of the nest. The eggs were either wrapped in aluminium foil and stored frozen until laboratory analysis (Lucia, Gabrielsen, Herzke, & Christensen, 2016) or kept individually in polyethylene bags in a refrigerator (+4°C), before being shipped by express delivery service to NINA’s laboratory in Trondheim for measurements and emptying. When emptying, the whole content of the eggs was removed from the shell and transferred to clean glass vials in a clean room for storage at − 21 °C. The dried eggshells were measured (length, breadth and weight of shell) in order to calculate the eggshell index, which is a measure of eggshell quality (Ratcliffe, 1970). In addition, the shell thickness was measured using a special calliper (Starrett model 1010) as a standard routine.

Common eider
Eggs from common eider (*Somateria mollissima*) were sampled on the islands in Kongsfjorden Svalbard. A total of 10 eggs (n=10) from 10 randomly chosen nests were collected in June 2017.

European shag
Eggs from European shag or common shag (*Phalacrocorax aristotelis*) were sampled on the Island of Røst. A total of 5 eggs (n=5) were collected from five randomly chosen nests in May 2017.

Glaucous gull
Eggs from glaucous gulls (*Larus hyperboreus*) were sampled on the Islands of Observasjonsholmen, Kapp Guissez and Krykkjefjellet in Kongsfjorden, Svalbard. A total of 5 eggs (n=5) were collected randomly in June 2017.

Black-legged kittiwake
Eggs from black-legged kittiwake (*Rissa tridactyla*) were sampled on the Islands of Observasjonsholmen, Kapp Guissez and Krykkjefjellet in Kongsfjorden, Svalbard. A total of 5 eggs (n= 5) were collected randomly in 2017. The sampling of eggs was performed in June.

Mink
American mink (*Neovison vison*) were sampled on the islands of Sommarøy and Hillerøy, in Troms County. A total of 10 individs (n=10) were collected randomly in 2013 and 2014. Whole animals were wrapped in aluminium foil and stored frozen until laboratory dissection and sampling at NINA's laboratory in Trondheim. Liver samples were excised and placed in aluminium foil before storage in a ziplock bag (at -20 °C) until analysis.

Polar bear
Blood from ten polar bears (n=5 females and n=5 males) was collected in April of 2017 at the north-eastern part of Svalbard. Blood samples were centrifuged in the field, and the plasma transferred to cryogenic vials and immediately frozen (-20 °C). Samples (n=10) were stored frozen at -20 °C until analysis.

2.1.3 Hot spot related samples

Common gull
Eggs from European common gull (*Larus canus*) were sampled on Tromsøya island, Tromsø. A total of 5 eggs (n=5) were collected from randomly chosen nests in June of 2017. The eggs were wrapped in aluminium foil and stored frozen (-20 °C) until homogenization at NINA's laboratory in Trondheim.

WWTP Effluent
Six 24-hour, flow proportional composite effluent samples were collected with an automatic water sampling device by personal of the WWTP at Breivika. The effluent samples were collected in clean glass bottles and shipped to NILU in Tromsø. Until analysis the effluent samples were stored dark at 4°C.

Marine plastic
Two marine plastic samples were collected in 2017. One sample-set was taken from the OSPAR beach Rekvika, Troms, which is affected by long range transported plastic. The additional sample-set was collected from a beach in Ersfjorden, Troms, which is affected by emissions from a local source (aquaculture). The collected plastics were sorted, and pieces of between 0.5 and 1 cm in length were selected for analysis. No attempt was made to detect the type of plastic.

Urban air
Air samples were collected using a passive air-sampling methodology. Samples were collected from three potential source localities within the city of Tromsø (outside a wastewater-treatment plant, outside the hospital, and at a waste-handling facility), and a reference sample was collected from a location approximately 30 km outside Tromsø. The passive air-samplers (XAD-PAS) consisted of approximately 10 grams of polystyrene-divinylbenzene copolymeric resin (XAD-2) inside a metal mesh cylinder. These were placed inside a stainless steel housing and deployed approximately two meters above ground level (Krogseth, Zhang, Lei, Wania, & Breivik, 2013; Wania, Shen, Lei, Teixeira, & Muir, 2003). Samplers were deployed from June 28th until September 20th (84 days), except for the sampler at the hospital which was deployed from July 7th until September 20th (75 days). Two field-blanks (one for siloxane compounds and one for fluorinated compounds) were collected on June 28th to monitor blank contamination from field-work, transport, and storage. All samples were wrapped in aluminum foil and zip-lock bags and stored frozen until extraction. An approximate sampling volume was estimated for siloxanes based on a calibration of uptake of cyclic volatile methyl siloxanes in XAD-PAS in Toronto, Canada (Ingjerd S. Krogseth et al., 2013).

2.2 Chemical analysis

2.2.1 Volatile fluoroorganic and related compounds

Samples were processed in the same manner as for volatile cyclic siloxane analysis. All operations were performed in a clean cabinet to avoid contamination from lab air. All samples were first spiked with an isotopically labelled internal standard mixture containing 13C-labeled cyclic siloxanes D4, D5 and D6 and perdeuterated diisopropylbenzene (C12D18).

Aqueous samples

Water samples (200 ml) were extracted with dichloromethane. The solvent extract was then collected for analysis.

Air samples

Sorbents from the air-sampling devices were extracted with hexane, and the solvent was collected for analysis.

Solid samples

Sediment, sludge and dust samples (approximately 1g) were extracted with 4ml of acetonitrile-hexane mixture (1:1), and the hexane layer collected for analysis via GC-MS.

Biota

Biota samples (approximately 1g) were extracted with 4ml of acetonitrile-hexane mixture (1:1), and the hexane layer was collected for analysis via GC-MS.

Instrumental analysis

All the solvent extracts were dried with Sodium Sulfate and injected onto GC-MS (Q Exactive GC-HRMS, Agilent GCMS or QuattroMicro GC-MS) without further purification or concentration. Specialty 30m RTx-200ms GC column (partially fluorinated siloxane polymer phase) was used for analysis to provide sufficient retention of the very volatile perfluorinated substances.

2.2.2 PFAS

Sample extraction and clean-up

Prior to extraction a mixture of isotope labelled perfluorinated sulfonic acids and PFCAs was added to the samples. The samples were extracted with acetonitrile. The solvent extracts were then concentrated under vacuum and treated with an emulsive clean-up before analysis.

Instrumental analysis

The instrumental analysis were performed on a Thermo UPLC-MS/MS in ESI(-) mode.

2.2.3 UV filters

Biota, water and plastics.

Samples were spiked with isotopically labelled internal standards before extraction. Biota samples were also spiked with a volume of zinc chloride solution to improve extraction efficiency. Biota and plastic samples were then extracted with organic solvents in an ultrasonic bath. Water samples were extracted with organic solvents with a magnetic stirrer. The organic-solvent extracts were removed and concentrated with vacuum under nitrogen flow before undergoing a final clean-up step with PSA sorbent to remove interferences. The final extracts were filtered using spinex 0.2μm and concentrated to approximately 0.2ml prior to the analysis.

Air samples
Sorbents from the air-sampling devices were extracted with hexane, and the solvent was collected and concentrated under nitrogen flow to approximately 0.2ml prior to analysis.

Instrumental Analysis
Samples from water and air were analysed with Agilent 6890N GC system equipped with 30-meter DB-5MS column and coupled to Agilent 5973N MSD operated in EI mode.
Samples from blood, egg and mink were analysed with Agilent 7890B GC system equipped with two 15 meter HP-5MS-UI columns coupled to an Agilent 7010B GC/MS Triple Quad operated in EI mode.

2.2.4 Semivolatile persistent organic compounds (PBT) including current-use pesticides (CUPs)

Sample extraction and clean-up
Samples were first spiked with a mixture of isotopically labelled PCBs and dechloranes. The samples of water, sediment, and biota were then extracted with organic solvents and concentrated under nitrogen flow before undergoing a final clean-up step using concentrated sulphuric acid and a silica column to remove lipids and other interferences prior to analysis. All samples were concentrated to approximately 150 μL for analysis.

Analysis
Sample extracts were injected into an Agilent 7890N GC system coupled to an Agilent 7200 QToF mass spectrometer operated in electron capture negative ionization mode (GC-ECNI-HRMS).

2.2.5 Bisphenols

Aqueous samples
Water samples (150 ml) were spiked with isotopically labelled internal standards and extracted by solid phase extraction (SPE). SPE columns were conditioned with ethyl acetate, acetonitrile and with MilliQ water, the samples were then extracted and analytes eluted with ethyl acetate. A final solvent-exchange to either toluene or methanol was then carried out ahead of analysis.

Sludge samples
Samples were extracted with accelerated solvent extraction and further cleaned with SPE.

Biological samples
Biological samples were extracted using ultrasonic assisted liquid extraction, and cleaned on a Florisil column and with dSPE (C18). Remaining interferences were removed with SPE.

Instrumental analysis
The bisphenols were analysed either with the Agilent 1290 UHPLC coupled to Agilent 6550 HR-QTOF or Waters Acquity UPLC copied to Waters LCT HR-TOF system operated in a negative electrospray ionisation mode. Separation of bisphenols was achieved with the use of Waters HSS T3 column (1.8 μm, 150 x 2.1 mm) with a gradient of water and methanol used as a mobile phase.

2.2.6 Other aromatic polar compounds

Sample preparation and extraction

Isotopic labelled internal standards were not commercially available and therefore these compounds were not spiked into the samples. Samples were extracted with a reagent mixture containing zinc sulfate solution, acetonitrile and sodium chloride. The samples were vortexed for 30 seconds and sonicated for 30 minutes. The acetonitrile layer was removed following centrifugation and transferred into a glass vials. The extract was concentrated to 1mL under dry nitrogen and a clean-up via PSA sorbent was performed before analysis.

Instrumental analysis

Analysis was performed via high resolution mass spectrometry (HRMS) on a Waters Acquity UPLC coupled to Waters Xevo G2-S QTOF system operated in positive electrospray ionisation mode.

2.2.7 Suspect and non-target screening

Sample preparation and extraction

The extracts from the analysis of the target substances in this study were also retained and re-used for non-target and suspect screening.

For non-target analysis by GC-HRMS the samples used were the residual extracts from the targeted analysis of volatile fluoro-organic substances and siloxanes. For non-target analysis by LC-HRMS the samples used were the residual extracts from the targeted analysis of the aromatic polar compounds as described in 2.2.6.

Non-target or suspect screening was carried out on 6 air samples, 6 effluent samples, 10 samples of polar bear blood, and 30 egg samples. Note that no field-blank samples were available for water or samples of biota.

Instrumental analysis

Screening on the GC-HRMS was achieved by 1 µL injection of the sample extracts onto a Q Exactive GC-HRMS instrument in scan mode with mass resolution of 60000. The “standard” 30m DB-5 type column was employed. Mass-labeled cyclic siloxanes D4, D5 and D6, as well as Perdeuterated diisopropylbenzene had already been added to the samples for targeted analysis, and these were used here as semi-quantitative ISTDs. After the acquisition the raw files were processed with the Deconvolution Plugin of the TraceFinder software (Thermo Scientific) to reveal individual components present in samples.

Screening on the LC-HRMS was achieved by injection of 5 µL of the sample extracts onto a Waters Acquity UPLC system connected to a Waters Xevo G2-S QTOF mass spectrometer (Waters Corp., Milford USA). Gradient elution was performed at a constant flow of 0.25 ml min^{-1} using 5 mM ammonium formate, pH 3.0 (solvent A) and acetonitrile with 0.1% formic acid (solvent B). The gradient elution starts with 80% A and then increasing B to 100% in 10 min, held until 13.5 and then back to initial conditions with a gradient until 14.5 and held to 16 minutes. Detection on the LC-HRMS was in electrospray positive mode using MSe in continuum data format and sensitivity mode, that allows both precursor and product ion data to be simultaneously acquired during a single run. The MS method consists of 3 functions, the first (low energy) applies collision energy of 6 eV, the second function (high energy, HE) acquires through a collision energy ramp of 15-50 eV and the third function acquires the lock mass data for online mass calibration. The MS range is 70-700 with a scan time of 0.2 s in continuum mode, preserving the peak shape of the exact-mass precursor and product ions.

2.3 Uncertainties

Each of the many steps involved in the process of performing environmental screening studies for contaminants of emerging concern will have an impact on the overall uncertainty of the final results. This uncertainty starts with the design of the sampling regime and is compounded through the entire process to storage of samples, chemical analysis and data treatment. Although it is difficult to estimate the absolute uncertainty for all steps in the process, we are confident that uncertainty in the results from screening studies are higher than that of routine monitoring of PCBs or other legacy POPs. While the total measurement uncertainty for PCBs is approximately 25 to 30 %, we would estimate that for screening studies this value would be in the order of 40 to 50 % for new emerging compounds as measured in this report.

3. Results and discussion

In this study about 90 different compounds with an array of physiochemical properties were measured in environmental samples. These samples included wastewater effluent samples, air from both urban and pristine arctic environments, and a selection of biota from localized hot-spot areas and from the most remote Arctic species. A complete data table is included in the appendix and a detailed presentation of selected results is given in the following chapters. Table 10 - Table 13 present the frequency of detection of all compounds in all sample types. Detection frequency is the percentage of samples in which a substance was detected relative to the total number of analysed samples. It should be noted that, as always, the results are dependent on detection limits for each compound. A non-detect or zero in this table is not a guarantee that the compound was not present, but instead that the compound was not detectable.

Table 10: Detection frequency (%) for volatile compounds

Shaded compounds: Selected according to AMAP report, Chapter 4 (AMAP Assessment 2016: Chemicals of Emerging Arctic Concern, 2017). Detection frequency is given by the number of detects divided by the total number of measured samples given in percent.

	Compound	Arctic							Hot spot/Urban			
		Arctic air	Common eider	European shag	Kittiwake	Glaucous gull	Polar bear	Mink	Common gull	Effluent	Urban air	Micro-plastic
Volatile fluoroorganic compounds	PFPHP	67	0	0	0	0	0	0	0	0	0	na
	PFBCH	0	0	0	0	0	0	0	0	0	0	na
	PFDMH	0	0	0	0	0	0	0	0	0	0	na
	PP90	0	0	0	0	0	0	0	0	0	0	na
	PFEPFD	0	0	0	0	0	0	0	0	0	0	na
	PFTPA	0	0	0	0	0	0	0	0	0	0	na
	PFTBA	100	0	0	100	0	0	0	0	0	0	na
	TCHFB	100	0	0	0	0	0	0	0	0	0	na
	BTFMBB	0	0	0	0	0	0	0	0	0	0	na
	BPFB	0	0	0	0	0	0	0	0	0	0	na
	DCTFP	83	0	0	0	0	0	0	0	0	0	na
	HFPO-T	0	0	0	0	0	0	0	0	0	0	na
	9M-PFDF	0	0	0	0	0	0	0	0	0	0	na
	DCTCB	100	0	0	0	0	0	0	0	0	0	na
Siloxanes	D4	100	0	0	0	0	0	0	0	100	100	na
	D5	100	0	0	0	0	0	0	0	100	100	na
	D6	100	0	0	0	0	0	0	0	100	75	na
	D4Ph	0	0	0	0	0	0	0	0	0	75	na
	D3F	0	0	0	0	0	0	0	0	0	0	na
	D4Vn	0	0	0	0	0	0	0	0	0	0	na

Table 11: Detection frequency (%) for PFAS
Detection frequency is given by the number of detects divided by the total number of measured samples given in percent.

	Compound	Arctic							Hot spot/Urban			
		Arctic air	Common eider	European shag	Kittiwake	Glaucous gull	Polar bear	Mink	Common gull	Effluent	Urban air	Micro-plastic
PFAS	PFOSA	na	60	100	40	0	50	60	80	0	na	0
	PFBS	na	0	0	0	0	60	100	80	0	na	0
	PFPS	na	0	0	0	0	0	0	0	0	na	0
	PFHxS	na	100	100	80	80	100	100	100	0	na	0
	PFHpS	na	20	100	60	60	100	100	100	0	na	0
	brPFOS	na	0	100	60	40	100	100	100	0	na	0
	PFOS	na	100	100	100	100	100	100	100	0	na	0
	PFNS	na	40	20	0	40	30	0	40	67	na	0
	PFDcS	na	0	0	60	20	30	0	100	0	na	0
	PFBA	na	0	0	0	0	0	0	0	0	na	0
	PFPA	na	80	60	60	80	100	60	40	83	na	0
	PFHxA	na	100	40	40	40	40	0	20	100	na	100
	PFHpA	na	80	100	60	100	100	60	100	100	na	0
	PFOA	na	100	100	100	100	100	100	100	83	na	0
	PFNA	na	100	100	100	100	100	100	100	83	na	0
	PFDcA	na	100	100	100	100	100	100	100	0	na	0
	PFUnA	na	100	100	100	100	100	100	100	0	na	0
	PFDoA	na	100	100	100	100	100	100	100	0	na	0
	PFTriA	na	100	100	100	100	100	100	100	0	na	0
	PFTeA	na	100	100	100	100	70	100	100	0	na	0
	PFHxDA	na	0	0	0	0	0	0	100	0	na	0
	PFOcDA	na	0	0	0	0	0	0	0	0	na	0
	6:2FTS	na	0	0	0	0	0	80	0	0	na	0
	8:2 FTS	na	0	20	0	0	10	20	100	0	na	0

Detection frequency is given by the number of detects divided by the total number of measured samples given in percent.

Table 12: Detection frequency (%) for UV filters, CUPs, new BFRs, dechloranes, and CPs

Shaded compounds: Selected according to AMAP report, Chapter 4 (AMAP Assessment 2016: Chemicals of Emerging Arctic Concern, 2017). Detection frequency is given by the number of detects divided by the total number of measured samples given in percent.

	Compound	Arctic							Hot spot/Urban			
		Arctic air	Common eider	European shag	Kittiwake	Glaucous gull	Polar bear	Mink	Common gull	Effluent	Urban air	Micro-plastic
UV filters	BP3	0	80	40	40	80	0	60	40	100	na	na
	ODBAPA	0	0	0	0	0	na	20	0	17	na	na
	UV-320	0	0	0	60	20	0	0	0	0	na	na
	UV-326	0	0	0	20	0	10	100	0	100	na	na
	UV-327	0	0	0	20	0	0	40	0	50	na	na
	UV-328	0	100	60	100	60	0	100	60	100	na	na
	UV-329	0	0	100	0	0	10	100	100	33	na	na
	UV-928	0	0	0	0	0	0	0	0	0	na	na
	OC	0	ns	na	na	na	50	0	na	100	na	na
	EHMC	0	100	0	100	100	0	80	0	100	na	na
Current-use pesticides	Trifluralin	0	0	0	0	0	0	0	0	0	na	0
	Chlorothalonil	0	0	0	0	0	0	0	0	0	na	0
	Chlorpyrifos	0	0	0	0	0	0	0	0	83	na	0
	Dachtal	100	0	0	0	0	0	0	0	0	na	0
	Bifenthrin	0	0	0	0	0	0	0	0	0	na	0
	Cypermethrin	0	0	0	0	0	0	0	0	100	na	50
New BFRs	PBCCH1	0	20	0	0	0	0	0	0	0	na	0
	PBCCH2	0	0	0	0	0	0	0	0	17	na	0
	PBCCH3	0	0	0	0	0	0	0	0	0	na	0
	PBCCH4	0	0	0	0	0	0	0	0	0	na	0
	BCPS	0	0	0	0	0	0	20	20	0	na	0
	DBCD	0	0	0	0	0	0	0	0	0	na	0
Dechloranes	Dibromoaldrin	na	0	0	0	0	0	0	0	na	na	na
	Dechlorane 601	na	0	0	0	0	0	0	0	na	na	na
	Dechlorane 602	na	100	100	100	100	100	100	100	na	na	na
	Dechlorane 603	na	0	0	0	0	0	40	100	na	na	na
	Dechlorane 604	na	0	0	0	0	0	0	0	na	na	na
	Dechlorane plus syn	na	80	100	80	100	100	100	100	na	na	na
	Dechlorane plus anti	na	80	100	100	100	100	100	100	na	na	na
CPs	SCCP	na	100	100	100	100	100	100	100	100	na	na
	MCCP	na	100	100	100	100	100	100	100	100	na	na

Table 13: Detection frequency (%) for bisphenols and other aromatic compounds
Shaded compounds: Selected according to AMAP report, Chapter 4 (AMAP Assessment 2016: Chemicals of Emerging Arctic Concern, 2017). Detection frequency is given by the number of detects divided by the total number of measured samples given in percent.

	Compound	Arctic							Hot spot/Urban			
		Arctic air	Common eider	European shag	Kittiwake	Glaucous gull	Polar bear	Mink	Common gull	Effluent	Urban air	Micro-plastic
Bisphenols	BPA	80	0	0	0	0	0	0	0	100	na	50
	BP-AF	0	0	0	0	0	0	0	0	17	na	0
	BPB	0	0	0	0	0	0	0	0	0	na	0
	BP-BP	0	0	0	0	0	0	0	0	0	na	0
	2,2'-BPF	0	0	0	0	0	0	0	0	0	na	0
	2,4'-BPF	0	0	0	0	0	0	0	0	17	na	0
	4,4'-BPF	0	0	0	0	0	0	0	0	0	na	0
	BPM	0	0	0	0	0	0	0	0	0	na	0
	BPP	0	0	0	0	0	0	0	0	17	na	0
	BPS	40	0	0	0	0	0	0	0	100	na	0
	BP-TMC	0	0	0	0	0	0	0	0	0	na	0
	BPZ	0	0	0	0	0	0	0	0	0	na	0
	TBBPA	0	0	0	0	0	0	0	0	0	na	0
Other aromatics	BDPPBD	0	0	0	0	0	0	0	0	0	na	na
	CTFPPA	0	0	0	0	0	0	0	0	0	na	na
	NPADPP	0	0	0	0	0	0	0	0	0	na	na

3.1 Volatile fluoroorganic and related compounds

3.1.1 Arctic air

In air samples from the high Arctic air monitoring station on mount Zeppelin five of the 13 prioritized volatile/semivolatile compounds could be detected (see Table 14), namely PFPHP, PFTBA, TCHFB, DCTFP, and DCTC. PFPHP and PFTBA are pure fluoro compounds; TCHFB and DCTFP are fluorochloro compounds, and DCTFP is a chlorinated compound. Of the siloxanes only the normal cyclic D5 and D6 were found. The measured cVMS concentrations are in agreement with results from the regular monitoring programme at Zeppelin.

Table 14: Volatile concentrations in air samples from Mount Zeppelin, Ny-Ålesund

Sample type	PFPHP*	PFTBA*	TCHFB*	DCTFP*	DCTCB*	D5	D6
	(Min - max) **Average*** Detection frequency					pg/m^3	
Air	(<1 - 1.8) **1.3** 60 %	(9.7 - 89) **15** 100 %	(4.7 - 9.5) **6.3** 100 %	(<0.5-0.25) **0.19** 80 %	(2.1 - 9.2) **3.8** 100 %	(30 - 2860) **560** 100 %	(10 - 180) **90** 100 %

*): Due to high volatility these compounds are exposed for breakthrough during sampling and the measured concentrations most probably underestimate the real air concentrations.

**): For the non-detects LoD/2 was used, when calculating the average.

3.1.2 Arctic biota

Of the volatile halogenated organic compounds only PFTBA could be detected slightly above LoD in the kittiwake samples from Svalbard. All other compounds were below LoD. For the LoD of these compounds please refer to the table in the appendix.

3.1.3 Hot-spot related samples

Urban air

The three cyclic siloxanes were detected at all sites in the urban air samples from Tromsø, while D4Vn and D3F were below detection limits at all sites. D4Ph was detected in three out of four air samples. However, concentrations were 2-4 orders of magnitude lower than that of the cyclic siloxanes, and results should be interpreted with care as the air sampling methodology has not been evaluated for this compound. D5 dominated in the urban air samples, while D4 dominated at the rural site. Of the three urban sites, cVMS concentrations were highest at the waste treatment facility (Remiks), but D4Ph was not detected here. However, concentrations are not directly comparable between sites, as sampling uptake rates may be affected by local temperature and wind conditions.

Due to limitations in available sample amount of the passive air samples for Tromsø, it was not possible to run the complete list of volatile fluoroorganic compounds. Some of these compounds (PFBCH, PFDMH, PP90, PFEPFD, PFTPA, PFTBA, BPFB, DCTFP, HFPO-T and 9M-PFDF) have complimentary requirements to the analytical method not appropriate for the rest of this group and could therefore not be analyzed with sufficient quality.

3.1.4 Discussion

For the first time the nonpolar halogenated organic chemicals PFPHP, PFTBA, TCHFB, DCTFP, and DCTFB were detected in Arctic air samples. Only PFTBA was found in environmental samples earlier (Hong, Young, Hurley, Wallington, & Mabury, 2013). These results give a strong indication of the potential for long-range transport and high persistency of these compounds. It should be noted that the measured concentrations for most of these compounds probably underestimate the real air concentrations at this sampling site, and do not qualify for model calculations or later time trend studies. This is because these compounds have a higher volatility (42.7, 192, 6240, 204 and 0.78 Pa) compared to D5 (26 Pa), and a much lower affinity to the hydrocarbon-based adsorbents, and we therefore must expect some breakthrough during sampling.

PFPHP is a pure perfluorocarbon and PFTBA is a perfluorinated tertiary amine. These poly- and perfluorinated compounds have very special technical properties, which make them very attractive for a lot of industrial and medical applications. These applications range from cooling and rinsing liquids in the electronic industry, via use as speciality solvent in the chemical industry, solvents in cosmetics, to the use as blood replacement, and in eye/retina surgery. PFPHP is marketed under the tradename Flutec PP-11 ("Flutec PP11," 2018). PFTBA is marketed under the tradename Fluorinert FC-43 ("Fluorinert FC-43," 2018). These two compounds are examples for a long range of perfluorocarbons and perfluoroamines, which are marketed and used as an inert liquid for special applications in electronic industry (cleaning and cooling). Some of these compounds have also medical applications. In this case, the good solubility for gases like oxygen and carbon dioxide, the high density together with its chemical inertness are very important properties. These perfluorinated inert liquids like PFPHP, PFTBA, and several others not included in this study have a much higher density than water. When treating retinal detachment, these liquids are injected into the eye, and by the higher density of the PFC liquid, the retina is pressed back and in place. The normal volume used during surgery is about 10 mL per eye (Blum, 2018; Yu, Liu, Su, Xia, & Xu, 2014). It is assumed that the industrial application exceed the medical applications. However, it is extremely difficult to get access to reliable production and consumption figures for these compounds.

TCHFB and DCTFP are fluorochloro compounds, which probably are only used as intermediates in the production of other chemicals. TCHFB are registered in REACH, however, without information on use. A recent review paper (Zhu, Chen, Wang, & Zhang, 2014) and several new patents show that TCHFB can be an important reaction intermediate in the production of hexafluorobutadiene (HFBD). HFBD is a monomer for several perfluorinated polymers, but also used in plasma etching during production of semiconductors. No information of the total production or release of TCHFB could be found. DCTFP is an important reaction intermediate in the production of the herbicide Fluroxypyr (Unger, 1996). Some patents indicate a possible use as curing catalyst in elastic adhesives (Hara, 2012). No information of the total production or release of DCTFP could be found.

DCTCB is a chlorinated compound, which is described as a reaction intermediate in the production of several other chemicals (Marhold & Baumann, 2001). Until now DCTCB was not measured in emissions and recipients, however, it is commonly known that chlorinated benzenes and alkylbenzenes are by-products of several industrial processes, where elementary chlorine is used together with organic solvents. Norwegian examples for such processes are the nickel refining at Glencore, and the closed Mg-production at Hydro, Porsgrund (Källqvist & Martinsen, 1987). There were no focus on DCTFP in the emissions and deposits from these factories, but the release of DCTCB as unintentional by-product can be a relevant additional source.

PFPHP and PFTBA are very inert chemicals, and according to the producers also low in toxicity ("Fluorinert FC-43," 2018; "Flutec PP11," 2018). However, they are volatile, they have no sink in the lower atmosphere, and they have a strong IR-absorbance, which together make it very likely that they can act as long-lived greenhouse gases. PFTBA has recently been measured in urban air of Toronto (Hong et al., 2013). The same group have also measured the IR-absorbance of PFTBA, calculated the atmospheric life time and has concluded that this compound clearly qualifies as a long lived greenhouse gas and contributes substantially to global warming. The same is true for the other detected compounds.

The measured PFTBA concentrations in kittiwake were very low and close to LoD. Since contamination during sampling, storage, and chemical analysis cannot be excluded, we strongly suggest that these measurements are repeated with new samples before using these results as proof for bioaccumulation of this compound.
All together the compounds measured in this group clearly are of severe environmental concern and should be followed up by more dedicated sampling and analysis. To open up for trend studies and calculation of the global warming potential the applied sampling and analysis should be specially designed and tested for full recovery of these PFCs.

The siloxane D4Ph was measured in low concentrations in some urban air samples from Tromsø, but this compound was not found in samples outside the city. According to LookChem a web-based commodity D4Ph is used as lubricant. The toolbox profiler DART gives an alert for toxicity to reproduction (Wu et al., 2013). The environmental risk of this compound remains unresolved.

3.2 PFAS

As PFAS were measured routinely in the Norwegian air monitoring programme these compounds were not measured in the air samples of this study.

3.2.1 Arctic biota

Table 15: Concentrations of major PFAS in Arctic biota and one urban opportunist

Sample type/ area	PFHxS	PFOS	PFOA	PFNA	PFDcA	PFUnA
	(Min - max) **Average*** Detection frequency			ng/g w.w.		
Common eider/ Svalbard	(0.05 - 0.31) **0.13** 100 %	(2.4 - 4.4) **3.1** 100 %	(0.12 - 0.46) **0.25** 100 %	(0.32 - 1.1) **0.81** 100 %	(0.13 - 0.32) **0.22** 100 %	(0.26 - 0.68) **0.45** 100 %
European shag/ Røst	(0.23 - 0.57) **0.45** 100 %	(12 - 16) **13** 100 %	(0.28 - 0.52) **0.39** 100 %	(0.52 - 0.80) **0.69** 100 %	(0.63 - 0.95) **0.78** 100 %	(1.9 - 3.1) **2.4** 100 %
Kittiwake/ Svalbard	(<0.05 - 0.07) **0.03** 80 %	(6.0 - 26) **12** 100 %	(0.08 - 0.18) **0.11** 100 %	(0.38 - 1.7) **0.64** 100 %	(0.72 - 2.0) **1.4** 100 %	(4.8 - 8.4) **6.5** 100 %
Glaucous gull/ Svalbard	(<0.05 - 0.17) **0.10** 80 %	(4.1 - 6.9) **5.6** 100 %	(0.13 - 0.83) **0.44** 100 %	(0.30 - 1.1) **0.72** 100 %	(0.21 - 0.49) **0.35** 100 %	(0.76 - 1.6) **1.2** 100 %
Polar bear/ Svalbard	(11 - 35) **25** 100 %	(56 - 201) **113** 100 %	(0.86 - 5.1) **3.3** 100 %	(8.8 - 38) **20** 100 %	(3.6 - 13) **6.9** 100 %	(7.0 - 24) **14** 100 %
Mink/ Sommarøy	(3.4 - 6.0) **4.5** 100 %	(86 - 201) **135** 100 %	(0.26 - 5.4) **2.3** 100 %	(13 - 31) **21** 100 %	(4.7 - 11) **8.2** 100 %	(4.3 - 11) **8.0** 100 %
Common gull/ Tromsø	(0.48 - 1.2) **0.82** 100 %	(35 - 97) **31** 100 %	(0.55 - 2.2) **1.1** 100 %	(0.48 - 1.6) **0.92** 100 %	(0.65 - 3.5) **1.7** 100 %	(2.2 - 8.1) **4.1** 100 %

*): For the non-detects LoD/2 was used, when calculating the average.

Of the measured PFAS compounds, PFOS shows up with the highest concentration for all samples. PFNA was the most prominent compound of the carboxylic acid group. The measured concentration were in good agreement with earlier measurements (*AMAP Assessment 2016: Chemicals of Emerging Arctic Concern*, 2017; Schlabach et al., 2017).

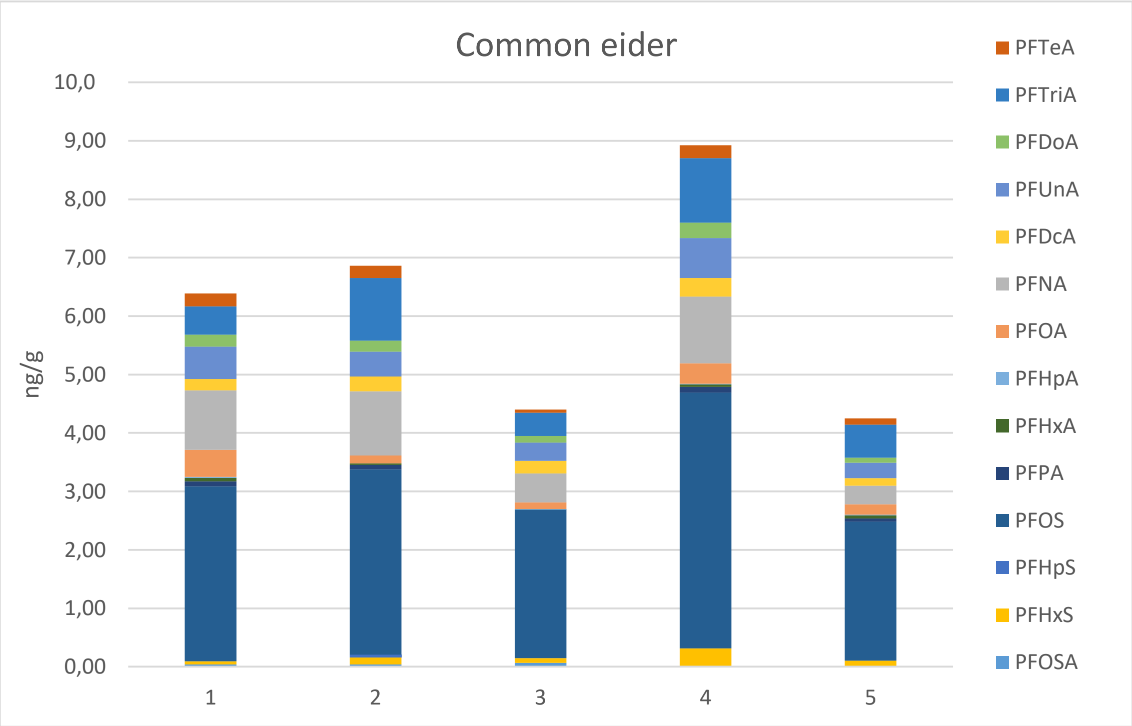


Figure 4: Concentration of PFAS in individual egg samples from common eider from Svalbard, Norway. Concentration given in ng/g w.w.

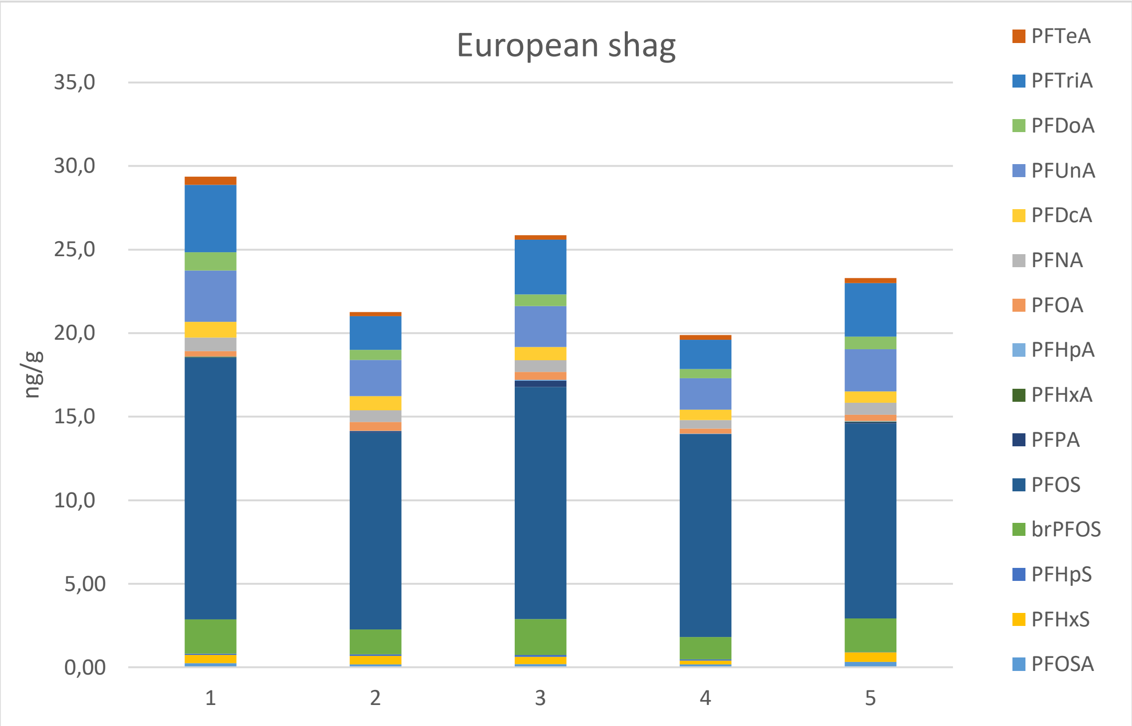


Figure 5: Concentration of PFAS in individual egg samples from European shag from Røst, Norway. Concentration given in ng/g w.w.

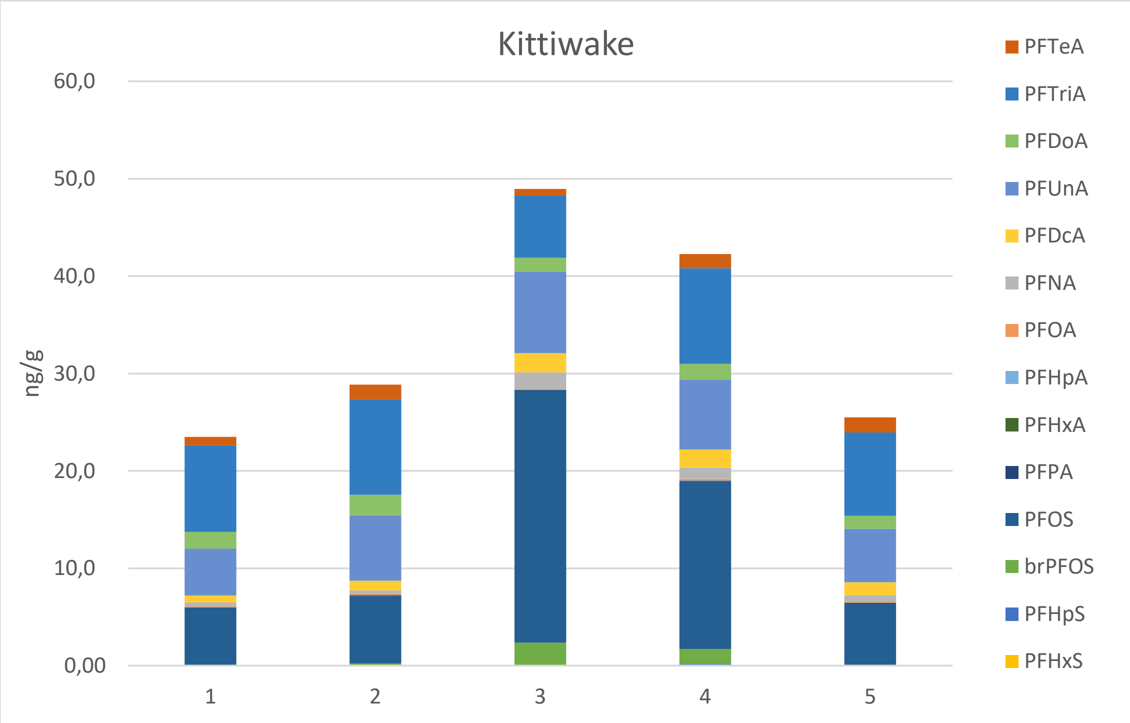


Figure 6: Concentration of PFAS in individual egg samples from Kittiwake from Svalbard, Norway. Concentration given in ng/g w.w.

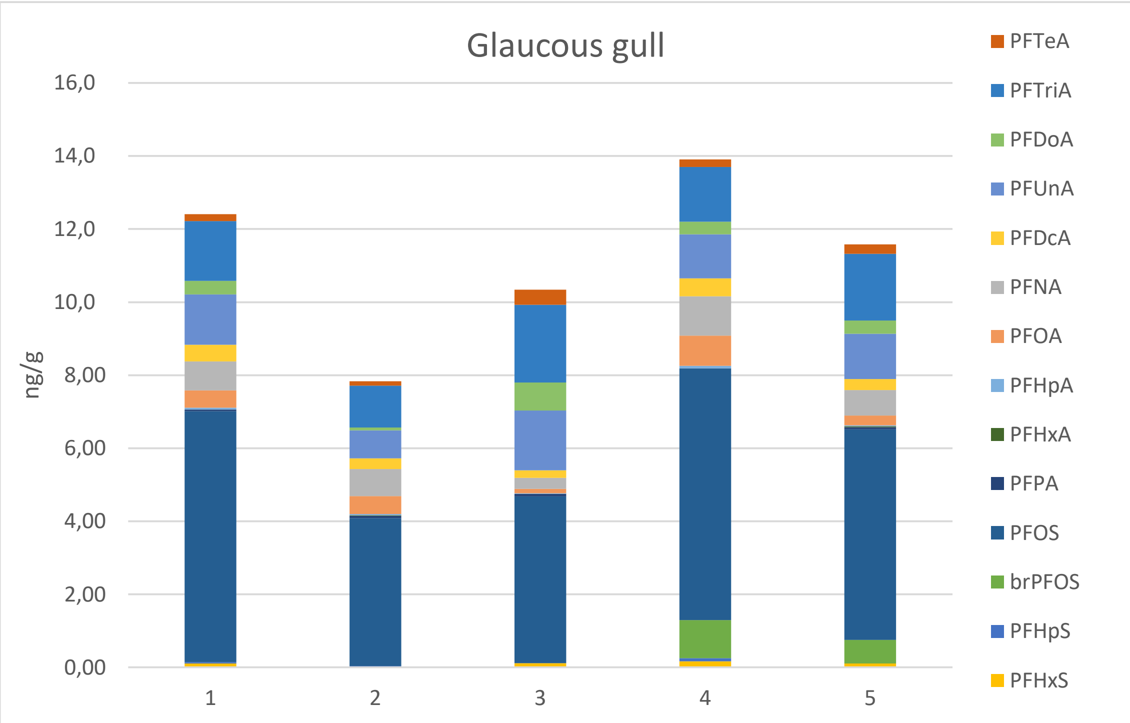


Figure 7: Concentration of PFAS in individual egg samples from glaucous gull from Svalbard, Norway. Concentration given in ng/g w.w.

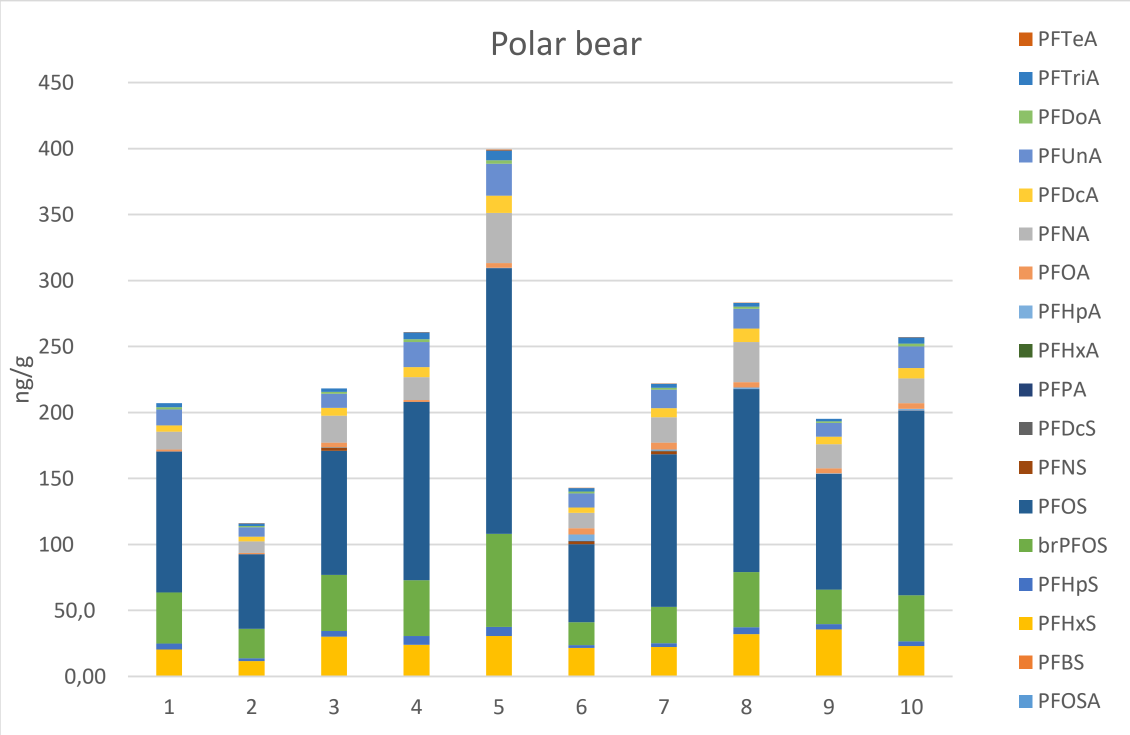


Figure 8: Concentration of PFAS in individual blood samples from polar bear from Svalbard, Norway. Concentration given in ng/g w.w.

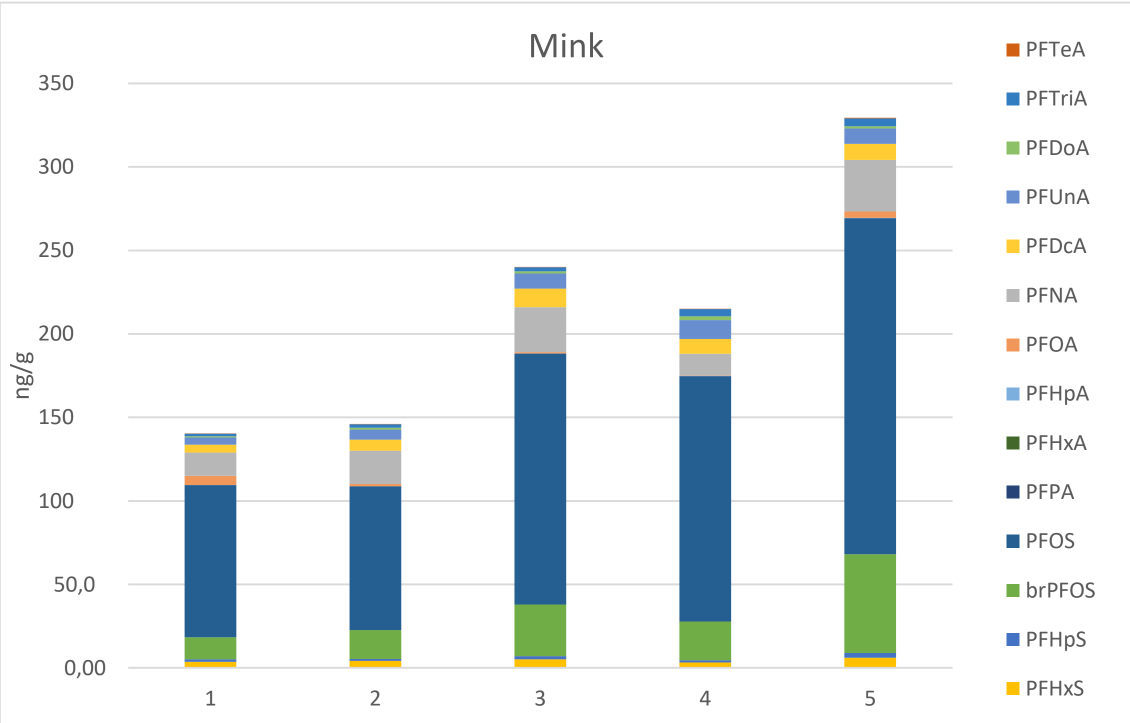


Figure 9: Concentration of PFAS in individual liver samples of mink from Hillesøy and Sommarøy, Troms county, Norway. Concentration given in ng/g w.w.

3.2.2 Hot spot related samples

Table 16: Concentrations of PFAS in Arctic and one urban opportunist

Sample type/ area	PFHxS	PFOS	PFOA	PFNA	PFDcA	PFUnA
	(Min - max) **Average*** Detection frequency			ng/L ng/g w.w.		
Effluent/ Tromsø WWTP	(<0.05) **<0.05** 0 %	(<0.1) **<0.1** 0 %	(<0.02 - 8.0) **5.2** 83 %	(<0.05 - 0.83) **0.38** 83 %	(<0.05) **<0.05** 0 %	(<0.05) **<0.05** 0 %
Common gull/ Tromsø	(0.48 - 1.2) **0.82** 100 %	(35 - 97) **31** 100 %	(0.55 - 2.2) **1.1** 100 %	(0.48 - 1.6) **0.92** 100 %	(0.65 - 3.5) **1.7** 100 %	(2.2 - 8.1) **4.1** 100 %

*): For the non-detects LoD/2 was used, when calculating the average.

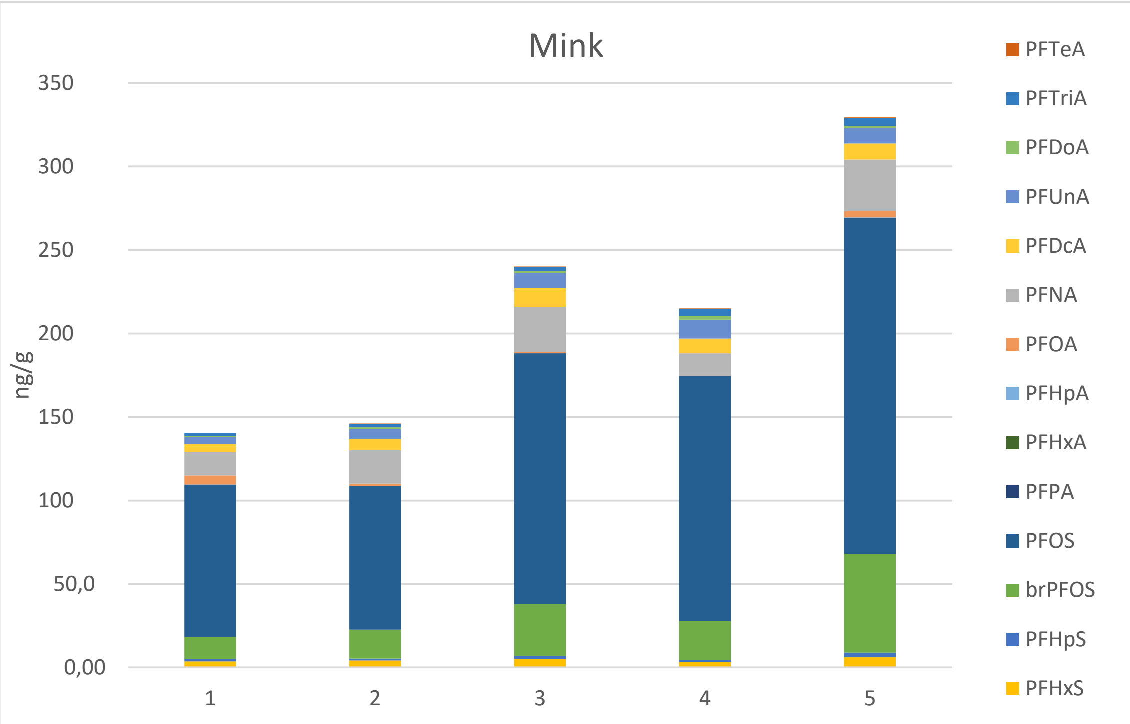


Figure 10: Concentration of PFAS in individual egg samples from common gull from Tromsø, Norway. Concentration given in ng/g w.w.

Also in hot spot samples PFOS showed up with the highest concentration for all samples. PFNA was the most prominent compound of the carboxylic acid group in effluent from Tromsø. In the urban common gulls PFUnA was the most prominent compound of the carboxylic acid group.

In micro plastic from Rekvika only PFHxA could be detected above LoD with an average concentration of 0.63 ng/g.

3.2.3 Discussion

This study targeted an array of PFAS substances and identified some at significant concentrations in Arctic predators and the urban opportunist (Common gull). Most of the targeted PFAS in this study have been detected in earlier measurements in Arctic biota. However, this study is completing the total picture with more results of perfluorinated alkylated carboxylic acids with odd-numbered carbon chain length, which earlier were not measured.

In effluent water from Tromsø PFNS was found with the highest concentration of all measured PFAS, which might be an indication for the replacement of PFOS with an odd-numbered perfluorinated sulfonate.

3.3 UV filters

There were some analytical problems for the UV filter octacrylene (OC) related to some matrix types, which unfortunately could not be solved in the time frame of this study. Therefore this compound could not be detected and quantified in a number of sample types. As UV 928 was not available as an analytical standard, this compound was analysed with the suspect screening approach. However, this compound was not found in the samples measured in this study. However, the LoD for this method is higher compared to the method used for the other UV filters.

3.3.1 Arctic air

The selected UV filters were not detected in air samples from Mount Zeppelin, Ny-Ålesund, Svalbard. For information on limit of detection, please refer to the complete data table in the appendix.

3.3.2 Arctic biota

Table 17: Concentrations of UV filters in Arctic biota and one urban opportunist

Sample type	BP3	UV320	UV326	UV328	UV329	OC	EHMC
	(Min - max) **Average*** Detection frequency				ng/g w.w.		
Common eider/ Svalbard	(<2 - 6.5) **4.2** 80 %	(<0.03) **<0.03** 0 %	(<0.2) **<0.2** 0 %	(0.11 - 0.25) **0.16** 100 %	(<0.2) **<0.2** 0 %	m	(2.6 - 6.1) **4.6** 100 %
European shag/ Røst	(<2.5 - 5.1) **2.7** 40 %	(<0.1) **<0.1** 0 %	(<0.2) **<0.2** 0 %	(<0.2 -0.23) **0.17** 60 %	(0.23 - 0.68) **0.35** 100 %	m	(<15) **<15** 0 %
Kittiwake/ Svalbard	(<2 - 8.3) **3.5** 40 %	(<0.03 - 0.07) **0.04** 60 %	(<0.2 - 0.24) **0.13** 20 %	(0.12 - 0.31) **0.19** 100 %	(<0.2) **<0.2** 0 %	m	(3.1 - 7.6) **5.1** 100 %
Glaucous gull/ Svalbard	(<2 - 4.3) **2.9** 80 %	(<0.3 - 0.3) **0.02** 20 %	(<0.2) **<0.2** 0 %	(<0.1 - 0.27) **0.12** 60 %	(<0.2) **<0.2** 0 %	m	(1.9 - 3.3) **2.8** 100 %
Polar bear/ Svalbard	(<1.5) **<1.5** 0 %	(<0.1) **<0.1** 0 %	(<0.5 - 0.81) **0.31** 10 %	(<0.3) **<0.3** 0 %	(<0.6 - 2.3) **0.5** 10 %	(<15 - 38) **18** 50 %	(<4) **<4** 0 %
Mink/ Sommarøy	(<0.2 - 2.3) **0.65** 40 %	(<0.06) **<0.06** 0 %	(0.31 - 0.51) **0.37** 100 %	(0.08 - 0.36) **0.18** 100 %	(<0.2) **<0.2** 0 %	(<3) **<3** 0 %	(<3 - 4.9) **4.0** 80 %
Common gull/ Tromsø	(<2.5 - 5.1) **2.7** 40 %	(<0.1) **<0.1** 0 %	(<0.2) **<0.2** 0 %	(<0.2 - 0.23) **0.17** 60 %	(0.23 - 0.68) **0.35** 100 %	m	(<15) **<15** 0 %

*): For the non-detects LoD/2 was used, when calculating the average.

The selected UV filters were frequently found in the different Arctic biota and the urban opportunist. EHMC and BP3 were found at the highest concentrations, typically 1 – 5 ng/g w.w. UV320 to UV329 were detected with concentrations between 0.1 and 1 ng/g w.w.

Common eider

In Common eider BP3, UV328, and EHMC were detected. BP3 and EHMC showed the highest concentration with an average of 4.2 and 4.6 ng/g w.w. (Figure 11), whereas the detected UV 328 showed a significant lower average concentration with 0.16 ng/g w.w.

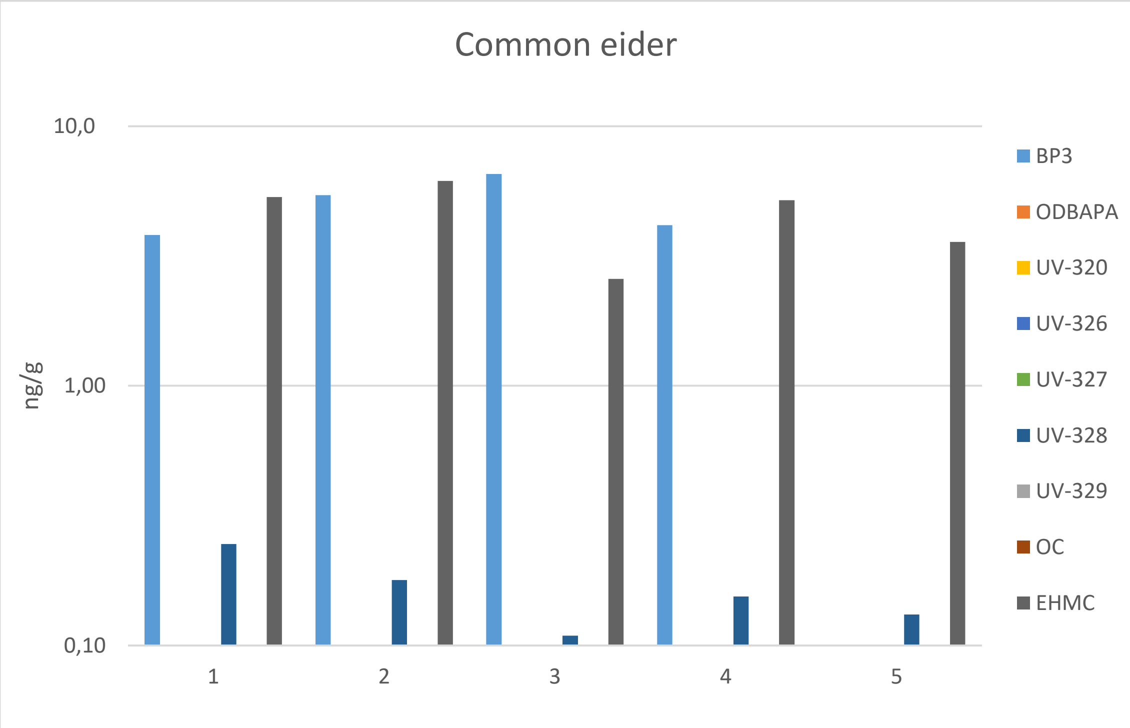


Figure 11: Concentration of BP3, UV328, and EHMC in individual egg samples from common eider from Svalbard, Norway. Concentration given in ng/g w.w.

European shag
In European shag from the Norwegian island Røst BP3, UV328, and UV329 were detected. BP3 showed the highest concentration with an average of 2.7 ng/g w.w., whereas UV328 and UV329 showed a significant lower average concentration with 0.17 and 0.35 ng/g w.w.

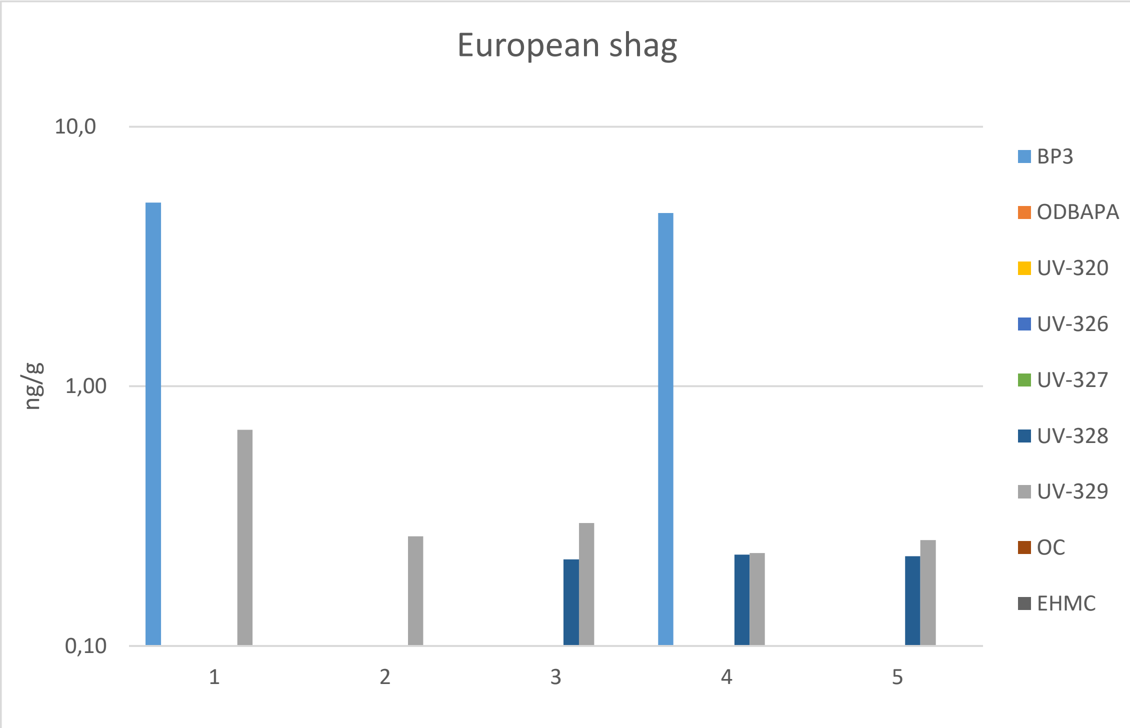


Figure 12: Concentration of BP3, UV328, and UV329 in individual egg samples from European shag from Røst, Norway. Concentration given in ng/g w.w.

Kittiwake

In Kittiwake BP3, UV320, UV326, UV328, and EHMC were detected. BP3 and EHMC showed the highest concentration with an average of 3.5 and 5.1 ng/g w.w. (Figure 13), whereas UV320, UV326, and UV328 showed a significant lower average concentration with 0.04, 0.13, and 0.19 ng/g w.w., respectively.

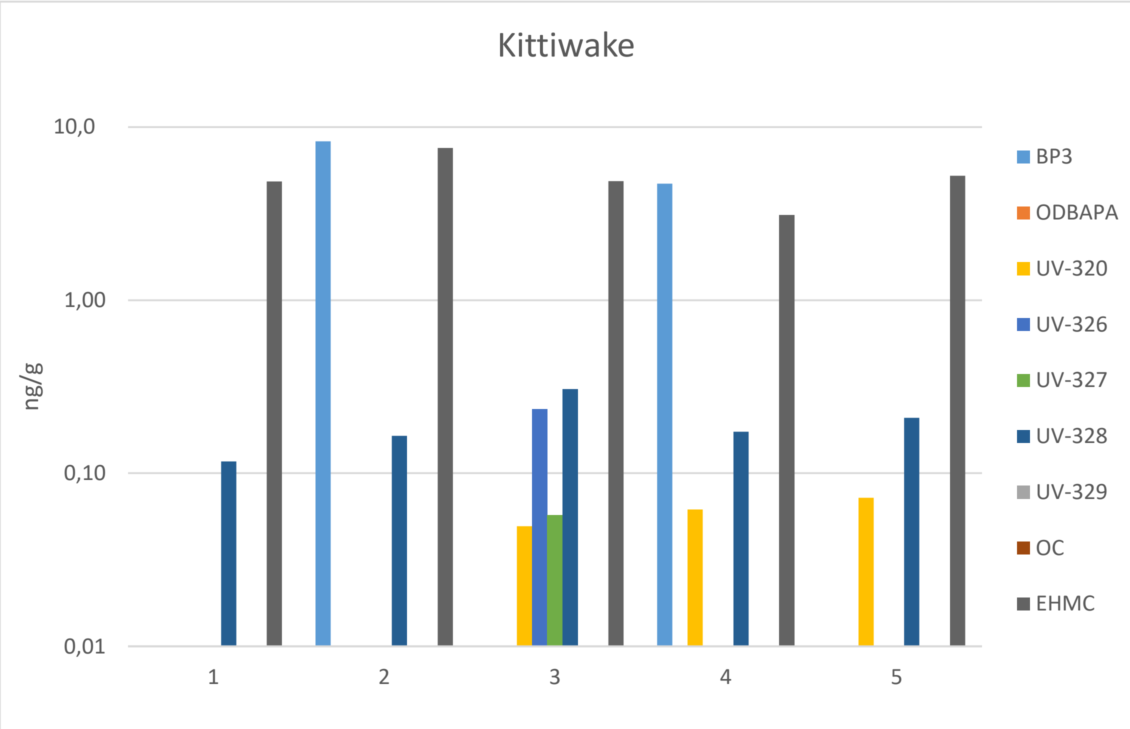


Figure 13: Concentration of BP3, UV320, UV326, UV328, and EHMC in individual egg samples from Kittiwake from Svalbard, Norway. Concentration given in ng/g w.w.

Glaucous gull

In glaucous gull BP3, UV320, UV328, and EHMC were detected. BP3 and EHMC showed the highest concentration with an average of 2.9 and 2.8 ng/g w.w. (Figure 14), whereas the UV320 and UV328 showed a significant lower average concentration with 0.02 and 0.12 ng/g w.w.

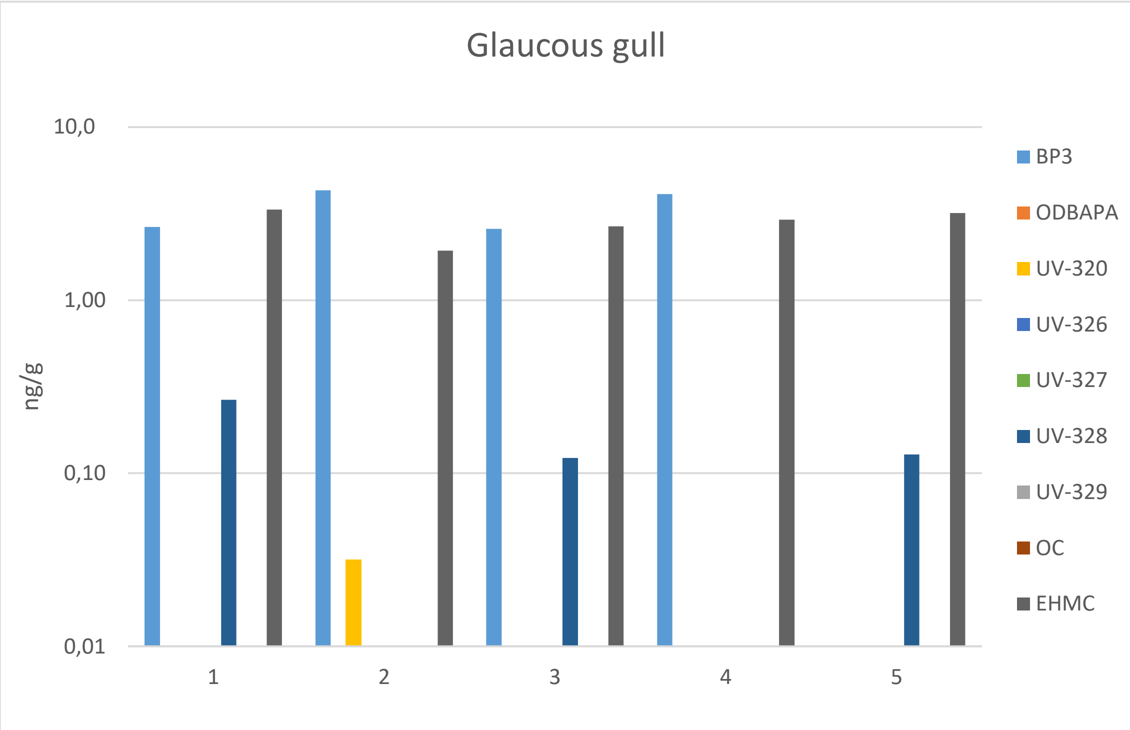


Figure 14: Concentration of BP3, UV320, UV328, and EHMC in individual egg samples from glaucous gull from Svalbard, Norway. Concentration given in ng/g w.w.

Polar bear

In polar bear UV326, UV329, and OC were detected. OC showed the highest concentration with an average of 18 ng/g w.w., whereas UV326 and UV329 showed a significant lower average concentration with 0.31 and 0.5 ng/g w.w. (Figure 15).

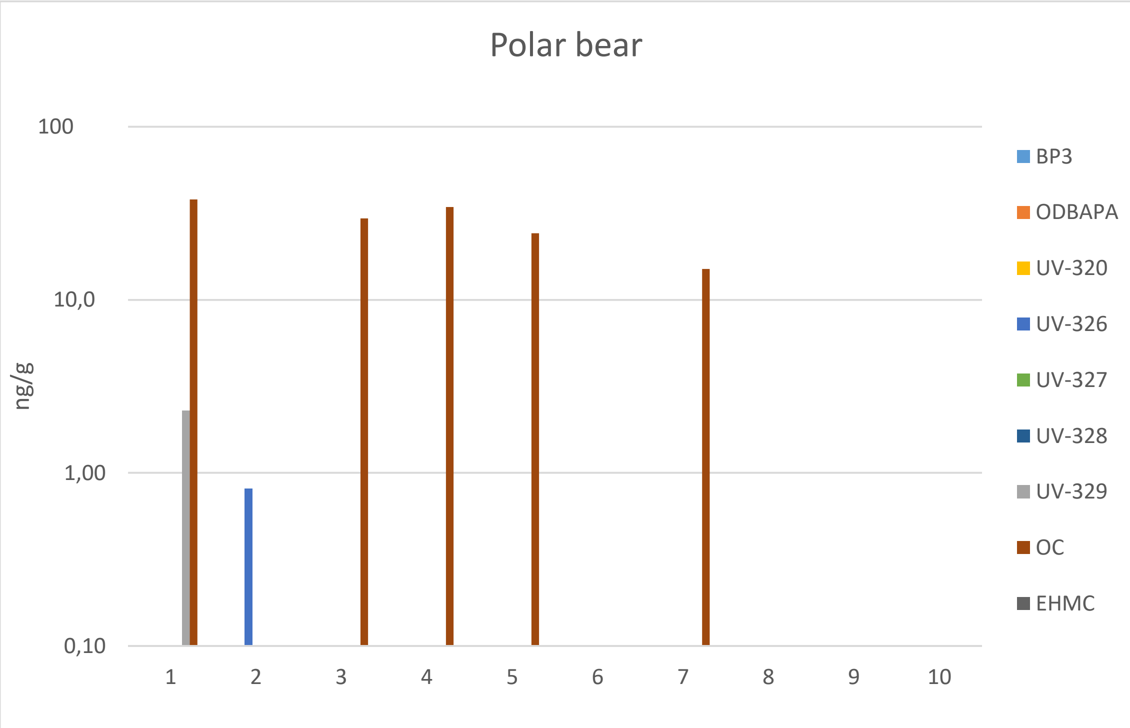


Figure 15: Concentration of UV326, UV329, and OC in individual blood samples from polar bears from Svalbard, Norway. Concentration given in ng/g w.w.

Mink

In mink from Hillesøy/Sommarøy in Troms County BP3, UV326, UV328, and EHMC were detected. EHMC showed the highest concentration with an average of 4.0 ng/g w.w., whereas BP3, UV326, and UV328 showed a significant lower average concentration with 0.65, 0.37, and 0.18 ng/g w.w., respectively (Figure 16).

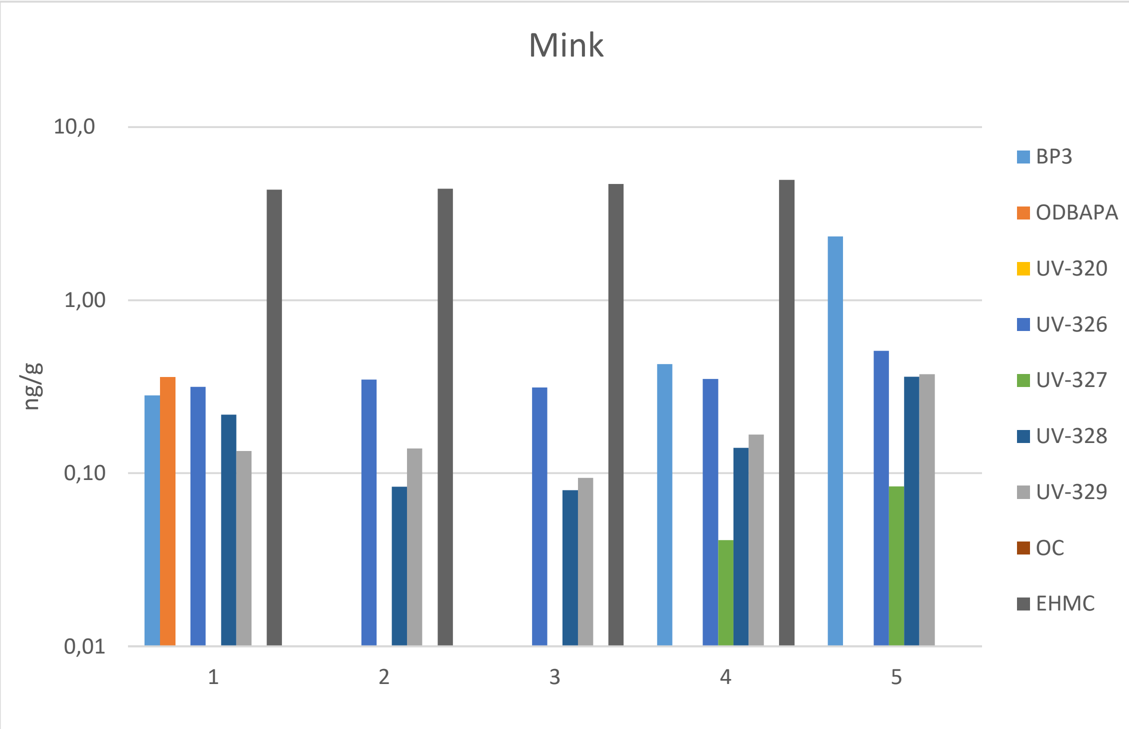


Figure 16: Concentration of BP3, UV326, UV328, and EHMC in individual liver samples of mink from Hillesøy and Sommarøy in Troms County, Norway. Concentration given in ng/g w.w.

3.3.3 Hot spot related samples

Table 18: UV filters in effluent from Tromsø

Sample type	BP3	ODBAPA	UV 326	UV 327	UV 328	UV 329	OC	EHMC
	(Min - max) Average* Detection frequency						ng/L	
Effluent	(115 - 156) 137 100 %	(<4 - 13) 5.2 17 %	(11 - 61) 37 100 %	(<2 - 6.6) 3.4 50 %	(7.0 - 57) 31 100 %	(<3 - 6.7) 3.0 33 %	(920 - 1900) 1390 100 %	(39 - 79) 62 100 %

*): For the non-detects LoD/2 was used, when calculating the average.

With exception of UV-320 all selected UV filters were found in effluent from Tromsø. OC showed the highest concentrations.

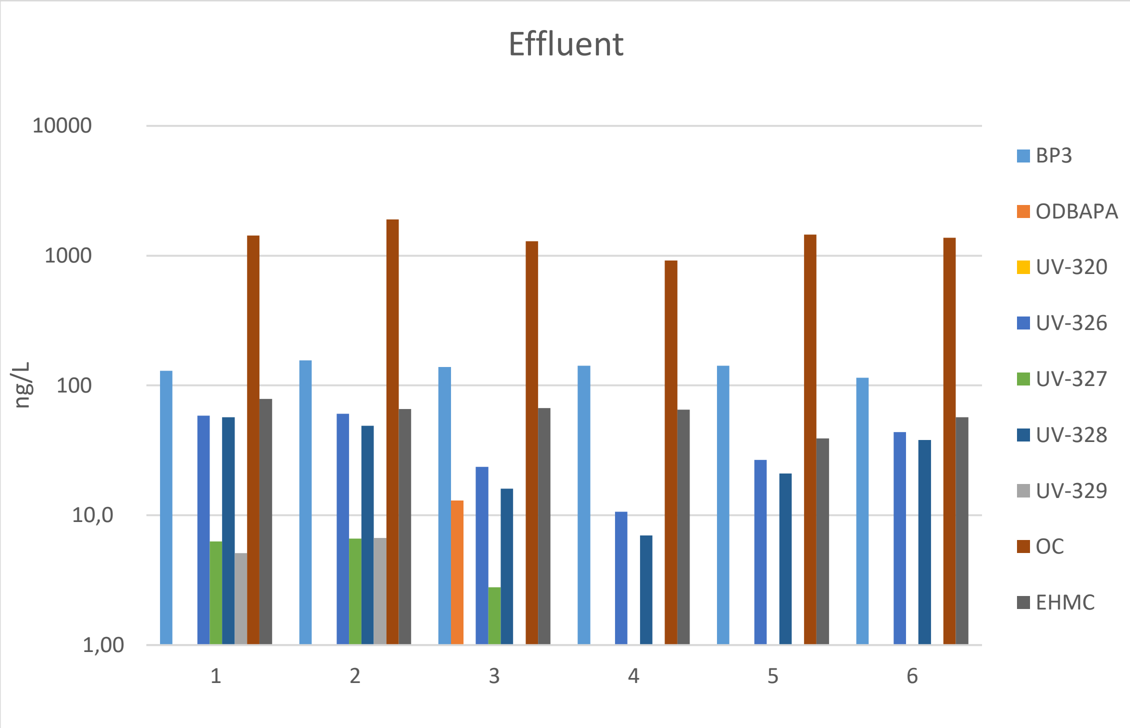


Figure 17: Concentration of the selected UV filters in effluent samples from Tromsø WWTP. Concentration given in ng/L.

Due to very limited available sample size, it was unfortunately not possible to measure this compound in micro plastic samples.

3.3.4 Discussion

The occurrence of BP3, UV320, UV326, UV328, UV329, OC, and EHMC in both Arctic biota and opportunist suggests the potential for these compounds to bioaccumulate. These results also add additional weight to similar conclusions made from the results of a previous study in southern Norway (Thomas et al., 2014). Also other research groups have seen bioaccumulation or biomagnification of these UV compounds both in densely populated areas (Gago-Ferrero, Diaz-Cruz, & Barcelo, 2015; Peng et al., 2017) and in pristine environments like Antarctica (Emnet, Gaw, Northcott, Storey, & Graham, 2015).

Little is known about the effect of these compounds in birds and polar bear, which prevents a relevant risk assessment.

3.4 Semivolatile persistent organic compounds (PBT) including current-use pesticides

3.4.1 Arctic air

The only compound of this group detected in Arctic air samples from Zeppelin mountain was dacthal, which was found in all five samples in the range of 0.02 to 0.12 pg/m^3 with an average of 0.06 pg/m^3. These concentrations are in the same range as the measurements of (Zhong, Xie, Cai, et al., 2012) at an ice-breaker cruise from East China Sea to the high Arctic. However, these results were much lower than measurements in the German bight with an average air concentration of 12 pg/m^3 (Zhong, Xie, Moller, et al., 2012). All other measured compounds in this group were below the limit of detection. The dechloranes and chlorinated paraffins were not measured in this project.

3.4.2 Arctic biota

None of priority compounds, currently used pesticides and new brominated flame retardants, could be detected in the selected Arctic biota. For the LoD of these compounds, please refer to the table in the appendix. However, as shown in Table 19 the optional compounds like dechloranes and chlorinated paraffins were detected regularly and with sometimes rather high concentrations in all samples of Arctic biota.

Table 19: Concentrations of PBT compounds in Arctic and urban biota

	Dec602	Dec603	DPsyn	DPanti	SCCP	MCCP
Sample type/ area	(Min - max) **Average*** Detection frequency			ng/g w.w.		
Common eider/ Svalbard	(0.01- 0.02) **0.01** 100 %	(<0.02) **<0.02** 0 %	(<0.02 - 0.06) **0.04** 80 %	(<0.02 - 0.11) **0.07** 80 %	(61 - 118) **84** 60 %	(13 - 59) **31** 100 %
European shag/ Røst	(0.03 - 0.07) **0.05** 100 %	(<0.02) **<0.02** 0 %	(0.18 - 0.25) **0.22** 100 %	(0.9 - 1.9) **1.4** 100 %	(34-217) **107** 100 %	(7.8 - 366) **150** 100 %
Kittiwake/ Svalbard	(0.27 - 0.47) **0.37** 100 %	(<0.02) **<0.02** 0 %	(<0.02 - 0.02) **0.01** 100 %	(0.02 - 0.04) **0.03** 100 %	(34 -69) **48** 100 %	(9.3 - 96) **40** 100 %
Glaucous gull/ Svalbard	(0.05 - 0.17) **0.14** 100 %	(<0.02) **<0.02** 0 %	(0.22 - 0.27) **0.24** 100 %	(1.4 - 2.3) **1.8** 100 %	(13 - 71) **48** 100 %	(8.6 - 49) **36** 100 %
Polar bear/ Svalbard	(0.12 - 0.82) **0.31** 100 %	(<0.02) **<0.02** 0 %	(0.44 - 1.1) **0.63** 100 %	(3.0 - 6.9) **4.5** 100 %	(40 - 7 300) **912** 100 %	(5.1 - 93) **41** 60 %
Mink/ Sommarøy	(0.07 - 0.13) **0.09** 100 %	(<0.02 - 0.06) **0.02** 40 %	(0.13 - 0.35) **0.21** 100 %	(0.29 - 2.0) **1.2** 100 %	(5.2 - 2 700) **560** 100 %	(1.1 32) **13** 100 %
Common gull/ Tromsø	(0.04 - 4.3) **1.0** 100 %	(0.29 - 1.2) **0.68** 100 %	(0.02 - 0.32) **0.10** 100 %	(0.11 - 2.5) **0.63** 100 %	(20 - 98) **52** 100 %	(9.4 - 87) **40** 100 %

*): For the non-detects LoD/2 was used, when calculating the average.

Common eider

In Common eider both Dec602, DPsyn and anti, and the chlorinated paraffins were detected with a very homogeneous distribution in the different individual samples. SCCP and MCCP showed the highest concentration with an average of 84 and 31 ng/g w.w. (Figure 18), whereas the detected dechloranes showed a significant lower average concentration with DPanti 0.07 ng/g w.w., DPsyn 0.04 ng/g w.w. and Dec602 0.01 ng/g w.w..

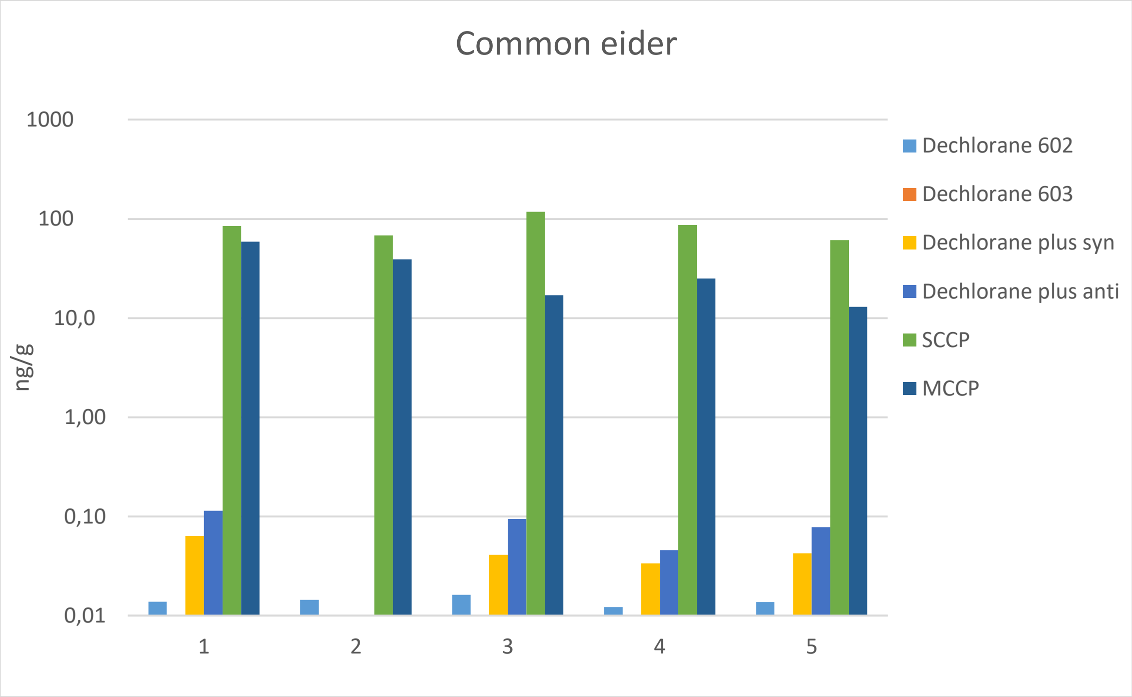


Figure 18: Concentration of Dec602, DPsyn and anti, SCCP, and MCCP in individual egg samples from common eider from Svalbard, Norway. Concentration given in ng/g w.w.

European shag

As in common eider also in the European shag from the Norwegian island Røst both Dec602, DPsyn and anti, and the chlorinated paraffins were detected. As illustrated in Figure 19, SCCP and MCCP showed the highest concentration with an average of 107 and 154 ng/g w.w., whereas the detected dechloranes showed a significant lower average concentration with DPanti 1.4 ng/g w.w., DPsyn 0.22 ng/g w.w. and Dec602 0.05 ng/g w.w. In contrast to common eider European shag samples showed a much bigger variation between the minimum and maximum concentration measured, especially for MCCP with a factor of 40 and a range of 8,5 to 366 ng/g w.w.

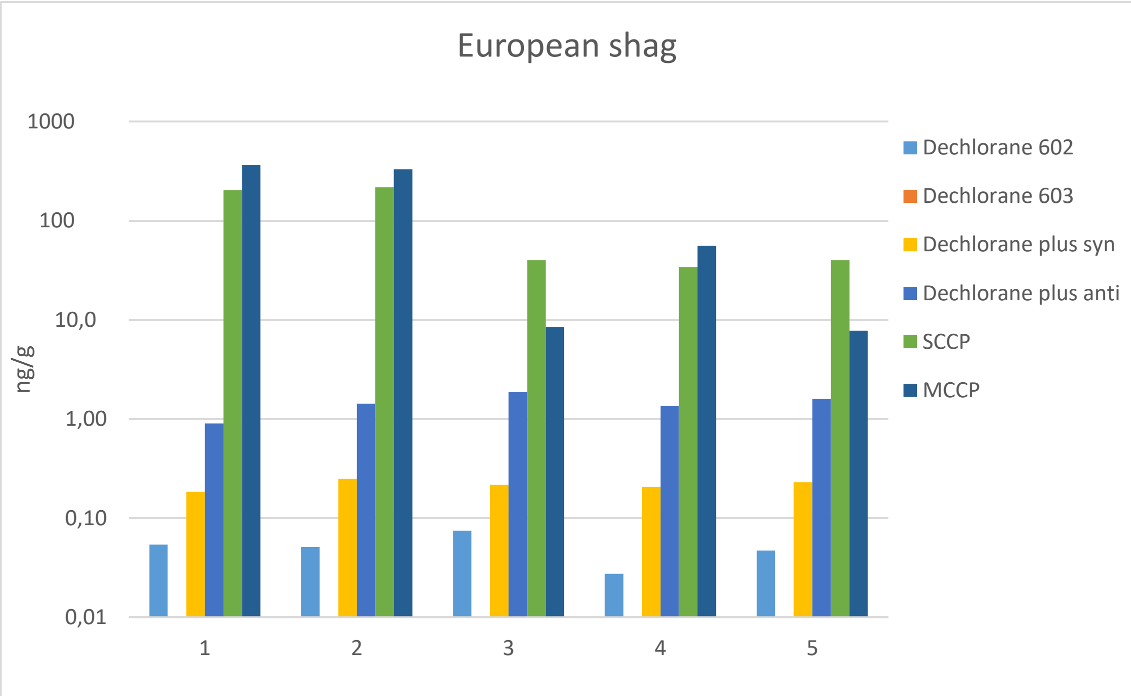


Figure 19: Concentration of Dec602, DPsyn and anti, SCCP, and MCCP in individual egg samples from European shag from Røst, Norway. Concentration given in ng/g w.w.

Kittiwake

As in common eider and European shag both Dec602, DPsyn and anti, and the chlorinated paraffins were detected in kittiwakes from Svalbard. SCCP and MCCP showed the highest concentration with an average of 53 and 40 ng/g w.w. (Figure 20), whereas the detected dechloranes showed a significant lower average concentration with Dec602 0.37 ng/g w.w.. DPanti 0.03 ng/g w.w., and DPsyn 0.01 ng/g w.w.. Kittiwake was the only species studied, where the Dec602 concentration was higher compared to DPsyn and DPanti.

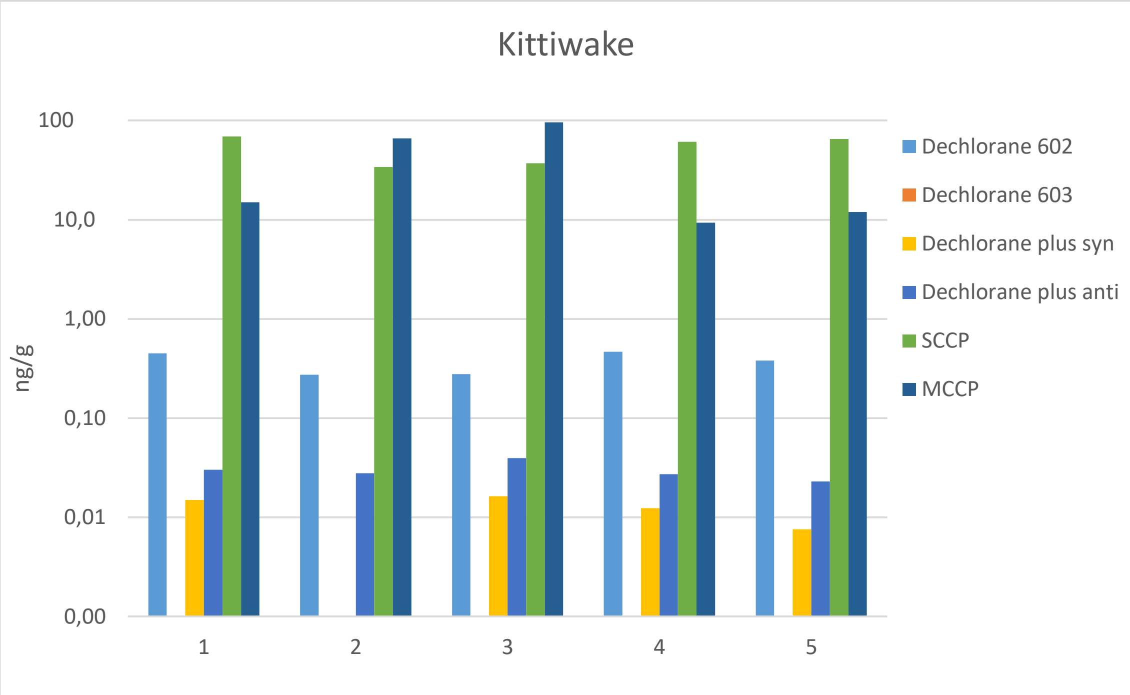


Figure 20: Concentration of Dec602, DPsyn and anti, SCCP, and MCCP in individual egg samples from Kittiwake from Svalbard, Norway. Concentration given in ng/g w.w.

Glaucous gull

As in the other bird egg samples both Dec602, DPsyn and anti, and the chlorinated paraffins were detected in glaucous gull from Svalbard. SCCP and MCCP showed the highest concentration with an average of 48 and 36 ng/g w.w. (Figure 21), whereas the detected dechloranes showed a significant lower average concentration with DPanti 1.8 ng/g w.w., DPsyn 0.24 ng/g w.w., and Dec602 0.14 ng/g w.w..

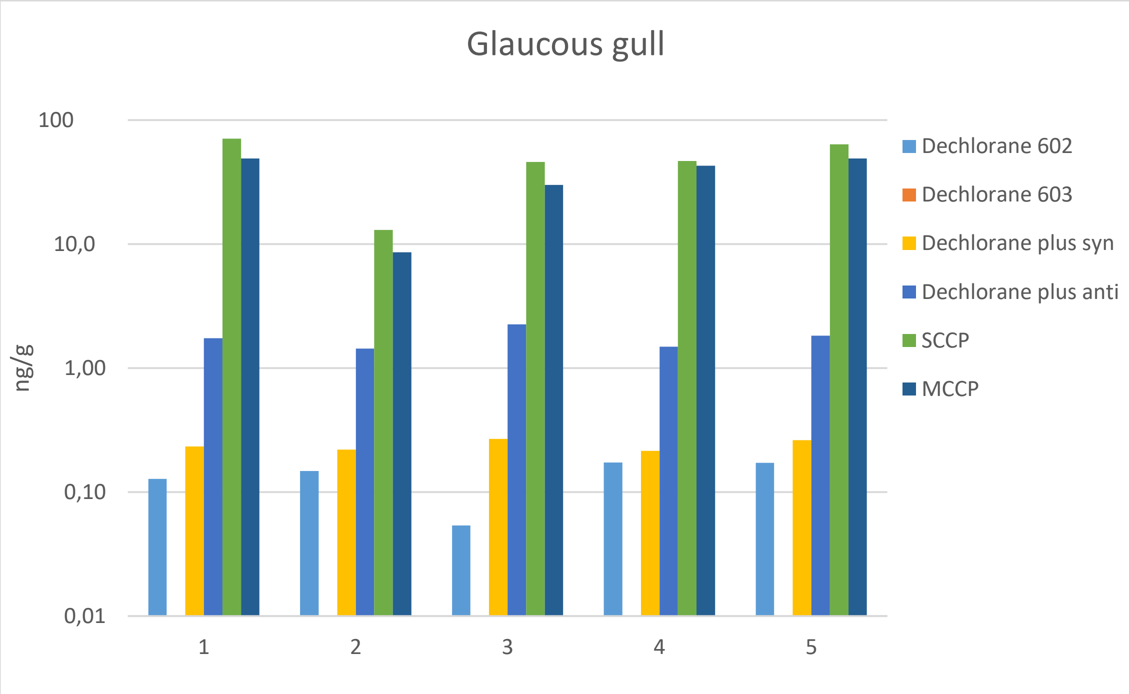


Figure 21: Concentration of Dec602, DPsyn and anti, SCCP and MCCP in individual egg samples from glaucous gull from Svalbard, Norway. Concentration given in ng/g w.w.

Polar bear

Analysis of the blood samples from polar bear identified Dec602, DPsyn and anti, and the chlorinated paraffins. SCCP and MCCP showed the highest concentration with an average of 1740 and 47 ng/g w.w., whereas the detected dechloranes showed a significant lower average concentration with DPanti 4.7 ng/g w.w., DPsyn 0.67 ng/g w.w., and Dec602 0.24 ng/g w.w. (Figure 22). The polar bear samples showed a strong sample-to-sample variation, especially for SCCP with a range from 40 to 7300 ng/g w.w..

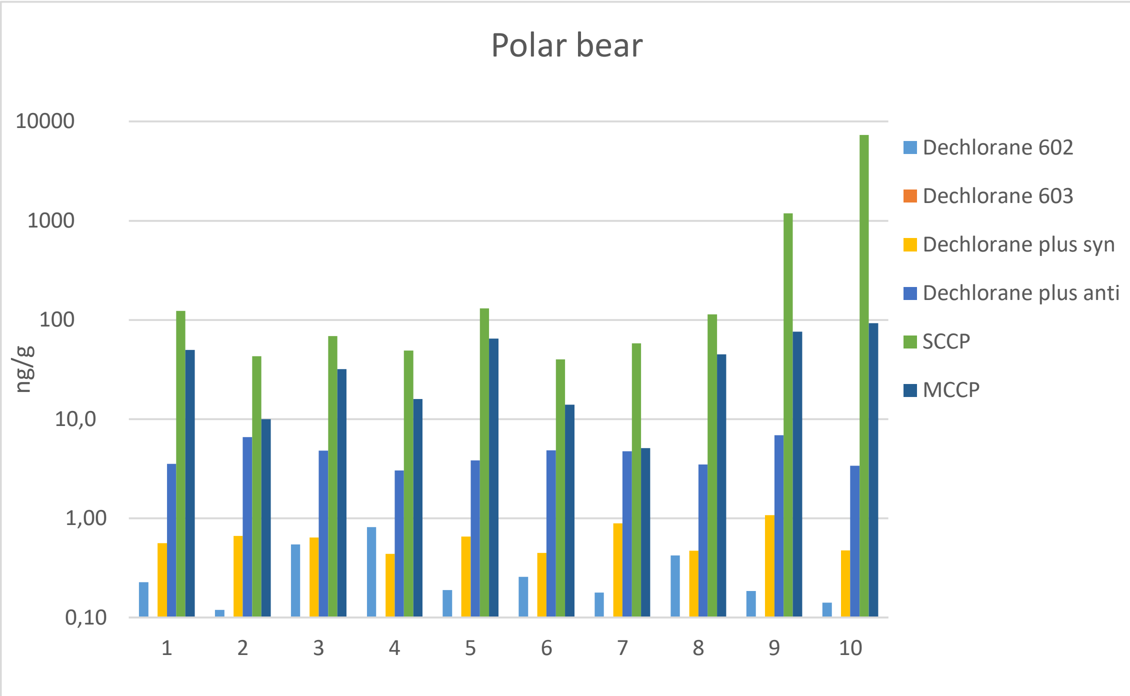


Figure 22: Concentration of Dec602, DPsyn and anti, SCCP, and MCCP in individual blood samples from polar bear from Svalbard, Norway. Concentration given in ng/g w.w.

Mink

Analysis of mink samples from Hillesøy/Sommerøy, Troms County in Norway identified Dec602, DPsyn and anti, and the chlorinated paraffins. The compound Dec603 was also detected in 2 of 5 samples. SCCP and MCCP showed the highest concentration with an average of 558 and 13 ng/g w.w., whereas the detected dechloranes showed a significant lower average concentration with DPanti 1.2 ng/g w.w., Dec602 1.02 ng/g w.w. DPsyn 0.21 ng/g w.w., and Dec603 0.02 ng/g w.w. (Figure 23). The mink samples showed a strong sample-to-sample variation, especially for SCCP with a range from 5.2 to 2700 ng/g w.w..

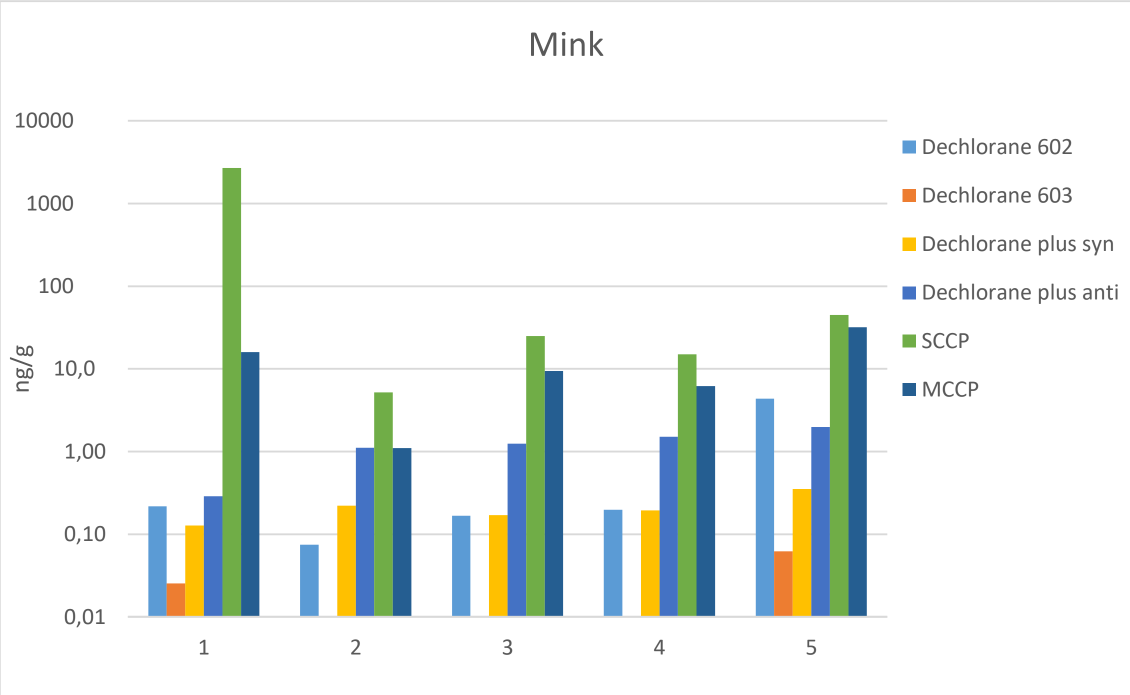


Figure 23: Concentration of Dec602, DPsyn and anti, SCCP, and MCCP in individual liver samples of mink from Hillesøy and Sommarøy in Troms county, Norway. Concentration given in ng/g w.w.

3.4.3 Hot spot related samples

Common gull

Similar to seabird eggs from the Arctic, also in eggs from common gull collected in the urban area around Tromsø, both Dec602, DPsyn and anti, and the chlorinated paraffins were detected. SCCP and MCCP showed the highest concentration with an average of 52 and 40 ng/g w.w., whereas the detected dechloranes showed a significant lower average concentration with Dec603 0.68 ng/g w.w., DPanti 0.63 ng/g w.w., DPsyn 0.10 ng/g w.w., and Dec602 0.09 ng/g w.w., see also Figure 24. Whereas Dec603 was absent in the other egg samples, it was the most prominent compound of the dechlorane group in common gulls. This might be caused either by differences in metabolism between species or by higher levels of Dec603 in the food web for common gulls. Without knowledge on the level of Dec602 and Dec603 in the feed it is not possible to conclude on this question.

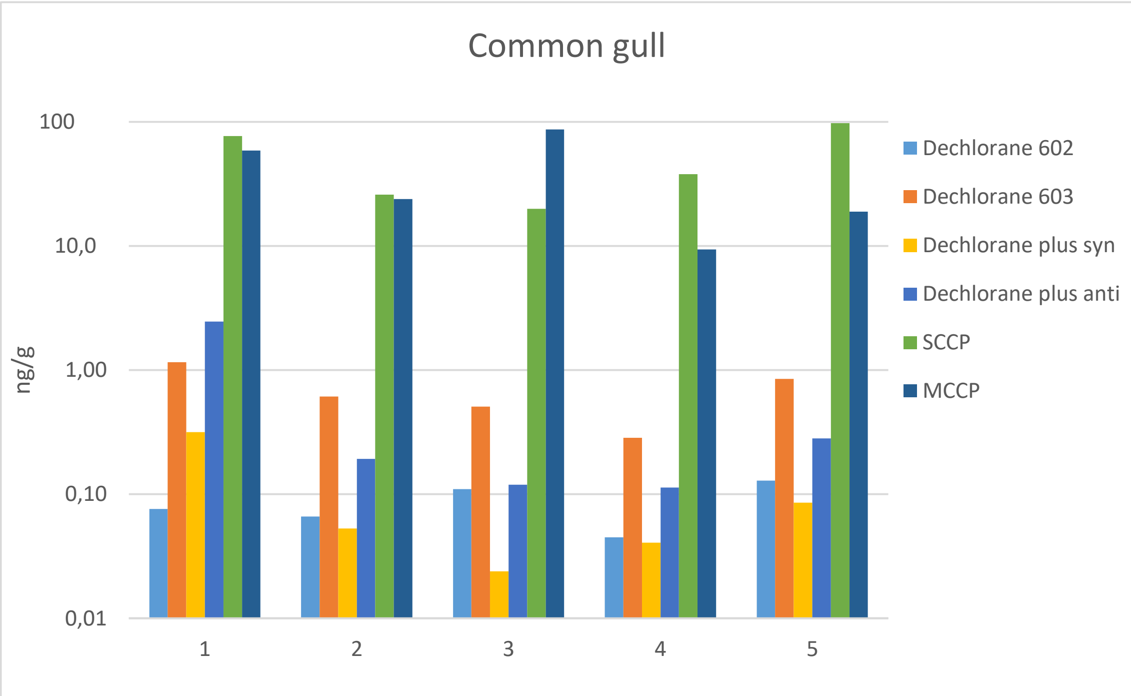


Figure 24: Concentration of Dec602, Dec 603, DPsyn and anti, SCCP, and MCCP in individual egg samples from common gull from Tromsø, Norway. Concentration given in ng/g w.w.

WWTP Effluent

In effluent samples from one of Tromsø's wastewater treatment plants the two pesticides chlorpyrifos and cypermethrin could be detected with an average concentration of 0.30 ng/L and 0.19 ng/L, respectively. Also SCCP and MCCP were detected in all effluent samples with an average concentrations of 258 and 798 ng/L. None of the other pesticides and PBT compounds were found. However, the dechlorane group was not measured in these samples.

Marine plastic

Due to restriction in available sample amount it was not possible to perform analysis of the PBT compounds in the sample type.

3.4.4 Discussion

Dacthal is the only compound of the selected currently used pesticides, which could be detected in Arctic air samples from Zeppelin Mountain. As there are no known local sources for dacthal, it can be assumed that dacthal is exposed to long range atmospheric transport. As summarized in the recent AMAP report (*AMAP Assessment 2016: Chemicals of Emerging Arctic Concern*, 2017) a larger number of current-use pesticides were measured at the Canadian air monitoring station, however, in concentrations below the LoD obtained in this study. At the Alert study it was possible to take much larger samples with a total volume of 13 000 m^3 compared to ~1 200 m^3 at Zeppelin, which give a much lower LoD.

Dechloranes and chlorinated paraffins were detected in all samples of Arctic biota. Without significant local sources these findings clearly show that these compounds are subject to both long-range atmospheric transport and bioaccumulation.

3.5 Bisphenols

3.5.1 Arctic air

In air samples from the high Arctic air monitoring station on mount Zeppelin, two of the 13 measured bisphenol compounds were detected (see Table 20). BPA was detected in four samples, and BPS detected in two samples.

Table 20: Concentrations of BPA and BPS in Arctic air samples

Sample type/ area	BPA	BPS
	(Min - max) **Average*** Detection frequency	pg/m^3
Active air samples/ Mount Zeppelin	(<1 - 16) **7.1** 80 %	(<0.1 - 0.22) **0.10** 40 %

*): For the non-detects LoD/2 was used, when calculating the average.

3.5.2 Arctic biota

No unequivocal detection of the bisphenols was made in Arctic species. There was however two samples which may have had traces of these compounds, but as bisphenols are commonly found contaminating the laboratory environment we assume that these findings are related to unintentional contamination of the samples and not a positive proof of bioaccumulation of these compounds. For information on detection limit, please refer to the full data table in the appendix.

3.5.3 Hot spot related samples

In all effluent samples from one of Tromsø's WWTPs BPA and BPS were detected. Also BP-AF, 2-4'-BPF, and BPP were occasionally found, however, quite close to the limit of detection, and not unequivocally.

Table 21: Concentrations of BPA and BPS in effluent samples from Tromsø WWTP

Sample type/ area	BPA	BPS
	(Min - max) **Average*** Detection frequency	ng/L
Effluent/ Tromsø	(156 - 452) **296** 100 %	(29 - 193) **141** 100 %

*): For the non-detects LoD/2 was used, when calculating the average.

3.5.4 Discussion

Whereas bisphenols were found regularly and in high concentrations in urban samples, only BPA and BPS were detected in air samples at Zeppelin. The other bisphenols measured were either not detected or detected at very low levels in air and biota. Therefore, it is not very likely that these compounds are exposed to long-range atmospheric transport.

3.6 Other aromatic polar compounds

Neither BDPPBD, CTFPPA, nor NDADPP were found above LoD in the samples selected for this study. LoDs for all compounds were given in the complete data table in the appendix.

CTFPPA is an intermediate in pesticide production. The ester group in this substance will probably hydrolyze rapidly. The resulting metabolite might be more persistent and exposed to bio-accumulation (logK_{OW} of phenol 4.34) (Howard & Muir, 2010).

3.7 Suspect and non-target screening

GC-HRMS screening

Samples for GC-HRMS screening were processed with the Deconvolution Plugin of the TraceFinder software (Thermo Scientific) to reveal individual components present in samples. The number of identified components ranged from slightly more than 200 (for a lab blank) to 500-1000 for sample extracts. The isolated components in the GC-HRMS data were then passed through a library-search algorithm to identify the chemicals present. Unfortunately, in most cases this search did not yield one specific chemical, but a list of possible candidates. To simplify and improve the quality of the identification we therefore applied the following filter strategy - total identification score >90% and HR score >90% - and thus more refined shortlists of candidate substances were created. These shortlists included 20-150 substances per sample (Table 22). However, the problems mentioned above for the library matches persisted. For example, for a simple and well-known substance such as hexachlorobenzene the software yielded another suggestion as the best library match. Application of stricter filters reduces the number of identifications further, but does not improve the usability of the outcome.

However, despite these challenges in identification it is possible to assign the major peaks in the data to lipid-related substances (fatty acids, their esters, cholesterol-related structures etc). Several sulfur containing substances (such as benzothiazol and its derivatives, and dimethyltrisulfide) were found in biota samples. Note, however, that due to the lack of blank samples for water and biota it is not clear whether these are natural products or xenobiotics.

Table 22: Average number of compounds identified by suspect screening of the volatiles extract

Sample type/ area	Average number
Arctic air	123
Common eider	113
European shag	102
Kittiwake	65
Glaucous gull	61
Polar bear	84
Mink	104
Common gull	75
Effluent	59

An important finding was hexachlobutadiene (HCBD), which was ubiquitous. HCBD has also earlier been detected in samples of Arctic biota (*AMAP Assessment 2016: Chemicals of Emerging Arctic Concern*, 2017). The authors concluded that HCBD were dispersed by long-range atmospheric transport. There are found higher levels in terrestrial birds and mammals and seabirds, than in fish and marine mammals. Therefore, future monitoring should be strongly considered, however more attention must be paid to collection of field blanks and to the purity of all sampling and sample-handling equipment in order to minimize the risk of contamination.

LC-HRMS screening

Samples for LC-HRMS screening were processed via a combination of NIVA in-house algorithms and commercially available software. Unifi (Waters Corp., Milford USA) was used for peak-detection and identification in the suspect-screening work flow, while NIVA's in-house algorithms are used for non-target screening activities.

For suspect screening the samples were checked against a library of approximately 1000 individual compounds. This library comprises mostly parent pharmaceuticals, pesticides, fungicides, personal care products and veterinary medicines. This library is, however, severely lacking in metabolites of these parent compounds, and it is often the metabolites that we would most likely expect to detect in biota samples.
Each sample showed a total number of approximately 8000 features. Each feature is associated with a unique chemical component, but note that one chemical component can be associated with numerous features in the LC-HRMS data. We are therefore confident in the fact that there are less than 8000 chemical substances in each sample, but it is difficult to give an exact number.

Of the 8000 features it was initially possible to link approximately 2% with potential candidates in the NIVA library (Table 22). However, this link was based on a relatively broad tolerance of 5 mDa mass accuracy only, and stricter identification criteria are generally required for unequivocal identification in HRMS screening. Applying the narrower identification criteria to these candidates reduced the number of positive identifications to zero (Table 22). None of the 1000 substances present in the NIVA library were detected in any of the samples.
The LC-HRMS data was then passed through NIVA's deconvolution and molecular-formula algorithms to generate an overview of the molecular classes present in each sample. Figures 25-27 present the resulting Kendrick's Mass Defect plots and associated Van Krevelen diagrams. The latter visualize graphical analysis in which the elemental composition of the compounds present in each sample are plotted according to the atomic ratios H/O, H/N, and H/Cl. In general these plots show typical patterns expected for naturally occurring chemical species in biota samples including fatty acids and sugars. The region of the plots associated with elevated levels of chlorinated compounds can be the focus of future identification efforts. Current workflows are however inhibited by the lack of reference samples which could be used to filter away (or exclude) the naturally occurring compounds and allow for greater focus on exogenous compounds.

Table 23: Percentage of identified substances relative to the total number of features obtained after applying different identification criteria on LC-HRMS data

Sample Type	Identification Criteria		
	Mass accuracy only (5 mDa)	Mass accuracy (5 mDa) and minimum 1 diagnostic fragment	Mass accuracy (3 mDa) and minimum 2 diagnostic fragments
Polar bear plasma	1.9	0.1	0.0
Black-legged kittiwake egg	1.6	0.1	0.0
Shag egg	2.3	0.1	0.0
Common eider egg	2.6	0.1	0.0
Mink liver	2.9	0.1	0.0

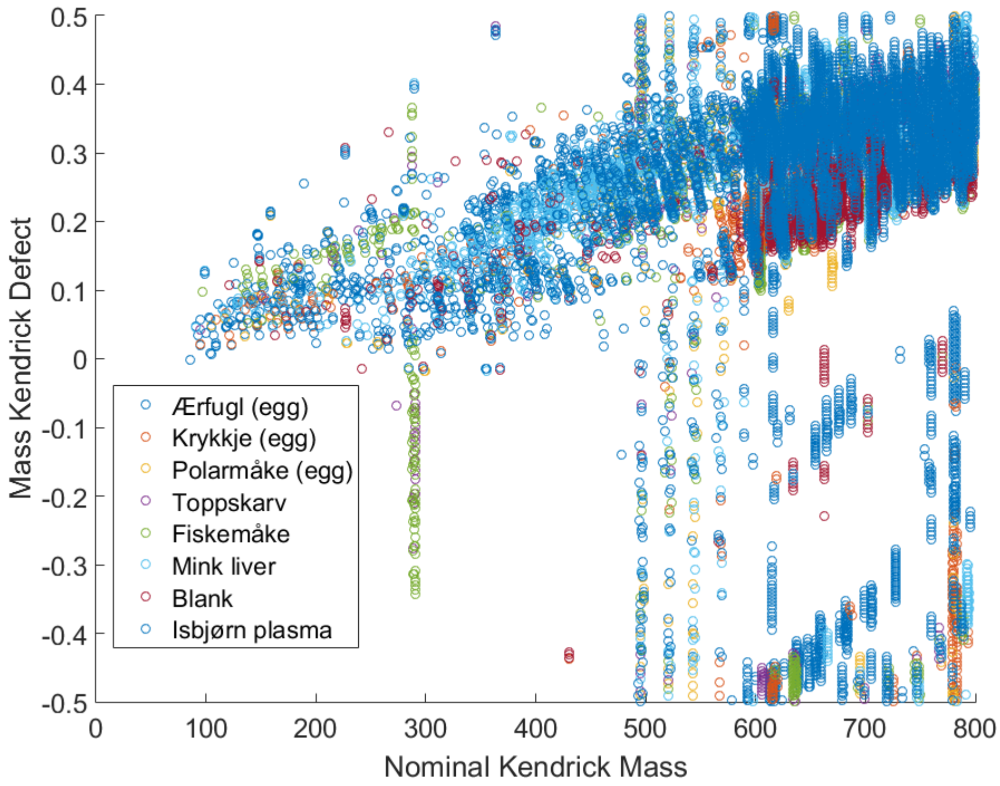


Figure 25: Kendrick's Mass Defect plot from LC-HRMS analysis of biota samples. Larger positive mass defects are expected with increasing nominal mass, and are indicative of increased proportions of heteroatoms in the molecules. Larger negative mass defects are typically associated with halogenated compounds.

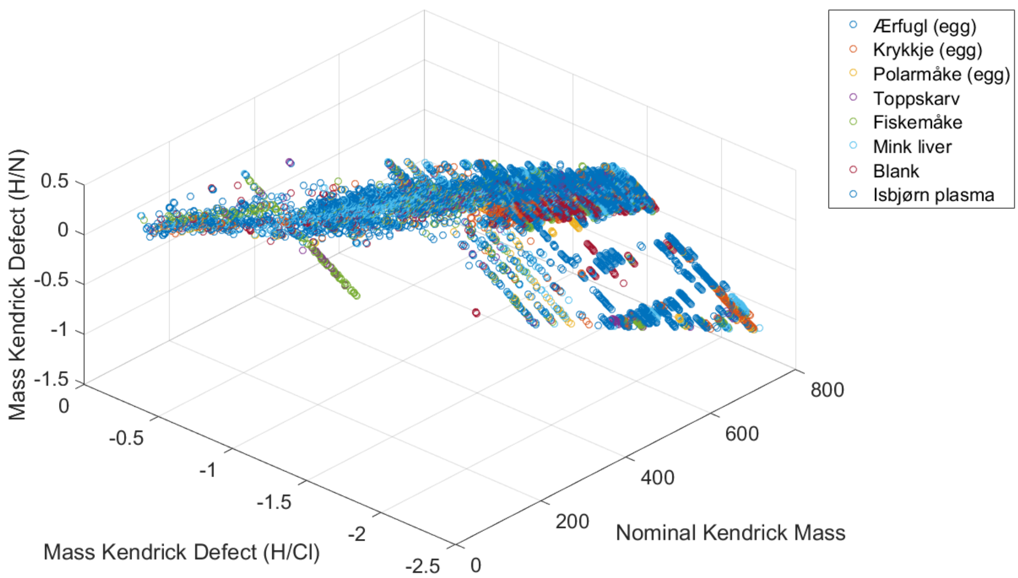


Figure 26: Van Krevelen diagram from LC-HRMS analysis of biota samples highlighting H/Cl and H/N ratios of the biota samples. The diagram indicates very little variation in the H/N ratio throughout. There do however appear to be significant numbers of chlorinated compounds present in all sample matrices.

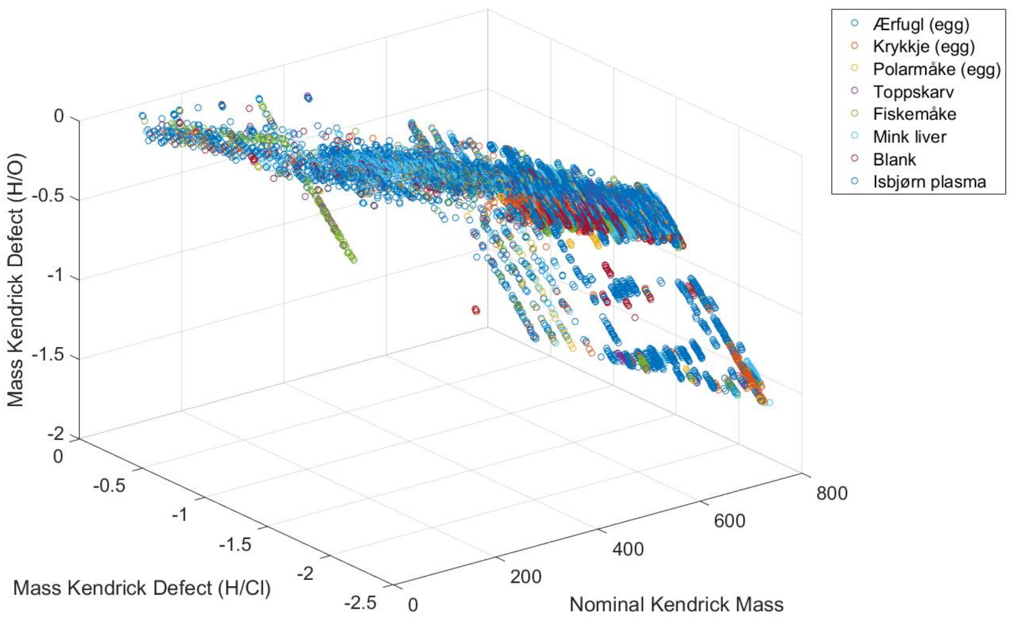


Figure 27: Van Krevelen diagram from LC-HRMS analysis of biota samples highlighting H/Cl and H/O ratios of the biota samples. The diagram shows a tendency to decreased H/O ratios with increasing nominal mass which is likely due to the presence of naturally occurring fatty acids, sugars, and phospholipids in the biota.

4. Conclusions

In a recent AMAP report (*AMAP Assessment 2016: Chemicals of Emerging Arctic Concern*, 2017) about 25 compounds were identified as chemicals with a potential to be of (Arctic) emerging concern. Compounds were selected on important properties like persistency (P), bioaccumulation (B), and long-range transport potential (LRTP). Further criteria for selection were that the compound was not measured before and priority were given to compounds with information about production volume. In addition to these "AMAP" compounds, some other compounds relevant for screening in Arctic samples were included in this work.

In this study, six of the 25 selected "AMAP"-compounds could be unequivocally identified in the Arctic environment. Five substances were found regularly in Arctic air. The last compound was found in urban air. There were no clear and certain indications for bioaccumulation of the "AMAP"-compounds. However, bioaccumulation could not be completely excluded either.

For the first time PFPHP, PFTBA, TCHFB, DCTFP, and DCTCB, which are ***volatile fluoroorganic and related compounds,*** were detected in Arctic air samples. Some of these compounds were not found in environmental samples earlier. The detection in Arctic air samples is a strong indication for long-range transport potential and high persistency of these compounds. We expect that the measured concentrations for most of these compounds probably underestimate the real air-concentrations. With other words, we know that these compounds are present in Arctic air, however, we do not know the real concentrations and model calculations of emissions or the use of these results for later time trend studies are not possible. Since most of these compounds are of severe environmental concern (global warming), a follow up by more dedicated sampling and analysis should get a high priority. To open up for trend studies and calculation of the global warming potential, the applied sampling and analysis should be specially designed and tested for full recovery of this type of compounds. It is extremely difficult to get access to reliable production and consumption figures. Therefore, the proposed follow up study should also open up for the systematic screening of other closely related fluorinated compounds, i.e. compounds with similar structure and volatility.

The ***siloxane*** D4Ph was measured in low concentrations in some urban air samples taken at different places in Tromsø. It was not found in Arctic air or biota. The environmental risk of this compound remains unresolved. Compared to other compounds found in this study, a follow up of D4Ph seems less relevant.

The ***UV filters*** BP3, UV320, UV326, UV328, UV329, OC, and EHMC were found in both Arctic and Arctic hotspot biota. These findings suggest the potential to bioaccumulate and support earlier conclusions. However, little is known about the effect of these compounds in birds and polar bear, which prevent a relevant environmental risk assessment.

Dacthal is the only compound of the selected ***currently used pesticides***, which could be detected in Arctic air samples from the Zeppelin Mountain. As there are no known local sources for dacthal, it can be assumed that dacthal is exposed to long range atmospheric transport. As other currently used pesticides were detected in Canadian Arctic air samples, these compounds should be measured again with improved sampling and analysis techniques.

Dechloranes and chlorinated paraffins were detected in all samples of Arctic biota. Without substantial local sources, these findings clearly show that these compounds are subject to both long-range atmospheric transport and bioaccumulation and emphasise again the importance of international regulations of these compounds.

An important finding of the ***suspect and non-target screening*** was hexachlobutadiene, which was ubiquitous. While this particular suspect and non-target analysis resulted in very few confirmed identifications, the true power of these data will be realised in the years to come. The data are archived and will be reinvestigated for new contaminants and new hypotheses in the coming years. The data are in effect a very valuable “digital” sample bank.

For the future work in this area, more attention must be paid to initial study-design to ensure the availability of appropriate “reference” samples. Non-target and suspect screening activities are time-consuming, and the work is made almost impossible without adequate reference materials. These can be blanks in the case of water samples, or in the case of biota samples they can be tissue/blood from exactly the same species at a reference location. Non-target and suspect screening is also heavily reliant on statistical tools which in themselves necessitate adequate sample numbers. In general, a small number of replicates from one location are not sufficient for this purpose, so larger sample number are recommended in future work.

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6. Appendix

	PFPHP	PFBCH	PFDMH	PP90	PFEPFD	PFTPA	PFTBA	TCHFB
	Air: pg/m^3 . Biota: ng/g w.w.. Marin plastic: ng/g d.w.. and Effluent: ng/L							
Air. Zeppelin	< 1	< 5	< 60	< 30	< 60	< 5	**9.7**	**4.9**
Air. Zeppelin	**1.8**	< 5	< 60	< 30	< 60	< 5	**80**	**7.6**
Air. Zeppelin	**1.7**	< 5	< 60	< 30	< 60	< 5	**85**	**5.8**
Air. Zeppelin	**1.6**	< 5	< 60	< 30	< 60	< 5	**75**	**4.7**
Air. Zeppelin	< 1	< 5	< 60	< 30	< 60	< 5	**10**	**5.4**
Air. Zeppelin	**1.9**	< 5	< 60	< 30	< 60	< 5	**89**	**9.5**
Common eider	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Common eider	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Common eider	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Common eider	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Common eider	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
European shag	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
European shag	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
European shag	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
European shag	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
European shag	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Kittiwake	< 1	< 1	< 10	< 1	< 10	< 1	**6.6**	< 1
Kittiwake	< 1	< 1	< 10	< 1	< 10	< 1	**3.0**	< 1
Kittiwake	< 1	< 1	< 10	< 1	< 10	< 1	**2.8**	< 1
Kittiwake	< 1	< 1	< 10	< 1	< 10	< 1	**4.8**	< 1
Kittiwake	< 1	< 1	< 10	< 1	< 10	< 1	**3.9**	< 1
Glaucous gull	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Glaucous gull	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Glaucous gull	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Glaucous gull	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Glaucous gull	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Polar bear	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Polar bear	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Polar bear	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Polar bear	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Polar bear	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Polar bear	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Polar bear	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Polar bear	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Polar bear	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Polar bear	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Mink	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Mink	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Mink	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Mink	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Mink	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1

	PFPHP	PFBCH	PFDMH	PP90	PFEPFD	PFTPA	PFTBA	TCHFB
	Air: pg/m³ . Biota: ng/g w.w.. Marin plastic: ng/g d.w.. and Effluent: ng/L							
Common gull	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Common gull	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Common gull	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Common gull	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Common gull	< 1	< 1	< 10	< 1	< 10	< 1	< 1	< 1
Effluent	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Effluent	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Effluent	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Effluent	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Effluent	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Effluent	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Marine plast								
Marine plast								
Air. Tromsø	<10							<20
Air. Tromsø	<10							<20
Air. Tromsø	<10							<20
Air. Tromsø	<10							<20

	BTFMBB	BPFB	DCTFP	HFPO-T	9M-PFDF	DCTCB
	Air: pg/m³ . Biota: ng/g w.w.. Marin plastic: ng/g d.w.. and Effluent: ng/L					
Air. Zeppelin	< 0.5	< 1	< 0.5	< 60	< 60	**2.3**
Air. Zeppelin	< 0.5	< 1	**0.25**	< 60	< 60	**3.2**
Air. Zeppelin	< 0.5	< 1	**0.15**	< 60	< 60	**3.6**
Air. Zeppelin	< 0.5	< 1	**0.16**	< 60	< 60	**2.1**
Air. Zeppelin	< 0.5	< 1	**0.17**	< 60	< 60	**9.2**
Air. Zeppelin	< 0.5	< 1	**0.15**	< 60	< 60	**2.3**
Common eider	< 1	< 1	< 1	< 10	< 10	< 1
Common eider	< 1	< 1	< 1	< 10	< 10	< 1
Common eider	< 1	< 1	< 1	< 10	< 10	< 1
Common eider	< 1	< 1	< 1	< 10	< 10	< 1
Common eider	< 1	< 1	< 1	< 10	< 10	< 1
European shag	< 1	< 1	< 1	< 10	< 10	< 1
European shag	< 1	< 1	< 1	< 10	< 10	< 1
European shag	< 1	< 1	< 1	< 10	< 10	< 1
European shag	< 1	< 1	< 1	< 10	< 10	< 1
European shag	< 1	< 1	< 1	< 10	< 10	< 1
Kittiwake	< 1	< 1	< 1	< 10	< 10	< 1
Kittiwake	< 1	< 1	< 1	< 10	< 10	< 1
Kittiwake	< 1	< 1	< 1	< 10	< 10	< 1
Kittiwake	< 1	< 1	< 1	< 10	< 10	< 1
Kittiwake	< 1	< 1	< 1	< 10	< 10	< 1
Glaucous gull	< 1	< 1	< 1	< 10	< 10	< 1
Glaucous gull	< 1	< 1	< 1	< 10	< 10	< 1
Glaucous gull	< 1	< 1	< 1	< 10	< 10	< 1
Glaucous gull	< 1	< 1	< 1	< 10	< 10	< 1
Glaucous gull	< 1	< 1	< 1	< 10	< 10	< 1
Polar bear	< 1	< 1	< 1	< 10	< 10	< 1
Polar bear	< 1	< 1	< 1	< 10	< 10	< 1
Polar bear	< 1	< 1	< 1	< 10	< 10	< 1
Polar bear	< 1	< 1	< 1	< 10	< 10	< 1
Polar bear	< 1	< 1	< 1	< 10	< 10	< 1
Polar bear	< 1	< 1	< 1	< 10	< 10	< 1
Polar bear	< 1	< 1	< 1	< 10	< 10	< 1
Polar bear	< 1	< 1	< 1	< 10	< 10	< 1
Polar bear	< 1	< 1	< 1	< 10	< 10	< 1
Polar bear	< 1	< 1	< 1	< 10	< 10	< 1
Mink	< 1	< 1	< 1	< 10	< 10	< 1
Mink	< 1	< 1	< 1	< 10	< 10	< 1
Mink	< 1	< 1	< 1	< 10	< 10	< 1
Mink	< 1	< 1	< 1	< 10	< 10	< 1

	BTFMBB	BPFB	DCTFP	HFPO-T	9M-PFDF	DCTCB
	Air: pg/m³ . Biota: ng/g w.w.. Marin plastic: ng/g d.w.. and Effluent: ng/L					
Mink	< 1	< 1	< 1	< 10	< 10	< 1
Common gull	< 1	< 1	< 1	< 10	< 10	< 1
Common gull	< 1	< 1	< 1	< 10	< 10	< 1
Common gull	< 1	< 1	< 1	< 10	< 10	< 1
Common gull	< 1	< 1	< 1	< 10	< 10	< 1
Common gull	< 1	< 1	< 1	< 10	< 10	< 1
Effluent	< 5	< 5	< 5	< 5	< 5	<20
Effluent	< 5	< 5	< 5	< 5	< 5	<20
Effluent	< 5	< 5	< 5	< 5	< 5	<20
Effluent	< 5	< 5	< 5	< 5	< 5	<20
Effluent	< 5	< 5	< 5	< 5	< 5	<20
Effluent	< 5	< 5	< 5	< 5	< 5	<20
Marine plast						
Marine plast						
Air. Tromsø	<65					< 100
Air. Tromsø	<65					< 100
Air. Tromsø	<65					< 100
Air. Tromsø	<65					< 100

	D4	**D5**	**D6**	**D4Ph**	**D3F**	**D4Vn**
	Air: pg/m³ . Biota: ng/g w.w.. Marin plastic: ng/g d.w.. and Effluent: ng/L					
Air. Zeppelin	**130**	**60**	**30**	< 60	< 60	< 3
Air. Zeppelin	**160**	**120**	**120**	< 60	< 60	< 3
Air. Zeppelin	**130**	**160**	**100**	< 60	< 60	< 3
Air. Zeppelin	**160**	**140**	**90**	< 60	< 60	< 3
Air. Zeppelin	**40**	**30**	**10**	< 60	< 60	< 3
Air. Zeppelin	**1430**	**2860**	**180**	< 60	< 60	< 3
Common eider	< 2.6	<3.6	<3	< 10	< 10	< 1
Common eider	< 2.4	<2.8	<2.5	< 10	< 10	< 1
Common eider	< 1.8	<3.2	<3.4	< 10	< 10	< 1
Common eider	< 2.3	<3.7	<4.8	< 10	< 10	< 1
Common eider	< 2.3	<3.5	<2.6	< 10	< 10	< 1
European shag	<3.3	<4.6	<4	< 10	< 10	< 1
European shag	< 2.2	<3.2	<2.6	< 10	< 10	< 1
European shag	<2.6	<2.8	<3.3	< 10	< 10	< 1
European shag	<2.7	<3.2	<2.8	< 10	< 10	< 1
European shag	< 2.1	<3	<3	< 10	< 10	< 1
Kittiwake	< 2.7	<2.7	<5.2	< 10	< 10	< 1
Kittiwake	< 2.4	<5.3	<6.5	< 10	< 10	< 1
Kittiwake	<2.9	<3.7	<5.1	< 10	< 10	< 1
Kittiwake	< 2	<3.1	<4	< 10	< 10	< 1
Kittiwake	< 1.8	<7.6	<7.8	< 10	< 10	< 1
Glaucous gull	< 2	< 2	<1.9	< 10	< 10	< 1
Glaucous gull	< 2.1	<2.6	<2.1	< 10	< 10	< 1
Glaucous gull	< 2.3	< 2.3	<2.3	< 10	< 10	< 1
Glaucous gull	< 2.6	< 2.6	<3.8	< 10	< 10	< 1
Glaucous gull	< 2.4	<3.2	<2.4	< 10	< 10	< 1
Polar bear	< 2.6	< 2.6	< 2.1	< 10	< 10	< 1
Polar bear	< 2.8	< 2.8	<3.5	< 10	< 10	< 1
Polar bear	< 2.7	< 2.7	< 2.2	< 10	< 10	< 1
Polar bear	< 2.8	< 2.8	< 2.3	< 10	< 10	< 1
Polar bear	< 2.6	< 2.6	< 2.1	< 10	< 10	< 1
Polar bear	< 2.5	< 2.5	<2.6	< 10	< 10	< 1
Polar bear	< 2.4	< 2.4	<2.4	< 10	< 10	< 1
Polar bear	< 2.6	< 2.6	<3	< 10	< 10	< 1
Polar bear	< 2.5	< 2.5	<3.9	< 10	< 10	< 1
Polar bear	< 2.6	< 2.6	<6.3	< 10	< 10	< 1
Mink	< 2.2	< 2.2	< 1.8	< 10	< 10	< 1
Mink	< 2	< 2	< 1.6	< 10	< 10	< 1
Mink	< 2.1	< 2.1	< 1.7	< 10	< 10	< 1
Mink	< 2.1	< 2.1	< 1.7	< 10	< 10	< 1
Mink	< 2.2	< 2.2	<4.2	< 10	< 10	< 1

	D4	D5	D6	D4Ph	D3F	D4Vn
	Air: pg/m^3 . Biota: ng/g w.w.. Marin plastic: ng/g d.w.. and Effluent: ng/L					
Common gull	<3.1	<11.6	<7.2	< 10	< 10	< 1
Common gull	<2.6	<10.4	<5	< 10	< 10	< 1
Common gull	< 2.1	<7.2	<4.8	< 10	< 10	< 1
Common gull	<2	<32.9	<10.6	< 10	< 10	< 1
Common gull	<2.8	<12.4	<5.7	< 10	< 10	< 1
Effluent	**408**	**1998**	**1240**	< 5	< 5	< 5
Effluent	**241**	**1663**	**745**	< 5	< 5	< 5
Effluent	**140**	**235**	**127**	< 5	< 5	< 5
Effluent	**148**	**282**	**161**	< 5	< 5	< 5
Effluent	**283**	**1975**	**826**	< 5	< 5	< 5
Effluent	**128**	**165**	**97**	< 5	< 5	< 5
Marine plast						
Marine plast						
Air. Tromsø	**6587**	**26395**	**4104**	**48**	< 100	< 5
Air. Tromsø	**19644**	**102939**	**12867**	< 45	< 100	< 5
Air. Tromsø	**12470**	**29703**	**6323**	**3371**	< 100	< 5
Air. Tromsø	**15292**	**2314**	<500	**2693**	< 100	< 5

	PFOSA	PFBS	PFPS	PFHxS	PFHpS	brPFOS	PFOS	PFNS	PFDcS
	Air: pg/m³ . Biota: ng/g w.w.. Marin plastic: ng/g d.w.. and Effluent: ng/L								
Air. Zeppelin									
Air. Zeppelin									
Air. Zeppelin									
Air. Zeppelin									
Air. Zeppelin									
Air. Zeppelin									
Common eider	**0.04**	<0.05	<0.05	**0.05**	<0.05	<0.10	**3.0**	<0.10	<0.10
Common eider	**0.04**	<0.05	<0.05	**0.12**	**0.05**	<0.10	**3.2**	<0.10	<0.10
Common eider	**0.07**	<0.05	<0.05	**0.08**	<0.05	<0.10	**2.5**	<0.10	<0.10
Common eider	<0.05	<0.05	<0.05	**0.31**	<0.05	<0.10	**4.4**	**1.0**	<0.10
Common eider	<0.05	<0.05	<0.05	**0.10**	<0.05	<0.10	**2.4**	**1.1**	<0.10
European shag	**0.25**	<0.05	<0.05	**0.49**	**0.08**	**2.0**	**16**	<0.10	<0.10
European shag	**0.18**	<0.05	<0.05	**0.51**	**0.09**	**1.5**	**12**	**1.1**	<0.10
European shag	**0.19**	<0.05	<0.05	**0.44**	**0.11**	**2.1**	**14**	<0.10	<0.10
European shag	**0.17**	<0.05	<0.05	**0.23**	**0.07**	**1.3**	**12**	<0.10	<0.10
European shag	**0.32**	<0.05	<0.05	**0.57**	**0.02**	**2.0**	**12**	<0.10	<0.10
Kittiwake	**0.02**	<0.05	<0.05	**0.02**	<0.05	<0.10	**6.0**	<0.10	**0.07**
Kittiwake	<0.05	<0.05	<0.05	<0.05	<0.05	**0.24**	**6.9**	<0.10	**0.04**
Kittiwake	<0.05	<0.05	<0.05	**0.03**	**0.01**	**2.3**	**26**	<0.10	**0.03**
Kittiwake	<0.05	<0.05	<0.05	**0.07**	**0.09**	**1.6**	**17**	<0.10	<0.10
Kittiwake	**0.05**	<0.05	<0.05	**0.02**	**0.04**	<0.10	**6.3**	<0.10	<0.10
Glaucous gull	<0.05	<0.05	<0.05	**0.11**	**0.03**	<0.10	**6.9**	<0.10	<0.10
Glaucous gull	<0.05	<0.05	<0.05	<0.05	**0.04**	<0.10	**4.1**	**1.1**	**0.07**
Glaucous gull	<0.05	<0.05	<0.05	**0.12**	<0.05	<0.10	**4.6**	**1.1**	<0.10
Glaucous gull	<0.05	<0.05	<0.05	**0.17**	**0.08**	**1.0**	**6.9**	<0.10	<0.10
Glaucous gull	<0.05	<0.05	<0.05	**0.11**	<0.05	**0.64**	**5.8**	<0.10	<0.10
Polar bear	**0.12**	<0.05	<0.05	**20**	**4.6**	**39**	**107**	<0.10	<0.10
Polar bear	<0.05	<0.05	<0.05	**11**	**2.2**	**22**	**56**	<0.10	<0.10
Polar bear	<0.05	<0.05	<0.05	**30**	**4.2**	**43**	**94**	**2.1**	<0.10
Polar bear	<0.05	**0.04**	<0.05	**24**	**6.7**	**42**	**135**	<0.10	<0.10
Polar bear	**0.07**	**0.02**	<0.05	**31**	**6.7**	**71**	**201**	<0.10	<0.10
Polar bear	<0.05	**0.05**	<0.05	**22**	**2.2**	**17**	**59**	**2.2**	**0.12**
Polar bear	**0.07**	**0.03**	<0.05	**22**	**2.8**	**28**	**116**	**2.1**	**0.22**
Polar bear	**0.03**	<0.05	<0.05	**32**	**5.2**	**42**	**139**	<0.10	<0.10
Polar bear	<0.05	**0.08**	<0.05	**35**	**4.0**	**26**	**88**	<0.10	<0.10
Polar bear	**0.04**	**0.03**	<0.05	**23**	**3.5**	**35**	**140**	<0.10	**0.30**
Mink	<0.05	**0.07**	<0.05	**3.6**	**1.5**	**13**	**91**	<0.10	<0.10
Mink	<0.05	**0.25**	<0.05	**4.2**	**1.1**	**17**	**86**	<0.10	<0.10
Mink	**9.9**	**0.33**	<0.05	**5.2**	**1.8**	**31**	**150**	<0.10	<0.10
Mink	**7.2**	**0.19**	<0.05	**3.4**	**1.2**	**23**	**147**	<0.10	<0.10
Mink	**9.9**	**0.09**	<0.05	**6.0**	**2.9**	**59**	**201**	<0.10	<0.10

	PFOSA	PFBS	PFPS	PFHxS	PFHpS	brPFOS	PFOS	PFNS	PFDcS
	Air: pg/m³ . Biota: ng/g w.w.. Marin plastic: ng/g d.w.. and Effluent: ng/L								
Common gull	**0.05**	**0.02**	<0.05	**1.1**	**0.73**	**3.1**	**54**	**1.1**	**1.6**
Common gull	**0.03**	**0.01**	<0.05	**0.59**	**0.32**	**2.8**	**61**	**1.1**	**0.95**
Common gull	**0.03**	**0.01**	<0.05	**0.79**	**0.41**	**2.4**	**35**	<0.10	**1.7**
Common gull	<0.05	<0.05	<0.05	**0.46**	**0.37**	**2.9**	**56**	<0.10	**0.31**
Common gull	**0.03**	**0.07**	<0.05	**1.2**	**0.93**	**6.7**	**97**	<0.10	**1.00**
Effluent	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.10	**148**	<0.10
Effluent	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.10	<0.10	<0.10
Effluent	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.10	**143**	<0.10
Effluent	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.10	<0.10	<0.10
Effluent	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.10	**151**	<0.10
Effluent	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.10	**142**	<0.10
Marine plast	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.10	<0.10	<0.10
Marine plast	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.10	<0.10	<0.10
Air. Tromsø									
Air. Tromsø									
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Air. Tromsø									

	PFBA	PFPA	PFHxA	PFHpA	PFOA	PFNA	PFDcA	PFUnA
	Air: pg/m³ . Biota: ng/g w.w.. Marin plastic: ng/g d.w.. and Effluent: ng/L							
Air. Zeppelin								
Air. Zeppelin								
Air. Zeppelin								
Air. Zeppelin								
Air. Zeppelin								
Air. Zeppelin								
Common eider	<0.10	**0.09**	**0.06**	**0.02**	**0.46**	**1.0**	**0.20**	**0.56**
Common eider	<0.10	**0.08**	**0.03**	<0.05	**0.13**	**1.1**	**0.25**	**0.43**
Common eider	<0.10	<0.10	**0.00**	**0.01**	**0.12**	**0.49**	**0.21**	**0.31**
Common eider	<0.10	**0.09**	**0.04**	**0.01**	**0.35**	**1.1**	**0.32**	**0.68**
Common eider	<0.10	**0.06**	**0.05**	**0.01**	**0.18**	**0.32**	**0.13**	**0.26**
European shag	<0.10	<0.10	**0.03**	**0.03**	**0.32**	**0.80**	**0.95**	**3.1**
European shag	<0.10	**0.08**	<0.10	**0.03**	**0.52**	**0.70**	**0.84**	**2.2**
European shag	<0.10	**0.38**	<0.10	**0.05**	**0.46**	**0.71**	**0.79**	**2.4**
European shag	<0.10	<0.10	<0.10	**0.04**	**0.28**	**0.52**	**0.63**	**1.9**
European shag	<0.10	**0.09**	**0.03**	**0.04**	**0.37**	**0.73**	**0.67**	**2.5**
Kittiwake	<0.10	<0.10	<0.10	**0.02**	**0.08**	**0.41**	**0.72**	**4.8**
Kittiwake	<0.10	**0.06**	**0.09**	<0.05	**0.08**	**0.38**	**0.97**	**6.7**
Kittiwake	<0.10	<0.10	<0.10	<0.05	**0.10**	**1.7**	**2.0**	**8.4**
Kittiwake	<0.10	**0.06**	<0.10	**0.01**	**0.18**	**1.1**	**1.9**	**7.2**
Kittiwake	<0.10	**0.09**	**0.04**	**0.01**	**0.13**	**0.64**	**1.3**	**5.5**
Glaucous gull	<0.10	**0.05**	<0.10	**0.04**	**0.48**	**0.80**	**0.45**	**1.4**
Glaucous gull	<0.10	**0.06**	**0.02**	**0.04**	**0.49**	**0.74**	**0.30**	**0.76**
Glaucous gull	<0.10	**0.07**	<0.10	**0.02**	**0.13**	**0.30**	**0.21**	**1.6**
Glaucous gull	<0.10	<0.10	<0.10	**0.07**	**0.83**	**1.1**	**0.49**	**1.2**
Glaucous gull	<0.10	**0.06**	**0.03**	**0.02**	**0.27**	**0.70**	**0.30**	**1.2**
Polar bear	<0.10	**0.11**	<0.10	**0.08**	**1.5**	**13**	**4.9**	**12**
Polar bear	<0.10	**0.09**	<0.10	**0.07**	**0.86**	**8.8**	**3.6**	**7.0**
Polar bear	<0.10	**0.09**	**0.04**	**0.18**	**3.6**	**21**	**5.8**	**11**
Polar bear	<0.10	**0.11**	<0.10	**0.06**	**1.5**	**17**	**7.6**	**19**
Polar bear	<0.10	**0.10**	<0.10	**0.20**	**3.6**	**38**	**13**	**24**
Polar bear	<0.10	**0.06**	**0.05**	**5.0**	**4.8**	**12**	**4.0**	**11**
Polar bear	<0.10	**0.12**	**0.04**	**1.1**	**5.1**	**19**	**6.8**	**14**
Polar bear	<0.10	**0.11**	<0.10	**1.0**	**4.0**	**30**	**10**	**15**
Polar bear	<0.10	**0.11**	**0.05**	**0.27**	**4.0**	**18**	**5.6**	**11**
Polar bear	<0.10	**0.11**	<0.10	**1.2**	**4.4**	**19**	**7.7**	**17**
Mink	<0.10	**0.23**	<0.10	**0.02**	**5.4**	**14**	**4.7**	**4.3**
Mink	<0.10	<0.10	<0.10	<0.05	**1.2**	**20**	**6.6**	**6.1**
Mink	<0.10	**0.13**	<0.10	<0.05	**0.85**	**27**	**11**	**9.1**
Mink	<0.10	**0.33**	<0.10	**0.08**	**0.26**	**13**	**8.9**	**11**
Mink	<0.10	<0.10	<0.10	**0.24**	**3.8**	**31**	**9.6**	**9.1**

	PFBA	PFPA	PFHxA	PFHpA	PFOA	PFNA	PFDcA	PFUnA
	Air: pg/m³ . Biota: ng/g w.w.. Marin plastic: ng/g d.w.. and Effluent: ng/L							
Common gull	<0.10	**0.23**	<0.10	**0.50**	**2.2**	**1.6**	**3.5**	**8.1**
Common gull	<0.10	<0.10	<0.10	**0.14**	**0.55**	**0.55**	**1.3**	**4.1**
Common gull	<0.10	**0.16**	<0.10	**0.24**	**0.94**	**0.76**	**0.97**	**2.2**
Common gull	<0.10	<0.10	<0.10	**0.23**	**0.61**	**0.48**	**0.65**	**2.8**
Common gull	<0.10	<0.10	**0.04**	**0.23**	**1.1**	**1.2**	**2.2**	**3.4**
Effluent	<0.10	**54**	**2.2**	**1.3**	<0.015	**0.32**	<0.05	<0.05
Effluent	<0.10	**3.1**	**6.6**	**1.6**	**5.8**	**0.28**	<0.05	<0.05
Effluent	<0.10	**4.4**	**4.6**	**1.5**	**8.0**	**0.83**	<0.05	<0.05
Effluent	<0.10	<0.10	**2.4**	**1.2**	**4.7**	<0.05	<0.05	<0.05
Effluent	<0.10	**3.2**	**4.1**	**1.3**	**6.7**	**0.22**	<0.05	<0.05
Effluent	<0.10	**3.3**	**4.5**	**1.9**	**6.1**	**0.64**	<0.05	<0.05
Marine plast	<0.10	<0.10	**0.98**	<0.05	<0.015	<0.05	<0.05	<0.05
Marine plast	<0.10	<0.10	**0.28**	<0.05	<0.015	<0.05	<0.05	<0.05
Air. Tromsø								
Air. Tromsø								
Air. Tromsø								
Air. Tromsø								

	PFDoA	**PFTriA**	**PFTeA**	**PFHxDA**	**PFOcDA**	**6:2FTS**	**8:2 FTS**
	Air: pg/m³ . Biota: ng/g w.w.. Marin plastic: ng/g d.w.. and Effluent: ng/L						
Air. Zeppelin							
Air. Zeppelin							
Air. Zeppelin							
Air. Zeppelin							
Air. Zeppelin							
Air. Zeppelin							
Common eider	**0.21**	**0.48**	**0.22**	<0.05	<0.05	<0.10	<0.10
Common eider	**0.19**	**1.1**	**0.21**	<0.05	<0.05	<0.10	<0.10
Common eider	**0.11**	**0.40**	**0.05**	<0.05	<0.05	<0.10	<0.10
Common eider	**0.26**	**1.1**	**0.22**	<0.05	<0.05	<0.10	<0.10
Common eider	**0.09**	**0.57**	**0.11**	<0.05	<0.05	<0.10	<0.10
European shag	**1.1**	**4.0**	**0.49**	<0.05	<0.05	<0.10	<0.10
European shag	**0.61**	**2.0**	**0.25**	<0.05	<0.05	<0.10	**0.10**
European shag	**0.71**	**3.3**	**0.25**	<0.05	<0.05	<0.10	<0.10
European shag	**0.55**	**1.7**	**0.29**	<0.05	<0.05	<0.10	<0.10
European shag	**0.77**	**3.2**	**0.30**	<0.05	<0.05	<0.10	<0.10
Kittiwake	**1.7**	**8.9**	**0.88**	<0.05	<0.05	<0.10	<0.10
Kittiwake	**2.1**	**9.8**	**1.5**	<0.05	<0.05	<0.10	<0.10
Kittiwake	**1.4**	**6.4**	**0.68**	<0.05	<0.05	<0.10	<0.10
Kittiwake	**1.6**	**9.8**	**1.5**	<0.05	<0.05	<0.10	<0.10
Kittiwake	**1.3**	**8.5**	**1.6**	<0.05	<0.05	<0.10	<0.10
Glaucous gull	**0.37**	**1.6**	**0.19**	<0.05	<0.05	<0.10	<0.10
Glaucous gull	**0.08**	**1.1**	**0.11**	<0.05	<0.05	<0.10	<0.10
Glaucous gull	**0.77**	**2.1**	**0.42**	<0.05	<0.05	<0.10	<0.10
Glaucous gull	**0.35**	**1.5**	**0.21**	<0.05	<0.05	<0.10	<0.10
Glaucous gull	**0.36**	**1.8**	**0.26**	<0.05	<0.05	<0.10	<0.10
Polar bear	**1.7**	**3.1**	<0.05	<0.05	<0.05	<0.10	<0.10
Polar bear	**0.90**	**2.0**	**0.04**	<0.05	<0.05	<0.10	<0.10
Polar bear	**1.3**	**2.6**	<0.05	<0.05	<0.05	<0.10	**0.09**
Polar bear	**2.1**	**5.3**	**0.19**	<0.05	<0.05	<0.10	<0.10
Polar bear	**2.7**	**7.4**	**0.75**	<0.05	<0.05	<0.10	<0.10
Polar bear	**1.4**	**2.7**	**0.06**	<0.05	<0.05	<0.10	<0.10
Polar bear	**1.4**	**3.2**	**0.11**	<0.05	<0.05	<0.10	<0.10
Polar bear	**1.8**	**2.8**	**0.13**	<0.05	<0.05	<0.10	<0.10
Polar bear	**1.1**	**2.0**	<0.05	<0.05	<0.05	<0.10	<0.10
Polar bear	**2.1**	**4.7**	**0.21**	<0.05	<0.05	<0.10	<0.10
Mink	**0.76**	**1.6**	**0.14**	<0.05	<0.05	**0.07**	<0.10
Mink	**1.1**	**2.0**	**0.15**	<0.05	<0.05	<0.10	<0.10
Mink	**1.3**	**2.3**	**0.15**	<0.05	<0.05	**0.02**	<0.10
Mink	**2.2**	**4.3**	**0.32**	<0.05	<0.05	**0.01**	<0.10
Mink	**1.3**	**4.8**	**0.40**	<0.05	<0.05	**0.07**	**0.13**

	PFDoA	PFTriA	PFTeA	PFHxDA	PFOcDA	6:2FTS	8:2 FTS
	Air: pg/m³ . Biota: ng/g w.w.. Marin plastic: ng/g d.w.. and Effluent: ng/L						
Common gull	**10**	**14**	**12**	**2.3**	<0.05	<0.10	**0.56**
Common gull	**4.7**	**8.5**	**5.7**	**1.2**	<0.05	<0.10	**0.20**
Common gull	**2.6**	**4.4**	**2.1**	**0.23**	<0.05	<0.10	**0.16**
Common gull	**2.6**	**7.0**	**2.7**	**0.16**	<0.05	<0.10	**0.16**
Common gull	**6.0**	**6.8**	**4.4**	**0.33**	<0.05	<0.10	**0.38**
Effluent	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.10
Effluent	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.10
Effluent	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.10
Effluent	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.10
Effluent	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.10
Effluent	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.10
Marine plast	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.10
Marine plast	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.10
Air. Tromsø							
Air. Tromsø							
Air. Tromsø							
Air. Tromsø							

	BP3	ODBAPA	UV-320	UV-326	UV-327	UV-328	UV-329	UV-928	OC	EHMC
	Air: pg/m³ . Biota: ng/g w.w.. Marin plastic: ng/g d.w.. and Effluent: ng/L									
Air. Zeppelin	<0.5	<5	<0.5	<0.3	<0.5	<1	<0.3	<100	<1	<0.1
Air. Zeppelin	<0.5	<3	<0.3	<0.3	<0.3	<1	<1.5	<100	<1	<0.1
Air. Zeppelin	<0.5	<2	<0.3	<0.3	<0.3	<0.5	<0.3	<100	<1	<0.1
Air. Zeppelin	<0.5	<2	<0.3	<0.3	<0.3	<0.5	<0.3	<100	<1	<0.1
Air. Zeppelin	<0.5	<2	<0.3	<0.3	<0.5	<2	<0.3	<100	<1	<0.1
Air. Zeppelin										
Common eider	**3.8**	<0.4	<0.03	<0.2	<0.05	**0.25**	<0.2	<100	m	**5.3**
Common eider	**5.4**	<0.4	<0.03	<0.2	<0.05	**0.18**	<0.2	<100	m	**6.1**
Common eider	**6.5**	<0.4	<0.03	<0.2	<0.05	**0.11**	<0.2	<100	m	**2.6**
Common eider	**4.2**	<0.4	<0.03	<0.2	<0.05	**0.15**	<0.2	<100	m	**5.2**
Common eider	<2	<0.4	<0.03	<0.2	<0.05	**0.13**	<0.2	<100	m	**3.6**
European shag	**5.1**	<0.4	<0.1	<0.2	<0.2	<0.2	**0.68**	<100	m	<15
European shag	<2.5	<0.4	<0.1	<0.2	<0.2	<0.2	**0.26**	<100	m	<15
European shag	<2.5	<0.4	<0.1	<0.2	<0.2	**0.22**	**0.30**	<100	m	<15
European shag	**4.7**	<0.4	<0.1	<0.2	<0.2	**0.23**	**0.23**	<100	m	<15
European shag	<2.5	<0.4	<0.1	<0.2	<0.2	**0.22**	**0.26**	<100	m	<15
Kittiwake	<2	<0.4	<0.03	<0.2	<0.05	**0.12**	<0.2	<100	m	**4.8**
Kittiwake	**8.3**	<0.4	<0.03	<0.2	<0.05	**0.16**	<0.2	<100	m	**7.6**
Kittiwake	<3	<0.4	**0.05**	**0.24**	**0.06**	**0.31**	<0.2	<100	m	**4.9**
Kittiwake	**4.7**	<0.4	**0.06**	<0.2	<0.05	**0.17**	<0.2	<100	m	**3.1**
Kittiwake	<4	<0.4	**0.07**	<0.2	<0.05	**0.21**	<0.2	<100	m	**5.2**
Glaucous gull	**2.7**	<0.4	<0.03	<0.2	<0.05	**0.27**	<0.2	<100	m	**3.3**
Glaucous gull	**4.3**	<0.4	**0.03**	<0.2	<0.05	<0.1	<0.2	<100	m	**1.9**
Glaucous gull	**2.6**	<0.4	<0.03	<0.2	<0.05	**0.12**	<0.2	<100	m	**2.7**
Glaucous gull	**4.1**	<0.4	<0.03	<0.2	<0.05	<0.1	<0.2	<100	m	**2.9**
Glaucous gull	<2	<0.4	<0.03	<0.2	<0.05	**0.13**	<0.2	<100	m	**3.2**
Polar bear	<1.5	m	<0.2	<0.5	<0.2	<0.3	**2.3**	<100	**38**	<4
Polar bear	<1.5	m	<0.2	**0.81**	<0.2	<0.3	<0.6	<100	<15	<4
Polar bear	<1.5	m	<0.2	<0.5	<0.2	<0.3	<0.6	<100	**30**	<4
Polar bear	<1.5	m	<0.2	<0.5	<0.2	<0.3	<0.6	<100	**34**	<4
Polar bear	<1.5	m	<0.2	<0.5	<0.2	<0.3	<0.6	<100	**24**	<4
Polar bear	<1.5	m	<0.2	<0.5	<0.2	<0.3	<0.6	<100	<15	<4
Polar bear	<1.5	m	<0.2	<0.5	<0.2	<0.3	<0.6	<100	**15**	<4
Polar bear	<1.5	m	<0.2	<0.5	<0.2	<0.3	<0.6	<100	<15	<4
Polar bear	<1.5	m	<0.2	<0.5	<0.2	<0.3	<0.6	<100	<15	<4
Polar bear	<1.5	m	<0.2	<0.5	<0.2	<0.3	<0.6	<100	<15	<4
Mink	**0.28**	**0.36**	<0.03	**0.32**	<0.03	**0.22**	**0.13**	<100	<3	**4.3**
Mink	<0.2	<0.3	<0.03	**0.35**	<0.03	**0.08**	**0.14**	<100	<3	**4.4**
Mink	<0.2	<0.3	<0.03	**0.31**	<0.03	**0.08**	**0.09**	<100	<3	**4.7**
Mink	**0.43**	<0.4	<0.03	**0.35**	**0.04**	**0.14**	**0.17**	<100	<3	**4.9**
Mink	**2.3**	<0.4	<0.06	**0.51**	**0.08**	**0.36**	**0.37**	<100	<3	<3

	BP3	**ODBAPA**	**UV-320**	**UV-326**	**UV-327**	**UV-328**	**UV-329**	**UV-928**	**OC**	**EHMC**
	Air: pg/m^3 . Biota: ng/g w.w.. Marin plastic: ng/g d.w.. and Effluent: ng/L									
Common gull	**5.1**	<0.4	<0.1	<0.2	<0.2	<0.2	**0.68**	<100	m	<15
Common gull	<2.5	<0.4	<0.1	<0.2	<0.2	<0.2	**0.26**	<100	m	<15
Common gull	<2.5	<0.4	<0.1	<0.2	<0.2	**0.22**	**0.30**	<100	m	<15
Common gull	**4.7**	<0.4	<0.1	<0.2	<0.2	**0.23**	**0.23**	<100	m	<15
Common gull	<2.5	<0.4	<0.1	<0.2	<0.2	**0.22**	**0.26**	<100	m	<15
Effluent	**130**	<10	<4	**59**	**6.3**	**57**	**5.1**	<100	**1430**	**79**
Effluent	**156**	<10	<6	**61**	**6.6**	**49**	**6.7**	<100	**1900**	**66**
Effluent	**139**	**13**	<3	**24**	**2.8**	**16**	<3	<100	**1290**	**67**
Effluent	**142**	<4	<2	**11**	<2	**7.0**	<3	<100	**917**	**65**
Effluent	**142**	<6	<2	**27**	<3	**21**	<3	<100	**1450**	**39**
Effluent	**115**	<6	<3	**44**	<4	**38**	<3	<100	**1370**	**57**
Marine plast										
Marine plast										
Air. Tromsø										
Air. Tromsø										
Air. Tromsø										
Air. Tromsø										

Air: pg/m³ . Biota: ng/g w.w.. Marin plastic: ng/g d.w.. and Effluent: ng/L

	Trifluralin	**Chlorothalonil**	**Chlorpyrifos**	**Dachtal**	**Bifenthrin**	**Cypermethrin**	**PBCCH1**	**PBCCH2**	**PBCCH3**	**PBCCH4**	**BCPS**
Air. Zeppelin	<0.2	<0.1	<0.1	**0.02**	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Air. Zeppelin	<0.2	<0.1	<0.1	**0.08**	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Air. Zeppelin	<0.2	<0.1	<0.1	**0.07**	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Air. Zeppelin	<0.2	<0.1	<0.1	**0.02**	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Air. Zeppelin	<0.2	<0.1	<0.1	**0.12**	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Common eider	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	**1.4**	<0.1	<0.1	<0.1	<0.5
Common eider	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Common eider	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Common eider	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Common eider	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
European shag	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
European shag	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
European shag	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
European shag	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
European shag	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Kittiwake	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Kittiwake	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Kittiwake	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Kittiwake	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Kittiwake	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Glaucous gull	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Glaucous gull	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Glaucous gull	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Glaucous gull	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Glaucous gull	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Polar bear	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Polar bear	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Polar bear	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Polar bear	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Polar bear	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Polar bear	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Polar bear	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Polar bear	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Polar bear	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Polar bear	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Mink	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Mink	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Mink	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Mink	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5

	Trifluralin	Chlorothalonil	Chlorpyrifos	Dachtal	Bifenthrin	Cypermethrin	PBCCH1	PBCCH2	PBCCH3	PBCCH4	BCPS
	Air: pg/m^3 . Biota: ng/g w.w.. Marin plastic: ng/g d.w.. and Effluent: ng/L										
Mink	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	**0.53**
Common gull	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	**0.20**
Common gull	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Common gull	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Common gull	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Common gull	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Effluent	<0.2	<0.1	**0.40**	<0.02	<0.3	**0.33**	<0.1	<0.1	<0.1	<0.1	<0.5
Effluent	<0.2	<0.1	**0.25**	<0.02	<0.3	**0.23**	<0.1	<0.1	<0.1	<0.1	<0.5
Effluent	<0.2	<0.1	**0.30**	<0.02	<0.3	**0.21**	<0.1	<0.1	<0.1	<0.1	<0.5
Effluent	<0.2	<0.1	**0.53**	<0.02	<0.3	**0.14**	<0.1	<0.1	<0.1	<0.1	<0.5
Effluent	<0.2	<0.1	<0.1	<0.02	<0.3	**0.12**	<0.1	<0.1	<0.1	<0.1	<0.5
Effluent	<0.2	<0.1	**0.26**	<0.02	<0.3	**0.11**	<0.1	**22**	<0.1	<0.1	<0.5
Marine plast	<0.2	<0.1	<0.1	<0.02	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.5
Marine plast	<0.2	<0.1	<0.1	<0.02	<0.3	**6.5**	<0.1	<0.1	<0.1	<0.1	<0.5
Air. Tromsø											
Air. Tromsø											
Air. Tromsø											
Air. Tromsø											

Air: pg/m^3 . Biota: ng/g w.w.. Marin plastic: ng/g d.w.. and Effluent: ng/L

	DBCD	Dibromoaldrin	Dechlorane 601	Dechlorane 602	Dechlorane 603	Dechlorane 604	Dechlorane plus syn	Dechlorane plus anti	SCCP	MCCP
Air. Zeppelin	<0.4		-					-		
Air. Zeppelin	<0.4		-					-		
Air. Zeppelin	<0.4		-					-		
Air. Zeppelin	<0.4		-					-		
Air. Zeppelin	<0.4									
Common eider	<0.4	<0.05	<0.02	**0.01**	<0.02	<0.1	**0.06**	**0.11**	**85**	**59**
Common eider	<0.4	<0.05	<0.02	**0.01**	<0.02	<0.1	<0.02	<0.02	**68**	**39**
Common eider	<0.4	<0.05	<0.02	**0.02**	<0.02	<0.1	**0.04**	**0.09**	**118**	**17**
Common eider	<0.4	<0.05	<0.02	**0.01**	<0.02	<0.1	**0.03**	**0.05**	**87**	**25**
Common eider	<0.4	<0.05	<0.02	**0.01**	<0.02	<0.1	**0.04**	**0.08**	**61**	**13**
European shag	<0.4	<0.05	<0.02	**0.05**	<0.02	<0.1	**0.18**	**0.90**	**204**	**366**
European shag	<0.4	<0.05	<0.02	**0.05**	<0.02	<0.1	**0.25**	**1.4**	**217**	**330**
European shag	<0.4	<0.05	<0.02	**0.07**	<0.02	<0.1	**0.22**	**1.9**	**40**	**8.5**
European shag	<0.4	<0.05	<0.02	**0.03**	<0.02	<0.1	**0.21**	**1.4**	**34**	**56**
European shag	<0.4	<0.05	<0.02	**0.05**	<0.02	<0.1	**0.23**	**1.6**	**40**	**7.8**
Kittiwake	<0.4	<0.05	<0.02	**0.45**	<0.02	<0.1	**0.01**	**0.03**	**69**	**15**
Kittiwake	<0.4	<0.05	<0.02	**0.27**	<0.02	<0.1	<0.02	**0.03**	**34**	**66**
Kittiwake	<0.4	<0.05	<0.02	**0.28**	<0.02	<0.1	**0.02**	**0.04**	**37**	**96**
Kittiwake	<0.4	<0.05	<0.02	**0.47**	<0.02	<0.1	**0.01**	**0.03**	**61**	**9.3**
Kittiwake	<0.4	<0.05	<0.02	**0.38**	<0.02	<0.1	**0.01**	**0.02**	**65**	**12**
Glaucous gull	<0.4	<0.05	<0.02	**0.13**	<0.02	<0.1	**0.23**	**1.7**	**71**	**49**
Glaucous gull	<0.4	<0.05	<0.02	**0.15**	<0.02	<0.1	**0.22**	**1.4**	**13**	**8.6**
Glaucous gull	<0.4	<0.05	<0.02	**0.05**	<0.02	<0.1	**0.27**	**2.3**	**46**	**30**
Glaucous gull	<0.4	<0.05	<0.02	**0.17**	<0.02	<0.1	**0.22**	**1.5**	**47**	**43**
Glaucous gull	<0.4	<0.05	<0.02	**0.17**	<0.02	<0.1	**0.26**	**1.8**	**64**	**49**
Polar bear	<0.4	<0.05	<0.02	**0.23**	<0.02	<0.1	**0.56**	**3.5**	**123**	**50**
Polar bear	<0.4	<0.05	<0.02	**0.12**	<0.02	<0.1	**0.67**	**6.6**	**43**	**10**
Polar bear	<0.4	<0.05	<0.02	**0.55**	<0.02	<0.1	**0.64**	**4.8**	**69**	**32**
Polar bear	<0.4	<0.05	<0.02	**0.82**	<0.02	<0.1	**0.44**	**3.0**	**49**	**16**
Polar bear	<0.4	<0.05	<0.02	**0.19**	<0.02	<0.1	**0.65**	**3.8**	**131**	**65**
Polar bear	<0.4	<0.05	<0.02	**0.26**	<0.02	<0.1	**0.45**	**4.9**	**40**	**14**
Polar bear	<0.4	<0.05	<0.02	**0.18**	<0.02	<0.1	**0.89**	**4.7**	**58**	**5.1**
Polar bear	<0.4	<0.05	<0.02	**0.42**	<0.02	<0.1	**0.47**	**3.5**	**114**	**45**
Polar bear	<0.4	<0.05	<0.02	**0.18**	<0.02	<0.1	**1.1**	**6.9**	**1190**	**76**
Polar bear	<0.4	<0.05	<0.02	**0.14**	<0.02	<0.1	**0.47**	**3.4**	**7300**	**93**
Mink	<0.4	<0.05	<0.02	**0.22**	**0.03**	<0.1	**0.13**	**0.29**	**2700**	**16**
Mink	<0.4	<0.05	<0.02	**0.07**	<0.02	<0.1	**0.22**	**1.1**	**5.2**	**1.1**
Mink	<0.4	<0.05	<0.02	**0.17**	<0.02	<0.1	**0.17**	**1.2**	**25**	**9.4**
Mink	<0.4	<0.05	<0.02	**0.20**	<0.02	<0.1	**0.19**	**1.5**	**15**	**6.2**

	DBCD	Dibromoaldrin	Dechlorane 601	Dechlorane 602	Dechlorane 603	Dechlorane 604	Dechlorane plus syn	Dechlorane plus anti	SCCP	MCCP
	Air: pg/m³ . Biota: ng/g w.w.. Marin plastic: ng/g d.w.. and Effluent: ng/L									
Mink	<0.4	<0.05	<0.02	**4.3**	**0.06**	<0.1	**0.35**	**2.0**	**45**	**32**
Common gull	<0.4	<0.05	<0.02	**0.08**	**1.2**	<0.1	**0.32**	**2.5**	**77**	**59**
Common gull	<0.4	<0.05	<0.02	**0.07**	**0.61**	<0.1	**0.05**	**0.19**	**26**	**24**
Common gull	<0.4	<0.05	<0.02	**0.11**	**0.51**	<0.1	**0.02**	**0.12**	**20**	**87**
Common gull	<0.4	<0.05	<0.02	**0.04**	**0.29**	<0.1	**0.04**	**0.11**	**38**	**9.4**
Common gull	<0.4	<0.05	<0.02	**0.13**	**0.85**	<0.1	**0.09**	**0.28**	**98**	**19**
Effluent	<0.4								**264**	**969**
Effluent	<0.4								**232**	**744**
Effluent	<0.4								**283**	**937**
Effluent	<0.4								**252**	**721**
Effluent	<0.4								**265**	**762**
Effluent	<0.4								**252**	**655**
Marine plast	<0.4									
Marine plast	<0.4									
Air. Tromsø										
Air. Tromsø										
Air. Tromsø										
Air. Tromsø										

	BPA	BP-AF	BPB	BP-BP	2.2'-BPF	2.4'-BPF	4.4'-BPF	BPM	BPP
	Air: pg/m³ . Biota: ng/g w.w.. Marin plastic: ng/g d.w.. and Effluent: ng/L								
Air. Zeppelin	**16**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Air. Zeppelin	**14**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Air. Zeppelin	<1.0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Air. Zeppelin	**1.8**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Air. Zeppelin	**2.8**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Air. Zeppelin									
Common eider	<21.0	<2.0	<7.0	<2.5	<5.0	<31.0	<25.0	<1.5	<3.0
Common eider	<21.0	<2.0	<7.0	<2.5	<5.0	<31.0	<25.0	<1.5	<3.0
Common eider	<21.0	<2.0	<7.0	<2.5	<5.0	<31.0	<25.0	<1.5	<3.0
Common eider	<21.0	<2.0	<7.0	<2.5	<5.0	<31.0	<25.0	<1.5	<3.0
Common eider	<21.0	<2.0	<7.0	<2.5	<5.0	<31.0	<25.0	<1.5	<3.0
European shag	<21.0	<2.0	<7.0	<2.5	<5.0	<31.0	<25.0	<1.5	<3.0
European shag	<21.0	<2.0	<7.0	<2.5	<5.0	<31.0	<25.0	<1.5	<3.0
European shag	<21.0	<2.0	<7.0	<2.5	<5.0	<31.0	<25.0	<1.5	<3.0
European shag	<21.0	<2.0	<7.0	<2.5	<5.0	<31.0	<25.0	<1.5	<3.0
European shag	<21.0	<2.0	<7.0	<2.5	<5.0	<31.0	<25.0	<1.5	<3.0
Kittiwake	<21.0	<2.0	<7.0	<2.5	<5.0	<31.0	<25.0	<1.5	<3.0
Kittiwake	<21.0	<2.0	<7.0	<2.5	<5.0	<31.0	<25.0	<1.5	<3.0
Kittiwake	<21.0	<2.0	<7.0	<2.5	<5.0	<31.0	<25.0	<1.5	<3.0
Kittiwake	<21.0	<2.0	<7.0	<2.5	<5.0	<31.0	<25.0	<1.5	<3.0
Kittiwake	<21.0	<2.0	<7.0	<2.5	<5.0	<31.0	<25.0	<1.5	<3.0
Glaucous gull	<21.0	<2.0	<7.0	<2.5	<5.0	<31.0	<25.0	<1.5	<3.0
Glaucous gull	<21.0	<2.0	<7.0	<2.5	<5.0	<31.0	<25.0	<1.5	<3.0
Glaucous gull	<21.0	<2.0	<7.0	<2.5	<5.0	<31.0	<25.0	<1.5	<3.0
Glaucous gull	<21.0	<2.0	<7.0	<2.5	<5.0	<31.0	<25.0	<1.5	<3.0
Glaucous gull	<21.0	<2.0	<7.0	<2.5	<5.0	<31.0	<25.0	<1.5	<3.0
Polar bear	<43.0	<3.0	<20.0	<3.0	<3.0	<12.0	<18.0	<2.0	<4.5
Polar bear	-	-	-	-	-	-	-	-	-
Polar bear	<43.0	<3.0	<20.0	<3.0	<3.0	<12.0	<18.0	<2.0	<4.5
Polar bear	<43.0	<3.0	<20.0	<3.0	<3.0	<12.0	<18.0	<2.0	<4.5
Polar bear	<43.0	<3.0	<20.0	<3.0	<3.0	<12.0	<18.0	<2.0	<4.5
Polar bear	<43.0	<3.0	<20.0	<3.0	<3.0	<12.0	<18.0	<2.0	<4.5
Polar bear	<43.0	<3.0	<20.0	<3.0	<3.0	<12.0	<18.0	<2.0	<4.5
Polar bear	<43.0	<3.0	<20.0	<3.0	<3.0	<12.0	<18.0	<2.0	<4.5
Polar bear	<43.0	<3.0	<20.0	<3.0	<3.0	<12.0	<18.0	<2.0	<4.5
Polar bear	<43.0	<3.0	<20.0	<3.0	<3.0	<12.0	<18.0	<2.0	<4.5

	BPA	**BP-AF**	**BPB**	**BP-BP**	**2.2'-BPF**	**2.4'-BPF**	**4.4'-BPF**	**BPM**	**BPP**
	Air: pg/m³ . Biota: ng/g w.w.. Marin plastic: ng/g d.w.. and Effluent: ng/L								
Mink	<43.0	<4.0	<17.0	<8.0	<8.0	<30.0	<21.0	<4.0	<8.0
Mink	<90.0	<4.0	<17.0	<8.0	<8.0	<30.0	<21.0	<4.0	<8.0
Mink	<90.0	<4.0	<17.0	<8.0	<8.0	<30.0	<21.0	<4.0	<8.0
Mink	<90.0	<4.0	<17.0	<8.0	<8.0	-	-	<4.0	<8.0
Mink	<90.0	<4.0	<17.0	<8.0	<8.0	<30.0	<21.0	<4.0	<8.0
Common gull	<21.0	<2.0	<7.0	<2.5	<5.0	<31.0	<25.0	<1.5	<3.0
Common gull	-	<2.0	<7.0	<2.5	<5.0	<31.0	<25.0	<1.5	<3.0
Common gull	<21.0	<2.0	<7.0	<2.5	<5.0	<31.0	<25.0	<1.5	<3.0
Common gull	<21.0	<2.0	<7.0	<2.5	<5.0	<31.0	<25.0	<1.5	<3.0
Common gull	<21.0	<2.0	<7.0	<2.5	<5.0	<31.0	<25.0	<1.5	<3.0
Effluent	**452**	**28**	<40.0	<15.0	<30.0	<100.0	<90.0	<7.0	<16.0
Effluent	**376**	<11.0	<40.0	<15.0	<30.0	**114**	<90.0	<7.0	<16.0
Effluent	**230**	<11.0	<40.0	<15.0	<30.0	<100.0	<90.0	<7.0	<16.0
Effluent	**250**	<11.0	<40.0	<15.0	<30.0	<100.0	<90.0	<7.0	**29**
Effluent	**156**	<11.0	<40.0	<15.0	<30.0	<100.0	<90.0	<7.0	<16.0
Effluent	**314**	<11.0	<40.0	<15.0	<30.0	<100.0	<90.0	<7.0	<16.0
Marine plast	**24**	<6.0	<4.0	<1.0	<2.5	<12.0	<14.0	<1.0	<1.0
Marine plast	<20.0	<6.0	<4.0	<1.0	<2.5	<12.0	<14.0	<1.0	<1.0
Air. Tromsø									
Air. Tromsø									
Air. Tromsø									
Air. Tromsø									

	BPS	BP-TMC	BPZ	TBBPA	BDPPBD	CTFPPA	NPADPP	Number of SUS compounds	Number of SUS compounds
	Air: pg/m^3 . Biota: ng/g w.w.. Marin plastic: ng/g d.w.. and Effluent: ng/L								
Air. Zeppelin	**0.12**	<0.1	<0.1	<0.1	<10	<10	<10	**140**	**103**
Air. Zeppelin	**0.22**	<0.1	<0.1	<0.1	<10	<10	<10	**136**	**112**
Air. Zeppelin	<0.1	<0.1	<0.1	<0.1	<10	<10	<10	**143**	**105**
Air. Zeppelin	<0.1	<0.1	<0.1	<0.1	<10	<10	<10	**113**	**101**
Air. Zeppelin	<0.1	<0.1	<0.1	<0.1	<10	<10	<10	**141**	**83**
Air. Zeppelin					<10	<10	<10	**156**	**145**
Common eider	<6.0	<17.0	<9.0	<16.0	<10	<10	<10	**139**	
Common eider	<6.0	<17.0	<9.0	<16.0	<10	<10	<10	**116**	
Common eider	<6.0	<17.0	<9.0	<16.0	<10	<10	<10	**110**	
Common eider	<6.0	<17.0	<9.0	<16.0	<10	<10	<10	**102**	
Common eider	<6.0	<17.0	<9.0	<16.0	<10	<10	<10	**97**	
European shag	<6.0	<17.0	<9.0	<16.0	<10	<10	<10	**113**	
European shag	<6.0	<17.0	<9.0	<16.0	<10	<10	<10	**108**	
European shag	<6.0	<17.0	<9.0	<16.0	<10	<10	<10	**108**	
European shag	<6.0	<17.0	<9.0	<16.0	<10	<10	<10	**97**	
European shag	<6.0	<17.0	<9.0	<16.0	<10	<10	<10	**86**	
Kittiwake	<6.0	<17.0	<9.0	<16.0	<10	<10	<10	**67**	
Kittiwake	<6.0	<17.0	<9.0	<16.0	<10	<10	<10	**65**	
Kittiwake	<6.0	<17.0	<9.0	<16.0	<10	<10	<10	**68**	
Kittiwake	<6.0	<17.0	<9.0	<16.0	<10	<10	<10	**54**	
Kittiwake	<6.0	<17.0	<9.0	<16.0	<10	<10	<10	**71**	
Glaucous gull	<6.0	<17.0	<9.0	<16.0	<10	<10	<10	**55**	
Glaucous gull	<6.0	<17.0	<9.0	<16.0	<10	<10	<10	**66**	
Glaucous gull	<6.0	<17.0	<9.0	<16.0	<10	<10	<10	**64**	
Glaucous gull	<6.0	<17.0	<9.0	<16.0	<10	<10	<10	**62**	
Glaucous gull	<6.0	<17.0	<9.0	<16.0	<10	<10	<10	**59**	
Polar bear	<6.0	<7.5	<8.0	<11.0	<10	<10	<10	**111**	
Polar bear	-	-	-	-	<10	<10	<10	**81**	
Polar bear	<6.0	<7.5	<8.0	<11.0	<10	<10	<10	**104**	
Polar bear	<6.0	<7.5	<8.0	<11.0	<10	<10	<10	**63**	
Polar bear	<6.0	<7.5	<8.0	<11.0	<10	<10	<10	**82**	
Polar bear	<6.0	<7.5	<8.0	<11.0	<10	<10	<10	**94**	
Polar bear	<6.0	<7.5	<8.0	<11.0	<10	<10	<10	**84**	
Polar bear	<6.0	<7.5	<8.0	<11.0	<10	<10	<10	**68**	
Polar bear	<6.0	<7.5	<8.0	<11.0	<10	<10	<10	**78**	
Polar bear	<6.0	<7.5	<8.0	<11.0	<10	<10	<10	**79**	

	BPS	BP-TMC	BPZ	TBBPA	BDPPBD	CTFPPA	NPADPP	Number of SUS compounds	Number of SUS compounds
	Air: pg/m³ . Biota: ng/g w.w.. Marin plastic: ng/g d.w.. and Effluent: ng/L								
Mink	<5.0	<25.0	<30.0	<7.0	<10	<10	<10	**86**	
Mink	<5.0	<25.0	<30.0	<7.0	<10	<10	<10	**91**	
Mink	<5.0	<25.0	<30.0	<7.0	<10	<10	<10	**91**	
Mink	<5.0	<25.0	<30.0	<7.0	<10	<10	<10	**104**	
Mink	<5.0	<25.0	<30.0	<7.0	<10	<10	<10	**147**	
Common gull	<6.0	<17.0	<9.0	<16.0	<10	<10	<10	**88**	
Common gull	<6.0	<17.0	<9.0	<16.0	<10	<10	<10	**88**	
Common gull	<6.0	<17.0	<9.0	<16.0	<10	<10	<10	**58**	
Common gull	<6.0	<17.0	<9.0	<16.0	<10	<10	<10	**84**	
Common gull	<6.0	<17.0	<9.0	<16.0	<10	<10	<10	**58**	
Effluent	**29**	<40.0	<26.0	<25.0	<10	<10	<10	**104**	
Effluent	**183**	<40.0	<26.0	<25.0	<10	<10	<10	**65**	
Effluent	**159**	<40.0	<26.0	<25.0	<10	<10	<10	**43**	
Effluent	**193**	<40.0	<26.0	<25.0	<10	<10	<10	**47**	
Effluent	**150**	<40.0	<26.0	<25.0	<10	<10	<10	**53**	
Effluent	**131**	<40.0	<26.0	<25.0	<10	<10	<10	**43**	
Marine plast	<4.5	<10.0	<7.5	<1.0					
Marine plast	<4.5	<10.0	<7.5	<1.0					
Air. Tromsø									
Air. Tromsø									
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The Norwegian Environment Agency is working for a clean and diverse environment. Our primary tasks are to reduce greenhouse gas emissions, manage Norwegian nature, and prevent pollution.

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

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

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