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Environmental Contaminants in an Urban Fjord, 2024

- Emphasis on Alna River

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Abstract
This report presents data from the fourth year of a 5-year period of the Urban Fjord programme. The programme started in 2013 and has since been altered/advanced. In 2024 the programme covers sampling and analyses of water, water moss, invertebrates, and trout from Alna River, as well as stormwater from Eastern Oslo City. A sampling campaign was also conducted for source tracing of chlorhexidine, dichloromethane and trichloromethane previously found in Alna River. A total of ~240 single compounds/isomers were analyzed, and frequent detection was found of specific PFAS compounds in aqueous phases, other specific PFAS compounds in trout liver, UV-compounds and certain QACs in the particulate fraction of stormwater, certain benzothiazoles in stormwater (dissolved and/or particulate fraction) , chlorinated paraffins (MCCP and LCCP) in biota, certain siloxanes in nearly all matrices, metals in all matrices, and PCBs in biota. Biomagnification was only observed for a couple of the PCB congeners. However, as expected, biomagnification was observed for mercury and PFOS. Biomagnification of silver was observed when trout was represented by liver samples, but not muscle samples. The source tracing showed the presence of the compounds at several stations.

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

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Preface

This report presents data from the fourth year of a new 5-year period of the Urban Fjord programme. The programme started in 2013 and has since been advanced. The content now differs between years, and the 2024 programme covers sampling and analyses of water, water moss, invertebrates, and trout from Alna River, as well as stormwater from Eastern Oslo City. A sampling campaign was also conducted for source tracing of chlorhexidine, dichloromethane and trichloromethane previously found in Alna River.

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

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

This report represents an extended summary of the Urban Fjord 2024 campaign and has been quality assured by senior scientist Merete Grung and research manager Morten Jartun.

Oslo, June 2025

Anders Ruus

Summary

The 2024 “Urban fjord” programme covers sampling and analyses of water, water moss, invertebrates, and trout from Alna River, as well as stormwater from Eastern Oslo City. A sampling campaign was also conducted for source tracing of chlorhexidine, dichloromethane and trichloromethane previously found in Alna River. A total of ~240 single compounds/isomers were determined, and frequent detection was found of:

- Specific PFAS compounds in aqueous phases,
- other specific PFAS compounds in trout liver,
- UV-compounds and certain QACs in the particulate phase of stormwater,
- certain benzothiazoles in stormwater,
- chlorinated paraffins (MCCP and LCCP) in biota,
- certain siloxanes in nearly all matrices,
- metals in all matrices,
- PCBs in biota.

Concentrations of PFAS were highest in trout liver (ng/g wet wt. basis) and in the dissolved fraction of aqueous phases (ng/L). In biota, PFOS was the most dominating PFAS. In aqueous phases, TFA (tri fluoro acetic acid) was the most dominating compound. UV-compounds were only determined in stormwater, and octocrylene was found in the highest concentrations. Quaternary ammonium compounds were only determined in stormwater, and alkyltrimethyl ammonium compounds (ATAC), benzylalkyldimethyl ammonium compounds (BAC) and the dialkyldimethyl ammonium compounds (DADMAC) were all represented in the samples. Dechloranes were only detected in water moss and the particulate fraction of stormwater, and it was only dechlorane plus *syn* and *anti* that were detected. MCCPs and LCCPs constituted the highest proportions of the sum-chlorinated paraffins concentrations in all matrices, and SCCPs were only found in water moss and the particulate fraction of stormwater. Phthalates were only determined in stormwater, and the highest concentrations were found in the particulate fraction, where DINP, DIDP and DEHP constituted the highest proportions of the sum-phthalates concentrations. OPFRs were only determined in stormwater, and the highest concentrations were generally found in the dissolved fraction. TEP, TCPP, TIBP and TBEP, EHDPP and TEHP were important constituents of the sum-OPFRs concentrations. Siloxanes were detected in all matrices, however only the cyclosiloxanes (D4, D5 and D6). Conspicuous concentrations of the siloxanes were observed in the dissolved fraction of river water from Alna River, likely associated with colloids (due to methodological issues). Musks were only determined in stormwater, and Galaxolide, Tonalide and Iso-E-super were the only compounds detected.

Concentrations of PCBs and PFAS in stormwater were among the most important risk drivers in the inputs to the Inner Oslofjord, as EQSs for PCB7 and PFOS were excessed. These are also compounds with known bioaccumulative potential.

Biomagnification (quantified by Trophic Magnification Factors, TMF) was observed for a couple of the PCB congeners. As expected, biomagnification was observed for mercury and PFOS. Biomagnification of silver was observed when trout was represented by liver samples, but not muscle samples.

The source tracing of chlorhexidine, dichloromethane and trichloromethane in the Alna River catchment indicated that multiple sources could be responsible for the elevated concentrations found earlier in the main Alna River. Reference is made here to the NIVA memo 0221/24, which among other things identified companies in the Alna catchment that could be potential sources of the findings of chlorhexidine, dichloromethane, and trichloromethane in the river. The results from this source tracing

do not make it possible to pinpoint any specific sources. The data basis is too weak and the number of variables too large for that. Most of the concentrations of all three compounds were relatively low compared to earlier findings in the same area except for trichloromethane during the second campaign where the concentrations were in the same range as earlier in the small streams. It is not clear to what degree the rain events and surface runoff contributed to the findings.

Sammendrag

"Urban fjord"-programmet i 2024 har omfattet prøvetaking og analyse av elvevann, elvemose, evertebrater (virvelløse dyr) og ørret fra Alnaelva, samt overvann fra lokaliteter på Oslo Øst. En prøvetakingskampanje ble også gjennomført for kildesporing av klorheksidin, diklormetan og triklorometan, som tidligere ble funnet i Alnaelva. Totalt ble ~240 enkeltforbindelser/isomerer bestemt, og hyppig deteksjon ble funnet av:

- Spesifikke PFAS-forbindelser i vannfaser,
- andre spesifikke PFAS-forbindelser i ørretlever,
- UV-forbindelser og visse QAC forbindelser i partikkelfasen av overvann,
- visse benzotiazoler i overvann,
- klorparafiner (MCCP og LCCP) i biota,
- visse siloksaner i nesten alle prøvetyper,
- metaller i alle prøvetyper,
- PCB-forbindelser i biota

Konsentrasjoner av PFAS var høyest i ørretlever (ng/g våtvektsbasis) og i den løste fraksjonen av vannfaser (ng/L). I biota var PFOS den mest dominerende PFAS-forbindelsen. I vannfaser var TFA den mest dominerende forbindelsen. UV-forbindelser ble kun bestemt i overvann, og oktokrylen ble funnet i de høyeste konsentrasjonene. Kvaternære ammoniumforbindelser ble kun bestemt i overvann, og alkyltrimetyl ammoniumforbindelser (ATAC), benzylalkyldimetyl ammoniumforbindelser (BAC) og dialkyldimetyl ammoniumforbindelser (DADMAC) var alle funnet i prøvene. Dekloraner ble kun påvist i elvemose og partikkelfraksjonen av overvann, og det var kun dekloran pluss *syn* og *anti* som ble detektert. MCCP og LCCP utgjorde de høyeste andelene av sum-klorparafinkonsentrasjonene i alle prøvetyper, og SCCP ble kun funnet i elvemose og partikkelfraksjonen av overvann. Ftalater ble kun bestemt i overvann, og de høyeste konsentrasjonene ble funnet i partikkelfraksjonen, hvor DINP, DIDP og DEHP utgjorde de høyeste andelene av sum-ftalatkonsentrasjonene. OPFR ble kun bestemt i overvann, og de høyeste konsentrasjonene ble generelt funnet i den løste fraksjonen. TEP, TCPP, TIBP og TBEP, EHDPP og TEHP utgjorde viktige andeler av sum-OPFR-konsentrasjonene. Siloksaner ble detektert i alle prøvetyper, men kun sykliske siloksaner (D4, D5 og D6). Iøynefallende konsentrasjoner av siloksaner ble observert i den oppløste fraksjonen av elvevann fra Alnaelva, sannsynligvis forbundet med kolloider (grunnet metodologiske faktorer). Muskforbindelser ble kun bestemt i overvann, og Galaxolide, Tonalide og Iso-E-super var de eneste forbindelsene som ble detektert.

Konsentrasjoner av PCB og PFAS i overvann var blant de viktigste risikodriverne i tilførsler til fjorden, siden EQS ble overskredet for PCB7 og PFOS. Dette er også stoffer med kjent bioakkumulerings-potensiale

Biomagnifisering (kvantifisert ved trofiske magnifiseringsfaktorer, TMF) ble observert for et par av PCB-kongenerene. Som forventet, ble biomagnifisering også observert for kvikksølv og PFOS. Biomagnifisering av sølv ble observert når ørret ble representert ved leverprøver, men ikke muskelprøver.

Kildesporingen av klorheksidin, diklormetan og triklorometan i Alnaelvas nedbørfelt indikerte at flere kilder kunne være årsak til de forhøyede konsentrasjonene som tidligere ble funnet i hovedelva Alna. Det vises her til NIVA-notatet 0221/24, som blant annet identifiserte bedrifter i nedbørsfeltet til Alna som kunne være potensielle kilder til funnene av klorheksidin, diklormetan og triklormetan i elva. Resultatene fra denne kildesporingen gjør det ikke mulig å peile nærmere inn på noen aktuelle kilder. Til

det er datagrunnlaget for spinkelt og antallet variabler for stort. De fleste konsentrasjonene av alle tre forbindelsene var relativt lave, sammenlignet med tidligere funn i samme område, bortsett fra triklorometan under den andre kampanjen. Da var konsentrasjonene i samme område som tidligere, i de små bekkene. Det er ikke klart i hvilken grad episoder med regn og overflateavrenning bidro til funnene.

1 Introduction

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

This report presents data from the fourth year of a new 5-year period of the Urban Fjord programme. The programme started in 2013 and has since been altered/advanced, and the content differs between years. The 2024 programme covers sampling and analyses of water, water moss, invertebrates, and trout from Alna River, as well as stormwater from Eastern Oslo City. A sampling campaign was also conducted for source tracing of chlorhexidine, dichloromethane and trichloromethane previously found in Alna River.

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

2 Extended summary of Urban Fjord 2024

2.1 Samples and localities

An overview of the samples collected in the Urban Fjord programme 2024 is presented in Table 1. Localities for sample collection are shown in Figure 1.

Table 1. Overview of samples collected for the "Urban Fjord" programme 2024.

Species/Sample	Matrix	Locality	Station code	No. for analysis
River water (Alna)	Water (dissolved) and particulate fraction	See Figure 1: Alna	Alna River	2 samples (2 samples of dissolved fraction plus 2 of particulate fraction)
Water moss (Alna)	Water moss	See Figure 1: Alna	Alna Mose 1 Alna Mose 2 Alna Mose 3	3 samples
Invertebrates (Alna)	Invertebrates	See Figure 1: Alna	Alna Evert. 1 Alna Evert. 2 Alna Evert. 3	3 pooled samples[1]
(River) Trout	Muscle, liver	See Figure 1: Alna	Alna Fisk Alna Fisk 2	6 pooled samples[2] (of each matrix)
Stormwater	Water (dissolved) and particulate fraction	See Figure 1: Breivoll Vollaveien Smalvollveien Gamle Oslo Hovin/Grenseveien Haraldrudbekken Trosterudbekken	Urban #1 Urban #2 Urban #3 Urban #4 Urban #5 Urban #6 Urban #7	7 samples (7 samples of dissolved fraction plus 7 of particulate fraction)
Water [3] (unfiltered)	Unfiltered water (River water or stormwater)	See Figure 1: Along Alna River	Kværner (Kildesp) Smalvollv. (Kildesp) Trosterudb. (Kildesp) Breivoll (Kildesp) Strømsv. (Kildesp) Verks.Furul.v. (Kildesp) Vollav. (Kildesp) Kjelsrudf. (Kildesp) Brubak (Kildesp) Stansev. (Kildesp) Julsbergb. (Kildesp) Tokerudb. 1 (Kildesp) Tokerudb. 2 (Kildesp)	26 (sampling twice at each station)

[1] For species constituting invertebrate samples, see Table 2.

[2] Each of 5 specimens (biometric data are presented in Appendix, Chapter4).

[3] For source tracing of dichloromethane and trichloromethane.

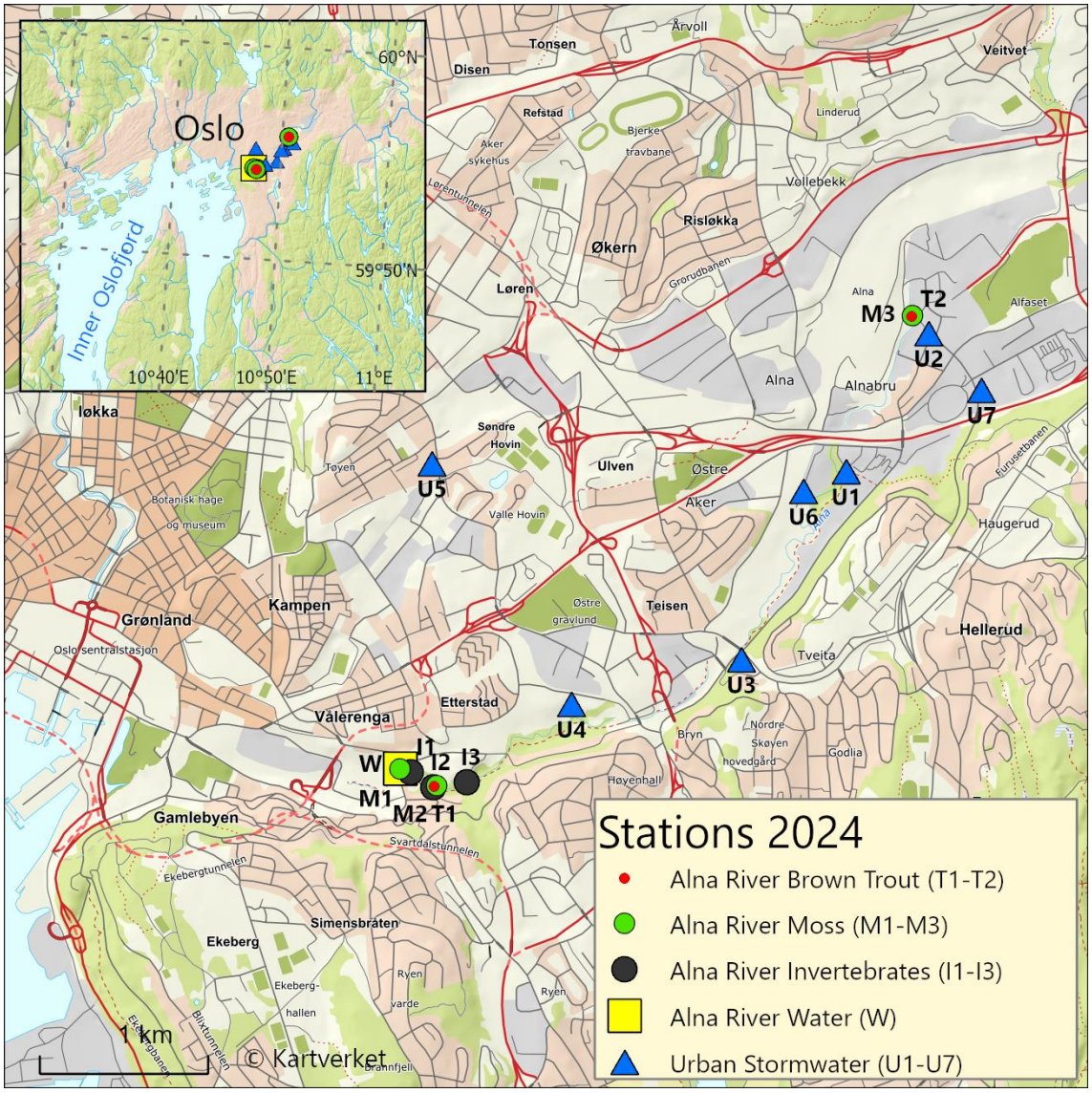
Table 2. Species constituting invertebrate samples (number of individuals).

Group	Family	Alna Invertebr. 1	Alna Invertebr. 2	Alna Invertebr. 3
Diptera	Chironomidae	70	147	215
Ephemeroptera	Baetidae [1]	94	92	84
Oligochaeta [2]		74	95	28
Trichoptera	Rhyacophilidae [1]	62	45	37
Trichoptera	Rhyacophilidae [2]	32	26	37
Oligochaeta [1]		21	37	28
Isopoda	Asellidae	26	12	12
Ephemeroptera	Baetidae [2]	5	25	14
Isopoda	Asellidae [2]	14	4	6
Diptera	Limoniidae/Pediciidae	4	5	2
Hirudinea	Erpobdella [1]	2	4	5
Gastropoda	Lymnaeidae	3	4	2
Hirudinea	Erpobdella [2]	0	1	3
Hirudinea	Glossiphonidae	1	2	0
Diptera	Tipulidae [1]	1	2	0
Plecoptera	Nemouridae	2	0	0
Trichoptera	Polycentropodidae [1]	0	1	1
Trichoptera	Polycentropodidae [2]	0	2	0
Diptera	Tipulidae [2]	1	0	0
Diptera	Chaoboridae	0	1	0

[1] Large individuals.

[2] Small individuals.

A.

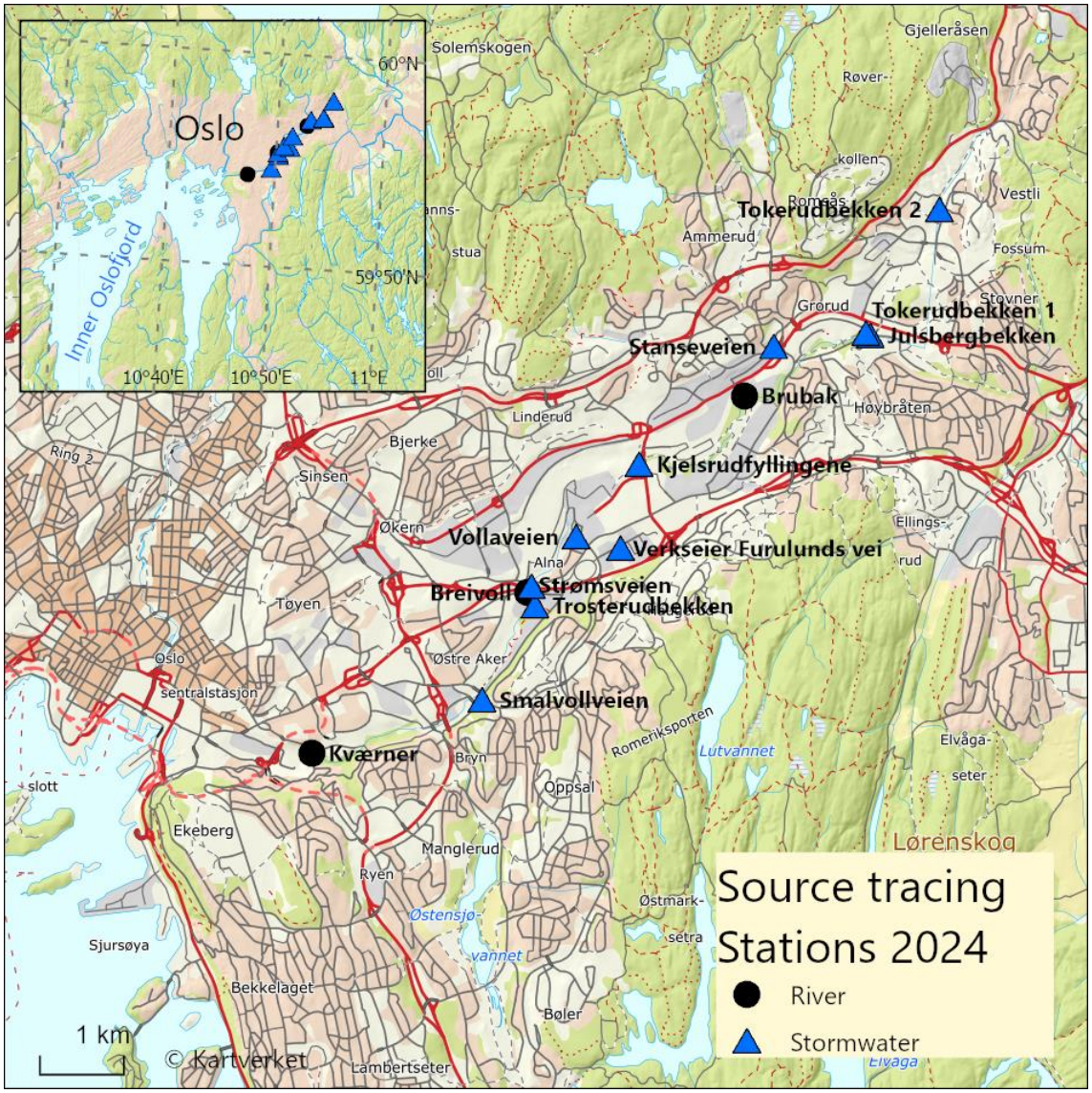


Explanation of station markings:

W:	Alna River (River water)	T2:	Alna River Trout 2 (Trout)
M1:	Alna Moss 1 (Water moss)	U1:	Urban #1 (Stormwater)
M2:	Alna Moss 2 (Water moss)	U2:	Urban #2 (Stormwater)
M3:	Alna Moss 3 (Water moss)	U3:	Urban #3 (Stormwater)
I1:	Alna Invertebr. 1 (Invertebrates)	U4:	Urban #4 (Stormwater)
I2:	Alna Invertebr. 2 (Invertebrates)	U5:	Urban #5 (Stormwater)
I3:	Alna Invertebr. 3 (Invertebrates)	U6:	Urban #6 (Stormwater)
T1:	Alna River Trout (Trout)	U7:	Urban #7 (Stormwater)

Figure 1. Map depicting stations for collection of river water, water moss, invertebrates and trout in Alna River, as well as stormwater in Eastern Oslo City (A.), and map depicting stations for tracing the source(s) of dichloromethane and trichloromethane to Alna River (B.; next page). A figure showing time of stormwater sampling in relation to precipitation can be found in Figure 25 in the Appendix, Chapter 4).

B.


Oslo
Inner Oslofjord
60°N
59°50'N
10°40'E
10°50'E
11°E
Solemskogen
Gjelleråsen
Røver-
kollen
Vestli
Tokerudbekken 2
Ammerud
Fossum
Grorud
Stovner
Tokerudbekken 1
Julsbergbekken
Stanseveien
Brubak
Høybråten
Linderud
Bjerke
Ring 2
Sinsen
Kjelsrudfyllingene
Økern
Vollaveien
Verkseier Furulunds vei
Ellings-
rud
Alna
Breivoll
Strømsveien
Trosterudbekken
Tøyen
Oslo
sentralstasjon
Østre Aker
Smalvollveien
Romeriksporten
Lutvannet
Elvåga-
seter
Kværner
Bryn
Oppsal
slott
Ekeberg
Manglerud
Ryen
Østensjø
vannet
Østmark-
sætra
Sjursøya
Bekkelaget
Bøler
Lambertseter
Elvaga
Lørenskog
Source tracing
Stations 2024
River
Stormwater
1 km
© Kartverket

2.2 Chemical analysis

Details of the chemical analytical methods are presented in Chapter 3. Table 3 shows an overview of the chemical analyses performed in the different samples, while Table 8 (in Appendix, Chapter 4) shows the specific analytes in the programme.

2.3 Assessment of biomagnification

The chemical analyses in this study were performed on pooled samples. However, analyses of stable isotopes ($\delta^{13}C$ and $\delta^{15}N$) were performed on individual muscle samples (n=15 on each of two stations) of trout. In the biomagnification assessment, the mean $\delta^{15}N$ values of the individuals constituting the pooled samples of trout applied.

Biomagnification was assessed in the food web consisting of water moss, invertebrates and trout (liver or muscle).

When exploring correlations between contaminant concentrations and trophic position, concentrations of the following contaminants were expressed on a wet weight basis: Metals and PFASs. The concentrations of the following contaminants were expressed on a lipid weight basis: PCBs and other organochlorine compounds, chlorinated paraffins, siloxanes and dechloranes.

Biomagnification potential was evaluated by comparing contaminant concentrations with trophic position, calculated from $\delta^{15}N$ levels (assuming an enrichment, $\Delta^{15}N$, of 3.4 between each integer trophic level and that the average $\delta^{15}N$ of water moss represents trophic level 1). Trophic Magnification Factors (TMFs) were calculated from statistically significant relationships:

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

as $TMF = 10^b$.

Table 3. Overview: Analyses in the different matrices in 2024.

	Water moss	Invertebrates	Trout [1]	River water [2]	Stormwater [2]	Water (unfiltered) [3]
Metals	X	X	X	X	X	
Siloxanes	X	X	X	X	X	
PCBs (and organochlorines)	X	X	X	X	X	
OPFRs					X	
Phenolic comp.					X	
PFAS	X	X	X	X	X	
UV-chemicals					X	
Dechloranes	X	X	X	X	X	
QAC					X	
Pesticides/Fungicides					X	X [4]
Musk					X	
Benzothiazoles					X	
Phthalates					X	
Chlorinated paraffins	X	X	X	X	X	
Solvents [5]						X
Stable isotopes of C and N	X	X	X			

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

[2] Dissolved and particulate fractions.

[3] For tracing the source(s) of dichloromethane and trichloromethane to Alna River.

[4] Chlorhexidine was determined in samples for source tracing.

[5] Dichloromethane and trichloromethane (source tracing).

2.4 Results and discussion

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

2.4.1. Stable isotopes

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

2.4.2. Detection frequencies of contaminants

A total of ~240 single compounds/isomers were determined in this study. Figure 2 gives the detection frequency of the various compounds in the different samples. The figure shows frequent detection of specific PFAS compounds in aqueous phases, other specific PFAS compounds in trout liver, UV-compounds and certain QACs in the particulate phase of stormwater, certain benzothiazoles in stormwater, chlorinated paraffins (MCCP and LCCP) in biota, certain siloxanes in nearly all matrices, metals in all matrices, and PCBs in biota (many congeners also in particulate phases).

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

A.

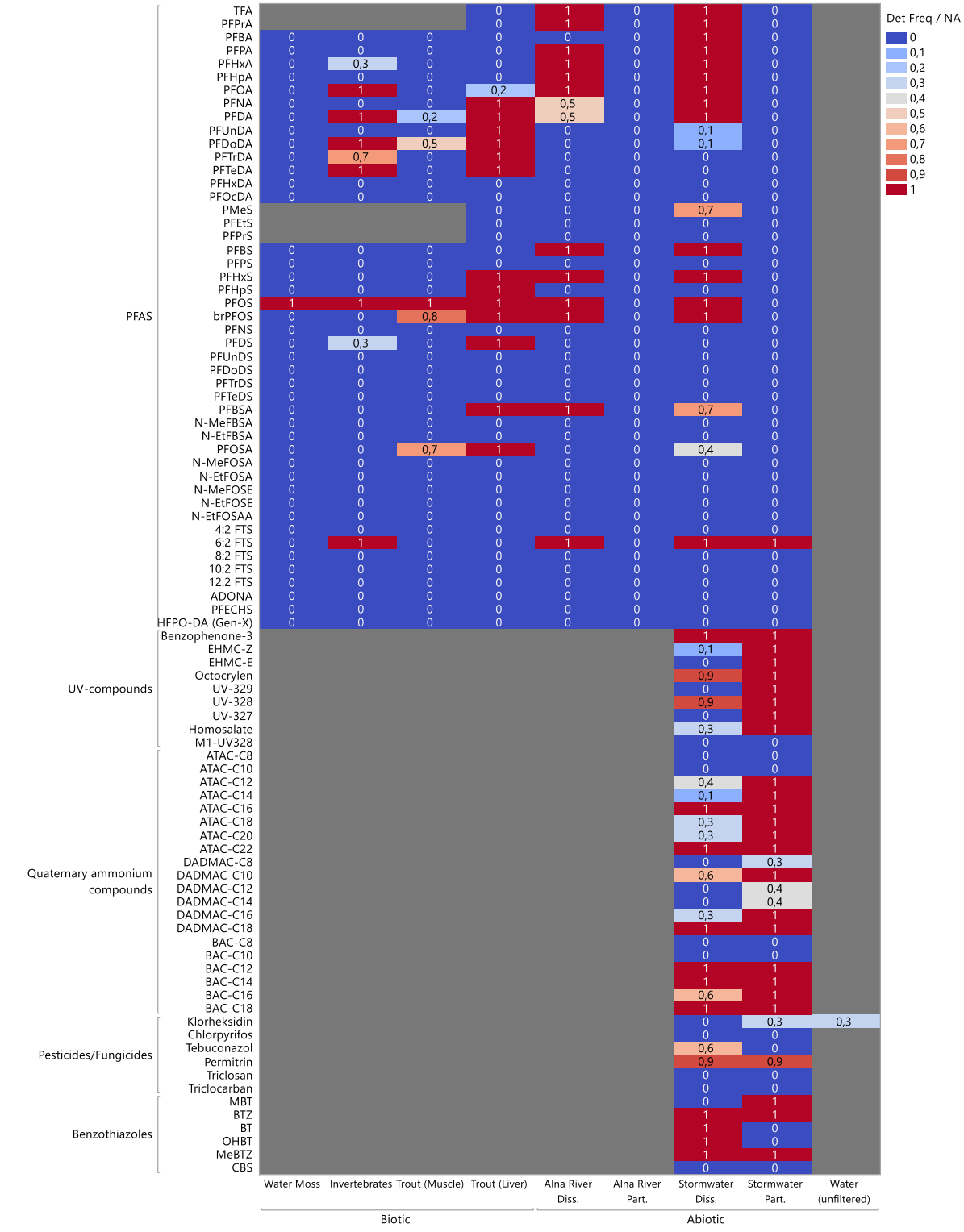
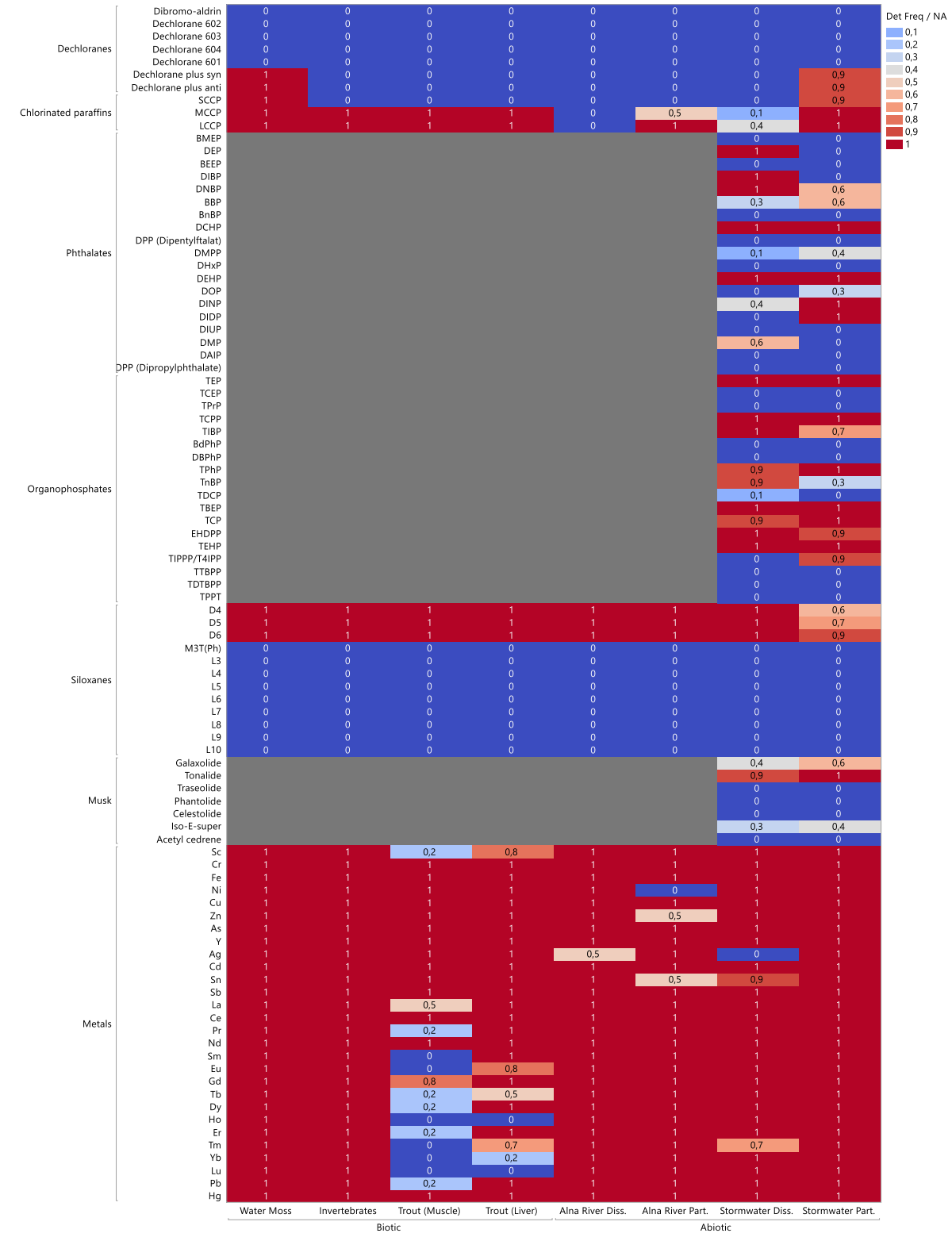
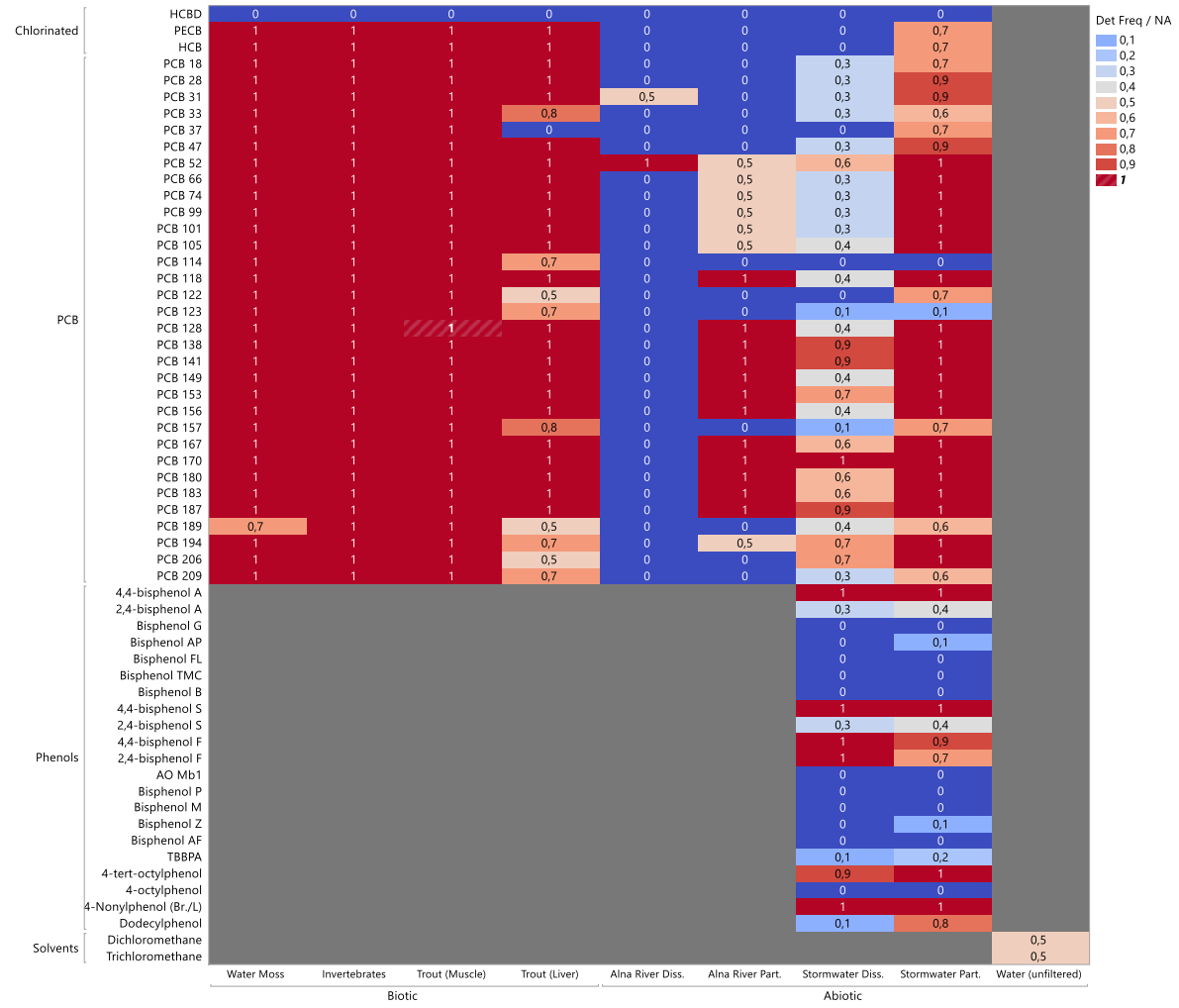


*Figure 2. Detection frequency (as fraction; %/100) of all compounds in the different species/matrices in this study. **A**: PFAS, UV-compounds, quaternary ammonium compounds, pesticides/fungicides and benzothiazoles; **B**: Chlorinated compounds, phthalates, OPFRs, siloxanes, musks and metals; **C**: More chlorinated compounds, phenolic compounds and solvents. "Water (unfiltered)" refers to the samples collected for source tracing.*

B.


Det Freq / NA
0,1
0,2
0,3
0,4
0,5
0,6
0,7
0,8
0,9
1
Dechloranes
Chlorinated paraffins
Phthalates
Organophosphates
Siloxanes
Musk
Metals
Dibromo-aldrin
Dechlorane 602
Dechlorane 603
Dechlorane 604
Dechlorane 601
Dechlorane plus syn
Dechlorane plus anti
SCCP
MCCP
LCCP
BMEP
DEP
BEEP
DIBP
DNBP
BBP
BnBP
DCHP
DPP (Dipentylftalat)
DMPP
DHxP
DEHP
DOP
DINP
DIDP
DIUP
DMP
DAIP
DPP (Dipropylphthalate)
TEP
TCEP
TPrP
TCPP
TIBP
BdPhP
DBPhP
TPhP
TnBP
TDCP
TBEP
TCP
EHDPP
TEHP
TIPPP/T4IPP
TTBPP
TDTBPP
TPPT
D4
D5
D6
M3T(Ph)
L3
L4
L5
L6
L7
L8
L9
L10
Galaxolide
Tonalide
Traseolide
Phantolide
Celestolide
Iso-E-super
Acetyl cedrene
Sc
Cr
Fe
Ni
Cu
Zn
As
Y
Ag
Cd
Sn
Sb
La
Ce
Pr
Nd
Sm
Eu
Gd
Tb
Dy
Ho
Er
Tm
Yb
Lu
Pb
Hg
Water Moss
Invertebrates
Trout (Muscle)
Trout (Liver)
Alna River Diss.
Alna River Part.
Stormwater Diss.
Stormwater Part.
Biotic
Abiotic

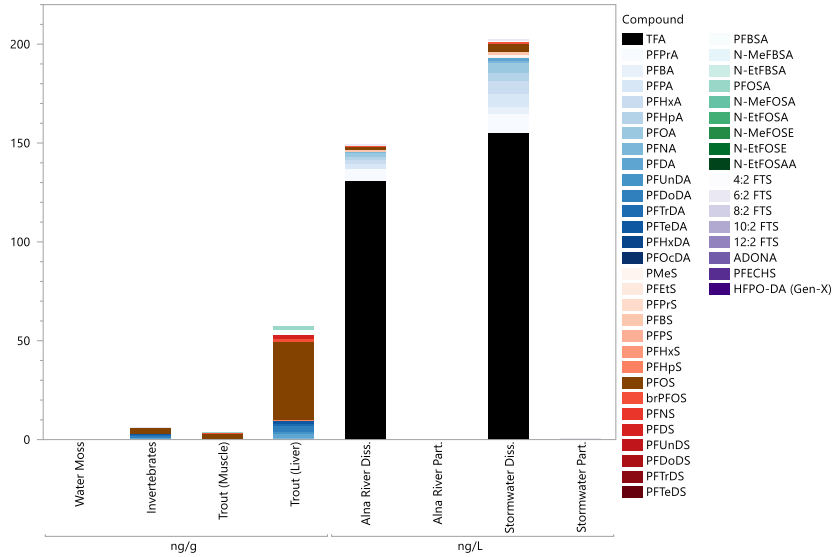
C.


Chlorinated
Phenols
Solvents
HCBD 0 0 0 0 0 0 0 0
PECB 1 1 1 1 0 0 0 0,7
HCB 1 1 1 1 0 0 0 0,7
PCB 18 1 1 1 1 0 0 0,3 0,7
PCB 28 1 1 1 1 0 0 0,3 0,9
PCB 31 1 1 1 1 0,5 0 0,3 0,9
PCB 33 1 1 1 0,8 0 0 0,3 0,6
PCB 37 1 1 1 0 0 0 0 0,7
PCB 47 1 1 1 1 0 0 0,3 0,9
PCB 52 1 1 1 1 1 0,5 0,6 1
PCB 66 1 1 1 1 0 0,5 0,3 1
PCB 74 1 1 1 1 0 0,5 0,3 1
PCB 99 1 1 1 1 0 0,5 0,3 1
PCB 101 1 1 1 1 0 0,5 0,3 1
PCB 105 1 1 1 1 0 0,5 0,4 1
PCB 114 1 1 1 0,7 0 0 0 0
PCB 118 1 1 1 1 0 1 0,4 1
PCB 122 1 1 1 0,5 0 0 0 0,7
PCB 123 1 1 1 0,7 0 0 0,1 0,1
PCB 128 1 1 1 1 0 1 0,4 1
PCB 138 1 1 1 1 0 1 0,9 1
PCB 141 1 1 1 1 0 1 0,9 1
PCB 149 1 1 1 1 0 1 0,4 1
PCB 153 1 1 1 1 0 1 0,7 1
PCB 156 1 1 1 1 0 1 0,4 1
PCB 157 1 1 1 0,8 0 0 0,1 0,7
PCB 167 1 1 1 1 0 1 0,6 1
PCB 170 1 1 1 1 0 1 1 1
PCB 180 1 1 1 1 0 1 0,6 1
PCB 183 1 1 1 1 0 1 0,6 1
PCB 187 1 1 1 1 0 1 0,9 1
PCB 189 0,7 1 1 0,5 0 0 0,4 0,6
PCB 194 1 1 1 0,7 0 0,5 0,7 1
PCB 206 1 1 1 0,5 0 0 0,7 1
PCB 209 1 1 1 0,7 0 0 0,3 0,6
4,4-bisphenol A 1 1
2,4-bisphenol A 0,3 0,4
Bisphenol G 0 0
Bisphenol AP 0 0,1
Bisphenol FL 0 0
Bisphenol TMC 0 0
Bisphenol B 0 0
4,4-bisphenol S 1 1
2,4-bisphenol S 0,3 0,4
4,4-bisphenol F 1 0,9
2,4-bisphenol F 1 0,7
AO Mb1 0 0
Bisphenol P 0 0
Bisphenol M 0 0
Bisphenol Z 0 0,1
Bisphenol AF 0 0
TBBPA 0,1 0,2
4-tert-octylphenol 0,9 1
4-octylphenol 0 0
4-Nonylphenol (Br./L) 1 1
Dodecylphenol 0,1 0,8
Dichloromethane 0,5
Trichloromethane 0,5
Water Moss
Invertebrates
Trout (Muscle)
Trout (Liver)
Alna River Diss.
Alna River Part.
Stormwater Diss.
Stormwater Part.
Water (unfiltered)
Biotic
Abiotic
Det Freq / NA
0,1
0,2
0,3
0,4
0,5
0,6
0,7
0,8
0,9
1

2.4.3. PFAS

Concentrations of PFAS were highest in trout liver (ng/g basis) and in the dissolved fraction of aqueous phases (ng/L basis; Figure 3). In biota, PFOS was the most dominating PFAS. In aqueous phases, TFA was the most dominating compound, and concentrations were not very different from those observed in both surface water from Mjøsa and rainwater from Hamar (~100 ng/L) in 2024 (Økelsrud et al. *in prep*).

A.



B.

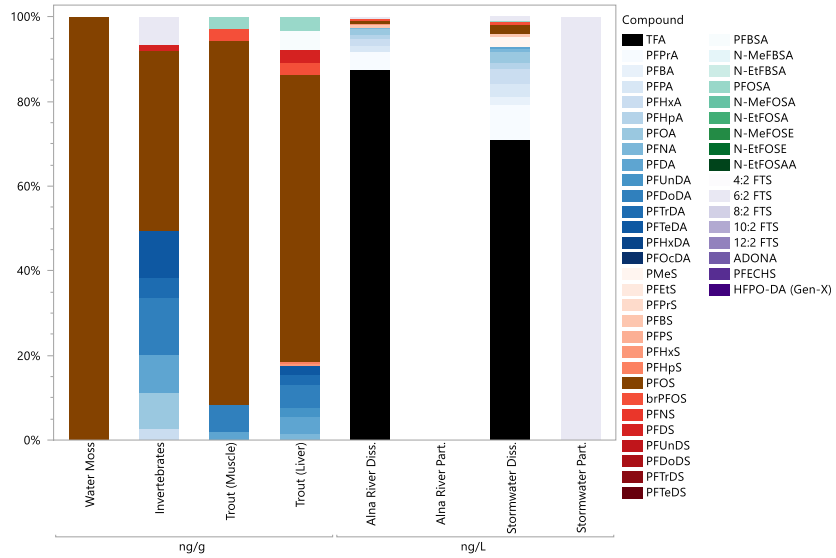
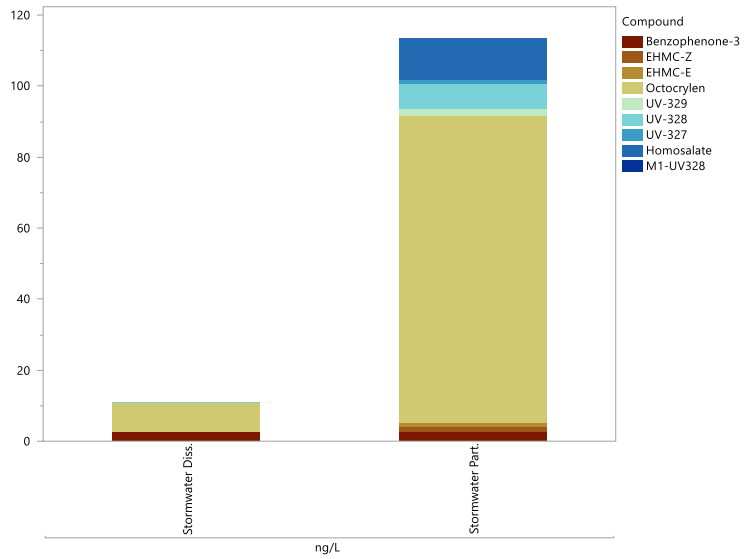


*Figure 3. Concentrations (median; ng/g wet wt. in biota and ng/L in river water and stormwater) of PFAS compounds in all matrices (**A**) and their contribution (%) to the sum-PFAS concentration (**B**). Non-detected compounds are assigned a value of zero (0). TFA, PFPrA, PMeS, PFEtS and PFPrS were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

2.4.4. UV-compounds

UV-compounds were only determined in stormwater. Octocrylene was found in the highest concentrations (Figure 4).

A.



B.

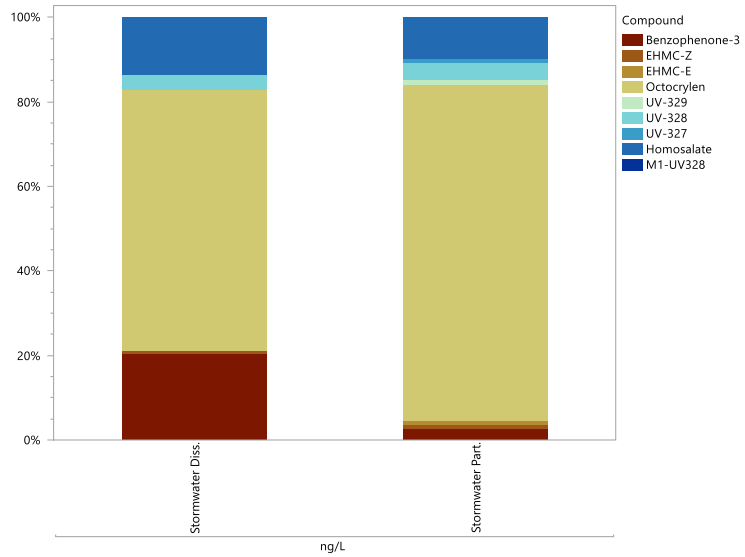
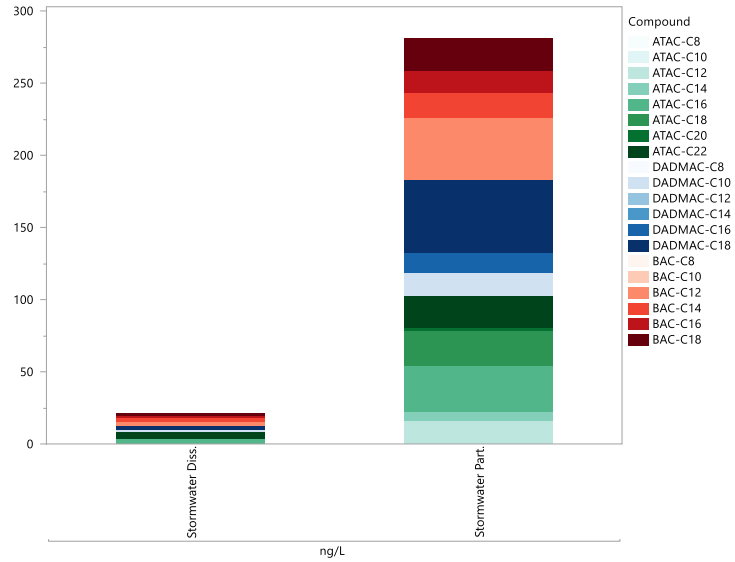


*Figure 4. Concentrations (median; ng/L) of UV-compounds in stormwater; dissolved and particulate fractions (**A**) and their contribution (%) to the sum-UV-compounds concentration (**B**). Non-detected compounds are assigned a value of zero (0).*

2.4.5. Quaternary ammonium compounds

Quaternary ammonium compounds were only determined in stormwater, and alkyltrimethyl ammonium compounds (ATAC), benzylalkyldimethyl ammonium compounds (BAC) and the dialkyldimethyl ammonium compounds (DADMAC) all constituted notable proportions of the sum-QAC concentrations (Figure 5).

A.



B.

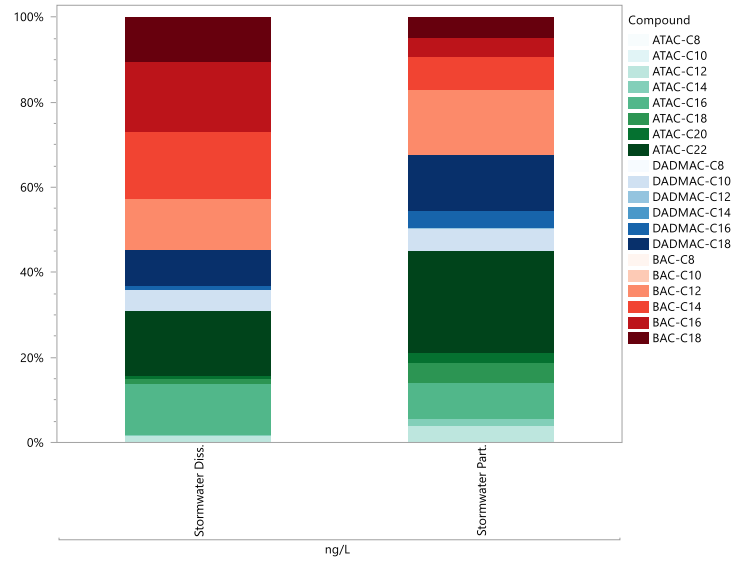


*Figure 5. Concentrations (median; ng/L) of quaternary ammonium compounds in stormwater; dissolved and particulate fractions (**A**) and their contribution (%) to the sum-QAC concentration (**B**). Non-detected compounds are assigned a value of zero (0).*

2.4.6. Pesticides/Fungicides

Pesticides/Fungicides were only determined in stormwater (Chlorhexidine also in unfiltered water for source tracing; see Chapter 2.4.20). Permethrin was detected in 6 samples of the dissolved fraction and 6 samples of the particulate fraction (median concentrations: 0.412 and 1 ng/L, respectively), while Tebuconazole was detected in 4 samples of the dissolved fraction (median concentration: 0.6 ng/L).

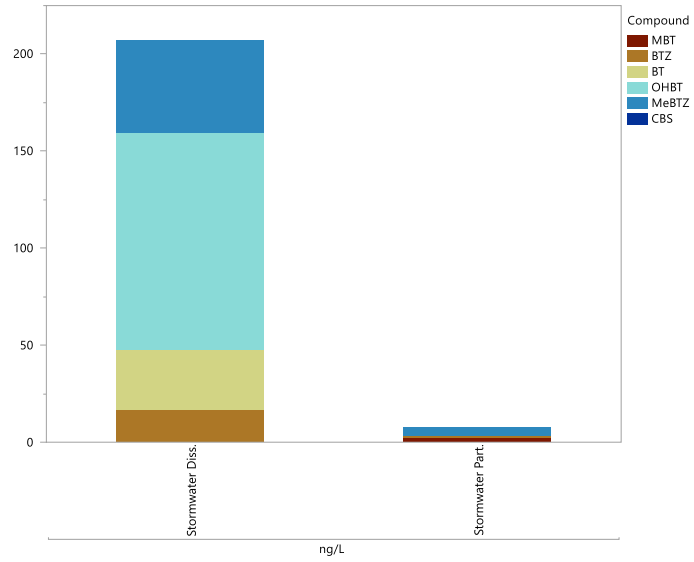
2.4.7. Benzothiazoles

Benzothiazoles were only determined in stormwater, and the highest concentrations were found in the dissolved fraction (Figure 6).

2.4.8. Organochlorines and PCBs

PCBs were detected in all matrices, although only a few detections of a couple of congeners in the dissolved fraction of river water. The highest concentrations were found in trout (liver and muscle), followed by invertebrates (see electronic Appendix). Also, PeCB and HCB were found in biota, as well as in the particulate fraction of stormwater (see electronic Appendix). HCBD, however, was not detected in any matrix.

A.



B.

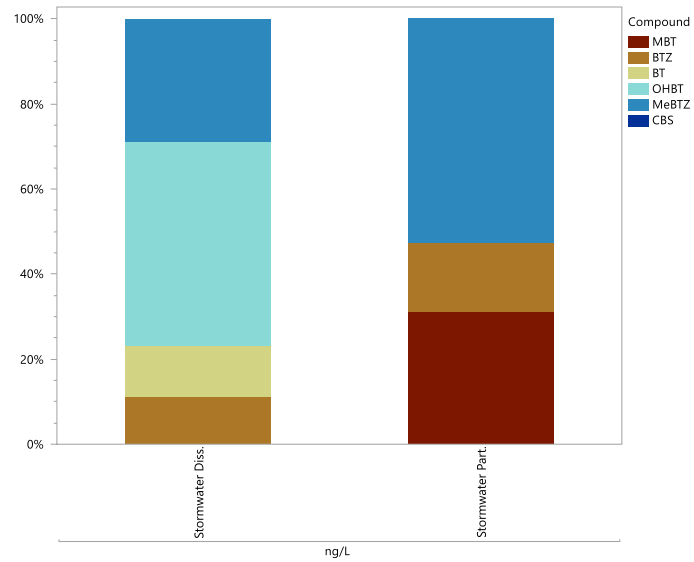
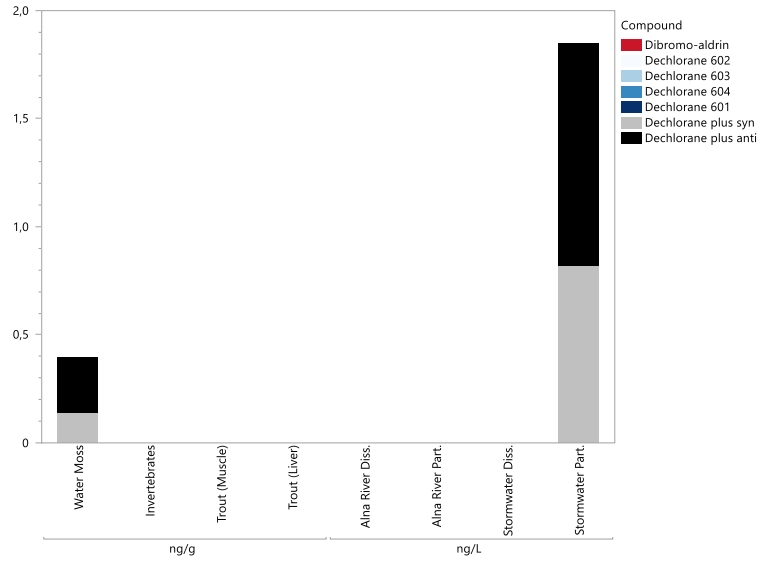


*Figure 6. Concentrations (median; ng/L) of benzothiazoles in stormwater; dissolved and particulate fractions (**A**) and their contribution (%) to the sum-benzothiazoles concentration (**B**). Non-detected compounds are assigned a value of zero (0).*

2.4.9. Dechloranes

Dechloranes were only detected in water moss and the particulate fraction of stormwater (Figure 7). It was only dechlorane plus *syn* and *anti* that were detected.

A.



B.

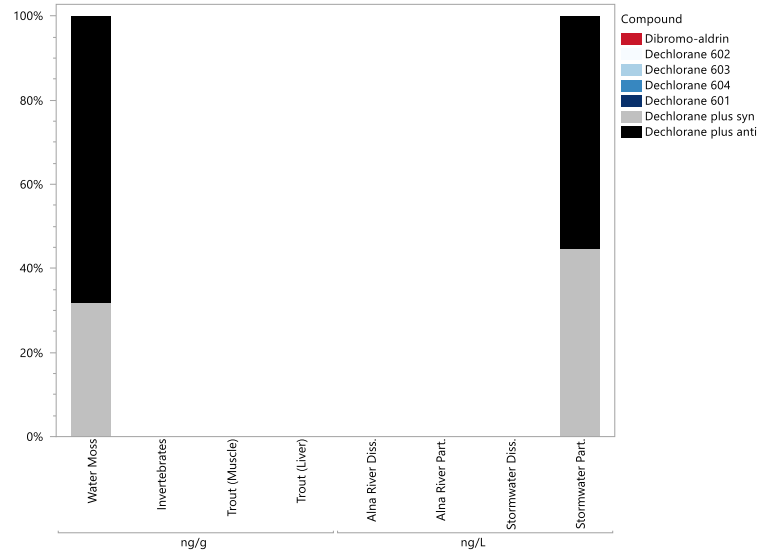
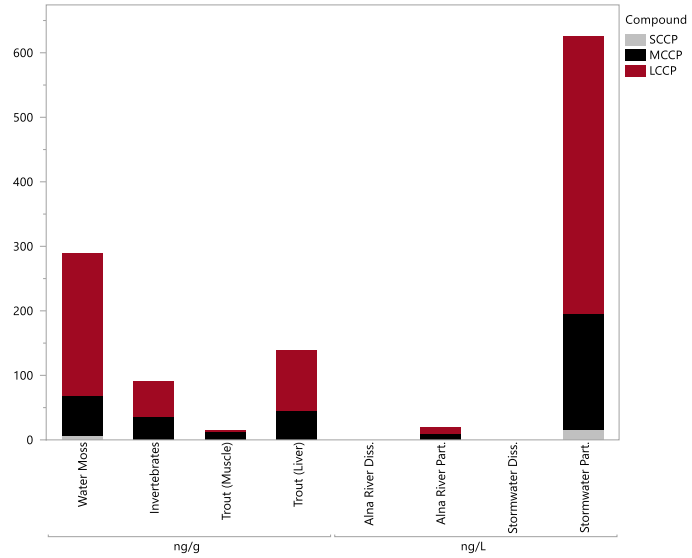


*Figure 7. Concentrations (median; ng/g wet wt. in biota and ng/L in river water and stormwater) of dechloranes in all matrices (**A**) and their contribution (%) to the sum-dechloranes concentration (**B**). Non-detected compounds are assigned a value of zero (0).*

2.4.10. Chlorinated paraffins

Chlorinated paraffins were not detected in the dissolved fraction of river water (and only in a few samples of the dissolved fraction of stormwater). MCCPs and LCCPs constituted the highest proportions of the sum-chlorinated paraffins concentrations in all matrices, and SCCPs were only found in water moss and the particulate fraction of stormwater (Figure 8). High proportions of LCCPs have earlier been found in Swedish peregrine falcons (*Falco peregrinus*; Yuan et al. 2019) and a killer whale (*Orchinus orca*) from Skagerrak (Yuan et al. 2021; muscle tissue of both), as well as in other environmental (biota) samples from Germany (Yuan et al. 2022).

A.



B.

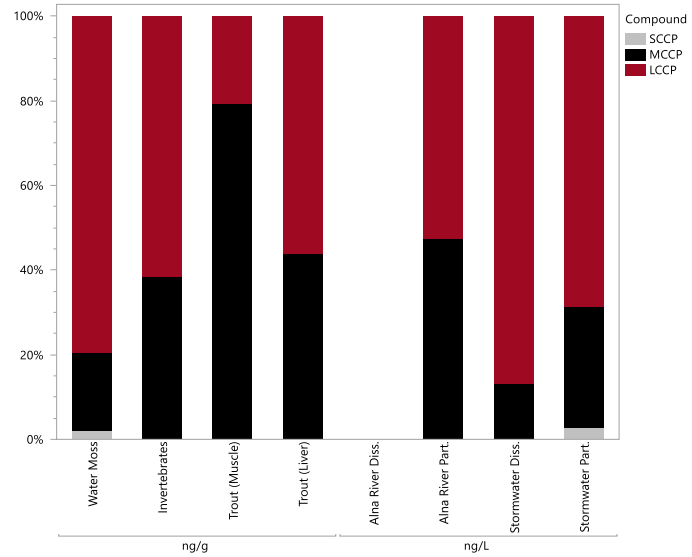
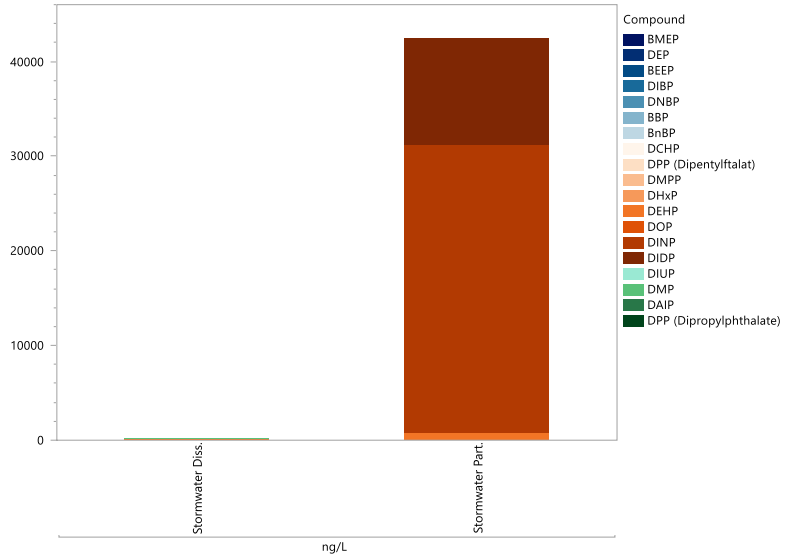


*Figure 8. Concentrations (median; ng/g wet wt. in biota and ng/L in river water and stormwater) of chlorinated paraffins in all matrices (**A**) and their contribution (%) to the sum-chlorinated paraffins concentration (**B**). Non-detected compounds are assigned a value of zero (0).*

2.4.11. Phthalates

Phthalates were only determined in stormwater, and the highest concentrations were found in the particulate fraction, where DINP, DIDP and DEHP constituted the highest proportions of the sum-phthalates concentrations (Figure 9). In the dissolved fraction, DINP, DEHP, DNBP, DIBP and DEP all constituted major proportions of the sum-phthalates concentrations.

A.



B.

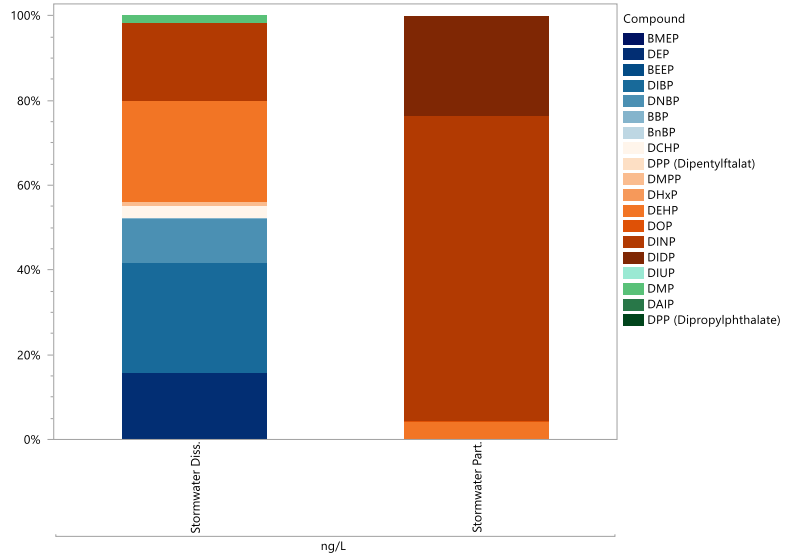
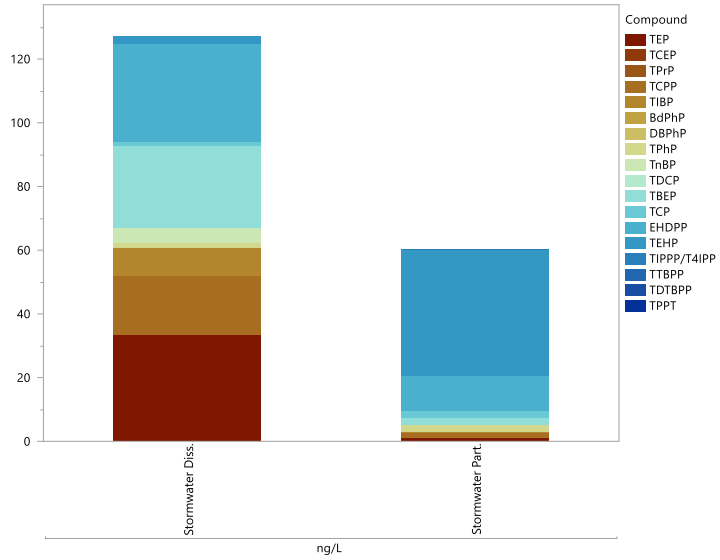


*Figure 9. Concentrations (median; ng/L) of phthalates in stormwater; dissolved and particulate fractions (**A**) and their contribution (%) to the sum-phthalates concentration (**B**). Non-detected compounds are assigned a value of zero (0).*

2.4.12. OPFRs

OPFRs were only determined in stormwater, and the highest concentrations were generally found in the dissolved fraction. TEHP, however, was found in the highest concentrations in the particulate fraction (Figure 10). TEP, TCPP, TIBP and TBEP, EHDPP and TEHP were important constituents of the sum-OPFRs concentrations.

A.



B.

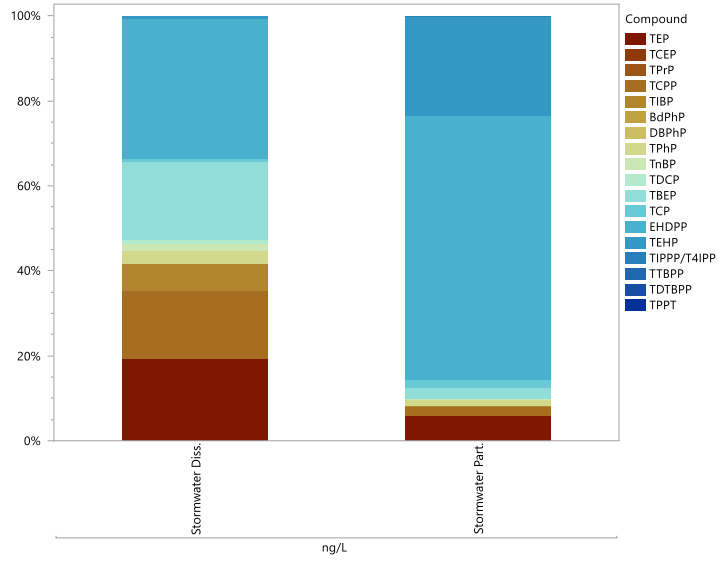
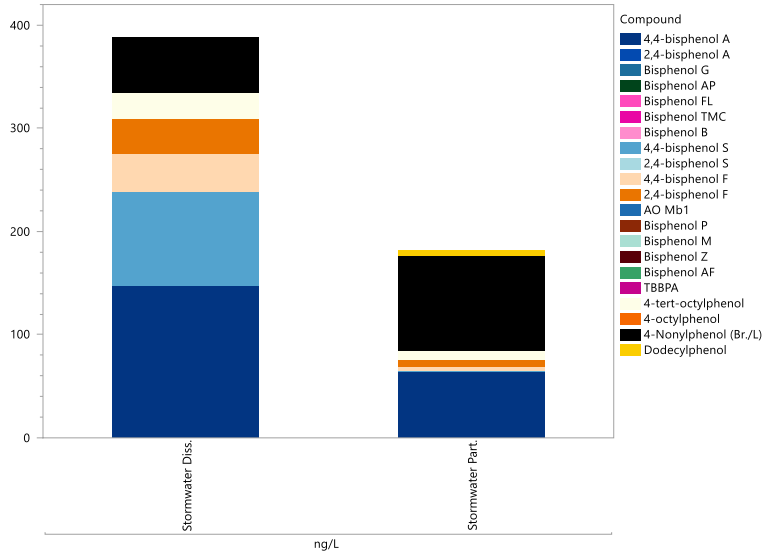


*Figure 10. Concentrations (median; ng/L) of OPFRs in stormwater; dissolved and particulate fractions (**A**) and their contribution (%) to the sum-OPFRs concentration (**B**). Non-detected compounds are assigned a value of zero (0).*

2.4.13. Phenolic compounds

Phenolic compounds were only determined in stormwater, and the highest concentrations were generally found in the dissolved fraction. 4-nonylphenol, however, was found in the highest concentrations in the particulate fraction (Figure 11). Especially 4,4-bisphenol A, 4,4-bisphenol S and 4-n-nonylphenol were important constituents of the sum-phenolic compounds concentrations.

A.



B.

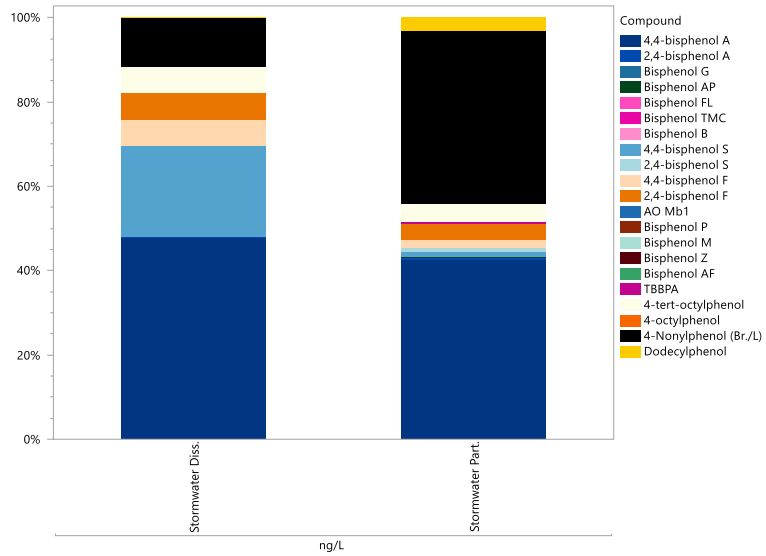
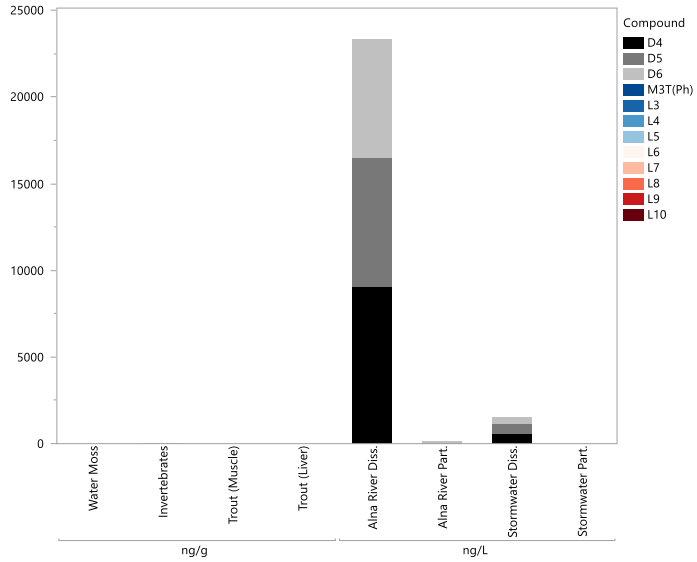


*Figure 11. Concentrations (median; ng/L) of phenolic compounds in stormwater; dissolved and particulate fractions (**A**) and their contribution (%) to the sum-phenolic compounds concentration (**B**). Non-detected compounds are assigned a value of zero (0).*

2.4.14. Siloxanes

Siloxanes were detected in all matrices, however only the cyclosiloxanes (D4, D5 and D6). Conspicuous concentrations were observed in the dissolved fraction of river water from Alna River (Figure 12). This observation may very well be a result of siloxanes associated with colloids present in the water. As explained in Chapter 3.1, for siloxanes, an aliquot of decanted (however unfiltered) water was secured before filtration and analysed.

A.



B.

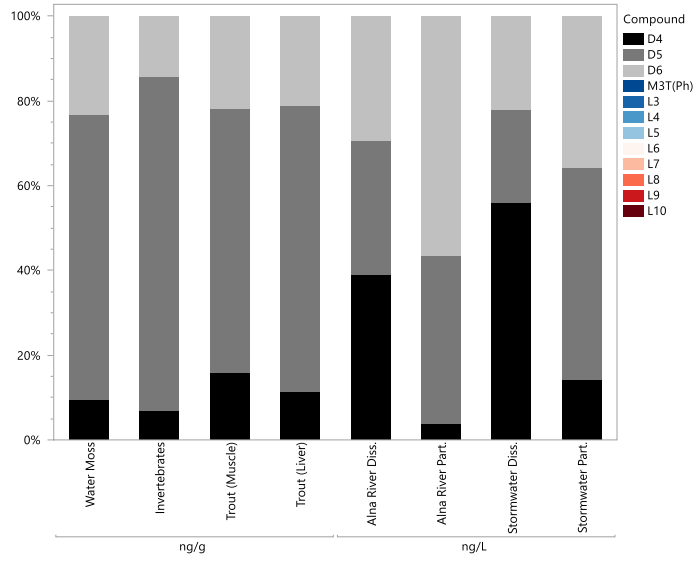
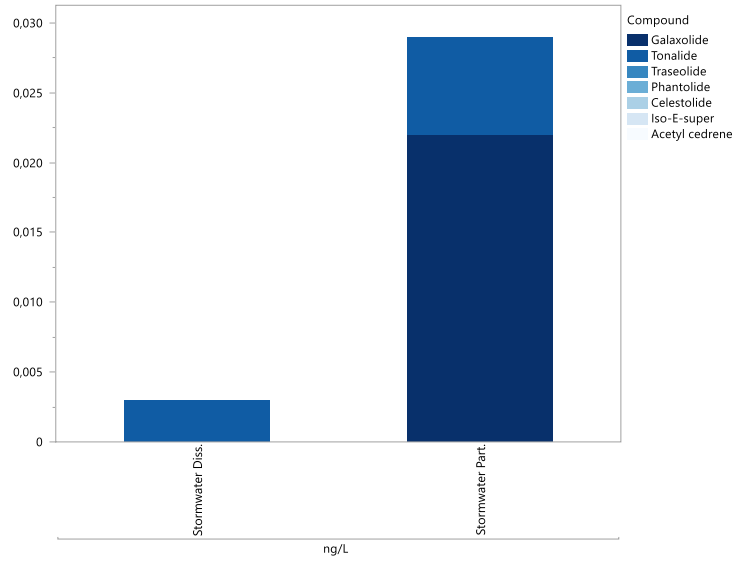


*Figure 12. Concentrations (median; ng/g wet wt. in biota and ng/L in river water and stormwater) of siloxanes in all matrices (**A**) and their contribution (%) to the sum-siloxanes concentration (**B**). Non-detected compounds are assigned a value of zero (0).*

2.4.15. Musks

Musks were only determined in stormwater, and Galaxolide, Tonalide and Iso-E-super were the only compounds detected (Figure 13). They were, however, not detected in all samples (Tonalide was detected in all samples except one, of the dissolved fraction; see also electronic Appendix).

A.



B.

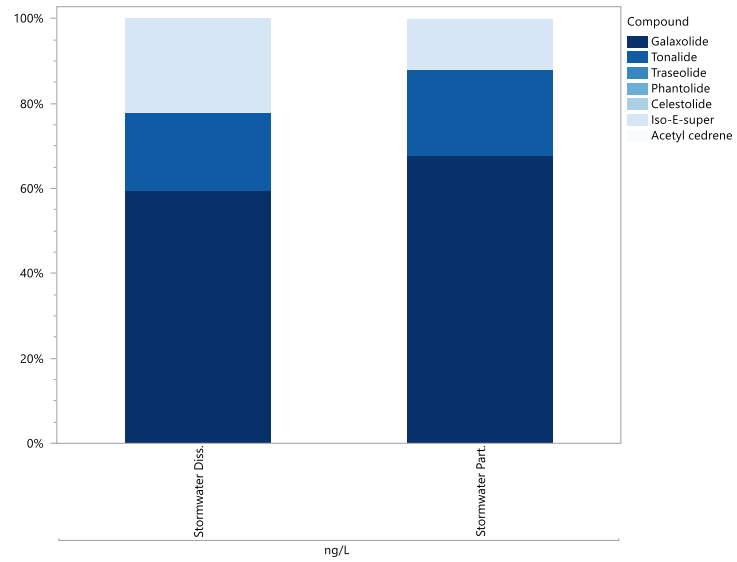
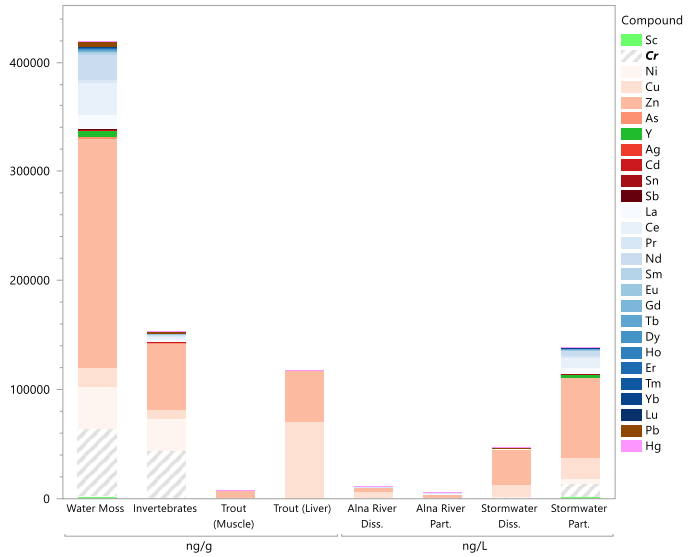


*Figure 13. Concentrations (median; ng/L) of musks in stormwater; dissolved and particulate fractions (**A**) and their contribution (%) to the sum-musks compounds concentration (**B**). Non-detected compounds are assigned a value of zero (0).*

2.4.16. Metals

Iron (Fe) is the dominating metal in all matrices (see electronic Appendix), and concentrations are so much higher than the other metals in the particulate phases, that it is omitted from graphical display in Figure 14. The essential metals zinc (Zn) and copper (Cu) also constituted large proportions of the sum of metals in all matrices. A particularly high concentration of chromium (Cr) was encountered in one stormwater sample (dissolved fraction; from station Vollaveien (218101)/Urban #2; see electronic Appendix). Rare earth metals (Sc, Y and lanthanides) were found in notable concentrations mainly in the particulate fraction of river water and stormwater, but also in water moss from Alna River. As previously, notable concentrations/proportions of arsenic (As) were found in trout. It is known that a significant proportion of arsenic in fish is organic As species (such as arsenobetaine), which are less toxic than inorganic As (Amlund, 2005).

A.



B.

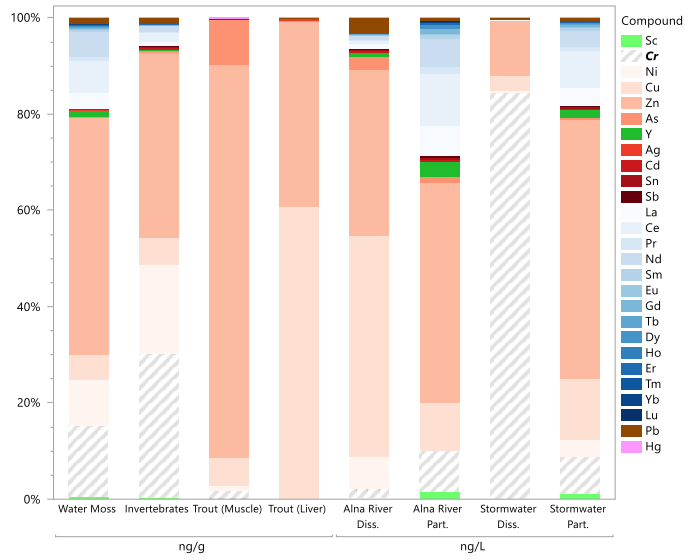


*Figure 14. Concentrations (median; ng/g wet wt. in biota and ng/L in river water and stormwater) of metals in all matrices (**A**) and their contribution (%) to the sum-metals concentration (**B**). Non-detected compounds are assigned a value of zero (0). Note that iron (Fe) has been omitted from the figure because of much higher concentrations than the other metals.*

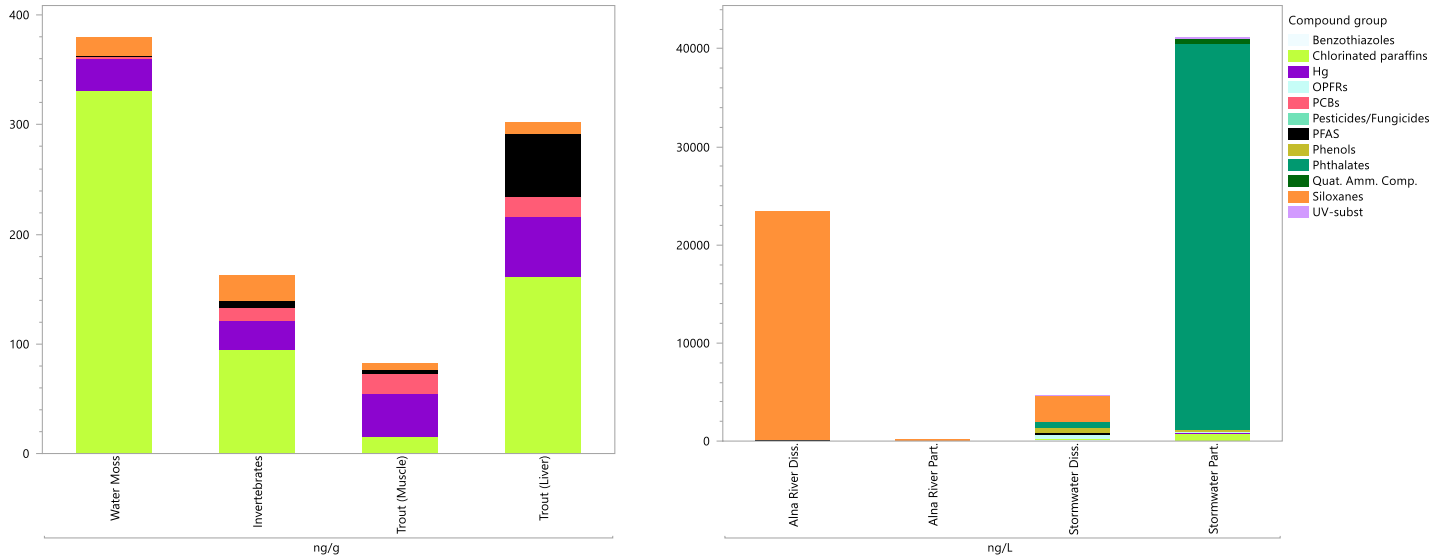
2.4.17. Comparisons of the different contaminant groups

Figure 15 shows concentrations of selected compounds/compound groups in all matrices, and their contribution (in %) to the sum concentration of all these compounds/compound groups. In terms of sources and sinks of contaminants in the Oslo Urban fjord system (including rivers, such as Alna River, entering the fjord), it is of interest to give a general impression of the dominating contaminants/groups of contaminants in the different matrices analysed. Phthalates were a dominating group in stormwater, mainly associated with the particulate fraction. Chlorinated paraffins dominated the biota samples, but mercury constituted a high proportion in trout muscle. Siloxanes were found in all matrices and displayed conspicuous proportions/concentrations in river water from Alna River.

The median concentration of sum siloxanes in Alna river (23315 ng/L) corresponds to an approximate input of 1000 kg (1 metric ton) per year of siloxanes transported to the Inner Oslofjord, from Alna River, according to a crude estimate with the following assumptions: the concentration is constant and the water flow is 1,36 m^3/s (mean flow in 2024; measured at Kvernerbyen; https://sildre.nve.no). The concentration of D5 only (one of the most important risk drivers in Alna, as EQS was excessed, see Table 4) corresponds to an input of ~320 kg per year to the Inner Oslofjord. In addition comes the contribution from stormwater, where siloxanes and phthalates were most dominating. Concentrations of PCBs and PFAS in stormwater were not equally high (as siloxanes and phthalates), but still were among the most important risk drivers, as EQSs for PCB7 and PFOS were excessed (Table 4). These are also compounds with bioaccumulative potential, and were shown to biomagnify in the selected food web consisting of water moss, invertebrates and trout (see Chapter 2.4.19). PCB7 and PFOS, in addition to Hg, also appeared as important risk drivers in biota, as EQSs in trout were excessed (Table 5).

Since concentrations of phthalates were so much higher than the other compound groups in stormwater, phthalates were omitted from graphical display in Figure 16. Excluding the phthalates also emphasizes the importance chlorinated paraffins in storm water, in addition to QACs.

A.



B.

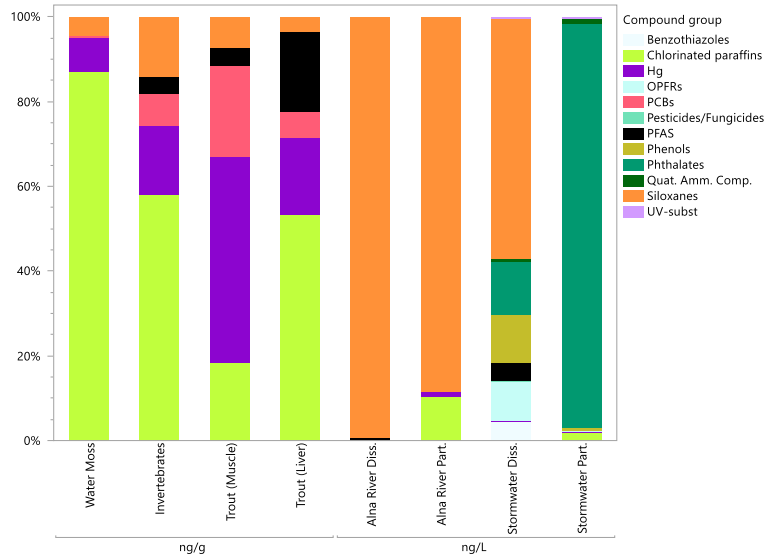
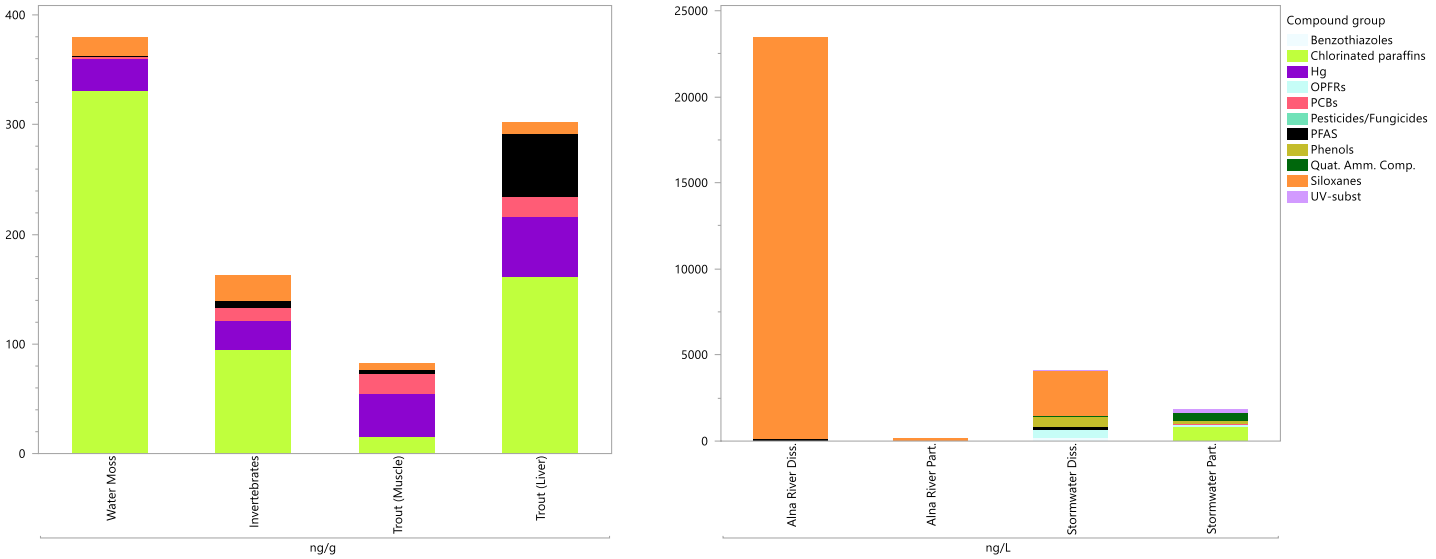


*Figure 15. Concentrations (means; ng/g wet wt. in biota and ng/L in river water and stormwater) of selected compounds/compound groups in all matrices (graph divided in biota samples and water samples; Note different concentration scales on axes; **A**) and their contribution (%) to the sum concentration of all these compounds/compound groups (**B**). Non-detected compounds are assigned a value of zero (0). Note: Benzothiazoles, OPFRs, pesticides/fungicides, phenols, phthalates, quaternary ammonium compounds and UV-substances were only determined in stormwater. Among the PFASs, TFA, PFPrA, PMeS, PFEtS and PFPrS were not determined in biota (except for trout liver, where they were determined).*

A.



B.

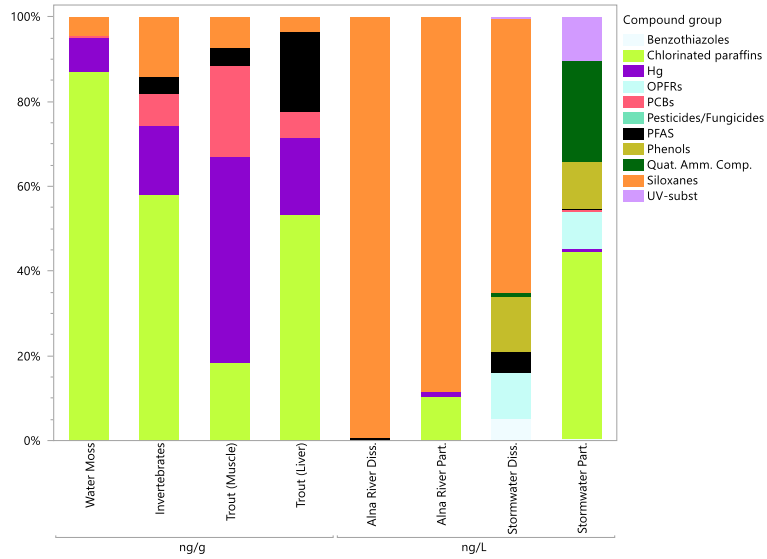


*Figure 16. Concentrations (means; ng/g wet wt. in biota and ng/L in river water and stormwater) of selected compounds/compound groups in all matrices (graph divided in biota samples and water samples; Note different concentration scales on axes; **A**) and their contribution (%) to the sum concentration of all these compounds/compound groups (**B**). Non-detected compounds are assigned a value of zero (0). Note: Benzothiazoles, OPFRs, pesticides/fungicides, phenols, quaternary ammonium compounds and UV-substances were only determined in stormwater. Among the PFASs, TFA, PFPrA, PMeS, PFEtS and PFPrS were not determined in biota (except for trout liver, where they were determined). This figure corresponds to Figure 15, excluding phthalates.*

2.4.18. Relation to Environmental Quality Standards (EQS)

In Table 4 and Table 5, concentrations are compared to environmental quality standards (EQS). Concentrations are means and according to Direktoratsgruppa for vannforvaltning (2025), ½ LoQ is applied when one or more (but not all) values are below LoQ. For sums of analogues, non-detected analogues are assigned a value of zero (0).

The mean chromium concentration exceeded the EQS in stormwater because of one extreme concentration measured at station «Vollaveien (218101)», labeled «Urban #2». For comparison, the median stormwater (dissolved) Cr-concentration was 0.9 µg/L (see electronic Appendix).

Table 4. Concentrations of contaminants (mean; µg/L) in Alna River water and stormwater (dissolved fraction of both), and the respective Norwegian quality standards (fresh water annual average, AA-EQS; Direktoratsgruppa for vannforvaltning, 2025). Red numbers indicate concentrations exceeding the quality standard.

River basin specific compounds	AA-EQS (µg/L)	Alna River water conc. (dissolved; µg/L)	Stormwater conc. (dissolved; µg/L)
Bisphenol A *	1.5	n.a.	0.254
Dodecylphenol	0.04	n.a.	0.0005
Decamethylcyclopentasiloxane (D5)	1.7	7.42	0.582
Medium chained chlorinated paraffins (MCCPs)	0.05	<0.005	0,004
Copper (Cu)	7.8	5.16	10.7
PCB7	0.0000024	<0.00012 ****	0.000146
PFOA	9.1	0.0022	0.0051
Zinc (Zn)	11	3.88	38.5
TBBPA	0.254	n.a.	0.00068
Arsenic (As)	0.5	0.305	0.324
Chromium (Cr)	3.4	0.22	288
TCEP	65	n.a.	<0.0001
Triclosan	0.1	n.a.	<0.003
EU priority substances			
Cadmium (Cd)	0.08	0.03	0.0557
Lead (Pb)	1.2	0.335	0.939
Nickel (Ni)	4	0.765	1.49
Mercury (Hg)	0.07 ***	0.00147	0.00141
Brominated diphenyl ethers *	0.14 ***	n.a.	n.a.
Hexachlorobenzene	0.05 ***	<0.00007	<0.00009
C10-13 chloroalkanes **	0.4	<0.008	<0.011
Pentachlorobenzene	0.007	<0.0001	<0.0001
Nonylphenol (4-)	0.3	n.a.	0.0616
Octylphenol (4-tert-)	0.1	n.a.	0.0316
PFOS *	0.00065	0.00167	0.0057
DEHP	1.3	n.a.	0.139

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

** Short chained chlorinated paraffins (SCCPs)

*** No AA-EQS for these substances, thus this is the MAC-EQS

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

Table 5. Concentrations of contaminants (µg/kg wet wt.) in brown trout from Alna River (liver and muscle, respectively), and the respective Norwegian quality standards (Direktoratsgruppa for vannforvaltning, 2025). Red numbers indicate concentrations exceeding the quality standard.

River basin specific compounds	EQS (µg/kg)	Brown trout liver conc. (µg/kg)	Brown trout muscle conc. (µg/kg)
Decamethylcyclopentasiloxane (D5)	15000	7.16	3.67
Medium chained chlorinated paraffins (MCCPs)	170	70.7	11.9
PCB7	0.6	9.04	9.22
PFOA	91	0.07	<0.4
TCEP	7300	n.a.	n.a.
Triclosan	15000	n.a.	n.a.
EU priority substances			
Mercury (Hg)	20	55	40
Brominated diphenyl ethers *	0.0085	n.a.	n.a.
Hexachlorobenzene	10	0.688	0.547
C10-13 chloroalkanes **	6000	<26	<6
Pentachlorobenzene	50	0.182	0.121
Nonylphenol (4-)	3000	n.a.	n.a.
Octylphenol (4-tert-)	0.004	n.a.	n.a.
PFOS *	9.1	40.6	3.11
DEHP	2900	n.a.	n.a.

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

** Short chained chlorinated paraffins (SCCPs)

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

2.4.19. Biomagnification of environmental contaminants in the selected Alna river food web

Biomagnification was evaluated in the selected food web consisting of water moss, invertebrates and trout. When trout was represented by liver samples, no PCB congeners displayed statistically significant biomagnification (expressed by trophic magnification factors; TMFs, on a lipid weight basis). Variability in concentrations were higher among trout liver samples, than among trout muscle samples, although median concentrations were not very different (see electronic Appendix). When trout was represented by muscle samples, significant TMFs were observed. However, TMFs were often <1 (i.e. trophic dilution; e.g. PCB-209 with TMF=0.30; Figure 17). PCB-99 and PCB-101 (Figure 18) displayed TMF>1 (1.36 and 1.32, respectively). No significant biomagnification was observed for dechloranes, chlorinated paraffins or siloxanes (trophic dilution of MCCPs and LCCPs, as well as of D4, D5 and D6; lipid weight basis).

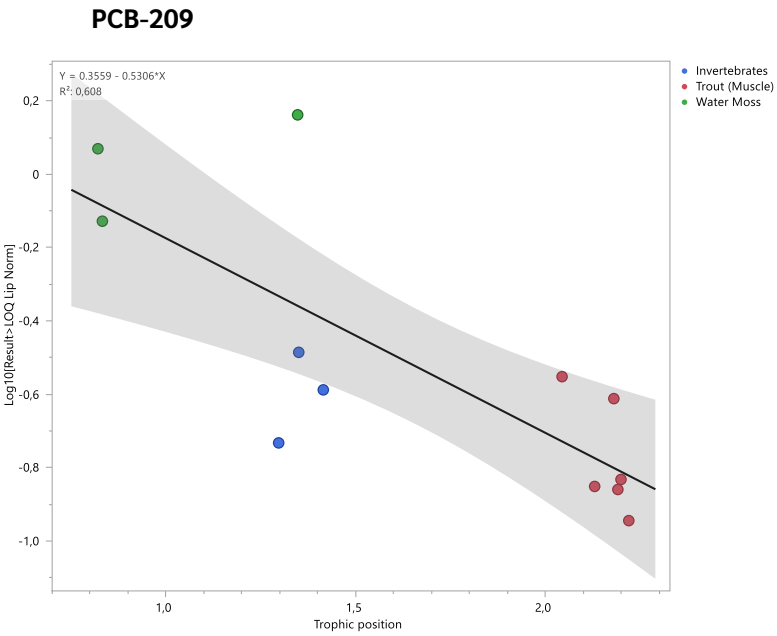


Figure 17. Trophic position against concentrations (ng/g lipid wt.; log_{10}-transformed) of PCB-209 in the selected Alna River food web (water moss invertebrates and trout muscle). The confidence region (95 %) of the fitted line is indicated with grey shading. TMF=0.30; p=0.0028.

PCB-101

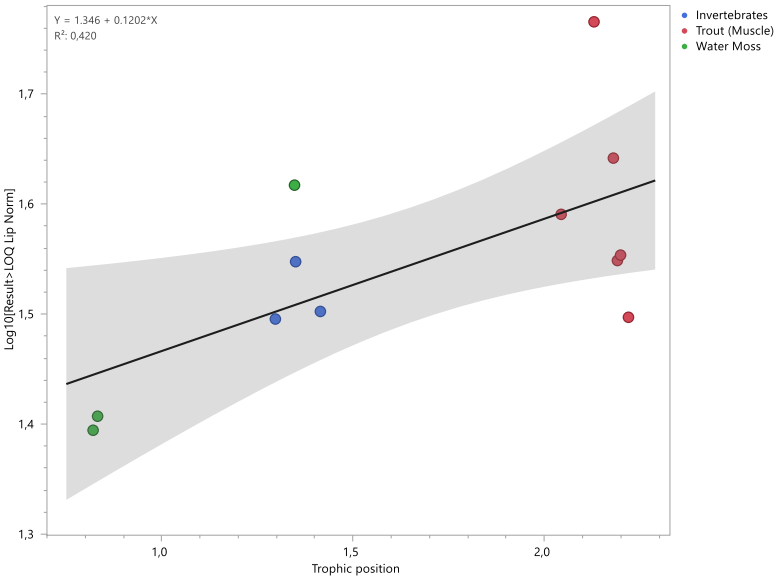


Figure 18. Trophic position against concentrations (ng/g lipid wt.; log_{10}-transformed) of PCB-101 in the selected Alna River food web (water moss invertebrates and trout muscle). The confidence region (95 %) of the fitted line is indicated with grey shading. TMF=1.32; p=0.0228.

Significant biomagnification was observed for several PFAS compounds (trout represented by liver samples; wet weight basis), although PFOS (TMF=60) was the only PFAS detected in water moss (Figure 19).

PFOS

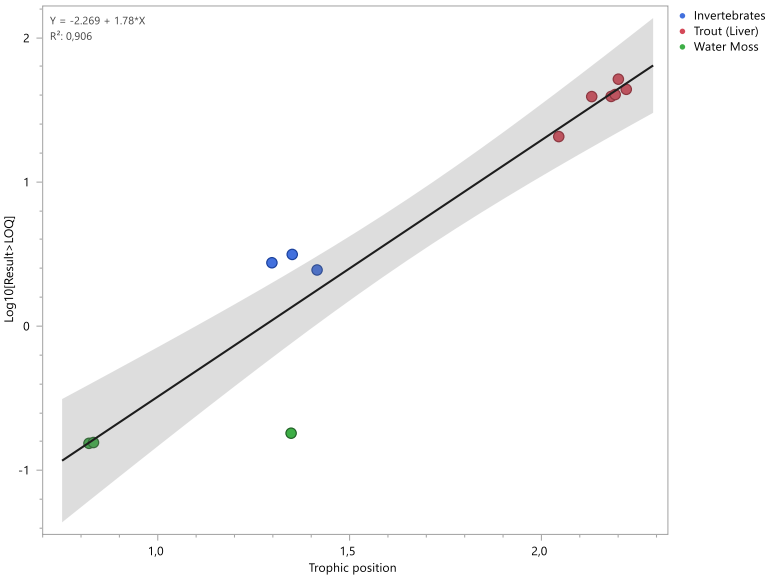
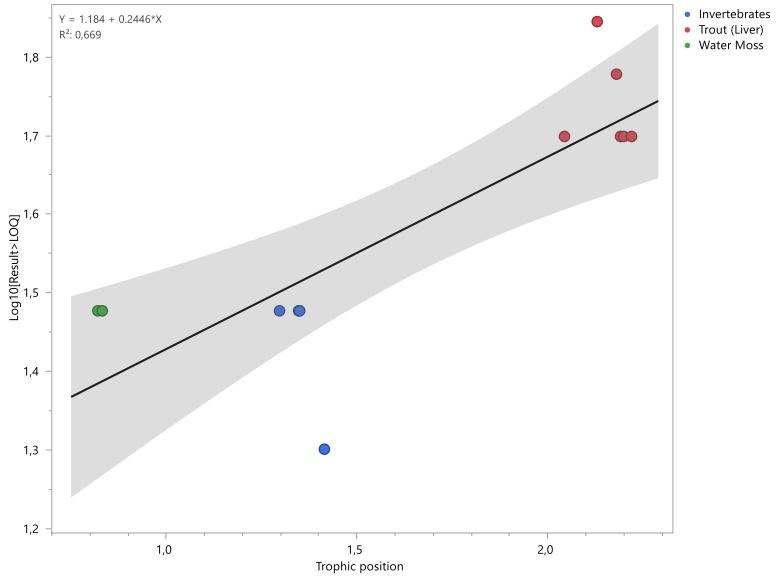


Figure 19. Trophic position against concentrations (ng/g wet wt.; log_{10}-transformed) of PFOS in the selected Alna River food web (water moss invertebrates and trout liver). The confidence region (95 %) of the fitted line is indicated with grey shading. TMF=60; p<0.0001.

As expected, mercury (Hg) biomagnified in the selected food web, both when trout was represented by liver samples (TMF=1.76) and muscle samples (TMF=1.33; wet weight basis; Figure 20). Silver (Ag), however, biomagnified when trout was represented by liver (TMF=3.41), but not muscle (TMF=0.004; Figure 21). The same could be observed for Cu (TMF=3.88 and TMF=0.066, respectively; not shown).

Hg

A.



B.

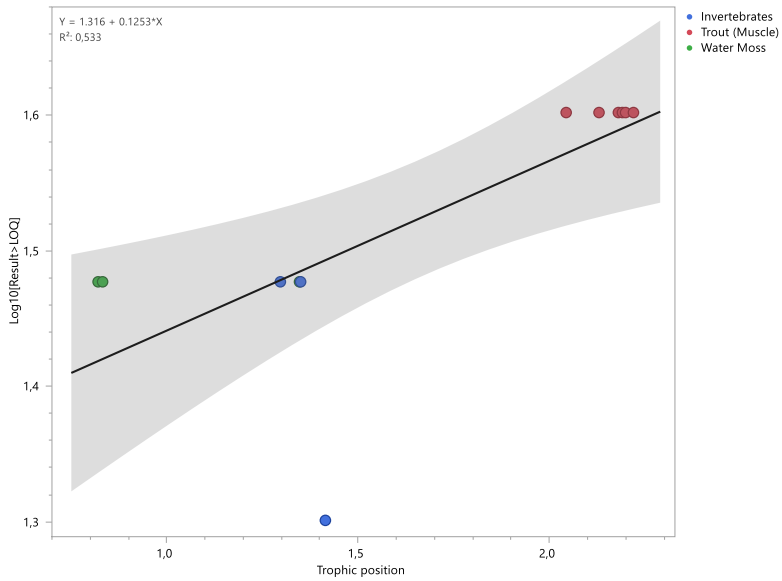
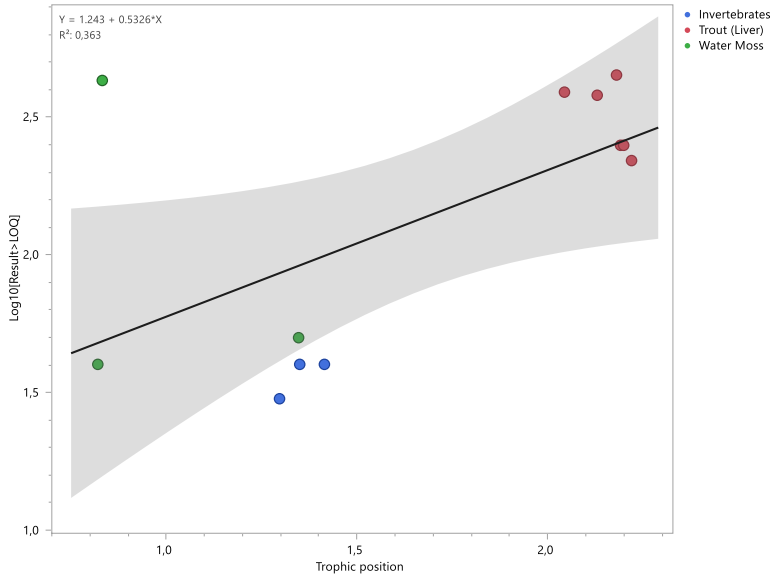


*Figure 20. Trophic position against concentrations (ng/g wet wt.; log_{10}-transformed) of mercury (Hg) in the selected Alna River food web (water moss invertebrates and trout liver (**A**) or trout muscle (**B**)). The confidence region (95 %) of the fitted line is indicated with grey shading. **A:** TMF=1.76; p=0.0011, **B:** TMF=1.33; p=0.0070.*

Ag

A.



B.

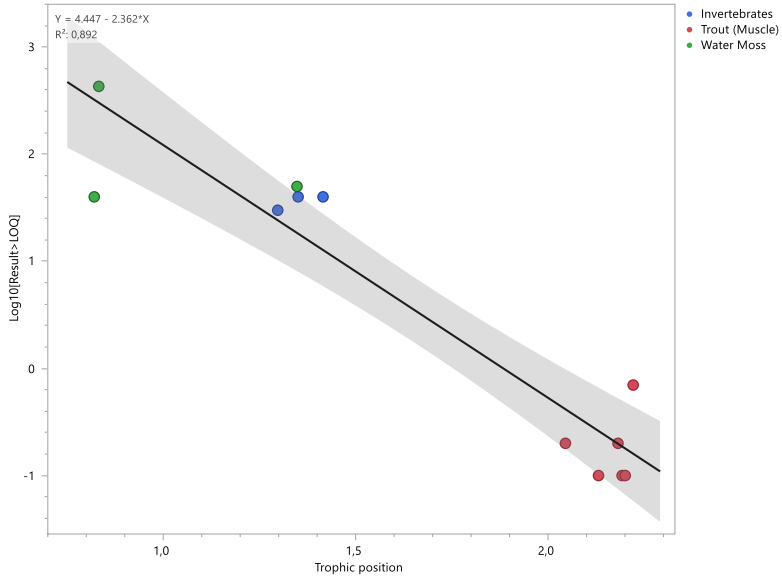


*Figure 21. Trophic position against concentrations (ng/g wet wt.; log_{10}-transformed) of silver (Ag) in the selected Alna River food web (water moss invertebrates and trout liver (**A**) or trout muscle (**B**)). The confidence region (95 %) of the fitted line is indicated with grey shading. **A:** TMF=3.41; p=0.0381, **B:** TMF=0.004; p<0.001.*

2.4.20. Source tracing

Water was sampled twice, during autumn 2024, at 13 locations (September 24th and October 10th, sampling at Brubak second time was October 11th). The concentrations of chlorhexidine, dichloromethane and trichloromethane measured are shown in Figure 22. For comparison, a similar figure with other previous measurements (of concentrations of chlorhexidine, dichloromethane and trichloromethane; data from Oslo kommune 2008-2021, the screening programme 2022, and Urban fjord 2021 and 2023; see NIVA memo 0221/24) is shown below (Figure 24).

PNEC-values (freshwater) for these compounds are as follows:

PNEC chlorhexidine: **232** ng/L
(Fass; https://www.fass.se/LIF/product?userType=2&nplId=19851108000021&docType=78)

PNEC dichloromethane: **310 000** ng/L
(ECHA; https://chem.echa.europa.eu/100.000.763/dossier-view/eab8b08d-9c83-45c0-ad24-fa66de453701/IUC5-0c36470d-05ea-4654-b436-db20cc94103c_fa44f2b5-b851-4ab2-ba4b-264367f1f131?searchText=dichloromethane)

PNEC trichloromethane: **146 000** ng/L
(ECHA; https://chem.echa.europa.eu/100.000.603/dossier-view/1b0c870b-6249-40d1-b67c-9c3becec94de/IUC5-38ffe563-b622-4df9-ad5b-735d0b2ca996_3242c6ee-14e0-4f05-a5e4-ce82f66f509b?searchText=trichloromethane).

As such, no observed concentrations (neither of the present study, nor previous measurements) exceeded the PNECs.

A.

Chlorhexidine

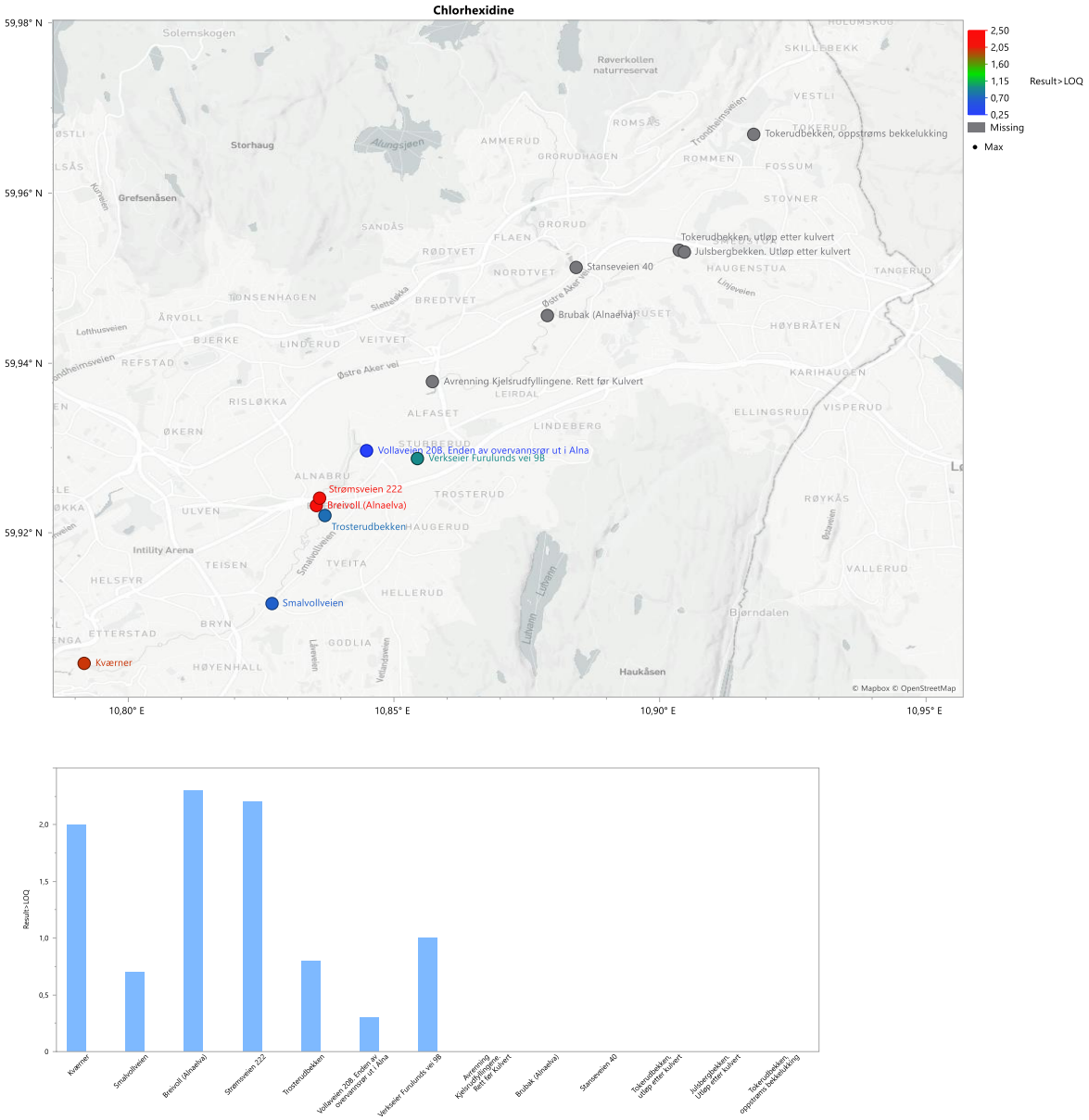


*Figure 22. Concentrations (ng/L; only detected concentrations considered) of Chlorhexidine (**A**), dichloromethane (**B**) and Trichloromethane (**C**) in unfiltered water (river water or stormwater) along Alna. The stations are depicted on a map, with a colour scale for concentrations (max of two samplings). Concentrations are also shown with bars (below the map), where the stations are organized from West to East. Blue bars represent the first sampling and red bars represent the second sampling.*

Figure 22 continued

B.

Dichloromethane

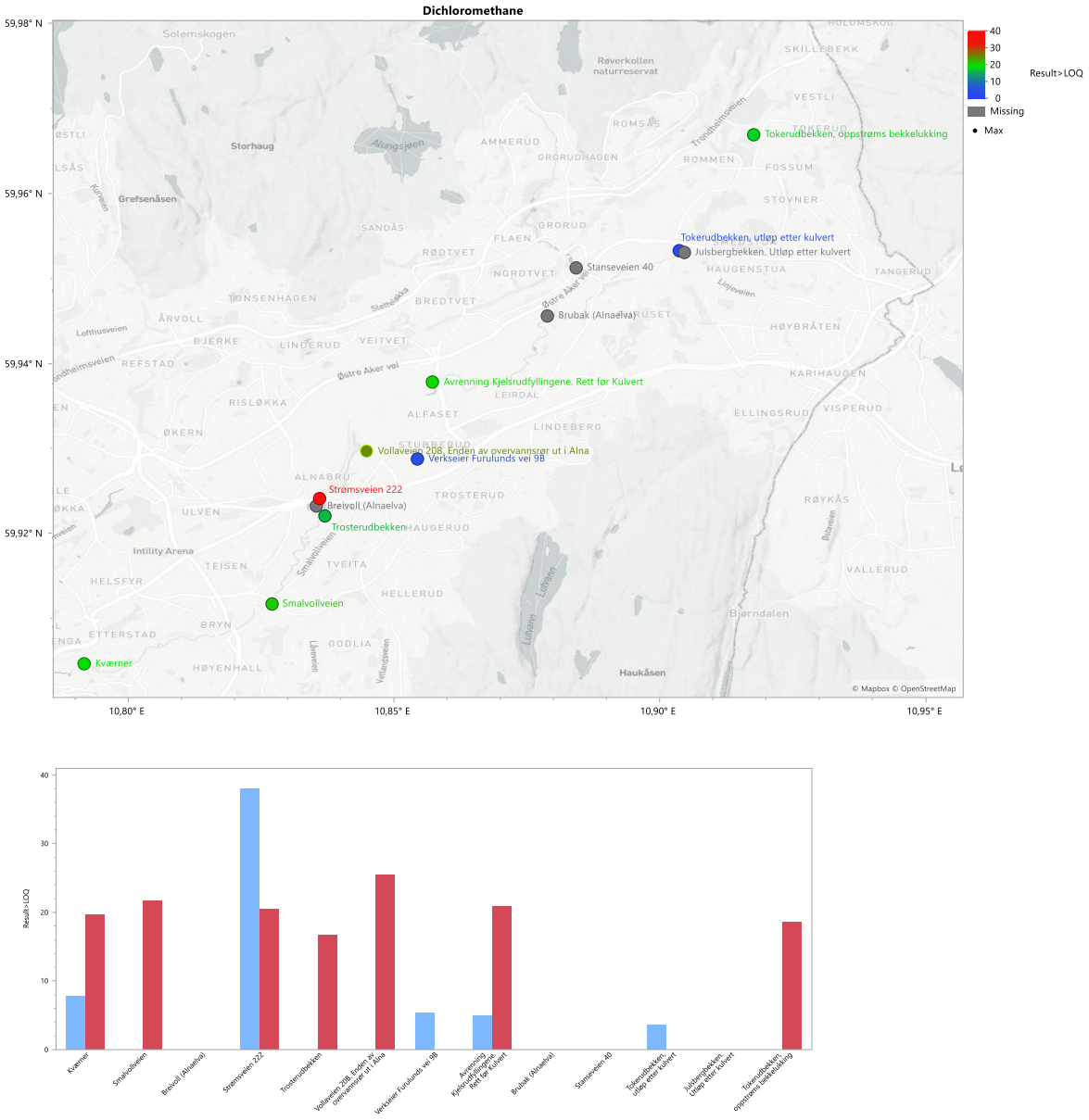
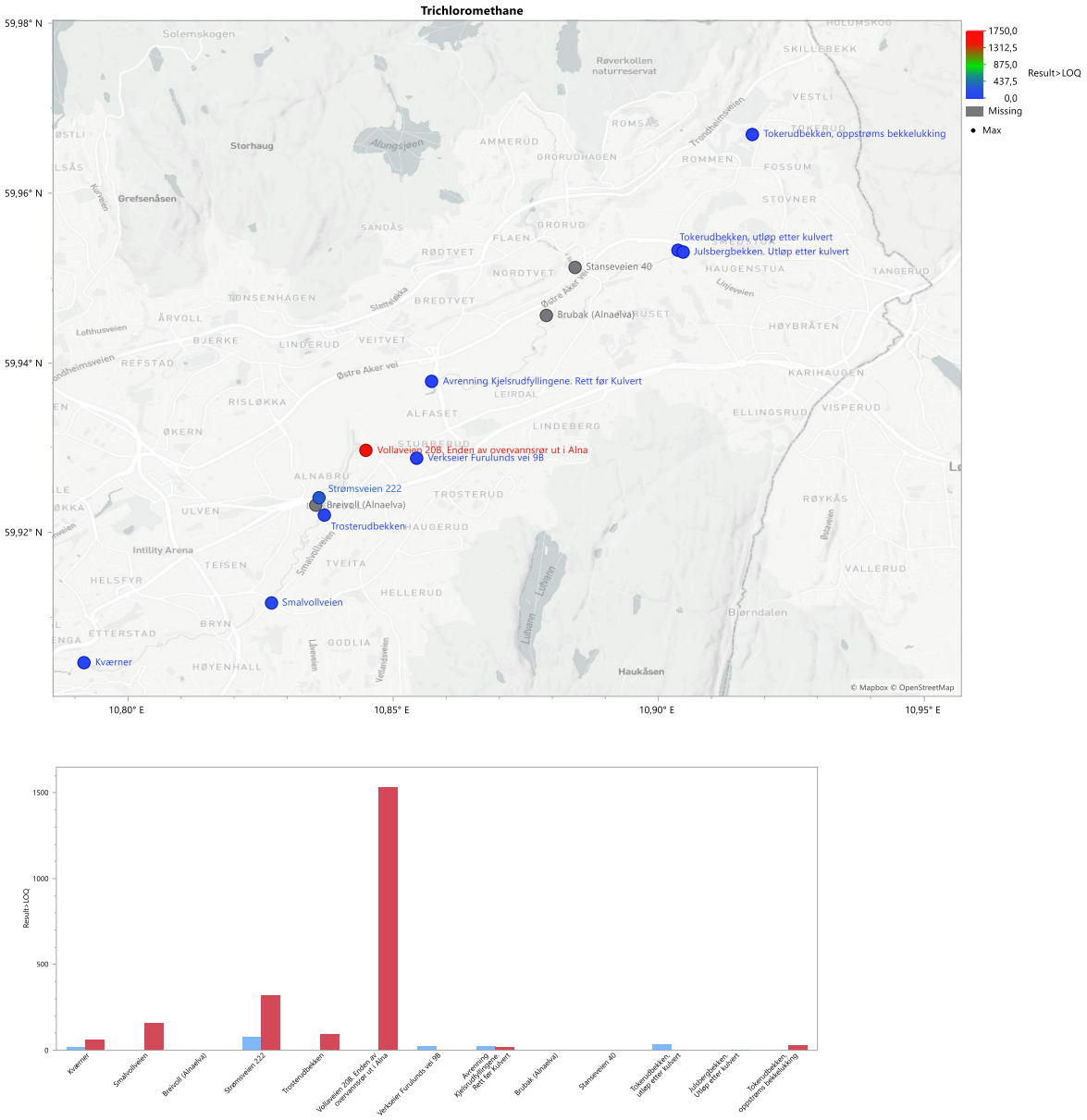


Figure 22 continued

C.

Trichloromethane



2.4.20.1. Chlorhexidine

During the first sampling campaign, chlorhexidine was found at all sampling stations along Alna below Verkstedseier Furulunds vei 9B, both in the Alna River itself and in side streams, but none at the sampling stations above. All the concentrations were low (<3 ng/L) and much lower than the highest concentrations that have been observed at some of these stations during sampling campaigns in the period 2021-2023:

- Vollaveien (from manhole before entering the Alna River at Vollaveien 20B): 39 ng/L
- Trosterudbekken (same location): 14 ng/L
- Breivoll (same location): 14 ng/L
- Kværner (same location): 112 ng/L

The higher LoQs (10-20 ng/L) earlier may have masked similar presence as observed now at the other stations. Moreover, samples from stations above Vollaveien have not been analysed for chlorhexidine earlier. There are numerous potential sources of chlorhexidine in the Alna catchment (see Vogelsang 2024; NIVA note 0221/24 to the Environment Agency), but none of these appears to be clear suspects as the concentrations are so low, also locally.

Chlorhexidine was only found in samples collected during the first sampling campaign. This may be related to the difference in precipitation patterns prior to and/or during the two sampling campaigns (see Figure 23). The first sampling campaign was conducted after a relatively dry weather period and quite early in the precipitation event, possibly catching the often-higher concentrated runoff (so-called first flush). When the second sampling campaign was conducted, several rain events had occurred just prior to this, possibly missing some of the more concentrated runoff.

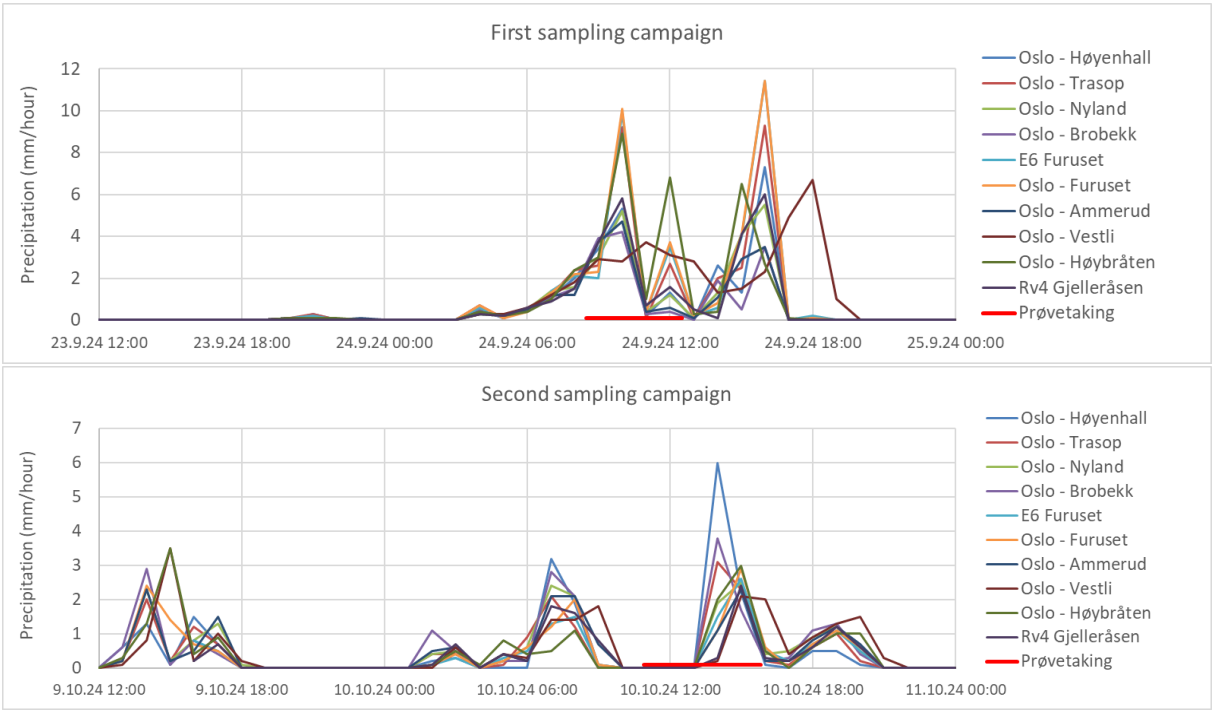


Figure 23. Hourly precipitation at the measuring stations in or close to the Alna catchment (from down and up in the catchment) the day before and during the two sampling campaigns. The sampling periods are shown with a red line.

2.4.20.2. Dichloromethane

Dichloromethane was found in many of the streams along the Alna River from the upper most station and to the final station, but only at the last station in the river itself. None of the concentrations appears to be extremes (<40 ng/L), indicating that there could be numerous small sources in much of the catchment area, but that the compound is too much diluted when in the larger river or that it is partly lost, possibly due to evaporation from the smaller streams. This finding may seem contrary to what was observed during the screening campaign in 2022 (Gundersen et al. 2023), where extreme concentrations (1337-1425 ng/L) were observed at three of the stations in the Alna River (Brubak, Breivoll and Kværner) on one out of three occasions. These high concentrations were observed during seemingly dry weather conditions. During the two other occasions (one dry and one wet) the concentrations were <LoQ (0.3 ng/L). The smaller streams were not sampled during this screening campaign.

Dichloromethane was found during both sampling campaigns, but more frequently (7 out of 13 stations) and generally at very similar concentrations (ca. 17-26 ng/L) during the second campaign. The higher concentration (38 ng/L) in the sample from the Strømsveien 222 station stands out as much higher than the other findings during the first sampling campaign. This station covers runoff from several waste managing sites around Haraldrud.

2.4.20.3. Trichloromethane

The observations of trichloromethane resembled much the observations of dichloromethane; found at most of the stations located in side streams, but only at the last station in the river itself. However, there was one extreme concentration found in one of the samples collected at the Vollaveien 20B station. There are no obvious sources to trichloromethane in the predicted catchment of this sampling point (but there are two companies that were predicted to use dichloromethane within this catchment). However, as the sampling point was actually in the Alna River itself, collecting the submerged effluent from the stormwater pipeline, the source could potentially also be upstream, or the company located on the site.

A.

Chlorhexidine

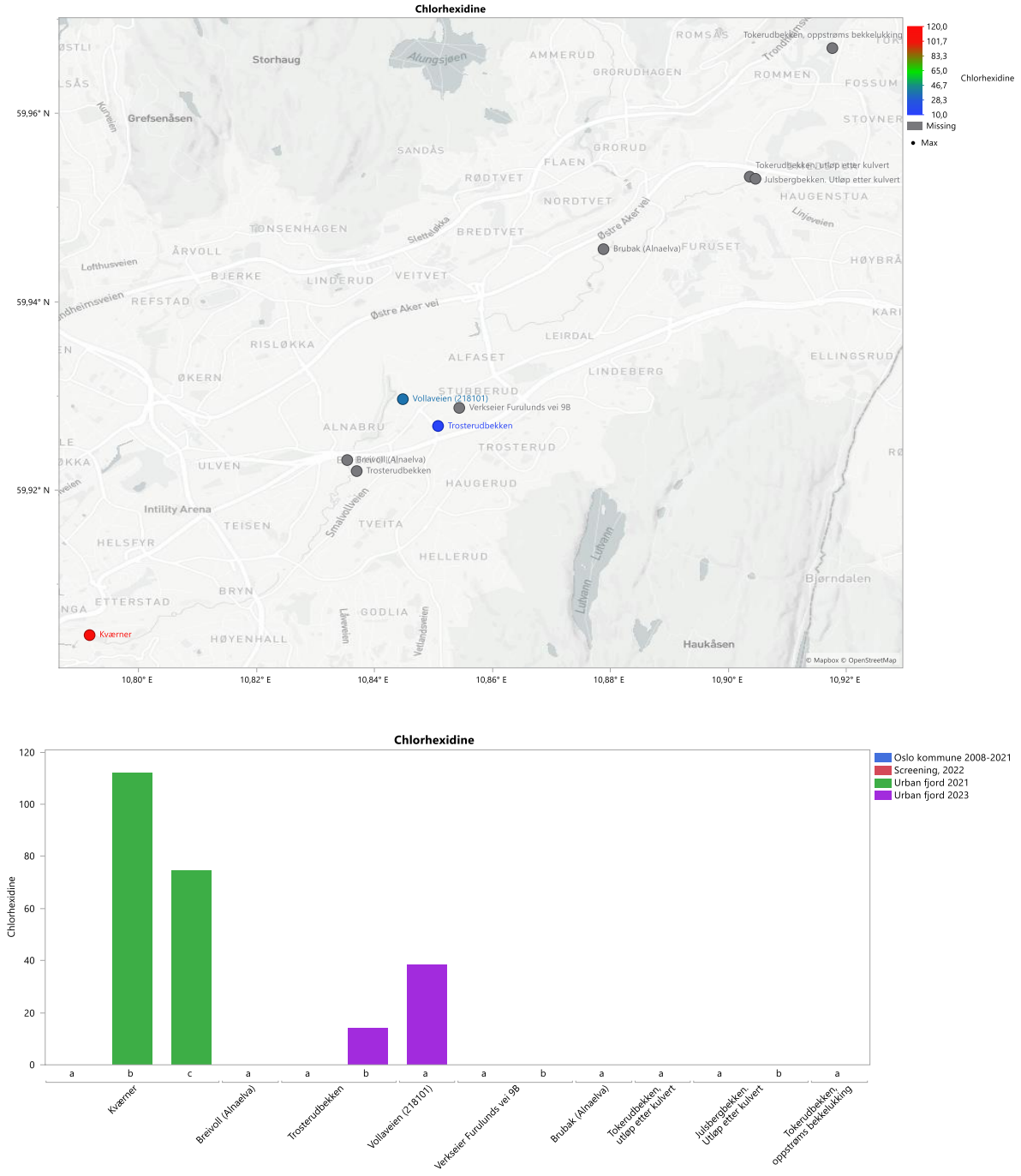
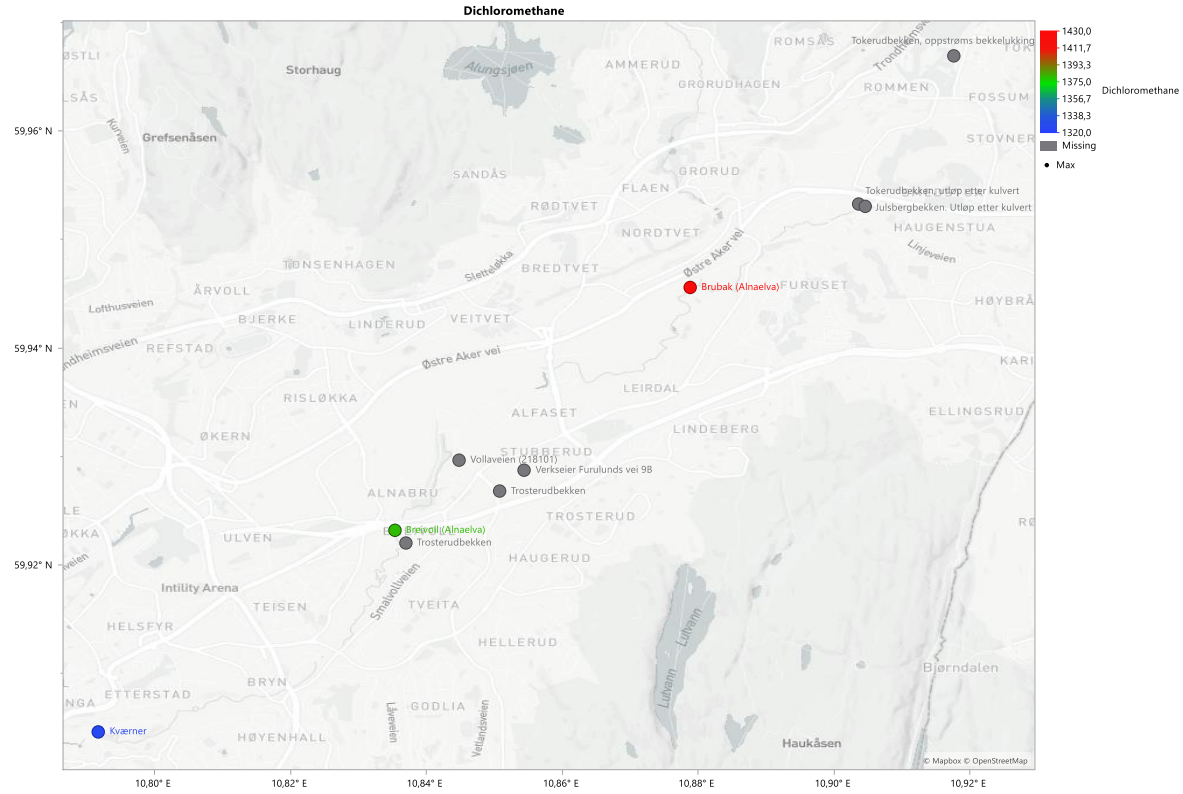


*Figure 24. Concentrations (ng/L) of Chlorhexidine (**A**), dichloromethane (**B**) and Trichloromethane (**C**) in river water or stormwater along Alna from previous measurements (data from Oslo kommune 2008-2021, the screening programme 2022, and Urban fjord 2021 and 2023; see NIVA memo 0221/24). The stations are depicted on a map, with a colour scale for concentrations (max of 1-2 measurements). Concentrations are also shown with bars (below the map), where the stations are organized from West to East. (The stations were visited and analysed for the compounds in question 1-3 times; marked a-c).*

Figure 24 continued

B.

Dichloromethane



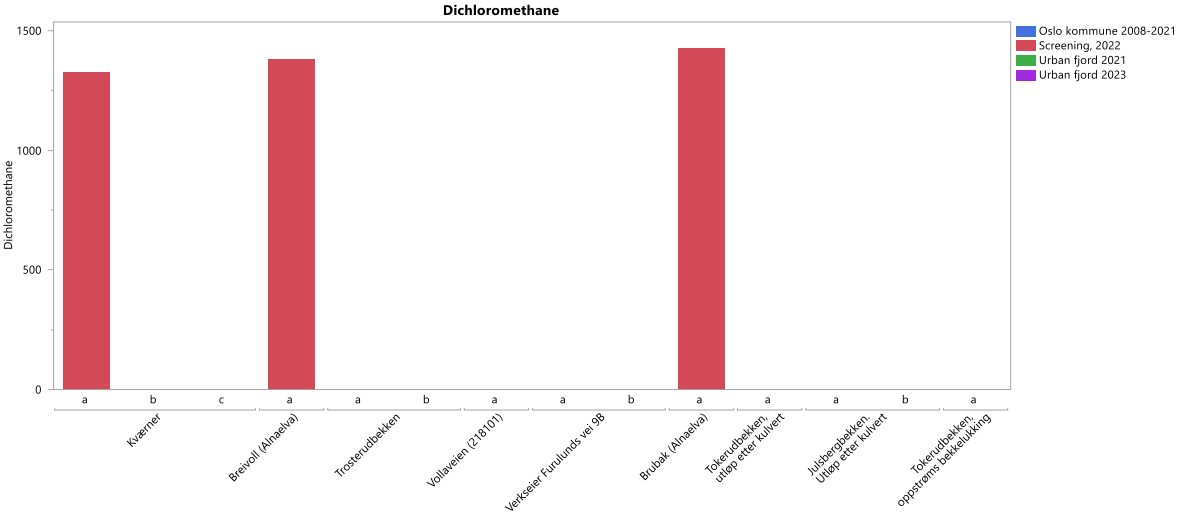
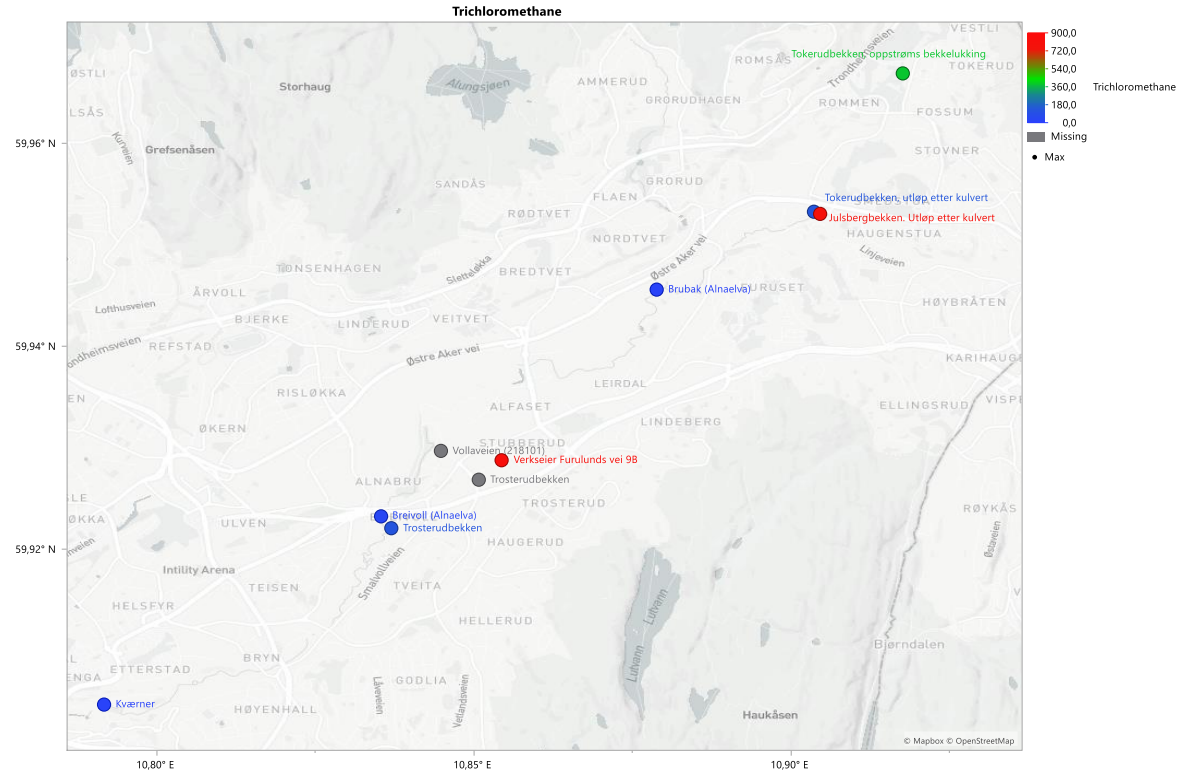
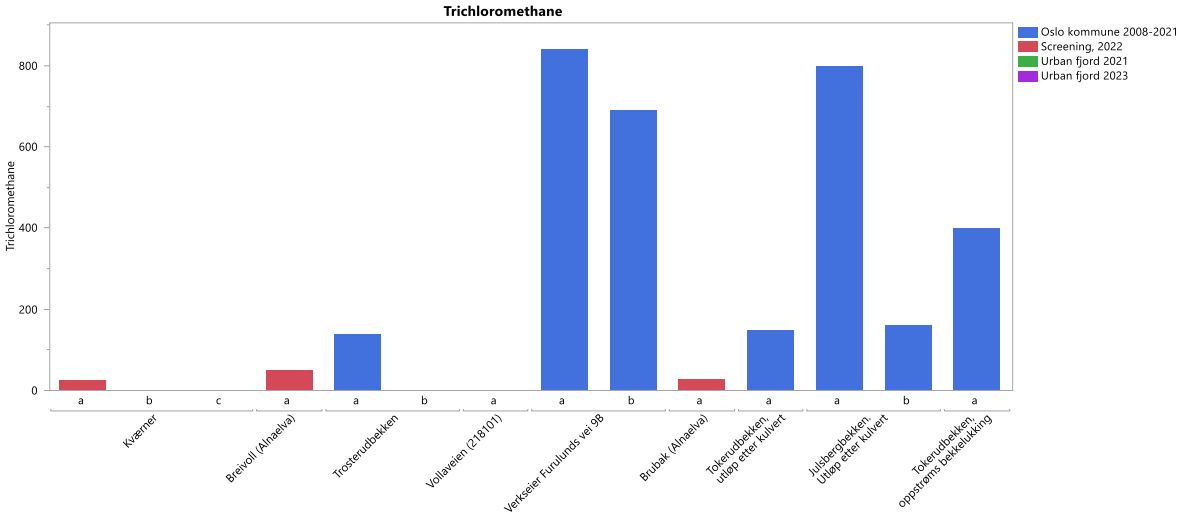


Figure 24 continued

C.

Trichloromethane





3 Material and Methods Appendix

3.1 Sampling and matrices

3.1.1. Water moss

Water moss was handpicked along Alna River, at the stations indicated in Figure 1 on June 13th, 2024.

3.1.2. Invertebrates

Macroinvertebrates were collected at the stations indicated in Figure 1 on April 17th and April 30th, 2024. They were sampled using a standardised kick sampling method with a kick net fitted with a 250 µm mesh. The collected material was subsequently sieved through a 1 mm mesh to remove fine particulate matter. Specimens retained on the sieve were extracted using forceps and placed in a sorting tray, where they were identified and counted before being transferred to containers as pooled samples.

3.1.3. Trout

Brown trout (*Salmo trutta*) were collected at two stretches of Alna River (Figure 1), on June 13th, 2024, using backpack electrofishing equipment. Biometric data for the fish are given in Appendix (Chapter 4). 15 specimens from each station were pooled into 3 pooled samples (5 individuals in each) for chemical analyses. Stable isotopes of carbon and nitrogen were performed on individual muscle samples (n=15).

3.1.4. River water (Alna River)

Two water samples were collected at "Kværner" in Alna, downstream the main part of the industrial area in the Alna area (Figure 1). The samples were collected as time-proportional 24-hour composite samples (50 mL every 5 min) with an automatic composite sampler (Avalange). The samples were taken during different rainfall conditions (on June 9th and August 27th, 2024). Oslo Municipality measures and reports the water flow in Alna River at the same station ("Kværnerristen"). The river water samples were separated into a filtered fraction (hereafter referred to as "dissolved fraction") and a particulate fraction by filtering, using Whatman GF/F filter, pore size 0.7 µm prior to analysis of per-and polyfluorinated substances, and Whatman Glass Microfilters GF, pore size 1.2 µm, prior to analysis of other chemical parameters[1] (at NILU).

3.1.5. Stormwater

Stormwater samples were collected on one occasion at seven specific sampling points (Figure 1), June 5th, 2024. The samples were collected from manholes or streams by filling bottles directly in the stormwater. Subsequently, the stormwater samples were separated into a filtered fraction (hereafter referred to as "dissolved fraction") and a particulate fraction by filtering, using Whatman GF/F filter, pore size 0.7 µm prior to analysis of per-and polyfluorinated substances, UV-compounds, QACs, pesticides/fungicides and benzothiazoles (at NIVA), and Whatman Glass Microfilters GF, pore size 1.2 µm, prior to analysis of other chemical parameters[1] (at NILU). Figure 25, in the Appendix (Chapter 4) shows the precipitation in the time around stormwater sampling.

3.1.6. Water (unfiltered; for source tracing)

Water samples were taken at 13 stations (Figure 1) on two occasions (September 24th, and October 10th, 2024). Stations were based on a review of possible sources of chlorhexidine, dichloromethane and

[1] *For siloxanes, an aliquot of decanted (however unfiltered) water was secured before filtration, and analysed. This was done to avoid hydrolysis (according to ISO 20596.2:2022). No visible particles were observed.*

trichloromethane in the area. Samples were taken by either filling bottles on sight (“grab” samples) or as 24-hour pooled samples (see Table 6).

Table 6. Sample number, type of sample and sampling time/period at the different stations for source tracing.

Station	First sampling 24.09.2024				Second sampling 10.10.2024			
	No.	Sample type	Start	End	No.	Sample type	Start	End
1	1	Grab	13:05		24	Composite	10:55	14:55
2	2	Grab	11:35		20	Grab	13:35	
3	3	Grab	11:13		19	Grab	13:30	
4	4	Composite	08:38	12:38	25	Composite	11:20	15:20
5	5	Grab	12:30		23	Grab	14:43	
6	6	Grab	12:18		22	Grab	14:26	
7	7	Grab	11:02		18	Grab	13:07	
8	8	Grab	10:50		17	Grab	12:55	
9	9	Grab	13:50		26	Composite	11:50	15:50
10	10	Grab	11:56		21	Grab	13:58	
11	11	Grab	10:15		15	Grab	12:30	
12	12	Grab	10:30		16	Grab	12:40	
13	13	Grab	9:46		14	Grab	12:15	

3.2 Analytical procedures

3.2.1. QA/QC

In Table 7 there is a short method description, including LoQ and an assessment and categorization of the uncertainty for every individual compound analyzed. The uncertainty is divided in three groups from 1-3.

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

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

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

Table 7. Method information
Uncertainty categories:
1. Results from analysis of control samples (spikes and blanks etc) are accurate and precise. The laboratory has participated in and has passed ring-tests and proficiency tests for this analysis. Results are considered to be very reliable.
2. Results from analysis of control samples (spikes and blanks etc) are accurate and precise. The laboratory has not participated in proficiency tests for this analysis, or ring-tests included too few participants to be reliable. Results are considered to be reliable.
3. Results from analysis of control samples (spikes and blanks etc) are variable and precision is not acceptable. Results of these analyses are considered to be least reliable.
UV-Compounds.

Parameter group	Name parameter	CAS Number	Blank subtraction and determination of LOQ	LOQ range ng/g or ng/L	Method	Uncertainty category
UV compounds	Benzophenone-3	131-57-7	Minimum three blanks per batch. Blank-subtraction and LOQ based on average signal of blanks +10*std. octocylene and homosalate have the highest levels in blanks.	0.5-1	Internal Standard (IS) added. Samples then extracted twice, followed by clean-up via GPC and/or PSA. GC-MS/MS detection	2
	Ethylhexylmethoxycinnamate (EHMZ-Z)	177352-99-7		0.2-0.4		2
	Ethylhexylmethoxycinnamate (EHMZ-E)	5466-77-3		0.4-0.8		2
	Octocrylene	6197-30-4		3-4		2
	UV-327	3864-99-1		0.1-0.2		2
	UV-328	25973-55-1		0.1-0.2		2
	UV-329	3147-75-9		0.1-0.4		2
	homosalate	118-56-9		3-5		2

Table 7. cont. Method information. Pesticides/Fungicides

Parameter group	Name parameter	CAS Number	Blank subtraction and determination of LOQ	LOQ range, ng/g or ng/L	Method	Uncertainty category
Pesticides/Fungicides	Chlorhexidine	55-56-01	Minimum one blank per batch. LOQ based on 10 x signal-to-noise.	1.0-20	Internal Standard (IS) added. Solid samples then extracted twice, while water samples were pre-concentrated on SPE. Clean-up via PSA when required. LC-MS/MS detection.	2
	Chlorpyrifos	2921-88-2		0.5-1		2
	Tebuconazol	107534-96-3		0.5-1		2
	Triclorcarban	101-20-2		0.2-1		2
	Permitrin (*cis*)	52645-53-1		0.1-0.2	IS added. Samples then extracted twice before clean-up via GPC and/or PSA. GC-MS/MS detection	2
	Permitrin (*trans*)	52645-53-1		0.1-0.2		2
	Triclosan	3380-34-5		0.5-3		2

Table 7. cont. Method information. PFAS

Parameter group	Name parameter	CAS Number	Blank subtraction and determination of LOQ	LOQ range, ng/g or ng/L	Method	Uncertainty category
PFAS	***PFSA***					
	TFA	76-05-1	Minimum three blanks per batch. Blank-subtraction and LOQ based on average signal of blanks +10*std.	5-10	Internal standards are added, and the samples are extracted twice before LC-MS/MS detection	2
	PFPrA	422-64-0	One blank per batch. LOQ based on 10 x signal-to-noise	0.5	Internal standard added, and solid samples are extracted twice. Water samples are extracted with solvent before LC-MS/MS detection	2
	PFBA	375-22-4		0.5	Internal standard is added, and solid samples are extracted twice. Water samples are concentrated on an SPE column. LC-QTOF-MS detection	2
	PFPA	2706-90-3		0.5		2
	PFHxA	307-24-4		0.5		1
	PFHpA	375-85-9		0.5		2
	PFOA	335-67-1		0.5		1
	PFNA	375-95-1		0.5		1
	PFDA	335-76-2		0.4		1
	PFUnDA	2058-94-8		0.4		1
	PFDoDA	307-55-1		0.4		1
	PFTrDA	72629-94-8		0.4		1
	PFTeDA	376-06-7		0.4		1
	PFHxDA	67905-19-5		0.4		2
	PFOcDA	16517-11-6		0.4		2
	PFSA					
	PMeS	1493-13-6	One blank per batch. LOQ based on 10 x signal-to-noise.	0.1	Same method as for PFPrA	2
	PFEtS	354-88-1		0.1		2
	PFPrS	423-41-6		0.1		2
	PFBS	375-73-5		0.2	Internal standard is added, and solid samples are extracted twice. Water samples are concentrated on an SPE column. LC-QTOF-MS detection	1
	PFPS	2706-91-4		0.2		2
	PFHxS	355-46-4		0.1		1
	PFHpS	375-92-8		0.1		1
	PFOS	2795-39-3		0.05		1
	brPFOS	1763-23-1		0.05		2
	PFNS	474511-07-4		0.1		2
	PFDS	335-77-3		0.2		1
	PFUnDS	441296-91-9		0.2		2
	PFDoDS	79780-39-5		0.2		2
	PFTrDS	791563-89-8		0.3		2

Parameter group	Name parameter	CAS Number	Blank subtraction and determination of LOQ	LOQ range, ng/g or ng/L	Method	Uncertainty category
	PFTeDS	1379460-39-5		0.3		3
	nPFAS					
	PFBSA	30334-69-1	One blank per batch. LOQ based on 10 x signal-to-noise.	0.3	Internal standard is added, and solid samples are extracted twice. Water samples are concentrated on an SPE column. LC-QTOF-MS detection	2
	N-MeFBSA	68298-12-4		0.3		2
	N-EtFBSA	40630-67-9		0.3		2
	PFOSA	754-91-6		0.1		1
	N-MeFOSA	31506-32-8		0.3		2
	N-EtFOSA	4151-50-2		0.3		2
	N-MeFOSE	24448-09-7		1.0		2
	N-EtFOSE	1691-99-2		1.0		2
	N-EtFOSAA	2991-50-6		0.3		2
	newPFAS					
	4:2 FTS	757124-72-4	One blank per batch. LOQ based on 10 x signal-to-noise.	0.3	Internal standard is added, and solid samples are extracted twice. Water samples are concentrated on an SPE column. LC-QTOF-MS detection	2
	6:2 FTS	27619-97-2		0.3		2
	8:2 FTS	481071-78-7		0.3		2
	10:2 FTS	120226-60-0		0.3		2
	12:2 FTS	149246-64-0		0.3		3
	ADONA	958445-44-8		0.3		2
	PFECHS	67584-42-3		0.3		2
	HFPO-DA (Gen-X)	13252-13-6		0.3		3

Comments to PFAS:

PFTeS and 12:2 FTS; Reference standard materials were unavailable for these compounds. The uncertainty category is therefore set to 3. However, knowledge from similar compounds provides confidence and we judge the results to be reliable.

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

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

Table 7. cont. Method information. Quaternary ammonium compounds.

Parameter group	Name parameter	CAS Number	Blank subtraction and determination of LOQ	LOQ range, ng/g or ng/L	Method	Uncertainty category
Quaternary ammonium compounds	DADMAC-C8	3026-69-5	One blank per batch. LOQ based on 10 x signal-to-noise.	5	Internal Standard (IS) added. Samples are then extracted twice before clean-up via SPE. LC-MS/MS detection	2
	DADMAC-C10	2390-68-3		50		2
	DADMAC-C12	3282-73-3		5		2
	DADMAC-C14	68105-02-2		1		2
	DADMAC-C16	70755-47-4		5		2
	DADMAC-C18	3700-67-2		5		2
	BAC-C8	959-55-7		5		2
	BAC-C10	965-32-2		5		2
	BAC-C12	139-07-1		25		2
	BAC-C14	139-08-2		25		2
	BAC-C16	122-18-9		25		2
	BAC-C18	122-19-0		25		2
	ATAC-C8	2083-68-3		5		2
	ATAC-C10	2082-84-0		5		2
	ATAC-C12	1119-94-4		5		2
	ATAC-C14	1119-97-7		50		2
	ATAC-C16	57-09-0		50		2
	ATAC-C18	1120-02-1		50		2
	ATAC-C20	15809-05-9		25		2
	ATAC-C22	17301-53-0		5		2

Table 7. cont. Method information. Benzothiazoles.

Parameter group	Name parameter	CAS Number	Blank subtraction and determination of LOQ	LOQ range, ng/g or ng/L	Method	Uncertainty category
Benzothiazoles	Mercaptobenzothiazole (MBT)	149-30-4	One blank per batch. LOQ based on 10 x signal-to-noise as measured in each sample	1.0	Internal Standard (IS) added. Solid samples are then extracted twice, while water samples are pre-concentrated on SPE. LC-MS/MS detection	2
	Benzotriazole (BTZ)	95-14-7		0.5		2
	Benzothiazole (BT)	95-16-9		10.0		2
	2(3H)-Benzothiazolone (OHBT)	934-34-9		1		2
	metyl-1H-benzotriazole (MeBTZ)	29385-43-1		0.5		2
	N-cyclohexylbenzothiazole-2-sulfenamide (CBS)	95-33-0		1.0		2
	Cl-benzotriazole	94-97-3		0.5		2
	6 PPD quinone	No CAS		0.5		2

Table 7. cont. Method information. Metals.

Parameter group	Compound	Cas no	Blank	LOD range (mg/kg)	LOQ range (mg/kg)	Method	Uncertainty category
Metals Biota	Sc	7440-20-2	Method blanks following sample series. LOD/LOQ based on calculation of 3 and 10 stddev respectively	0.0001-0.0002	0.0005-0.001	In-house accredited method. Microwave assisted decomposition with HNO3. Analysed by ICP-MS (Agilent 7700x).	2
	V	7440-62-2		0.001-0.002	0.005-0.01		1
	Cr	7440-47-3		0.0001-0.0005	0.001-0.002		1
	Mn	7439-96-5		0.0001-0.0002	0.0005-0.001		1
	Fe	7439-89-6		0.002-0.01	0.02-0.1		1
	Co	7440-48-4		0.0001-0.0002	0.0005-0.001		1
	Ni	7440-02-0		0.0002-0.0005	0.001-0.002		1
	Cu	7440-50-8		0.0005-0.001	0.002-0.005		1
	Zn	7440-66-6		0.002-0.005	0.01-0.05		1
	As	7440-38-2		0.0001-0.0002	0.0005-0.001		1
	Y	7440-65-5		0.00005-0.0001	0.0002-0.0005		2*
	Ag	7440-22-4		0.0001-0.0002	0.0005-0.001		1*
	Cd	7440-43-9		0.0001-0.0002	0.0004-0.001		1
	Sn	7440-31-5		0.0005-0.001	0.002-0.005		2*
	Sb	7440-36-0		0.0001-0.0001	0.0005-0.001		1
	La	7439-91-0		0.00003-0.0001	0.0002-0.0005		2
	Ce	7440-45-1		0.00003-0.00010	0.0002-0.0005		2*
	Pr	7440-10-0		0.00001-0.0001	0.0002-0.0005		2
	Nd	7440-00-8		0.00004-0.0001	0.0002-0.0005		2*
	Sm	7440-19-9		0.00001-0.0001	0.0002-0.0005		2*
	Eu	7440-53-1		0.00005-0.0001	0.0002-0.0005		2*
	Gd	7440-54-2		0.00005-0.0001	0.0002-0.0005		2*
	Tb	7440-27-9		0.00001-0.0001	0.0002-0.0005		2*
	Dy	7429-91-6		0.00001-0.0001	0.0002-0.0005		2*
	Ho	7440-60-0		0.00001-0.0001	0.0002-0.0005		2*
	Er	7440-52-0		0.00001-0.0001	0.0002-0.0005		2*

Parameter group	Compound	Cas no	Blank	LOD range (mg/kg)	LOQ range (mg/kg)	Method	Uncertainty category
	Tm	7440-30-4		0.00001-0.0001	0.0002-0.0005		2*
	Yb	7440-64-0		0.00001-0.0001	0.0002-0.0005		2*
	Lu	7439-94-3		0.00001-0.0001	0.0002-0.0005		2*
	Pb	7439-92-1		0.0001-0.0003	0.0005-0.001		1
	Hg	7439-97-6		0.0002-0.0004	0.0007-0.001	In-house accredited method. Microwave assisted decomposition with HNO_3. digestate stabilized with HCl. Analysed by ICP-MS (Agilent 7700x).	1

*Not accredited

Table 7. cont. Method information. Metals cont.

Parameter group	Compound	Cas no	Blank	Typical LOD (ng/ml)	Typical LOQ (ng/ml)	Method	Uncertainty category
Metals (fresh) water	Sc	7440-20-2	Method blanks following sample series. LOD/LOQ based on calculation of 3 and 10 stddev respectively	0.004	0.01	In-house accredited method. Sample acidified to 1% (v/v) with HNO_3. Analyzed by ICP-MS (Agilent 7700x).	2
	V	7440-62-2		0.004	0.02		1
	Cr	7440-47-3		0.02	0.09		1
	Mn	7439-96-5		0.01	0.2		1
	Fe	7439-89-6		0.3	0.9		1
	Co	7440-48-4		0.002	0.008		1
	Ni	7440-02-0		0.02	0.06		1
	Cu	7440-50-8		0.006	0.02		1
	Zn	7440-66-6		0.2	0.6		1
	As	7440-38-2		0.005	0.05		1
	Y	7440-65-5		0.0005	0.005		2*
	Ag	7440-22-4		0.002	0.006		1*
	Cd	7440-43-9		0.0004	0.003		1
	Sn	7440-31-5		0.010	0.100		2*
	Sb	7440-36-0		0.002	0.005		1
	La	7439-91-0		0.001	0.004		2
	Ce	7440-00-8		0.001	0.003		2*
	Pr	7440-10-0		0.0002	0.0006		2
	Nd	7440-00-8		0.001	0.003		2*
	Sm	7440-19-9		0.001	0.003		2*
	Eu	7440-53-1		0.001	0.003		2*
	Gd	7440-53-2		0.001	0.003		2*
	Tb	7440-27-9		0.001	0.003		2*
	Dy	7429-91-6		0.001	0.003		2*
	Ho	7440-60-0		0.001	0.003		2*
	Er	7440-52-0		0.001	0.003		2*

Parameter group	Compound	Cas no	Blank	Typical LOD (ng/ml)	Typical LOQ (ng/ml)	Method	Uncertainty category
	Tm	7440-28-0		0.001	0.003		2*
	Yb	7440-64-0		0.001	0.003		2*
	Lu	7439-94-3		0.001	0.003		2*
	Pb	7439-92-1		0.001	0.003		1
	Hg	7440-02-0		0.001	0.002	In-house accredited method. Samples acidifies with HCl and an oxidation agent is added. Analysed by CV-AFS (Tekran).	1

*Not accredited

Table 7. cont. Method information. PCBs and organochlorines.

Parameter group	Name parameter	Cas no	Blank	LOD range ng/g (ng/L)	LOQ range ng/g (ng/L)	Method	Uncertainty category	Stable isotope labeled (SIL) analogue
PCB/HCB	PECB	608-93-5	Method blanks following sample series. LOD/LOQ based on calculation of 3 and 10 stddev respectively	0.01-0.2	0.02-0.5	In-house, accredited method for PCB, PeCB and HCB. Internal standard addition, extraction, GPC and/or H2SO4 cleanup followed by adsorption chromatography. GC/HRMS (autspec)	1	Y
	HCB	118-74-1		0.01-0.1	0.03-0.3		1	Y
	HCBD	87-68-3		0.1-0.3	0.3-1		3	N
	PCB 28	7012-37-5		0.006-0.02	0.02-0.06		1	Y
	PCB 52	35693-99-3		0.008-0.03	0.02-0.07		1	Y
	PCB 101	37680-73-2		0.01-0.04	0.03-0.1		1	Y
	PCB 118	31508-00-6		0.008-0.04	0.02-0.1		1	Y
	PCB 138	35065-28-2		0.02-0.05	0.04-0.1		1	Y
	PCB 153	35065-27-1		0.02-0.03	0.04-0.08		1	Y
	PCB 180	35065-29-3		0.008-0.02	0.02-0.05		1	Y

Table 7. cont. Method information. Dechloranes.

Parameter group	Name compound	Cas no	Blank	LOD range ng/g (ng/L)	LOQ range ng/g (ng/L)	Method	Uncertainty category	Stable isotope labeled (SIL) analogue
Dechlorane	Dibromoaldrin	20389-65-5	Method blanks following sample series. LOD/LOQ based on calculation of 3 and 10 stddev respectively	0.1-0.7	0.3-1.7	In-house method. Internal standard addition, extraction, GPC cleanup followed by adsorption chromatography. GCGC-qToF 7200 in ECNI	2	N
	Dechlorane 602	31107-44-5		0.01-0.1	0.03-0.3		2	Y
	Dechlorane 603	13560-92-4		0.01-0.	0.03-2		2	N
	Dechlorane 604	34571-16-9		0.2-1.4	0.7-4.6		2	N
	Dechlorane 601	13560-90-2		0.02-0.1	0.07-0.3		2	N
	Dechlorane plus syn	135821-03-3		0.03-0.2	0.1-0.7		2	Y
	Dechlorane plus anti	135821-74-8		0.05-0.2	0.2-0.7		2	N

Table 7. cont. Method information. Chlorinated paraffins.

Parameter group	Name parameter	Cas no	Blank	LOD range ng/g (ng/L)	LOQ range ng/g (ng/L)	Method	Uncertainty category	Stable isotope labeled (SIL) analogue
CP	SCCP	85535-84-8	Method blanks following sample series. S, M and LCCP are corrected for blanks prior to deconvolution. Results are corrected for blanks. Blanks are subtracted on congener group level prior to deconvolution. LOD/LOQ based on calculation of 3 and 10 stddev respectively	6-26		In-house method. Internal standard addition, extraction, H_2SO_4 cleanup followed by adsorption chromatography. In some cases with high levels of sulfur and/or PCB an additional cleanup with florsil is needed. GC-qToF 7200 in ECNI	3	13C-hexachlorodecane
	MCCP	85535-85-9		5-35			3	
	LCCP	85535-86-0		0.4-5		In-house method. Internal standard addition, extraction, GPC and/or H_2SO_4 cleanup followed by adsorption chromatography. Agilent LC-qToF 6546	3	

Table 7. cont. Method information. Phthalates.

Parameter group	Compound	Cas no	Blank	LOD range (ng/L)	LOQ range (ng/L)	Method	Uncertainty category	Stable isotope labeled (SIL) analogue
Phthalate water	DEP	84-66-2	Three blanks pr batch. Blank substraction for each batch based on the blank average. LOD and LOQ calculated from 3 x stdev and 10 x stdev. From blanks	30-100	50-200	To an aliquot of 100 mL water, labelled standards were added before the sample was cleaned up on HLB column, extracted with CAN. Up-concentrated before recovery standard was added, and analysed on LC-HRMS.	2	Y
	DiBP	84-69-5		5-20	20-40		2	Y
	DnBP	84-74-2		5-20	20-40		2	Y
	DHxP	84-75-3		5-20	20-40		2	Y
	BBP	85-68-7		1-5	5-15		2	N
	DEHP	117-81-7		10-20	40-60		2	Y
	DCHP	84-61-7		1-3	3-9		2	Y
	DOP	117-84-0		10-20	40-60		2	N
	DNP	84-76-4		10-20	40-60		2	Y
	DiNP	28553-12-0		10-20	40-60		2	Y
	DiDP	26761-40-0		5-20	20-40		2	N
	DAIP	131-17-9		5-20	20-40		2	N
	DPP	131-16-8		5-20	20-40		2	N
	DCHA	849-99-0		5-20	20-40		2	N
	DHP	3648-21-3		5-20	20-40		2	N
	DEHT	6422-86-2		Coelutes with DEHP	Coelutes with DEHP		2	N
	DPHP	53306-54-0		5-20	20-40		2	Y

Table 7. cont. Method information. OPFRs.

Parameter group	Name of parameter	Cas no	Blank	LOD range (ng/L)	LOQ range (ng/L)	Method	Uncertainty category	Stable isotope labeled (SIL) analogue
OPFR water	TEP	78-40-0	Three blanks per batch. Blank subtraction for each batch based on the blank average. LOD and LOQ calculated from 3 x stdev and 10 x stdev. From blanks	0.5-5	5-10	To an aliquot of 100 mL water, labelled standards were added before the sample was cleaned up on HLB column, extracted with CAN. Up-concentrated before recovery standard was added, and analysed on LC-HRMS.	2	Y
	TCEP	115-96-8		1-2	2-3		2	Y
	TPrP	513-08-6		0.5-1	1-2		2	N
	TCPP	13674-84-5		10-20	20-40		2	Y
	TiBP	126-71-6		0.5-2	2-4		2	N
	DBPhP	2528-36-1		0.5-2	2-4		2	N
	TPhP	115-86-6					2	Y
	TnBP	126-73-8		0.5-2	2-4		2	Y
	BdPhP	2752-95-6		0.5-2	2-4		2	N
	TDCP	13674-87-8		1-3	2-5		2	Y
	TBEP	78-51-3		1-3	2-5		2	N
	2-IPPDPP	64532-94-1		1-3	2-5		2	N
	4-IPPDPP	55864-04-5		1-3	2-5		2	N
	TCP	1330-78-5		0.5-2	2-4		2	N
	EHDPP	1241-94-7		0.5-2	2-4		2	N
	IDDPP	29761-21-5		1-3	2-5		2	N
	B4IPPPP	55864-07-8		1-3	2-5		2	N
	TXP	25155-23-1		1-3	2-5		2	N
	TIPPP	26967-76-0		1-3	2-5		2	Y
	TEHP	78-42-2		1-3	2-5		2	Y
	TTBPP	78-33-1		1-3	2-5		3	N

Table 7. cont. Method information. Siloxanes.

Parameter group	Name parameter	Cas nr	Blank	LOQ range ng/g or ng/L	Method	Uncertainty category	Stable isotope labeled (SIL) analogue
Siloxanes, biota/sediment/ particles	D4 - octamethylcyclotetrasiloxane	556-67-2	Three blanks per batch. Blank subtraction for each batch based on the blank average. LOQ calculated from 10 x stdev. From blanks	0.255-0.6383	To 1-2 g of sample, ^{13}C D4, D5 and D6 were added as internal standard, followed by addition of acetonitrile and hexane. Ultrasonic bath and shaking before centrifugation. No further cleanup. Recovery standard added to a sub sample before analysis on GC/MSD. As described in previous MILFERSK/Urban fjord reports. No standard was available for L9-L10, and we used a crude product to estimate the retention time and transitions.	2	Y
	D5 - decamethylcyclopentasiloxane	541-02-6		0.174-0.910		2	Y
	D6 - dodecamethylcyclohexasiloxane	540-97-6		0.316-1.20		2	Y
	M3T (Ph)	2116-84-9		0.035-0.791		2	N
	L3 - octamethyltrisiloxane	107-51-7		0.167-0.513		2	N
	L4 - decamethyltetrasiloxane	141-62-8		0.764-2.50		2	N
	L5 - dodecamethylpentasiloxane	141-63-9		2.23-10.02		2	N
	L6 - tetradecamethylhexasiloxane	107-52-8				3	N
	L7 - hexadecamethylheptasiloxane	541-01-5				3	N
	L8 - octadecamethyloctasiloxane	556-69-4				3	N
	L9 – eicosamethylnonasiloxane *	2652-13-3				3	N
	L10 – docosamethyldecasiloxane *	556-70-7				3	N

* No standard available

Table 7. cont. Method information. Siloxanes.

Parameter group	Name parameter	Cas nr	Blank	LOQ range ng/L	Method	Uncertainty category	Stable isotope labeled (SIL) analogue
Siloxanes, water	D4 - octamethylcyclotetrasiloxane	556-67-2	Three blanks per batch. Blank subtraction for each batch based on the blank average. LOQ calculated from 10 x stdev. From blanks	5-10	To 100 mL of water, ^{13}C D4, D5 and D6 were added as internal standard, before addition of 40 mL dichloromethane (DCM). The sample was stirred for 1 h before 20 mL was transferred to a vial containing Na_2SO_4. No further cleanup before analysis.	2	Y
	D5 - decamethylcyclopentasiloxane	541-02-6		10-40		2	Y
	D6 - dodecamethylcyclohexasiloxane	540-97-6		15-50		2	Y
	M3T (Ph)	2116-84-9		15-50		2	N
	L3 - octamethyltrisiloxane	107-51-7		7-15		2	N
	L4 - decamethyltetrasiloxane	141-62-8		50-100		2	N
	L5 - dodecamethylpentasiloxane	141-63-9		160-300		2	N
	L6 - tetradecamethylhexasiloxane	107-52-8		160-300		3	N
	L7 - hexadecamethylheptasiloxane	541-01-5		160-300		3	N
	L8 - octadecamethyloctasiloxane	556-69-4		160-300		3	N
	L9 – eicosamethylnonasiloxane *	2652-13-3		160-300		3	N
	L10 – docosamethyldecasiloxane *	556-70-7		160-300		3	N

* No standard available

Table 7. cont. Method information. Musks.

Parameter group	Name parameter	Cas nr	Blank	LOQ range ng/g or ng/L	Method	Uncertainty category	Stable isotope labeled (SIL) analogue
Musk, filtered water/ suspended particles/ sediment/biota	Traseolide	68140-48-7	Filtered water: 100 mL of MilliQ water was prepared as a laboratory blank alongside each batch of ~8 samples. Suspended particles: Three blanks were prepared per batch. All extractions were done in a clean room or clean cabinet. Sediment/Biota: One laboratory blank was prepared alongside each batch of ~6 samples. For all samples, LODs were calculated by 3xSD of the associated laboratory blanks. Where compounds were not present in the laboratory blanks, sample/calibration standard peaks with signal:noise ratios of ~3:1 were converted to a sample concentration using the average blank volume/mass.	0.07 (0.17-0.45)	Filtered water: 200 mL of sample water was liquid-liquid extracted with 2x 10 mL of hexane. Extracts were dried with Na_2SO_4 and concentrated. Suspended particles: A subsample of the siloxane extracts were analysed for musks. Sediment/Biota: 1 g sample was mixed with Na_2SO_4. extracted via sonication with 2x 10 mL of acetone:hexane (1:1). After concentration. the extract was cleaned-up with EZ-POP SPE and concentrated. For all samples. d11-Tonalide was added as the internal standard prior to extraction and ^{13}C-PCB-159 was added as the recovery standard immediately prior to analysis on a GC-MS/MS with EI ionisation.	3	N
	Phantolide	15323-35-0		0.153 (0.47-1.52)		3	N
	Otne/Iso-E-super	54464-57-2		0.269 (1.09-8.98)		3	N
	Acetyl cedrene	32388-55-9		0.45 (0.59-1.99)		3	N
	Galaxolide	1222-05-5		0.01 (0.2-0.68)		3	N
	AHMT/Tonalide	21145-77-7		0.098 (0.05-0.29)		3	Y
	Celestolide	13171-00-1		0.023 (0.56-1.41)		3	N

Table 7. cont. Method information. Phenolic compounds.

Parameter group	Name parameter	Cas nr	Blank	Method	LOD range (ng/L)	LOQ range (ng/L)	Uncertainty category	Stable isotope labelled (SIL) analogue
Bisphenols	4,4-bisphenol A	80-05-7	Method blanks following sample series. LOD/LOQ based on calculation of 3 and 10 stdev respectively (or instrument detection limit if this is higher)	In-house method. Internal standard addition, accelerated solvent extraction (ASE) or supramolecular solvent extraction (SUPRAS), solid phase extraction cleanup. LC/HRMS (Orbitrap)	2-5	4-13	3	Y
	2,4-bisphenol A	837-08-1			0.4-1	1-3	3	N
	bisphenol G	127-54-8			1-3	1-7	3	N
	4,4-Bisphenol S	80-09-1			0.1-0.4	0.3-1	3	Y
	2,4-bisphenol S	5397-34-2			0.1-0.2	0.2-0.6	3	Y
	4,4-bisphenol F	620-92-8			0.5-1.5	1-4	3	Y
	2,4-bisphenol F	2467-03-0			1-3	3-9	3	N
	Bisphenol P	2167-51-3			0.6-2	2-6	3	Y
	Bisphenol Z	843-55-0			1-3	2-7	3	Y
	TBBPA	79-94-7			1.5-5	4-12	3	Y
	Bisphenol TMC	129188-99-4			1-3	3-8	3	N
	Bisphenol FL	3236-71-3			0.6-2	1-4	3	N
	Bisphenol B	77-40-7			0.4-1	0.8-3	3	Y
	Bisphenol M	13595-25-0			0.2-0.5	0.4-1.4	3	N
	Bisphenol AF	1478-61-1			0.1-0.3	0.3-1	3	Y
	Bisphenol AP	1571-75-1			0.4-1	0.8-2	3	N
Alkylphenols	4-tert-octylphenol	140-66-9			1-3	3-9	3	Y
	Dodecylphenol (branched)	27193-86-8			2-5	4-13	3	N
	4-octylphenol	1806-26-4			1-3	3-11	3	N
	Nonylphenol (branched)	84852-15-3			24-76	60-190	3	N
	4-nonylphenol	104-40-5			0.3-3	1-8	3	Y
Other phenolic compounds	MB1	118-82-1		In-house method. Internal standard addition, extraction. HRMS	1-6	2-20	3	N

Table 7. cont. Method information. Solvents (Chlorinated Volatile Organic Compounds).

Parameter group	Name compound	Cas no	Blank	LOD range ng/g (ng/L)	LOQ range ng/g (ng/L)	Method	Uncertainty category	Stable isotope labeled (SIL) analogue
Chlorinated VOC	Dichloromethane	75-09-2	LOD calculated using a series of 5-10 standards with a concentration close to LOD and using the following formula: $\frac{t_a * S_{\bar{x}}}{\frac{\bar{x}}{Std\ conc}}$ t_a = degrees of freedom (students t-test= $S_{\bar{x}}$ = Standard deviation of signal $\bar{x}$ = Average signal Std conc = the concentration of the 5-10 injected standards	0.4	1.3	VOC extracted from water using synthetic air and collected on to sorbent tubes. Analyzed using high resolution thermal desorption gas chromatography time-of-flight mass spectrometry (TD-GC-QToF-MS)	2	
	Trichloromethane	67-66-3		0.6	2		2	

4 Appendix

Three electronic appendices are also associated with this report:

1. concentrations of all compounds/isomers in all matrices (n, mean, median, min, max, LoQ and number of detected are presented)

2. Median concentrations of all compounds/isomers in all matrices, compared (cross table). Two tables where (a.) medians are calculated with non-detected compounds assigned a value of zero (0) and (b.) medians are calculated from concentrations >LoQ only.

3. Additional figures: all concentrations in all samples presented in bar plots.

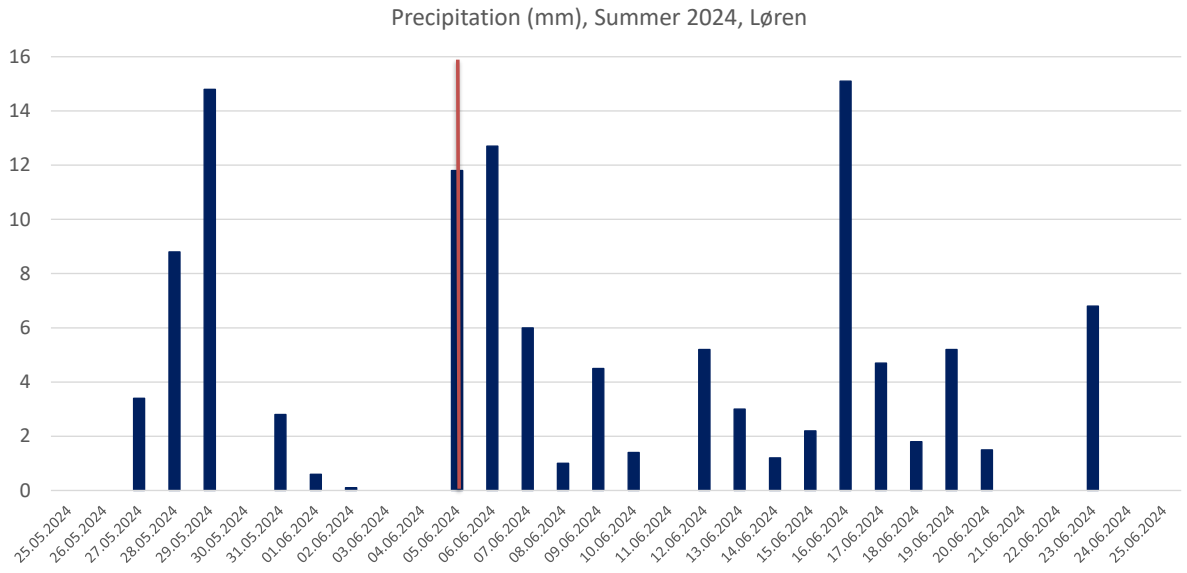


Figure 25. Time of stormwater sampling (|) in relation to precipitation (mm). Data from the Norwegian Centre for Climate Services (https://seklima.met.no/), measuring station Løren (SN18205).

Table 8. Analytes and support parameters analysed/evaluated in this study.

Substances	Abbreviation	CAS
Metals		
Mercury	Hg	7439-97-6
Chromium	Cr	7440-47-3
Iron	Fe	7439-89-6
Nickel	Ni	7440-02-0
Copper	Cu	7440-50-8
Zinc	Zn	7440-66-6
Arsenic	As	7440-38-2
Yttrium	Y	7440-65-5
Silver	Ag	7440-22-4
Cadmium	Cd	7440-43-9
Antimony	Sb	7440-36-0
Lead	Pb	7439-92-1
Scandium	Sc	7440-20-2
Lanthanum	La	7439-91-0
Cerium	Ce	7440-45-1
Praeseodymium	Pr	7440-10-0
Neodymium	Nd	7440-00-8
Samarium	Sm	7440-19-9
Europium	Eu	7440-53-1
Gadolinium	Gd	7440-54-2
Terbium	Tb	7440-27-9
Dysprosium	Dy	7429-91-6
Holmium	Ho	7440-60-0
Erbium	Er	7440-52-0
Thulium	Tm	7440-30-4
Ytterbium	Yb	7440-64-4
Lutetium	Lu	7439-94-3
Siloxanes		

2,2,4,4,6,6,8,8-Octamethyl-1,3,5,7,2,4,6,8-tetroxatetrasilocane	D4	556-67-2
2,2,4,4,6,6,8,8,10,10-Decamethyl-1,3,5,7,9,2,4,6,8,10-pentoxapentasilecane	D5	541-02-6
Dodecamethylcyclohexasiloxane	D6	540-97-6
tris(trimethylsiloxy)phenylsilane	M3T (Ph)	2116-84-9
Octamethyltrisiloxane (L3)	L3	107-51-7
Decamethyltetrasiloxane (L4)	L4	141-62-8
Dodecamethylpentasiloxane (L5)	L5	141-63-9
Tetradecamethylhexasiloxane (L6)	L6	107-52-8
Hexadecamethylheptasiloxane (L7)	L7	541-01-5
Octadecamethyloctasiloxane (L8)	L8	556-69-4
Eicosamethylnonasiloxane (L9)	L9	2652-13-3
Docosamethyldecasiloxane (L10)	L10	556-70-7
Polychlorinated biphenyls (PCB)		
2,2',5-Trichlorobiphenyl	PCB 18	37680-65-2
2,4,4'-Trichlorobiphenyl	PCB 28	7012-37-5
2,4',5-Trichlorobiphenyl	PCB 31	16606-02-3
2,3',4'-Trichlorobiphenyl	PCB 33	38444-86-9
3,4,4'-Trichlorobiphenyl	PCB 37	38444-90-5
2,2',4,4'-Tetrachlorobiphenyl	PCB 47	2437-79-8
2,2',5,5'-Tetrachlorobiphenyl	PCB 52	35693-99-3
2,3',4,4'-Tetrachlorobiphenyl	PCB 66	32598-10-0
2,4,4',5-Tetrachlorobiphenyl	PCB 74	32690-93-0
2,2',4,4',5-Pentachlorobiphenyl	PCB 99	38380-01-7
2,2',4,5,5'-Pentachlorobiphenyl	PCB 101	37680-73-2
2,3,3',4,4'-Pentachlorobiphenyl	PCB 105	32598-14-4
2,3,4,4',5-Pentachlorobiphenyl	PCB 114	74472-37-0
2,3',4,4',5-Pentachlorobiphenyl	PCB 118	31508-00-6
2,3,3',4',5'-Pentachlorobiphenyl	PCB 122	76842-07-4
2,3',4,4',5'-Pentachlorobiphenyl	PCB 123	65510-44-3
2,2',3,3',4,4'-Hexachlorobiphenyl	PCB 128	38380-07-3
2,2',3,4,4',5'-Hexachlorobiphenyl	PCB 138	35065-28-2

2,2',3,4,5,5'-Hexachlorobiphenyl	PCB 141	52712-04-6
2,2',3,4',5',6-Hexachlorobiphenyl	PCB 149	38380-04-0
2,2',4,4',5,5'-Hexachlorobiphenyl	PCB 153	35065-27-1
2,3,3',4,4',5-Hexachlorobiphenyl	PCB 156	38380-08-4
2,3,3',4,4',5'-Hexachlorobiphenyl	PCB 157	69782-90-7
2,3',4,4',5,5'-Hexachlorobiphenyl	PCB 167	52663-72-6
2,2',3,3',4,4',5-Heptachlorobiphenyl	PCB 170	35065-30-6
2,2',3,4,4',5,5'-Heptachlorobiphenyl	PCB 180	35065-29-3
2,2',3,4,4',5',6-Heptachlorobiphenyl	PCB 183	52663-69-1
2,2',3,4',5,5',6-Heptachlorobiphenyl	PCB 187	52663-68-0
2,3,3',4,4',5,5'-Heptachlorobiphenyl	PCB 189	39635-31-9
2,2',3,3',4,4',5,5'-Octachlorobiphenyl	PCB 194	35694-08-7
2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	PCB 206	40186-72-9
Decachlorobiphenyl	PCB 209	2051-24-3
Organochlorines		
Pentachlorobenzene	PECB	608-93-5
Hexachlorobenzene	HCB	118-74-1
Hexachlorobutadiene	HCBD	87-68-3
Organophosphorus Flame Retardants (OPFRs)		
Triethyl phosphate	TEP	78-40-0
Tris(2-chloroethyl) phosphate	TCEP	115-96-8
Tripropyl phosphate	TPrP	513-08-6
Tris(1-chloropropyl) phosphate	TCPP	13674-84-5
Triisobutyl phosphate	TiBP	126-71-6
Butyl diphenyl phosphate	BdPhP	2752-95-6
Dibutyl phenyl phosphate	DBPhP	2528-36-1
Triphenyl phosphate	TPhP	115-86-6
Tri-n-butyl phosphate	TnBP	126-73-8
Tris(1,3-dichloro-2-propyl) phosphate	TDCP	13674-87-8
Tris(2-butoxyethyl) phosphate	TBEP	78-51-3
Tricresyl phosphate	TCP	1330-78-5
2-Ethylhexyl diphenyl phosphate	EHDPP	1241-94-7
Tris(2-ethylhexyl) phosphate	TEHP	78-42-2

Tris(4-isopropylphenyl) phosphate	TIPPP/T4IPP	26967-76-0
Tris(4-Tert-butylphenyl) phosphate	TTBPP	78-33-1
Tri(2,4-di-t-butylphenyl) phosphate	TDTBPP	95906-11-9
O,O,O-triphenylphosphorothiate	TPPT	597-82-0
Phenols		
4-[2-(4-hydroxyphenyl)propan-2-yl]phenol	4,4-bisphenol A	80-05-7
2-[2-(4-hydroxyphenyl)propan-2-yl]phenol	2,4-bisphenol A	837-08-1
4-[2-(4-hydroxy-3-propan-2-ylphenyl)propan-2-yl]-2-propan-2-ylphenol	Bisphenol G	127-54-8
4-[1-(4-hydroxyphenyl)-1-phenylethyl]phenol	Bisphenol AP	1571-75-1
4-[9-(4-hydroxyphenyl)fluoren-9-yl]phenol	Bisphenol FL	3236-71-3
4-[1-(4-hydroxyphenyl)-3,3,5-trimethylcyclohexyl]phenol	Bisphenol TMC	129188-99-4
4-[2-(4-hydroxyphenyl)butan-2-yl]phenol	Bisphenol B	77-40-7
4-(4-hydroxyphenyl)sulfonylphenol	4,4-bisphenol S	80-09-1
2-(4-hydroxyphenyl)sulfonylphenol	2,4-bisphenol S	5397-34-2
4-[(4-hydroxyphenyl)methyl]phenol	4,4-bisphenol F	620-92-8
2-[(4-hydroxyphenyl)methyl]phenol	2,4-bisphenol F	2467-03-0
2,6-ditert-butyl-4-[(3,5-ditert-butyl-4-hydroxyphenyl)methyl]phenol	AO-MB1	118-82-1
4-[2-[4-[2-(4-hydroxyphenyl)propan-2-yl]phenyl]propan-2-yl]phenol	Bisphenol P	2167-51-3
4-[2-[3-[2-(4-hydroxyphenyl)propan-2-yl]phenyl]propan-2-yl]phenol	Bisphenol M	13595-25-0
4-[1-(4-hydroxyphenyl)cyclohexyl]phenol	Bisphenol Z	843-55-0
4-[1,1,1,3,3,3-hexafluoro-2-(4-hydroxyphenyl)propan-2-yl]phenol	Bisphenol AF	1478-61-1
2,6-dibromo-4-[2-(3,5-dibromo-4-hydroxyphenyl)propan-2-yl]phenol	TBBPA	79-94-7
4-(2,4,4-trimethylpentan-2-yl)phenol	4-tert-octylphenol	140-66-9
4-octylphenol	4-octylphenol	1806-26-4
4-(7-methyloctyl)phenol	4-nonylphenol, branched and linear	104-40-5, 84852-15-3
Dodecylphenol	Dodecylphenol	27193-86-8, 104-43-8, 121158-58-5
Per- and polyfluoroalkyl substances (PFAS)		

PFCA (perfluorinated carboxylate acids)		
Tri fluoro acetic acid	TFA	76-05-1
Perfluoro propanoic acid	PFPrA	422-64-0
Perfluorinated butanoic acid	PFBA	375-22-4
Perfluorinated pentanoic acid	PFPA	2706-90-3
Perfluorinated hexanoic acid	PFHxA	307-24-4
Perfluorinated heptanoic acid	PFHpA	375-85-9
Perfluorinated octanoic acid	PFOA	335-67-1
Perfluorinated nonanoic acid	PFNA	375-95-1
Perfluorinated decanoic acid	PFDA	335-76-2
Perfluorinated undecanoic acid	PFUnDA	2058-94-8
Perfluorinated dodecanoic acid	PFDoDA	307-55-1
Perfluorinated tridecanoic acid	PFTrDA	72629-94-8
Perfluorinated tetradecanoic acid	PFTeDA	376-06-7
Perfluorinated hexadecanoic acid	PFHxDA	67905-19-5
Perfluorinated octadecanoic acid	PFOcDA	16517-11-6
PFSA (Perfluoroalkane sulfonic acids)		
Perfluoro methane sulfonic acid	PMeS	1493-13-6
Perfluoro ethan sulfonic acid	PFEtS	354-88-1
perfluoropropan sulfonic acid	PFPrS	423-41-6
Perfluorinated butane sulfonic acid	PFBS	375-73-5
Perfluorinated pentane sulfonic acid	PFPS	2706-91-4
Perfluorinated hexane sulfonic acid	PFHxS	355-46-4
Perfluorinated heptane sulfonic acid	PFHpS	375-92-8
Perfluorinated octane sulfonic acid (linear)	PFOS	2795-39-3
Perfluorinated octane sulfonic acid (branched)	brPFOS	1763-23-1
Perfluorinated nonane sulfonic acid	PFNS	474511-07-4
Perfluorinated decane sulfonic acid	PFDS	335-77-3
Perfluoroundecane sulfonic acid	PFUnDS	441296-91-9
Perfluorododecane sulfonic acid	PFDoDS	79780-39-5
Perfluorotridecane sulfonic acid	PFTrDS	791563-89-8
Perfluorotetradecane sulfonic acid	PFTeDS	1379460-39-5
nPFAS (polyfluorinated neutral compounds)		

Perfluorobutylsulphonamide	PFBSA	30334-69-1
n-(methyl)nonafluorobutanesulfonamide	N-MeFBSA	68298-12-4
N-ethyl-perfluorobutane-1-sulfonamide	N-EtFBSA	40630-67-9
Perfluorooctane sulfonamide	PFOSA	754-91-6
N-Methyl perfluorooctane sulphonamide	N-MeFOSA	31506-32-8
N-Ethyl perfluorooctane sulfonamide	N-EtFOSA	4151-50-2
N-Methyl perfluorooctane sulfonamidoethanol	N-MeFOSE	24448-09-7
N-Ethyl perfluorooctane sulfonamidoethanol	N-EtFOSE	1691-99-2
N-Ethyl perfluorooctane sulfonamidoacetic acid	N-EtFOSAA	2991-50-6
newPFAS		
4:2 Fluorotelomer sulfonic acid	4:2 FTS	757124-72-4
6:2 Fluorotelomer sulfonic acid	6:2 FTS	27619-97-2
8:2 Fluorotelomer sulfonic acid	8:2 FTS	481071-78-7
10:2 Fluorotelomer sulfonic acid	10:2 FTS	120226-60-0
12:2 Fluorotelomer sulfonic acid	12:2 FTS	149246-64-0
Sodium Dodecafluoro-3H- 4,8-dioxanonanoate	ADONA	958445-44-8
Cyclohexanesulfonic acid	PFECHS	67584-42-3
2,3,3,3-Tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy)propanoic acid (Gen-X)	HFPO-DA (Gen-X)	13252-13-6
UV Chemicals		
Benzophenone-3	BP3	131-57-7
Ethylhexylmethoxycinnamate Z	EHMC-Z	177352-99-7
Ethylhexylmethoxycinnamate E	EHMC-E	5466-77-3
Octocrylene	OC	6197-30-4
UV-329	UV-329	3147-75-9
UV-328	UV-328	25973-55-1
UV-327	UV-327	3864-99-1
Homosalate	Homosalate	118-56-9
3-(2H-benzotriazol-2-yl)-5-(1,1-dimethylethyl)-4-hydroxy-benzenepropanoic acid l	M1-UV328	84268-36-0
Dechloranes		
Dibromoaldrin	DBA	20389-65-5
Dechlorane 602	Dec-602	31107-44-5

Dechlorane 603	Dec-603	13560-92-4
Dechlorane 604	Dec-604	34571-16-9
Dechlorane 601	Dec-601	3560-90-2
Dechlorane plus syn	syn-DP	135821-03-3
Dechlorane plus anti	anti-DP	135821-74-8
Quaternary ammonium compounds		
Trimethyloctylammonium	ATAC-C8	2083-68-3
Decyltrimethylammonium	ATAC-C10	2082-84-0
Dodecyltrimethylammonium	ATAC-C12	1119-94-4
Tetradecyltrimethylammonium	ATAC-C14	1119-97-7
Hexadecyltrimethylammonium	ATAC-C16	57-09-0
Trimethyloctadecylammonium	ATAC-C18	1120-02-1
ATAC-C20	ATAC-C20	15809-05-9
ATAC-C22	ATAC-C22	17301-53-0
Dimethyldioctylammonium	DADMAC-C8	3026-69-5
Didecyldimethylammonium	DADMAC-C10	2390-68-3
Didodecyldimethylammonium	DADMAC-C12	3282-73-3
Dimethylditetradecylammonium	DADMAC-C14	68105-02-2
Dihexadecyldimethylammonium	DADMAC-C16	70755-47-4
Dimethyldioctadecylammonium	DADMAC-C18	3700-67-2
Benzyldimethyloctylammonium	BAC-C8	959-55-7
Benzyldimethyldecylammonium	BAC-C10	965-32-2
Benzyldimethyldodecylammonium	BAC-C12	139-07-1
Benzyldimethyltetradecylammonium	BAC-C14	139-08-2
Benzyldimethylhexadecylammonium	BAC-C16	122-18-9
Benzyldimethyloctadecylammonium	BAC-C18	122-19-0
Pesticides/Fungicides		
Chlorhexidine	Klorheksidin	55-56-01
Chlorpyrifos	Chlorpyrifos	2921-88-2
Tebuconazol	Tebuconazol	107534-96-3
Triclocarban	Triclocarban	101-20-2
Permitrin (*cis*)	Permitrin (cis)	52645-53-1
Permitrin (*trans*)	Permitrin (trans)	52645-53-1

Triclosan	Triclosan	3380-34-5
Musks		
Galaxolide	HHCB	1222-05-5
Tonalide	TONA	21145-77-7
Traseolide	TRAS	68140-48-7
Phantolide	PANT	15323-35-0
Celestolide	KELE	13171-00-1
Iso-E-super	OTNE	54464-57-2
Acetyl cedrene	MCKETON	32388-55-9
Benzothiazoles		
Mercaptobenzothiazole	MBT	149-30-4
Benzotriazole	BTZ	95-14-7
Benzothiazole	BT	95-16-9
2(3H)-Benzothiazolone	OHBT	934-34-9
Methyl-1H-benzotriazole	MeBTZ	29385-43-1
N-cyclohexylbenzothiazole-2-sulfenamide	CBS	95-33-0
Phthalates		
Bis(2-methoxyethyl) phthalate	BMEP (DMEP)	117-82-8
Diethyl phthalate	DEP	84-66-2
Bis(2-ethoxyethyl) phthalate	BEEP	605-54-9
Diisobutyl phthalate	DIBP	84-69-5
Di-n-butyl phthalate	DNBP	84-74-2
Butylbenzyl phthalate	BBP	85-68-7
Bis(2-butoxyethyl) phthalate	BnBP (DBOEP)	117-83-9
Dicyclohexyl phthalate	DcHP	84-61-7
Dipentylphthalate	DDP	131-18-0
Bis(4-methyl-2-pentyl) phthalate	DMPP	84-63-9
Dihexylphthalate	DHxP	84-75-3
Bis(2-ethylhexyl) phthalate	DEHP	117-81-7
Dioctyl phthalate	DOP	117-84-0
Diisononyl phthalate	DINP	28553-12-0
Diisodecyl phthalate	DIDP	26761-40-0
Diundecyl phthalate, branched and linear	DiUP	85507-79-5

Dimethyl phthalate	DMP	131-11-3
Diallylphthalate	DAIP	131-17-9
Dipropylphthalate	DPP (dipropylphthalate)	131-16-8
Chlorinated paraffins		
Short-chain chlorinated paraffins (C10-C13)	SCCP	85535-84-8
Medium-chain chlorinated paraffins (C14-C17)	MCCP	85535-85-9
Long-chain chlorinated paraffins (C>17)	LCCP	85535-86-0
Support parameters		
Stable isotopes $\delta^{15}N$, $\delta^{13}C$		
Lipid content (biota)		
Length/weight (fish)		
TOC (sediment) and pH		

Stable isotopes

The results of the individual stable isotope-analysis of C and N are given in Table 9.

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

Figure 26 shows that trout is a higher trophic species than invertebrates and water moss (the latter having the lowest average $\delta^{15}N$. There was no significant relationship between $\delta^{15}N$ and fish length for trout (not shown).

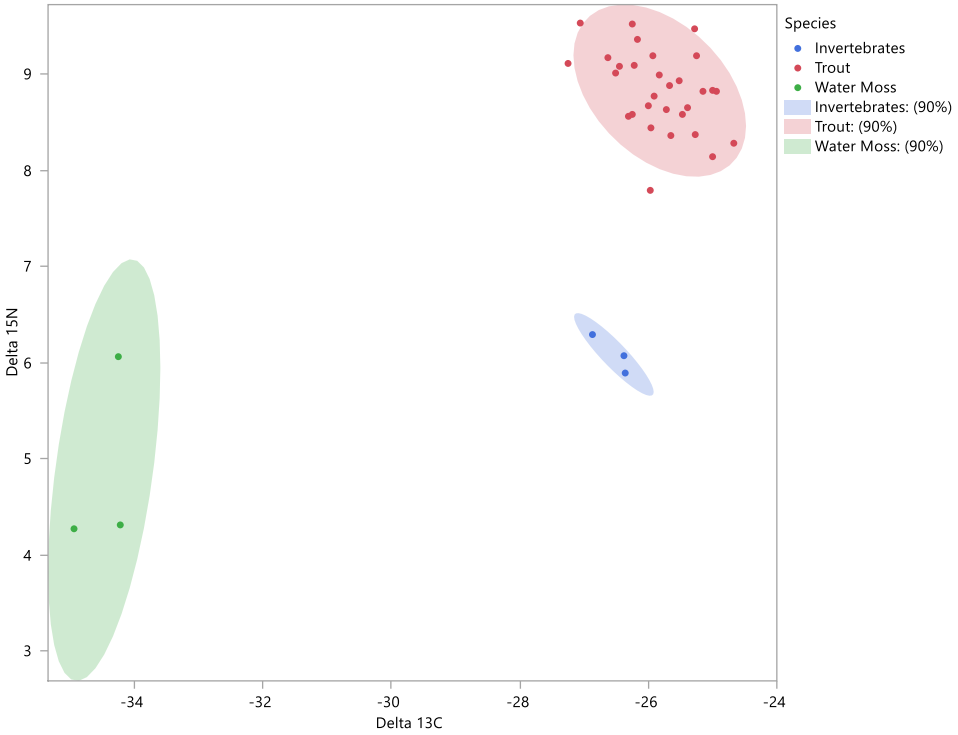


Figure 26. $\delta^{15}N$ plotted against $\delta^{13}C$ in individual samples of brown trout from Alna river, as well as in pooled samples of invertebrates, and in water moss from Alna river. The 90% confidence areas are indicated.

*Table 9. Biometric data for individual specimens of trout (**A** and **B**), invertebrates (**C**) and water moss (**D**) from Alna River.*

A. (Trout, station 1)

Trout station	Ind. No.	$\delta^{13}C$	$\delta^{15}N$	W%C	W%N	Part of pooled sample	Length (cm)	Weight (g)	Sex	Trophic level
1	1	-25.28	9.47	48.8	12.9	1	24.2	184.1	M	2.35
1	2	-25.27	8.37	48.9	12.7	1	21.6	120.5	F	2.03
1	3	-26.25	9.52	51.7	11.2	1	19.2	73.4	F	2.36
1	4	-24.67	8.28	44.4	12.9	1	20.2	101.9	M	2.00
1	5	-25	8.83	48.4	13.3	1	19.7	86.5	M	2.16
1	6	-25.25	9.19	48.8	12.5	2	21.2	112.1	M	2.27
1	7	-25	8.14	46.7	13	2	24.5	192.8	M	1.96
1	8	-26	8.67	51.4	11.1	2	22.1	137.2	M	2.11
1	9	-25.97	7.79	51.2	11.2	2	20	96.5	F	1.86
1	10	-25.65	8.36	49.9	12.3	2	19.7	80.5	M	2.02
1	11	-25.15	8.82	47	13.1	3	21.3	126.7	M	2.16
1	12	-25.39	8.65	49.1	12.7	3	22.3	131.9	M	2.11
1	13	-24.94	8.82	45.8	13	3	20.6	99.4	F	2.16
1	14	-25.96	8.44	50.3	11.5	3	21.2	116.2	F	2.05
1	15	-25.67	8.88	49.4	12.3	3	19.5	103.3	M	2.18

B. (Trout, station 2)

Trout station	Ind. No.	$\delta^{13}C$	$\delta^{15}N$	W%C	W%N	Part of pooled sample	Length (cm)	Weight (g)	Sex	Trophic level
2	1	-26.63	9.17	52	11	1	22.2	169.7	M	2.26
2	2	-27.25	9.11	52.1	9.95	1	19.8	99.7	F	2.24
2	3	-25.91	8.77	48.9	12.4	1	19.2	80.7	M	2.14
2	4	-27.06	9.53	50.7	10.5	1	19.8	103.9	M	2.37
2	5	-26.31	8.56	48.8	11.7	1	19.4	100.8	M	2.08
2	6	-25.52	8.93	47.8	13.5	2	19.5	96.7	F	2.19
2	7	-25.47	8.58	45.7	12.8	2	20.7	124.3	F	2.09
2	8	-26.45	9.08	50.1	11.7	2	18.9	87.1	F	2.24
2	9	-25.93	9.19	49	12.3	2	20.3	107.1	M	2.27
2	10	-26.51	9.01	50.7	11.6	2	23.6	178.7	M	2.21
2	11	-26.22	9.09	48.2	12.6	3	20.7	112.5	F	2.24
2	12	-26.25	8.58	49.2	11.7	3	19.5	95.3	M	2.09
2	13	-25.72	8.63	46	12.4	3	21.2	122.3	F	2.10
2	14	-25.83	8.99	49	12.6	3	19.2	91.4	M	2.21
2	15	-26.17	9.36	48.2	12.4	3	21.5	127.5	F	2.32

C. (Invertebrates)

Sample no.	$\delta^{13}C$	$\delta^{15}N$	W%C	W%N	Trophic Level
1	-26.87	6.29	38.7	7.07	1.41
2	-26.38	6.07	32.1	5.52	1.35
3	-26.36	5.89	39.6	6.95	1.30

D. (Water moss)

Sample no.	$\delta^{13}C$	$\delta^{15}N$	W%C	W%N	Trophic Level
1	-34.94	4.27	13.2	0.983	0.82
2	-34.22	4.31	13.4	0.901	0.83
3	-34.25	6.06	9.01	0.615	1.35

5 References

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

Direktoratsgruppa for vannforvaltning. (2025, 7. mai). Veileder for klassifisering av miljøtilstand i kyst- og ferskvann. Vannportalen.

Gundersen CB, Reid M, Rostkowski P, Bæk K, Rundberget T, Vogelsang C, Rødland E, Beylich B, Eikenes H, Bäcklund A, Walker S-E, Borgen AR, Nikiforov V, Håland A, Schmidbauer N. 2023. Screening Programme 2022. New environmental pollutants. Report M2612-2023 from the Norwegian Environment Agency. NIVA-report 7906-2023. 73 pp + appendix.

Vogelsang C. 2024. Sak: Forslag til prøvetakingspunkter for kildesporing av desinfeksjons- og løsemidler i Alna. NIVA-memo dated August 21st, 2024. J.no. 0221/24.

Yuan B, McLachlan MS, Roos AM, Simon M, Strid A, de Wit CA. 2021. Long-Chain Chlorinated Paraffins Have Reached the Arctic. *Environ Sci Technol Lett*. 8(9):753–759. doi:10.1021/acs.estlett.1c00470.

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

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

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