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Environmental contaminants in freshwater food webs, 2021

Photo: Morten Jartun

Norwegian Institute for Water Research

REPORT

Main Office
Økernveien 94
NO-0579 Oslo, Norway
Phone (47) 22 18 51 00

NIVA Region South
Jon Lilletuns vei 3
NO-4879 Grimstad, Norway
Phone (47) 22 18 51 00

NIVA Region East
Sandvikaveien 59
NO-2312 Ottestad, Norway
Phone (47) 22 18 51 00

NIVA Region West
Thormøhlensgate 53 D
NO-5006 Bergen Norway
Phone (47) 22 18 51 00

NIVA Denmark
Njalsgade 76, 4th floor
DK 2300 Copenhagen S, Denmark
Phone (45) 39 17 97 33

Internet: www.niva.no

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Author(s) Morten Jartun, Asle Økelsrud, Kine Bæk, Anders Ruus, Thomas Rundberget, Christian Vogelsang, Marthe T.S. Jenssen, Espen Lund, Merete Grung, Sigurd Øxnevad, Ellen Katrin Enge (NILU), Martin Schlabach (NILU), Linda Hanssen (NILU) and Ingar Johansen (IFE)	Topic group Environmental monitoring	Distribution Open
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Summary

This report presents monitoring data from freshwater food webs and abiotic samples from Lake Mjøsa and Femunden within the Milfersk programme. Studies and monitoring of legacy and emerging contaminants have been carried out through this programme for several years, focusing on the pelagic food web. This is the first report in the monitoring program focusing on a benthic food chain (Chironomids, ruffe, roach and perch) in addition to inputs to Lake Mjøsa by analysis of lake sediments, surface waters, stormwater, effluent and sludge from a wastewater treatment plant (WWTP). The analytical programme includes the determination of a total of ~ 260 single components.

Four keywords	Fire emneord
1. Contaminants	1. Miljøgifter
2. Freshwater ecosystems	2. Ferskvann
3. Bioaccumulation	3. Bioakkumulering
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Morten Jartun, Asle Økelsrud	*Anders Ruus*	*Marianne Olsen*
Project Manager/Main Author	Quality Assurance	Research director

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Environmental contaminants in freshwater food webs, 2021

Preface

This report presents data from the first year of a new 5-year monitoring period of freshwater ecosystems in Lakes Mjøsa and Femunden (MILFERSK). Studies of environmental contaminants in food webs of great Norwegian lakes date back several years, and the new monitoring program period from 2021-2025 will cover new insight in the environmental risk posed by local contaminant sources on both the pelagic and benthic food webs of Lake Mjøsa. In 2021, we have studied samples of stormwater from an urban area, effluent and sludge from a wastewater treatment plant (inputs to Lake Mjøsa), surface lake water and lake sediments in addition to samples of the benthic food chain. Biota samples in 2021 include brown trout (*Salmo trutta*) from Lakes Mjøsa and Femunden, and *Chironomidae*, roach (*Rutilus rutilus*), ruffe (*Gymnocephalus cernua*) and perch (*Perca fluviatilis*) representing a benthic food chain in Lake Mjøsa.

This year's sampling campaign was carried out by NIVA, with help from local fishermen in Lake Mjøsa (Harald Jøranli) and Lake Femunden (Arne Elgaaen and Øystein Trondsen). Chemical analyses were performed by NIVA, the Norwegian Institute for Air Research (NILU) and the Institute for Energy Technology (IFE).

This report represents an extended summary of the MILFERSK 2021 campaign, and the scientific quality assurance have been performed by Anders Ruus and Merete Grung.

Oslo, 28.11.2022

Morten Jartun
Project manager

Table of contents

Summary

The 2021 program for environmental contaminants in freshwater food webs (MILFERSK) covers sampling and analyses of sediments and surface water within Lake Mjøsa, stormwater, effluent from a wastewater treatment plant (WWTP) as a measure of inputs to Lake Mjøsa, and biological samples of chironomid larvae, roach, ruffe, perch and brown trout from Lake Mjøsa. Brown trout were also sampled from Lake Femunden as a reference location. A total of ~260 single compounds/isomers were determined within the major contaminants groups per- and polyfluorinated alkyl substances (PFAS), UV-chemicals, brominated flame retardants (e.g., PBDEs), siloxanes, pesticides, benzothiazoles, chlorinated paraffins, quaternary ammonium compounds (QAC), polychlorinated biphenyls (PCBs), phthalates, dechloranes, phosphorus flame retardants (oPFR), phenolic compounds, metals and rare earth metals.

Highest concentrations of contaminants were found in sludge from the WWTP, with levels dominating other sample media. Phtalates and QAC were dominating contaminants in the sludge from WWTP. In the other abiotic samples, UV-chemicals and benzothiazoles were mostly detected in the soluble phase, whereas pesticides, chlorinated paraffins and phthalates were found in the particulate fractions of stormwater and WWTP effluent. The cyclic siloxanes D4, D5 and D6 were the dominating siloxane compounds in all matrices. PFAS and brominated flame retardants were found in lower concentrations, and several congeners not detected in abiotic matrices, except WWTP sludge.

In biota, we see that some of the contaminant groups are dominating in lower trophic levels, such as QAC and phenols, whereas contaminants such as PCBs, PFASs and siloxanes seem to biomagnify up the food chain. PFOS is the dominating PFAS in lower trophic levels, whereas long chained PFSAs dominate in top predator brown trout liver. QAC is the most dominating contaminant group in chironomids and lower trophic level fish (roach). Phtalates dominates in ruffe, whereas phenols is a dominating group in perch muscle. In the top predator brown trout muscle, PCBs and siloxanes are dominating.

Sammendrag

Tittel: Environmental contaminants in freshwater food webs, 2021
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I 2021 omfattet programmet for miljøgifter i ferskvannsnæringsnett (MILFERSK) prøvetaking og analyser av sedimenter og overflatevann i Mjøsa, overvann, avløp fra et avløpsrenseanlegg som mål på tilførsler til Mjøsa, og biologiske prøver av fjærmygglarver, mort, hork, abbor og ørret fra Mjøsa. Det ble også tatt prøver av ørret fra Femunden som referanse. Totalt ble ca. 260 enkeltforbindelser/isomerer bestemt fra de viktigste forurensningsgruppene per- og polyfluorerte alkylsubstanser (PFAS), UV-kjemikalier, bromerte flammehemmere (f.eks. PBDE), siloksaner, pesticider, benzothiazoler, klorerte parafiner, kvartærnære ammoniumforbindelser (QAC), polyklorerte bifenyler (PCB), ftalater, dekloraner, fosfororganiske flammehemmere (oPFR), fenoliske forbindelser, metaller og sjeldne jordmetaller.

Høyeste konsentrasjoner av miljøgifter ble funnet i slam fra renseanlegget, med nivåer som dominerte over andre prøvematerialer. Ftalater og QAC var dominerende miljøgifter i slammet fra renseanlegget. I de andre abiotiske prøvene ble UV-kjemikalier og benzotiazoler for det meste påvist i løselig fase, mens det ble funnet pesticider, klorparafiner og ftalater i partikkelfraksjonene av overvann og avløpsvann. Siloksanene D4, D5 og D6 var de dominerende siloksanforbindelsene i alle prøvetyper. PFAS og bromerte flammehemmere ble funnet i lavere konsentrasjoner, og flere kongenere ble ikke påvist i abiotiske matriser, bortsett fra i WWTP-slam.

I biota ser vi at noen av miljøgiftene først og fremst påvises i lavere trofiske nivåer, bl.a. QAC og fenoler, mens stoffgrupper som PCB, PFAS og siloksaner ser ut til å biomagnifisere oppover i næringskjeden. PFOS er den dominerende PFAS-en i lavere trofiske nivåer, mens langkjedede PFSA-er dominerer i toppen av næringskjeden i lever fra ørret. QAC er stoffgruppa med høyest konsentrasjon i fjærmygglarver og fisk på lavere trofisk nivå (mort). Ftalater dominerer i hork, mens fenoler er en påvises i abbormuskel. I toppredatoren ørret er det PCB og siloksaner som dominerer i muskel.

1 Introduction

"Environmental contaminants in freshwater food webs (MILFERSK)" is a program designed to monitor the presence and potential sources of contaminants in a lake with a high anthropogenic impact (Lake Mjøsa). For some samples, a more rural lake (Lake Femunden) is used for comparison. We are studying how input from legacy and emerging contaminants affect freshwater food webs. In contrast to previous years, this program will in the coming years address empirical data on inputs of contaminants from potential local sources such as urban stormwater and effluent from wastewater treatment plants (WWTP) in addition to measurements of contaminant concentrations in different aquatic species and assessment of bioaccumulation patterns within pelagic and benthic food webs.

Studies of environmental contaminants in food webs of great Norwegian lakes date back several years, and the new monitoring program period from 2021-2025 will cover new insight in the environmental risk posed by local contaminant sources on both the pelagic and benthic food webs of Lake Mjøsa. In 2021, we have studied samples of stormwater, effluent and sludge from a wastewater treatment plant (inputs to Lake Mjøsa), surface lake water and lake sediments in addition to samples of the food chain. Biota samples in 2021 include brown trout (*Salmo trutta*) from Lakes Mjøsa and Femunden, and larvae stages of *Chironomidae*, roach (*Rutilus rutilus*), ruffe (*Gymnocephalus cernua*) and perch (*Perca fluviatilis*) representing a benthic food chain in Lake Mjøsa.

2 Extended summary

2.1 Samples and localities

An overview of the samples collected in the MILFERSK program in 2021 is presented in Table 1. Localities for sample collection are shown in Figure 1 and Figure 2.

Table 1. Overview of samples collected for the MILFERSK programme 2021.

Main category	Species/sample	Matrix	Locality	Station code	Coordinates UTM 33	No. for analysis
Abiotic samples	Sediment	Whole sediment	Pooled sample transect 1, Mjøsa		See surface water	1
	Surface water	Water	Transect 1, Mjøsa	M1	N: 6744423 E: 285298	3
				M2	N: 6745020 E: 285721	
				M3	N: 6745472 E: 286262	
	Stormwater	Water phase (dissolved) and particulate fraction	Hamar, central city	St.1	N: 6746040 E: 286363	4
				St.2	N: 6746367 E: 285547	
	Effluent from WWTP	Water (dissolved)	HIAS, Mjøsa	HIAS	N: 6743155 E: 286139	2
	Sludge from WWTP	Sludge	HIAS, Mjøsa	HIAS	N: 6743155 E: 286139	1
Biological samples	Chironomidae (larvae stage)	Whole body	Hamar – HIAS, Mjøsa		N: 6744576 E: 286465	1
	Roach (*Rutilus rutilus)*	Whole body	Hamar – HIAS, Mjøsa		N: 6744576 E: 286465	1 pooled sample of 15 individuals
	Ruffe (*Gymnocephalus cernua*)	Whole body	Hamar – HIAS, Mjøsa		N: 6744576 E: 286465	1 pooled sample of 15 individuals
	Perch (*Perca fluviatilis*)	Muscle and liver	Hamar – HIAS, Mjøsa		N: 6744576 E: 286465	1 pooled sample of 15 individuals
	Brown trout (*Salmo trutta*)	Muscle and liver	Gjøvik, Mjøsa		N: 6749999 E: 265299	3 pooled samples of 15 individuals
	Brown trout (*Salmo trutta*)	Muscle and liver	Femunden		N: 6890748 E: 332137	3 pooled samples of 15 individuals

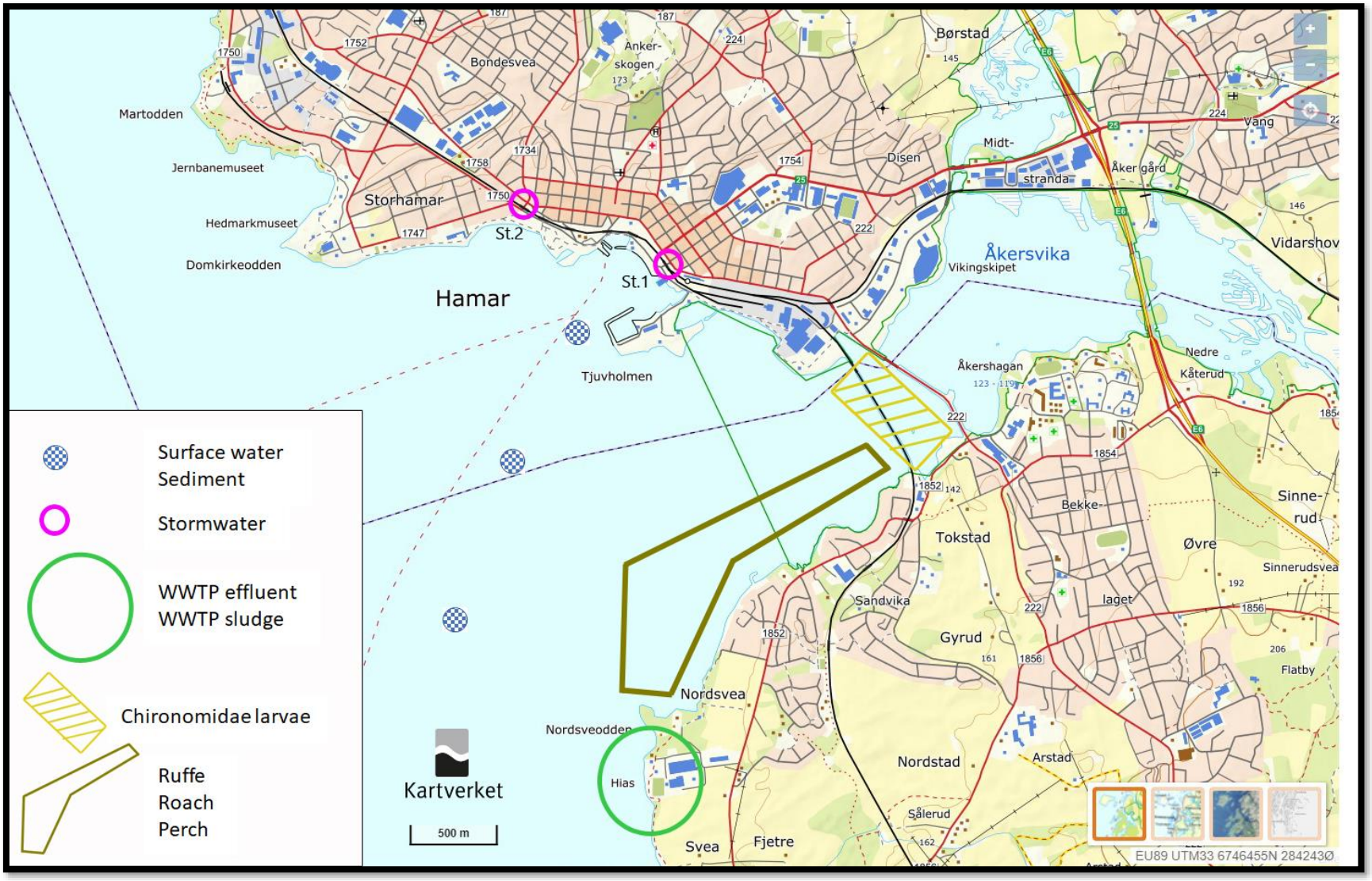


Figure 1. Sampling stations for abiotic samples and benthic food chain close to Hamar city.

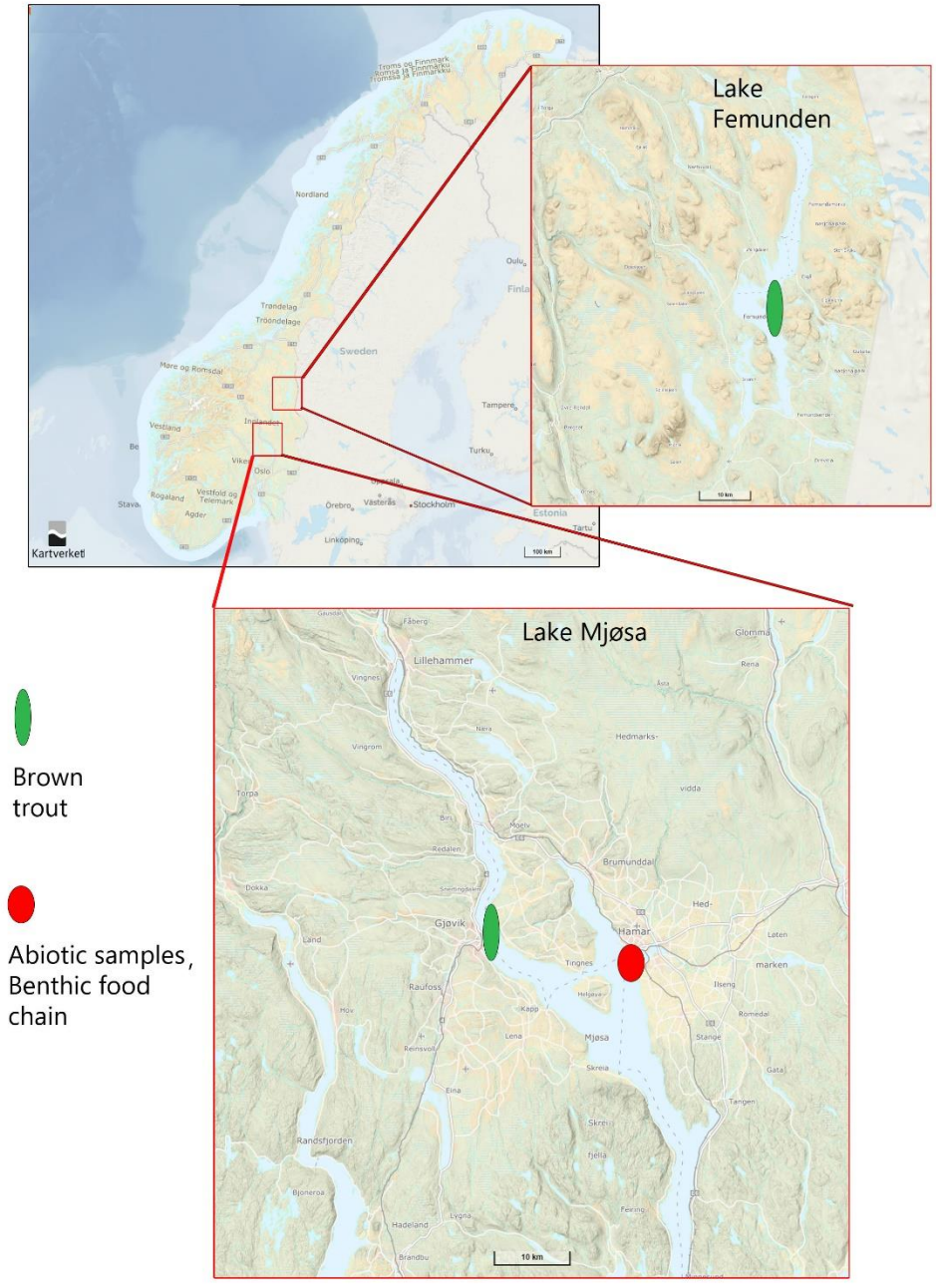


Figure 2. Map depicting overview of the sample stations in Lakes Mjøsa and Femunden.

2.2 Chemical analysis

Details of the chemical analysis are presented in Appendix. Table 2 shows an overview of the chemical analyses performed in the different samples.

Table 2. Overview: Analyses in different matrices from the different localities in 2021.

	Abiotic					Biota					
	Sediment	Surface water	Stormwater	WWTP Effluent	WWTP Sludge	Chironomidae*	Ruffe*	Roach*	Perch**	Brown trout, Mjøsa**	Brown trout, Femunden**
Metals	X	X	X	X	X	X	X	X	X	X	X
Siloxanes	X	X	X	X	X	X	X	X	X	X	X
PCBs	X		X	X	X	X	X	X	X	X	X
PBDEs	X		X	X	X	X	X	X	X	X	X
Other BFRs	X		X	X	X	X	X	X	X	X	X
OPFRs	X		X	X	X						
PFCA, PFSA, nPFAS, new PFAS	X		X	X	X	X	X	X	X	X	X
UV-chemicals	X		X	X	X	X	X	X	X	X	X
Dechloranes	X		X	X	X	X	X	X	X	X	X
QAC	X		X	X	X	X	X	X	X	X	X
Pesticides			X	X	X	X	X	X	X	X	
Musk	X		X	X	X	X	X	X	X	X	X
Benzothiazoles	X	X	X	X	X	X	X	X	X	X	X
Phthalates	X	X	X	X	X	X	X	X	X	X	
Chlorinated paraffins	X		X	X	X	X	X	X	X	X	
Stable isotopes of C and N						X	X	X	X	X	X

*Whole body, **Muscle and liver

2.3 Results

In this chapter, key results and findings are presented. All results are presented in an electronic appendix.

2.3.1 Stable isotopes

The results of the individual stable isotope-analysis of $\delta^{13}C$ and $\delta^{15}N$ are given in Appendix (Table 11 and Table 12).

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 the 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, see Figure 3.

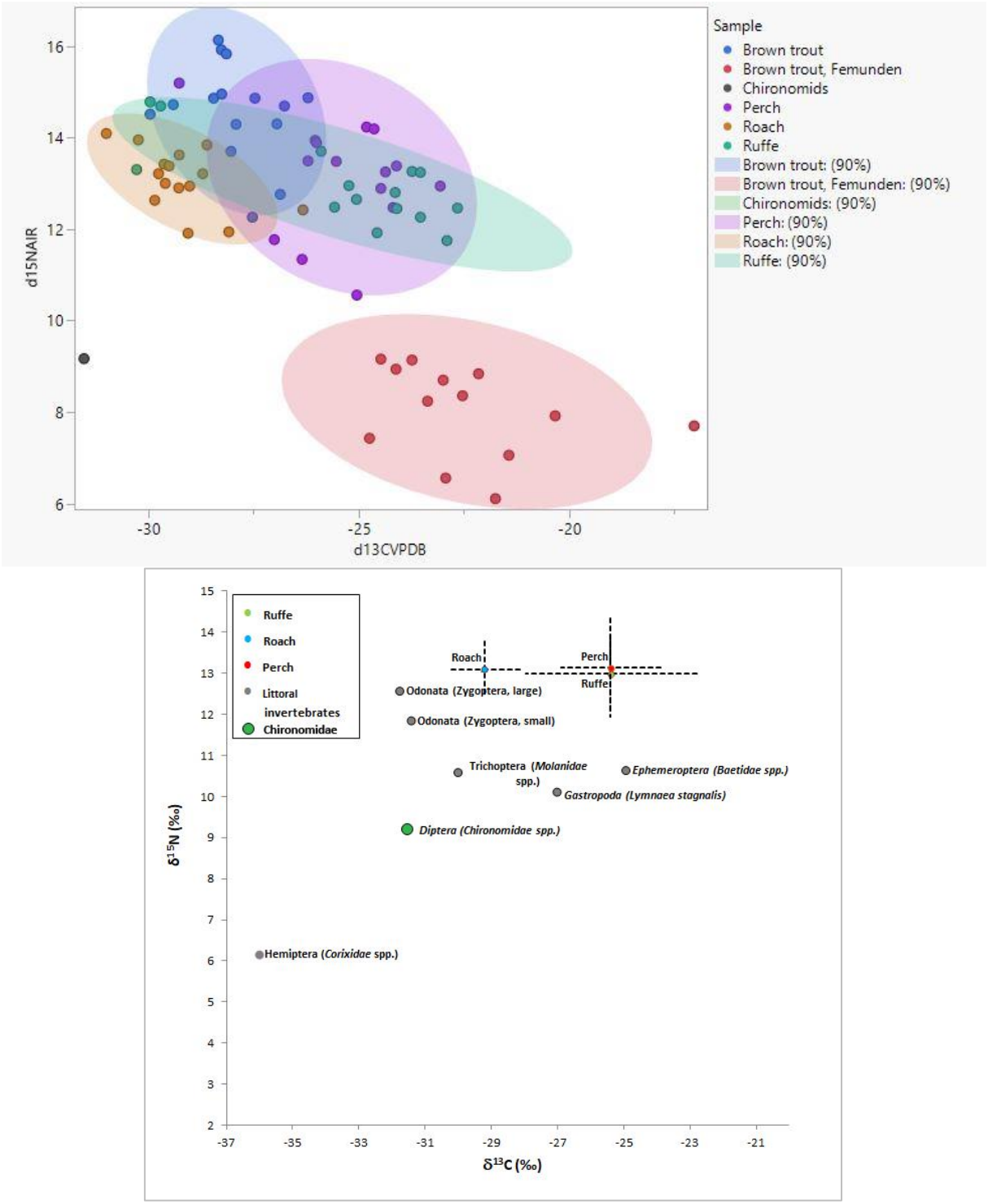


Figure 3. $\delta^{15}N$ plotted against $\delta^{13}C$ in individual samples of fish and Chironomids in this study from Lakes Mjøsa. Brown trout was the only species from Lake Femunden. 90% confidence areas are indicated (top), and isotope signatures from additional invertebrates (bottom).

2.3.2 Detection frequencies of contaminants

A total of approx. 280 single compounds/isomers were determined in samples of invertebrates (*Chironomides*), fish (ruffe, roach, perch and brown trout), and abiotic samples (sediment, surface water, WWTP effluent, WWTP sludge and stormwater runoff) in this study. The following tables provide the detection frequency (in factor 0-1, and -1 for compounds not included in analysis) of the various compounds within compound groups for the different sample types.

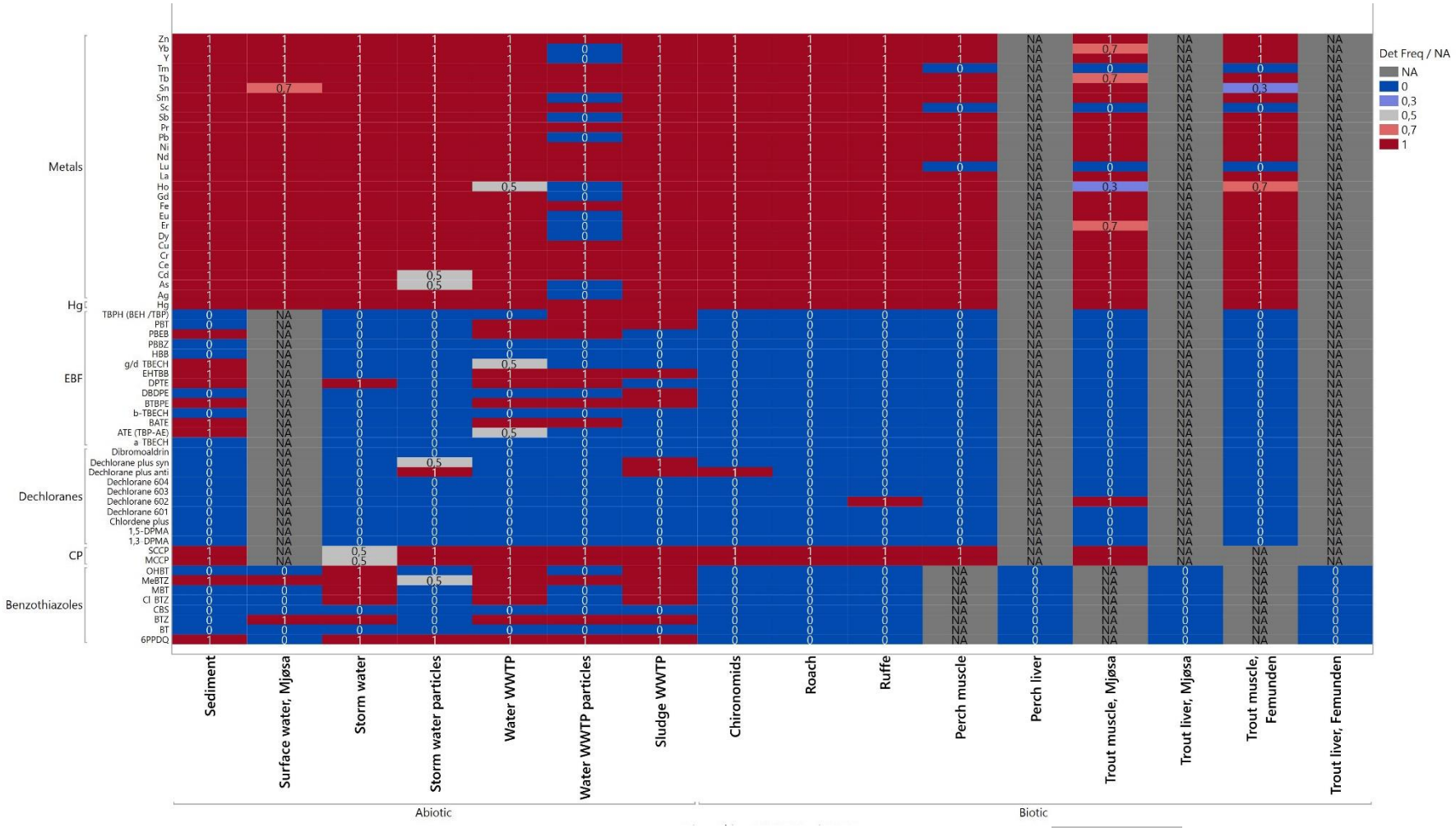


Figure 4. Detection frequency (as fraction 0-1) of all the analysed compounds in the different environmental samples in this study. Grey boxes (NA) indicate compounds not included in analyses (not analysed). In this table: Benzothiazoles, chlorinated paraffins, dechloranes, emerging brominated flame retardants (EBF) and metals.

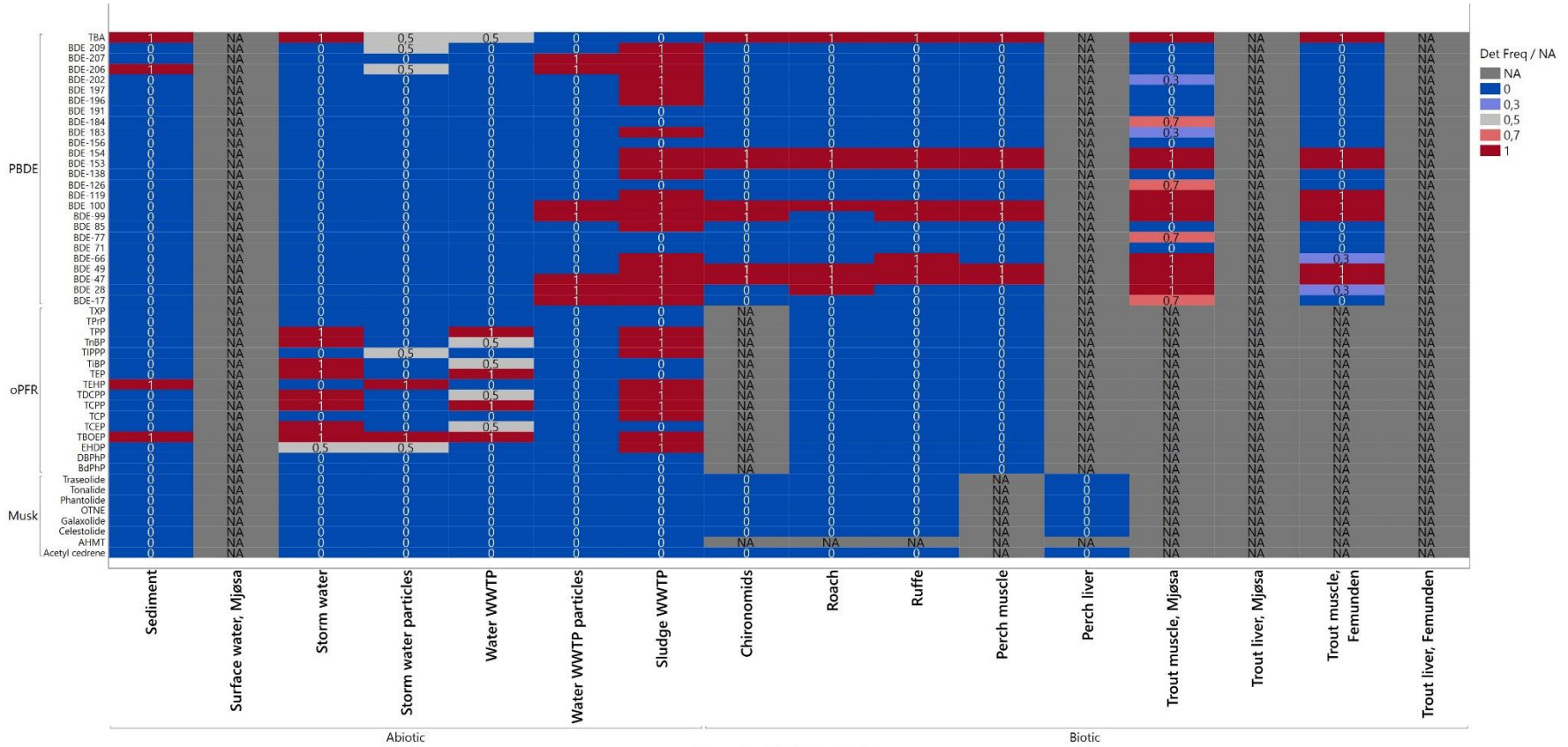


Figure 4 continued. Musk, oPFR and PBDEs.

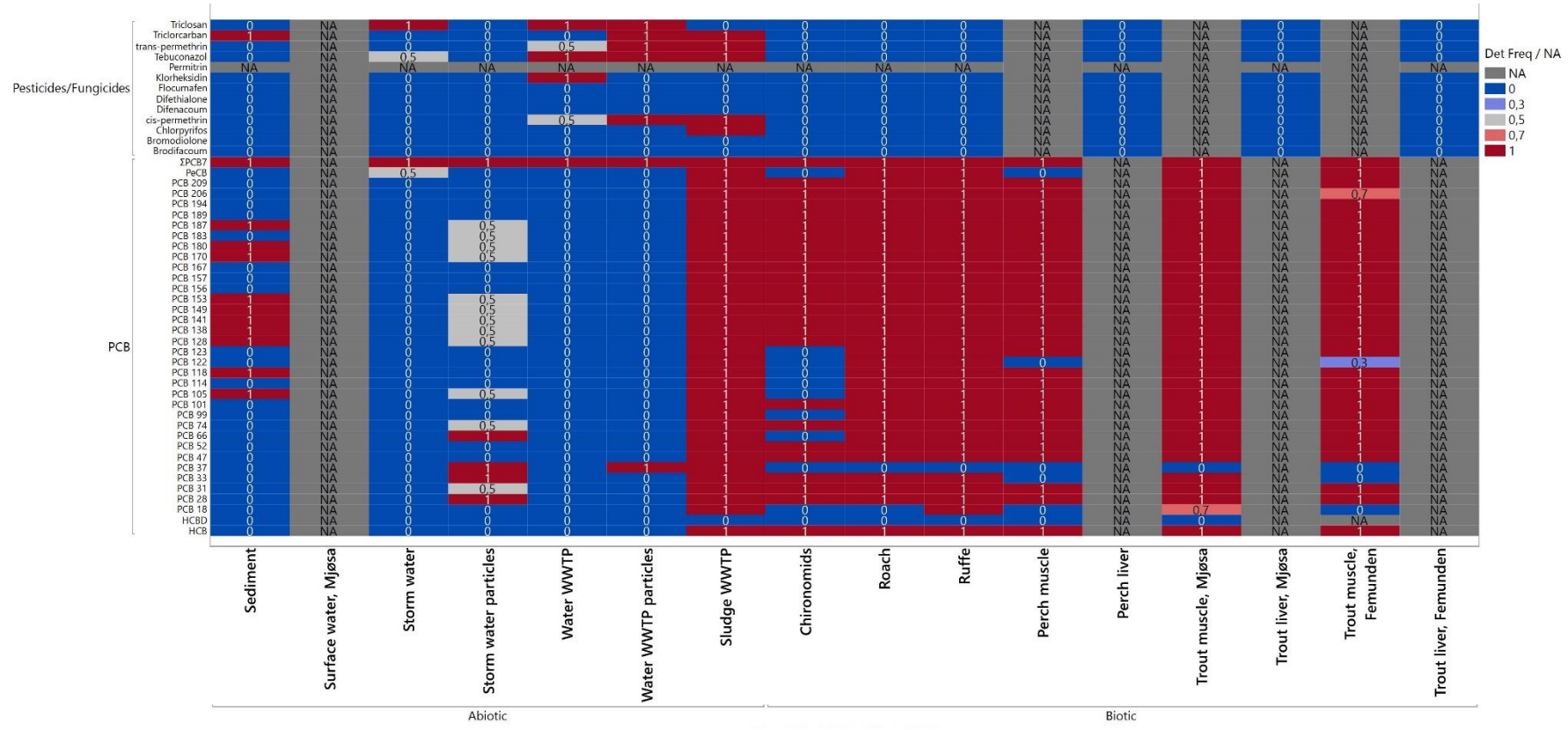


Figure 4 continued. PCBs and pesticides/fungicides.

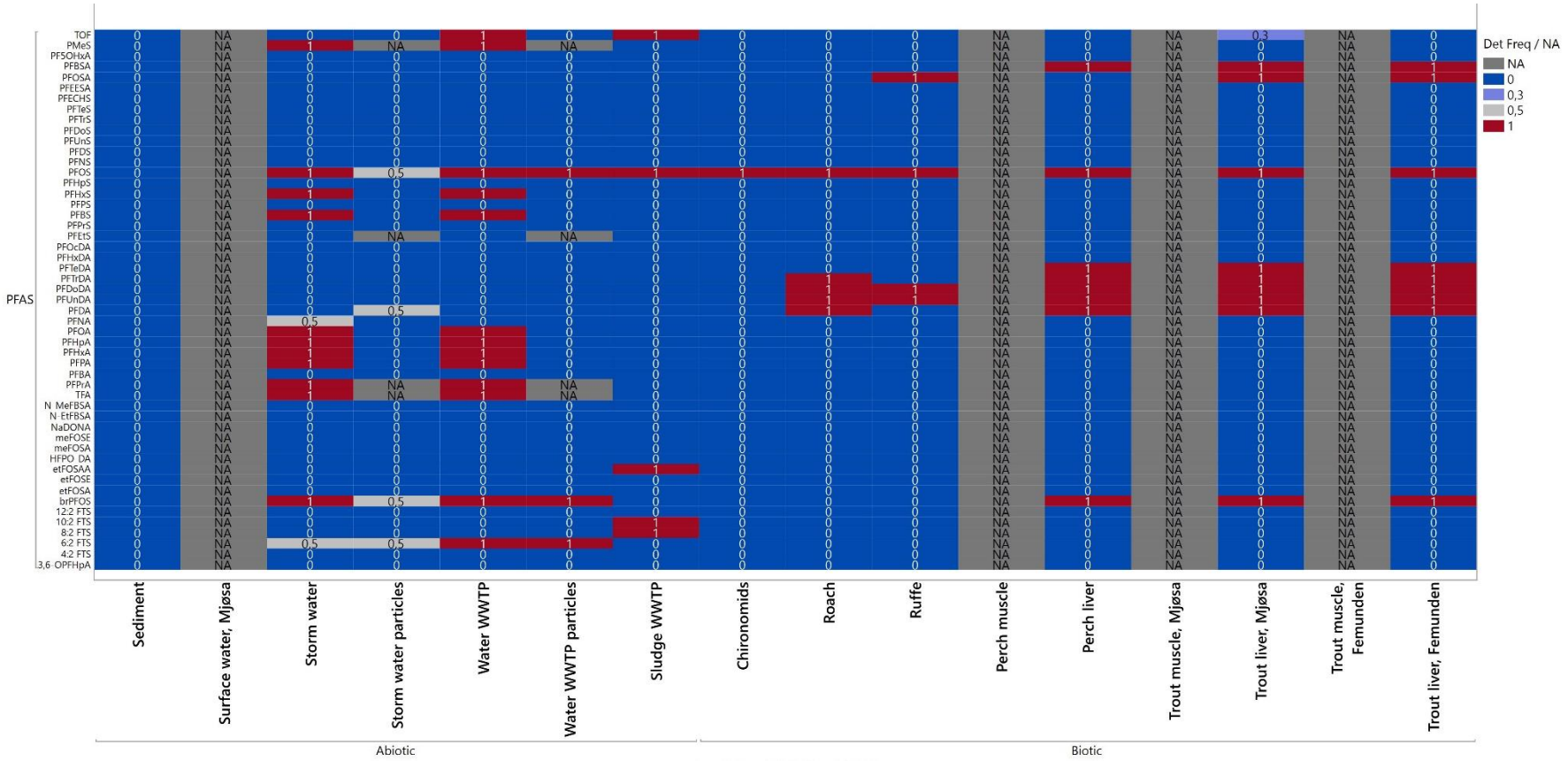


Figure 4 continued. PFAS

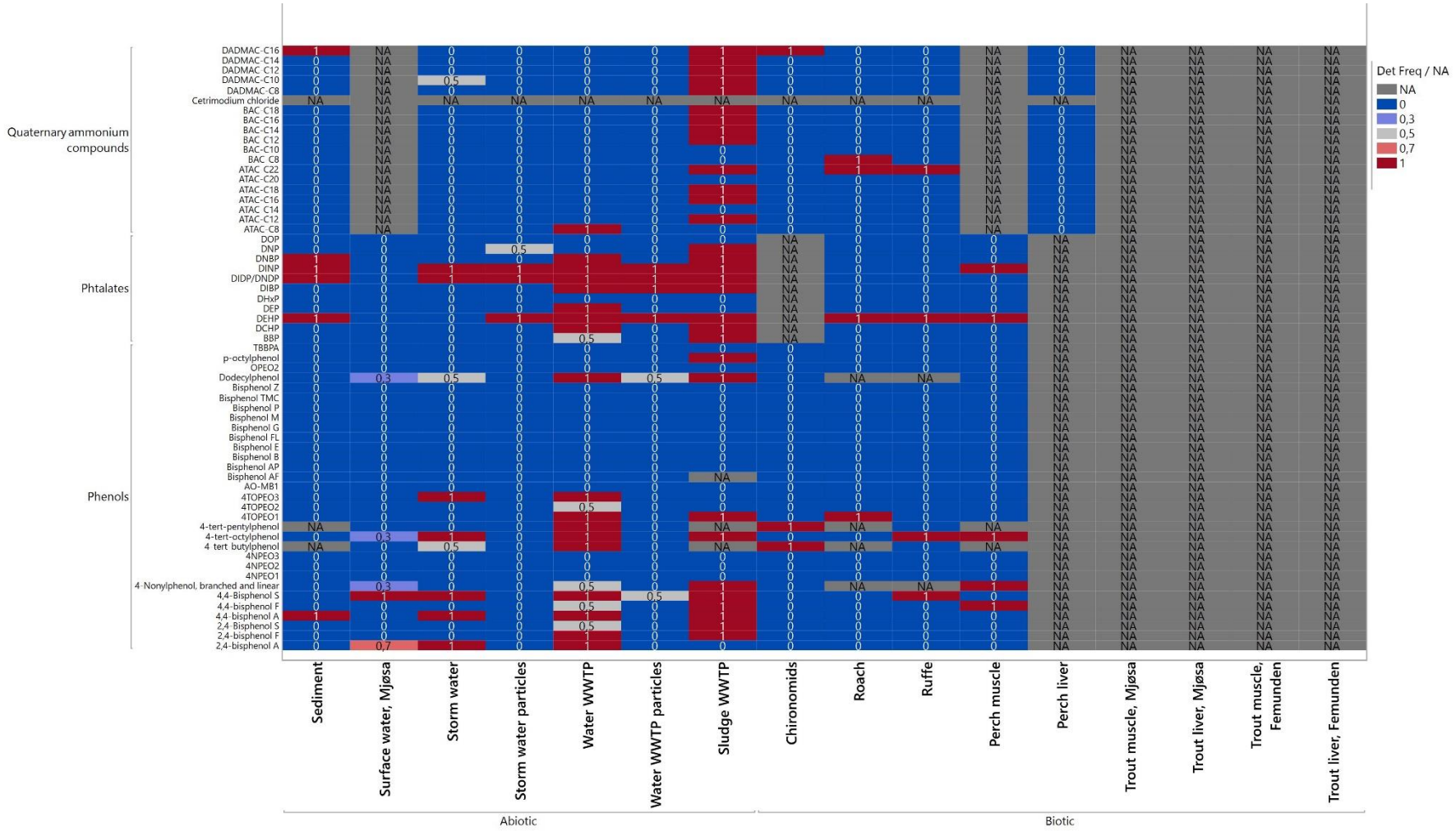


Figure 4 continued. Phenols, phthalates and quaternary ammonium compounds.

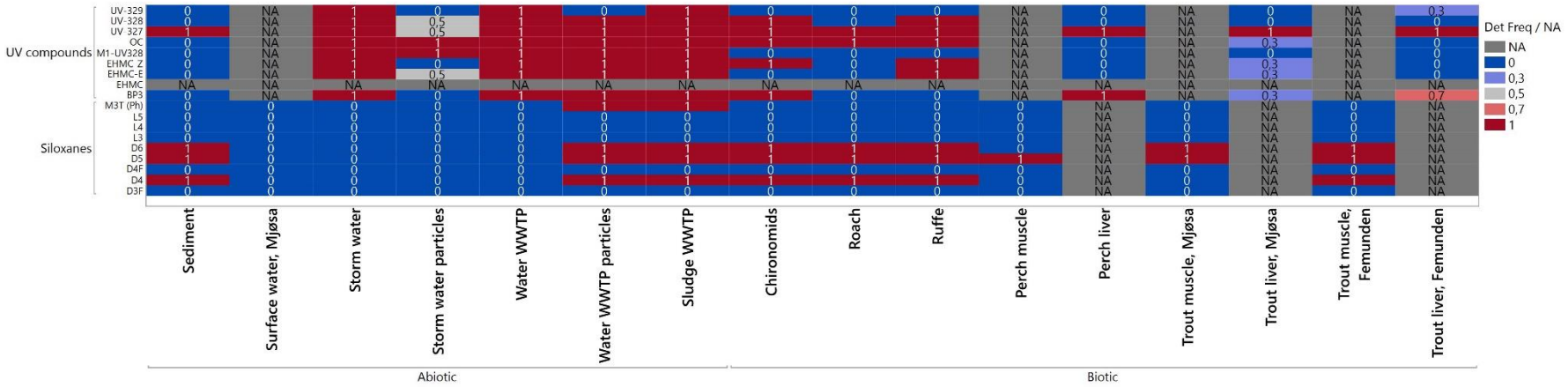


Figure 4 continued. Siloxanes and UV compounds.

2.3.3 Overview of major results

Major overview of the results is presented in Figure 5 and 0. In these two figures, metals have been removed from the calculation because they dominate the total content by several orders of magnitude compared to the other contaminant groups. Concentrations of the compounds/compound groups are shown for all matrices, and their contribution (in %) to the sum concentration of all these compounds/compound groups. Dry sludge from the WWTP dominates, with dominating concentrations of phthalates and quaternary ammonium compounds (Figure 5). In 0 the percentage contribution within all sample types is presented. Zooming in on abiotic sample types, benzothiazoles, oPFRs, phthalates and QAC seem to dominate in the dissolved fractions of surface water, stormwater and WWTP effluent. In the particle fraction of sediment, stormwater and WWTP effluent, chlorinated paraffins and phthalates are dominating contaminants (Figure 5 and Figure 6).

Focusing on biota, in Figure 7 and Figure 8**Error! Reference source not found.**, QAC and phthalates are the dominating contaminants within the lower trophic levels (chironomids, ruffe and roach). Lower concentrations are found in perch muscle compared to both roach and ruffe (within the benthic food chain) and the pelagic brown trout, where PBDEs, PCBs and siloxanes are dominating compound groups. In the liver samples of perch and brown trout, the long chained PFCAs are dominating.

Graphs indicating concentration ranges and congener patterns for individual contaminant groups are given in subchapters.

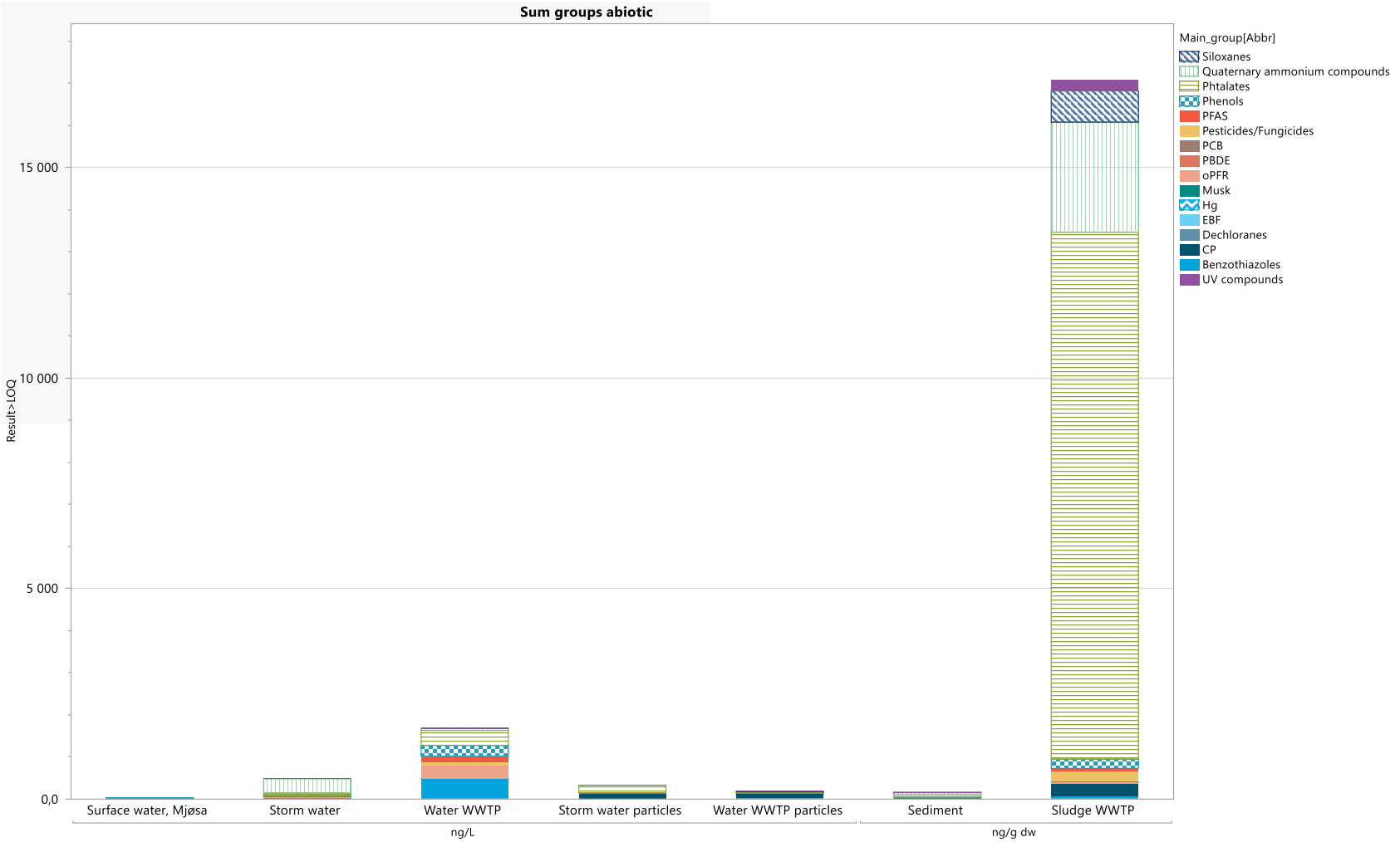


Figure 5. Relative contribution of selected contaminants/groups of contaminants to the sum of these contaminants/groups of contaminants in all abiotic matrices. Concentrations are in ng/L for all water samples, including surface water in Lake Mjøsa, stormwater and stormwater particles from Hamar, as well as in effluent (water WWTP, water WWTP particles) from the local wastewater treatment plant (WWTP), HIAS, close to Hamar. Concentrations in sediment from Lake Mjøsa and sludge from the local WWTP are in ng/g dry weight (dw). Non-detected concentrations are assigned a value of zero (0). See Table 2 for analytical program.

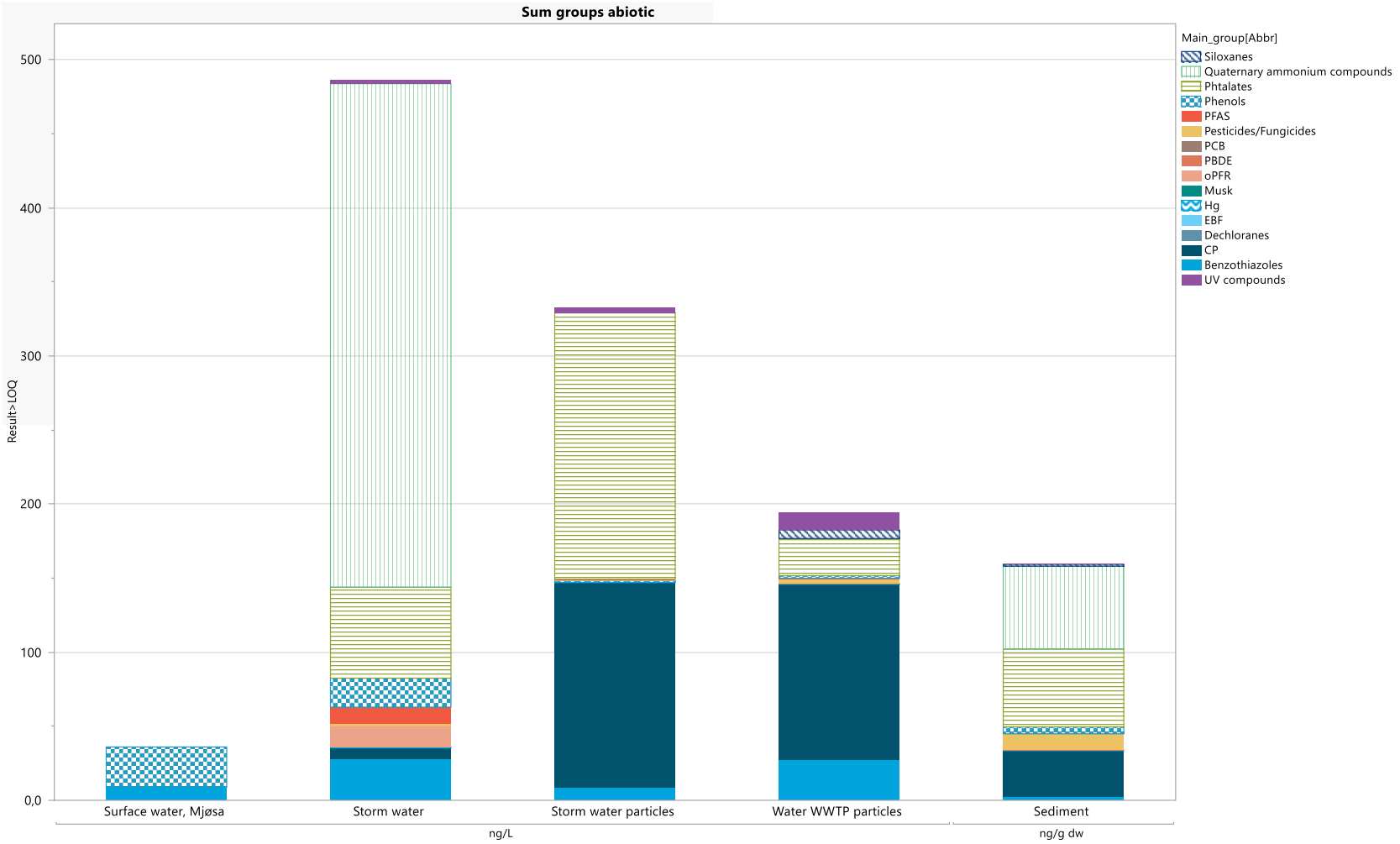


Figure 5, with WWTP sludge and WWTP water (dissolved) removed.

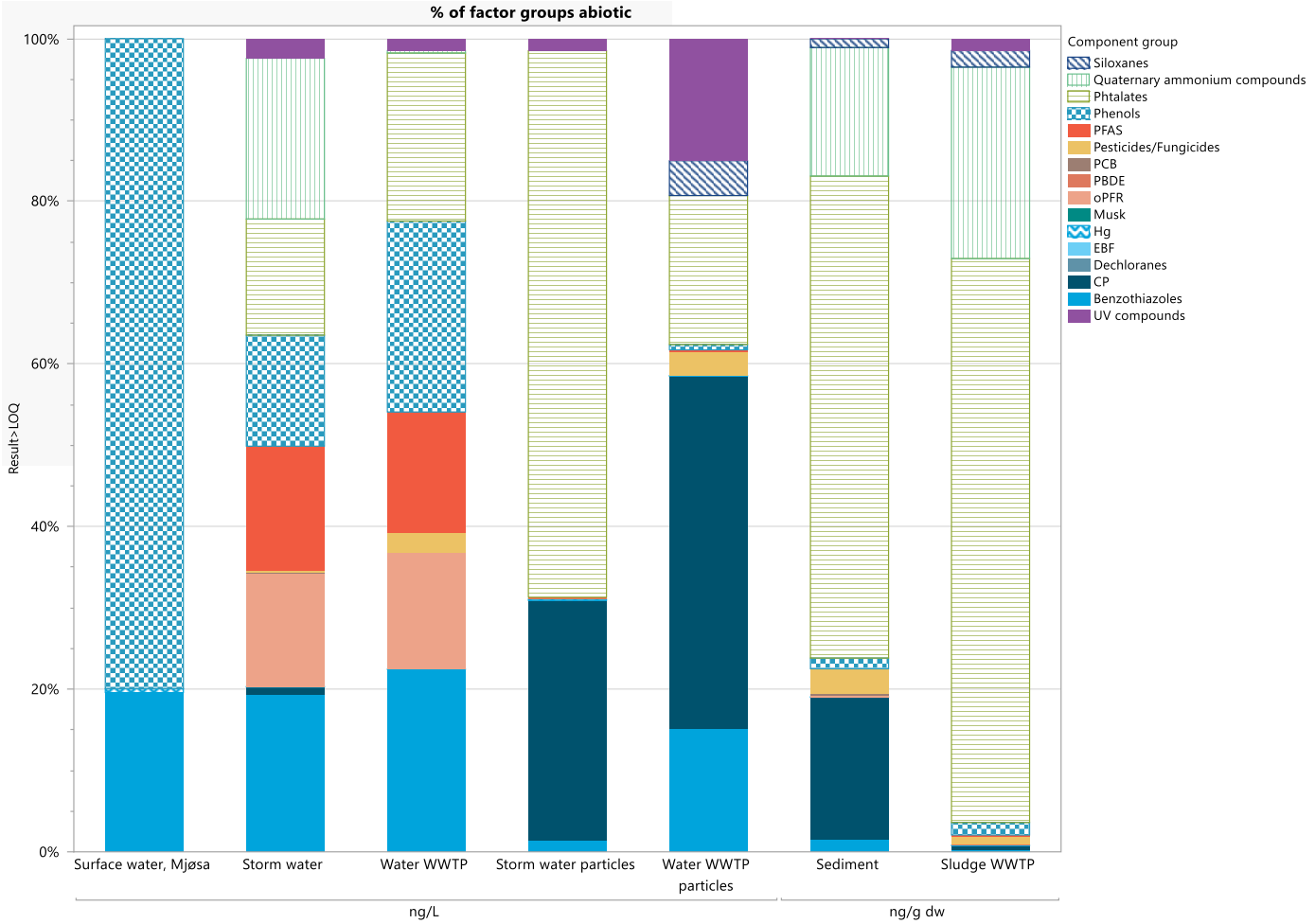


Figure 6. Percentage contribution of selected contaminants/groups of contaminants to the sum of these contaminants/groups of contaminants in all abiotic matrices. Concentrations are in ng/L for all water samples, including surface water in Lake Mjøsa, stormwater and stormwater particles from Hamar, as well as in water (water WWTP, water WWTP particles) from the local wastewater treatment plant (WWTP), HIAS, close to Hamar. Concentrations in sediment from Lake Mjøsa and sludge from the local WWTP are in ng/g dry weight (dw). Non-detected concentrations are assigned a value of zero (0). See Table 2 for analytical program.

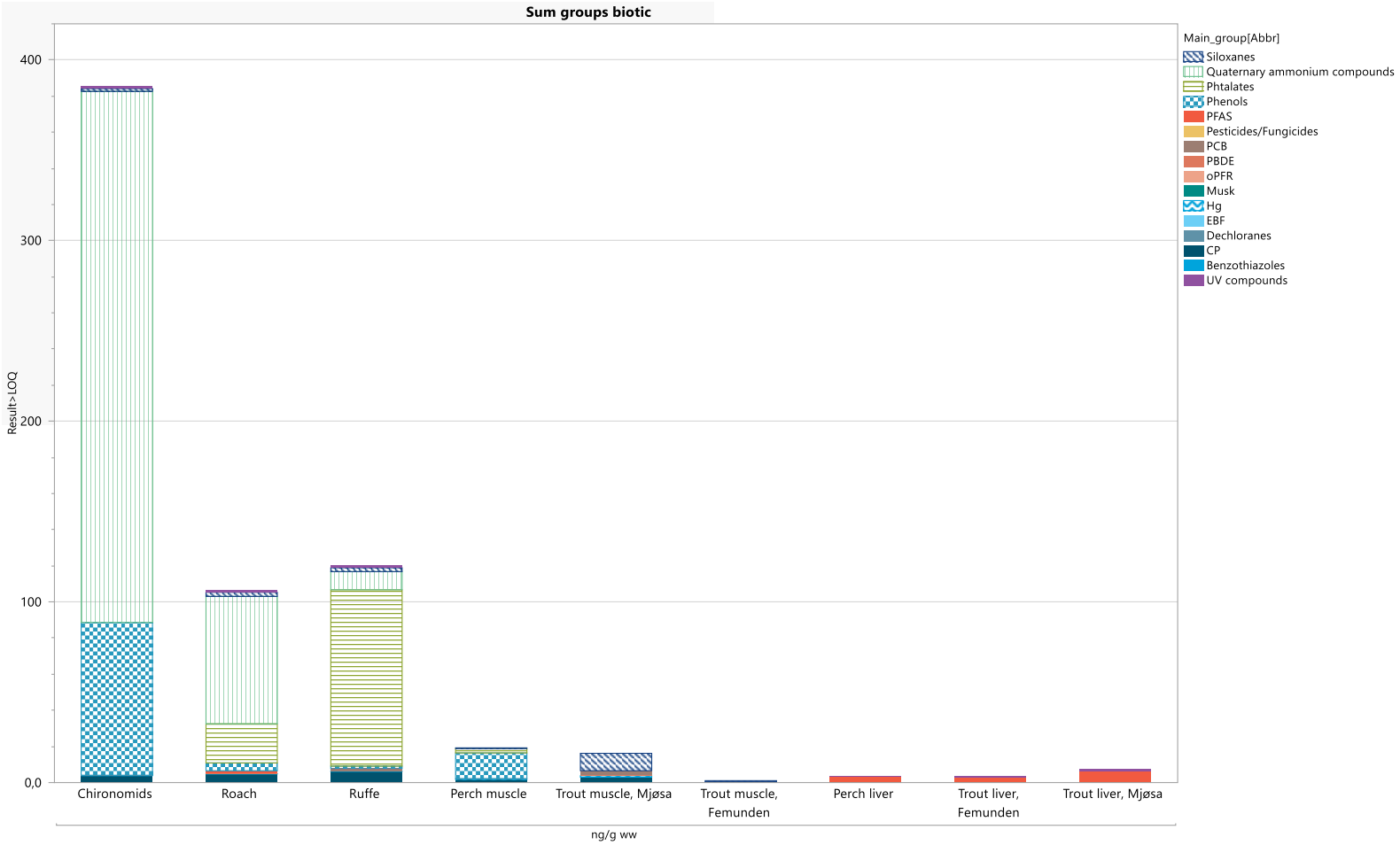


Figure 7. Relative contribution of selected contaminants/groups of contaminants to the sum of these contaminants/groups of contaminants in all biotic matrices. Concentrations are in ng/g w.w. for chironomids, roach and ruffe (whole body), perch (muscle and liver) and brown trout (muscle and liver from both Lake Mjøsa and Femunden). Non-detected concentrations are assigned a value of zero (0). See Table 2 for analytical program.

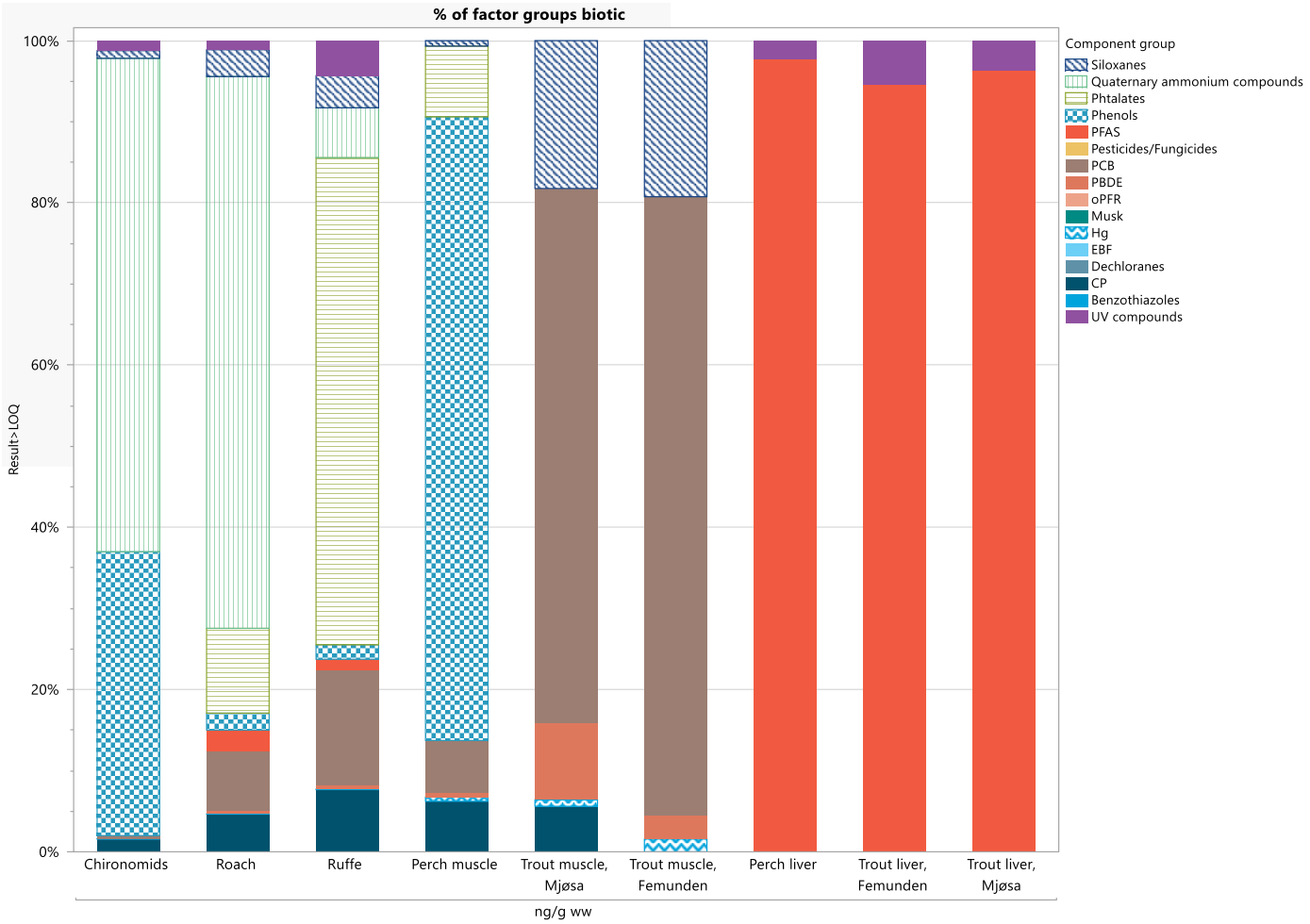
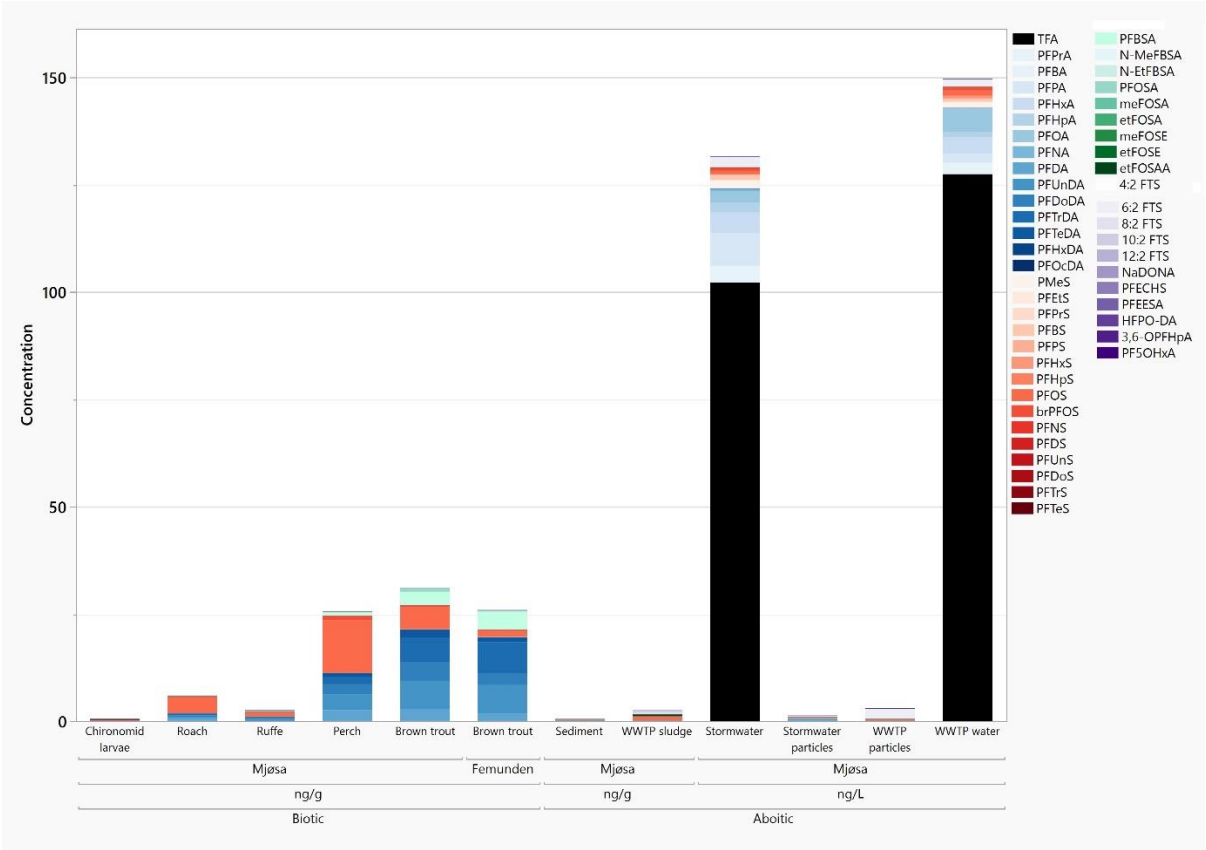


Figure 8. Percentage contribution of selected contaminants/groups of contaminants to the sum of these contaminants/groups of contaminants in all biotic matrices, including whole body samples of chironomids (non-biting midges, larvae), roach and ruffe (whole body), as well as muscle and liver in perch and brown trout from Lake Mjøsa, and muscle + liver in brown trout from Lake Femunden. Concentrations are in ng/g w.w. for all matrices. Non-detected concentrations are assigned a value of zero (0). See Table 2 for analytical program.

2.3.4PFAS

In biota, the long chained PFCAs are the dominant PFAS compounds (Figure 9) in top predators (Brown trout from both lakes), while PFOS is the dominant compound in perch and the lower trophic levels. For abiotic samples, TFA dominates the PFAS pattern for the dissolved fractions of stormwater and WWTP effluent. WWTP sludge has a low total concentration of PFAS, and the pattern is represented by several individual PFAS compounds. Low concentrations were also found in the particulate phase of stormwater and WWTP effluent.

A.



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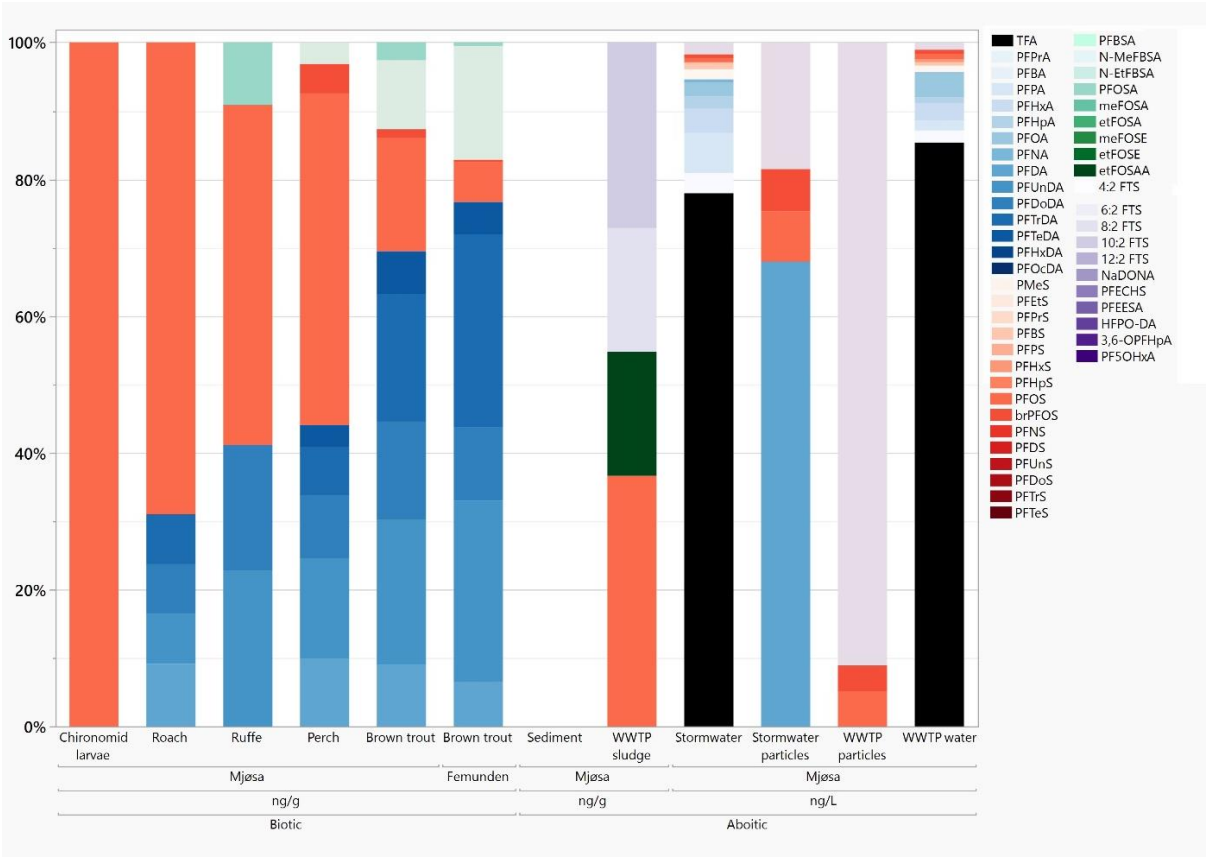

Figure 9. (**A**)Concentrations (ng/g ww in biota, ng/g dw in sediment and sludge, and ng/L in water samples) of individual PFAS compounds for all matrices. (**B**) PFAS compounds as percentage contribution to the sum of PFAS. Non detects are assigned a value of zero.

2.3.5 Phtalates

High concentrations of phthalates were found in WWTP sludge, dominating the overview results (Figure 10 A). In the sludge sample, the individual compounds DINP and DIDP/DNDP dominated the pattern. We also see high concentrations of phthalates in the dissolved phase of WWTP effluent, but the pattern here is dominated by DEP and DIBP.

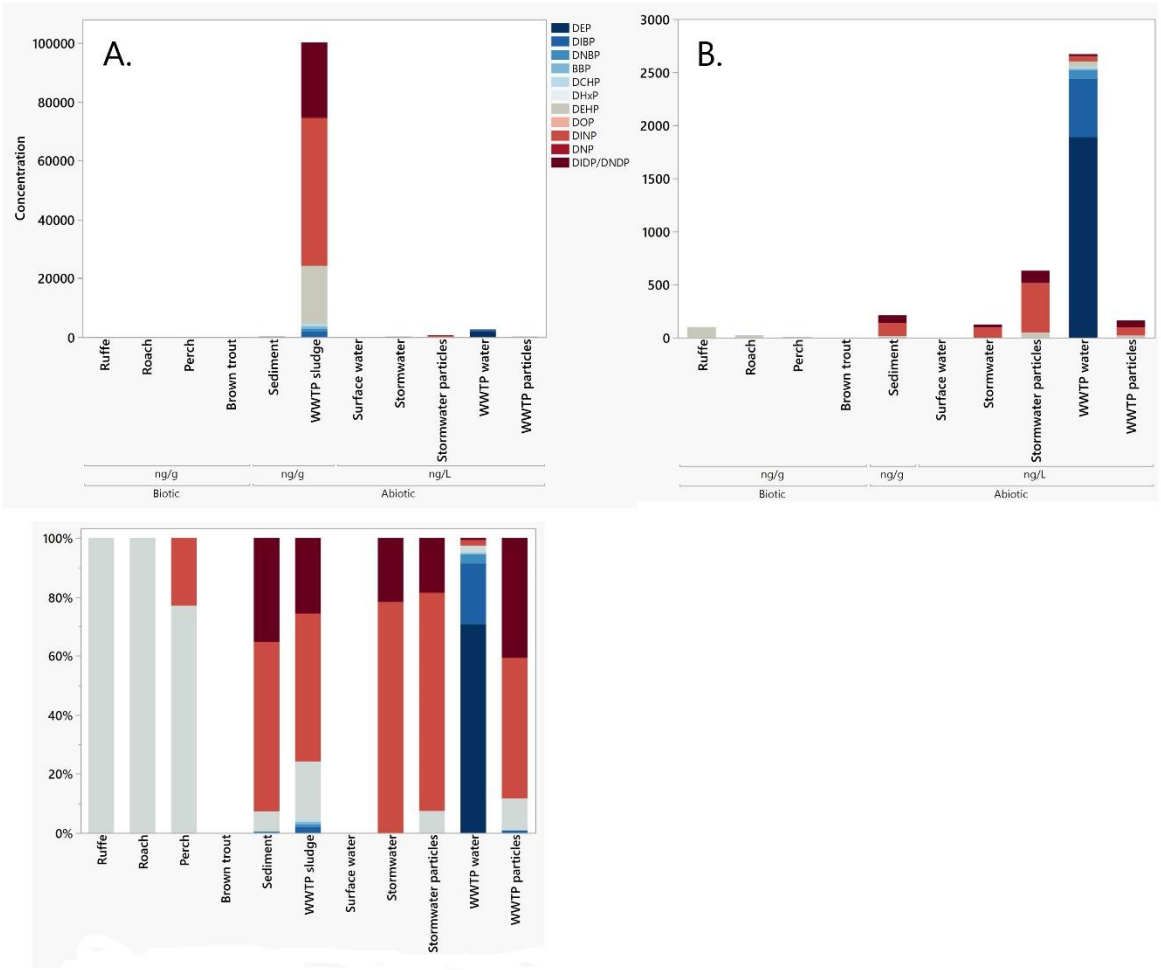

Figure 10. Concentrations (median; ng/g ww in biota, ng/g dw in sediment and WWTP sludge, and ng/L in surface water, stormwater and WWTP effluent water) of phthalates in all matrices (**A top**) and their contribution (%) to the sum-phthalates concentration (**A bottom**). To the right are the phthalate concentrations for all matrices with WWTP sludge excluded. Non-detected compounds are assigned a value of zero (0). Phthalates were not analysed in brown trout, only in a pooled liver sample.

2.3.6 Quarternary ammonium compounds (QAC)

Quarternary ammonium compounds were found in high concentrations in WWTP sludge (Figure 11 A), with DADMAC-C10 constituting about 40 % of the total QAC pattern. When excluding WWTP sludge from the results, the highest concentrations were found in sediment and the sediment dwelling chironomids (Figure 11 B), with DADMAC-C18 dominating in chironomids.

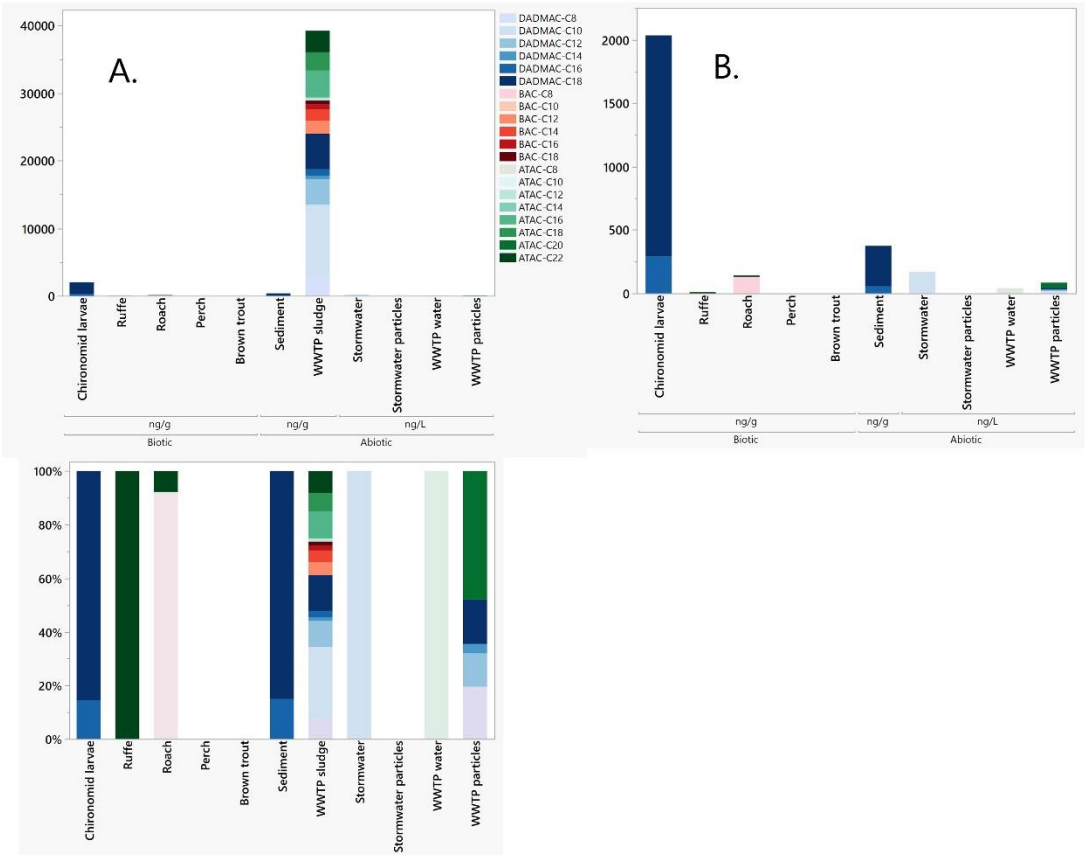

Figure 11. Concentrations (median; ng/g ww in biota, ng/g dw in sediment and WWTP sludge, and ng/L in surface water, stormwater and WWTP effluent water) of quaternary ammonium compounds in all matrices (**A top**), shown in all matrices except WWTP sludge (**B**) and their contribution (%) to the sum-quaternary ammonium compounds concentration (**A bottom**). Non-detected compounds are assigned a value of zero (0).

2.3.7 Phenols

Phenolic compounds were detected in high concentrations in sludge and water from the WWTP, except the particulate fraction of WWTP effluent (Figure 12 A). The compound 4-nonylphenol appear to dominate the WWTP samples. These results are however uncertain. The two samples of WWTP water provided one high concentration (2600 ng/L) and one below LOQ. Furthermore, 4,4-bisphenol A and 4,4-bisphenol S and F were found in the WWTP water, sludge and stormwater samples, but not in the particulate phase. Phenolic compounds were not found in detectable concentrations in fish, but there were two detections of 4-tert-butylphenol and 4-tert-pentylphenol in Chironomid larvae.

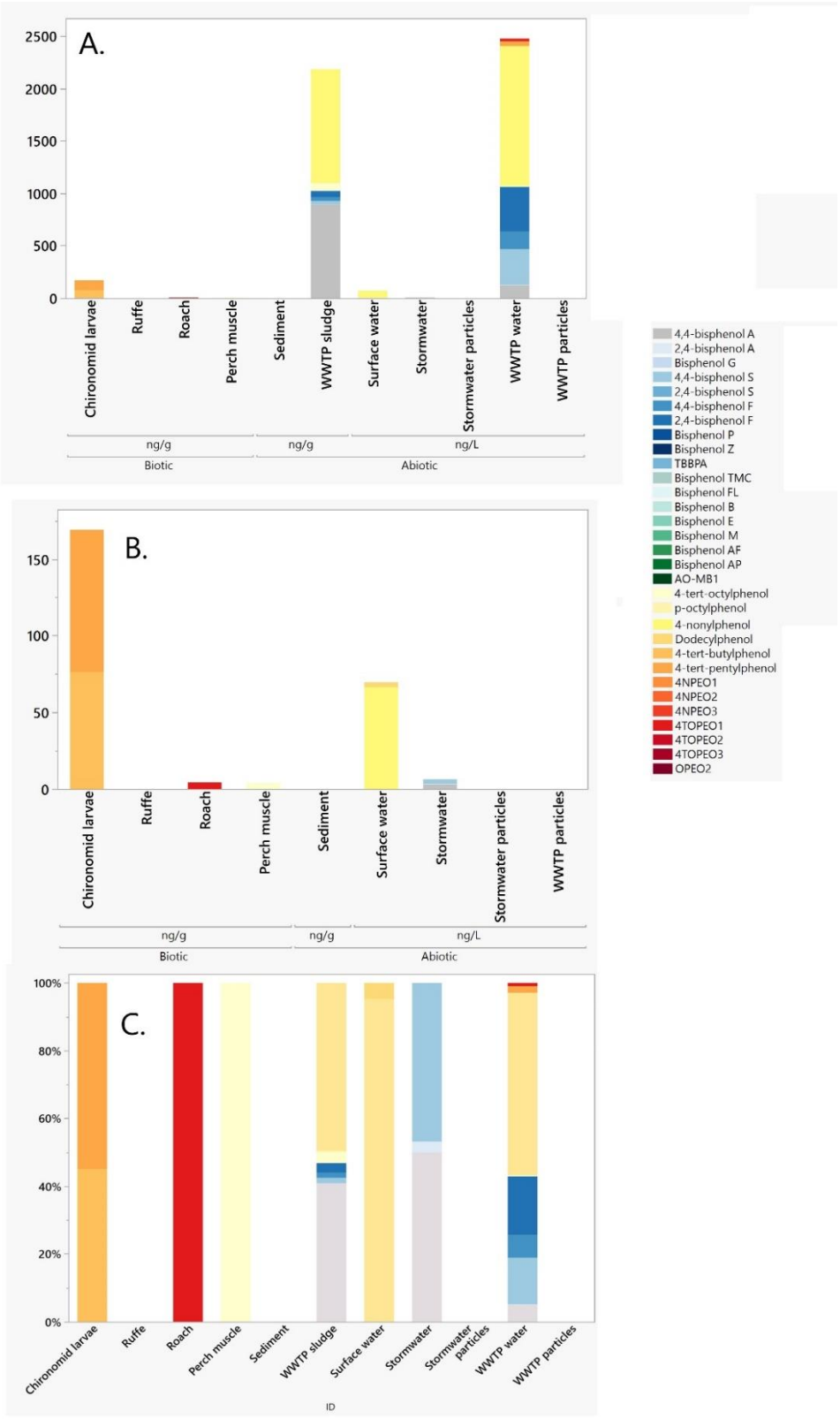

Figure 12. Concentrations (median; ng/g ww in biota, ng/g dw in sediment and sludge, and ng/L in surface water, stormwater and WWTP effluent water) of phenolic compounds in all matrices (**A**), all matrices except WWTP sludge and water (**B**) and their contribution (%) to the sum-Phenolic compounds concentration (**C**). Non-detected compounds are assigned a value of zero (0). Phenolic compounds were not analysed in brown trout.

2.3.8 Chlorinated paraffins

Both short (SCCPs) and medium (MCCPs) chained chlorinated paraffins were detected in all matrices (Figure 13). In abiotic matrices, highest concentrations were found in the WWTP sludge and particulate fractions of stormwater and WWTP effluent. In WWTP sludge, MCCP is the dominating group of chlorinated paraffins, whereas SCCPs dominate in sediment and particulate fractions. In biota, the concentrations are lower, ranging from 1 ng/g in brown trout muscle (top predator) to 8 ng/g ww in fish from lower trophic levels (ruffe).

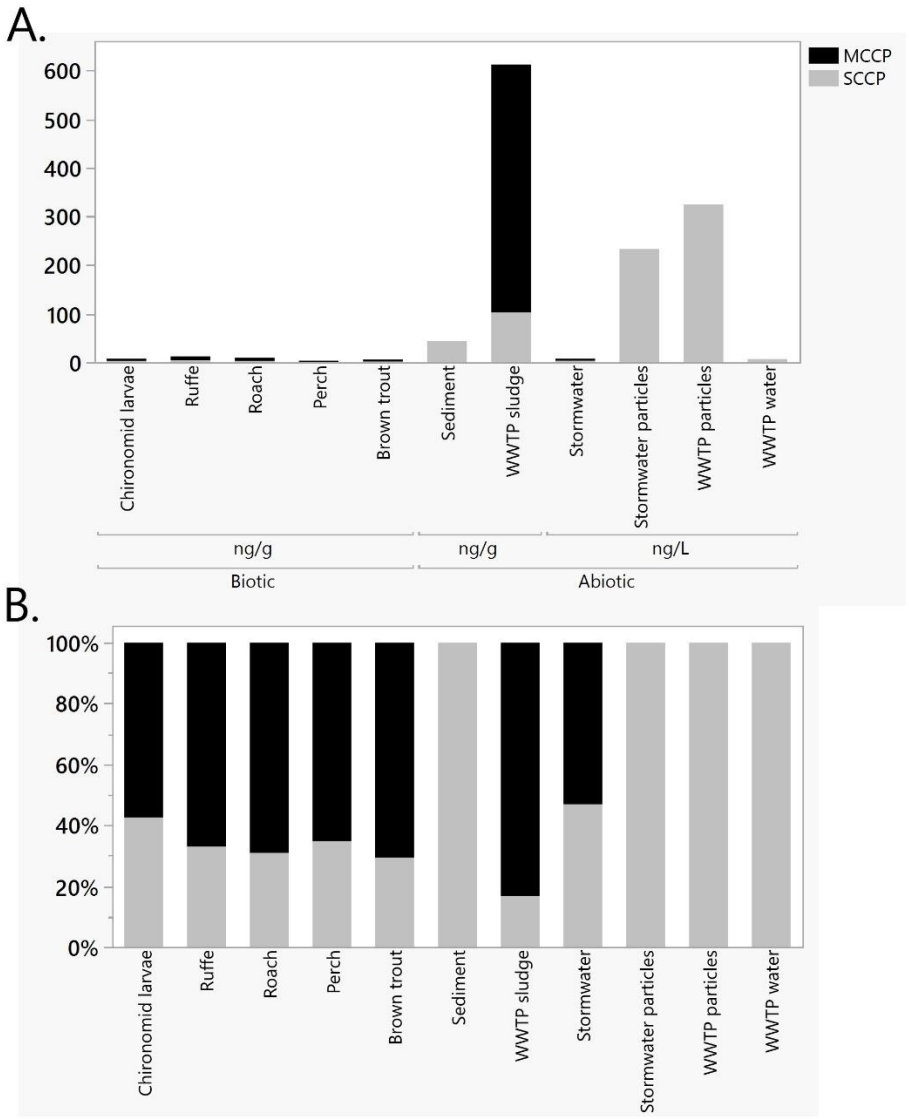

Figure 13. Concentrations (median; ng/g ww in biota, ng/g dw in sediment and WWTP sludge, and ng/L in stormwater and WWTP effluent water) of chlorinated paraffins (S/MCCPs) in all matrices (**A**) and their contribution (%) to the sum-S/MCCP concentration (**B**). Non-detected compounds are assigned a value of zero (0).

2.3.9 Metals in abiotic and biotic samples

In this study, some of the more important metals, including heavy metals, metalloids, rare earth metals and lanthanoids were included in samples of both abiotic and biotic sample types. Mercury (Hg) were included in the figures showing the major organic contaminants, and iron (Fe) has been removed from the data treatment being very dominant.

Major findings of metal concentrations within the sample types are presented in Figure 14, indicating a predominance by copper (Cu), nickel (Ni) and zinc (Zn) in dissolved fractions, most likely related to input from major urban sources such as tire wear.

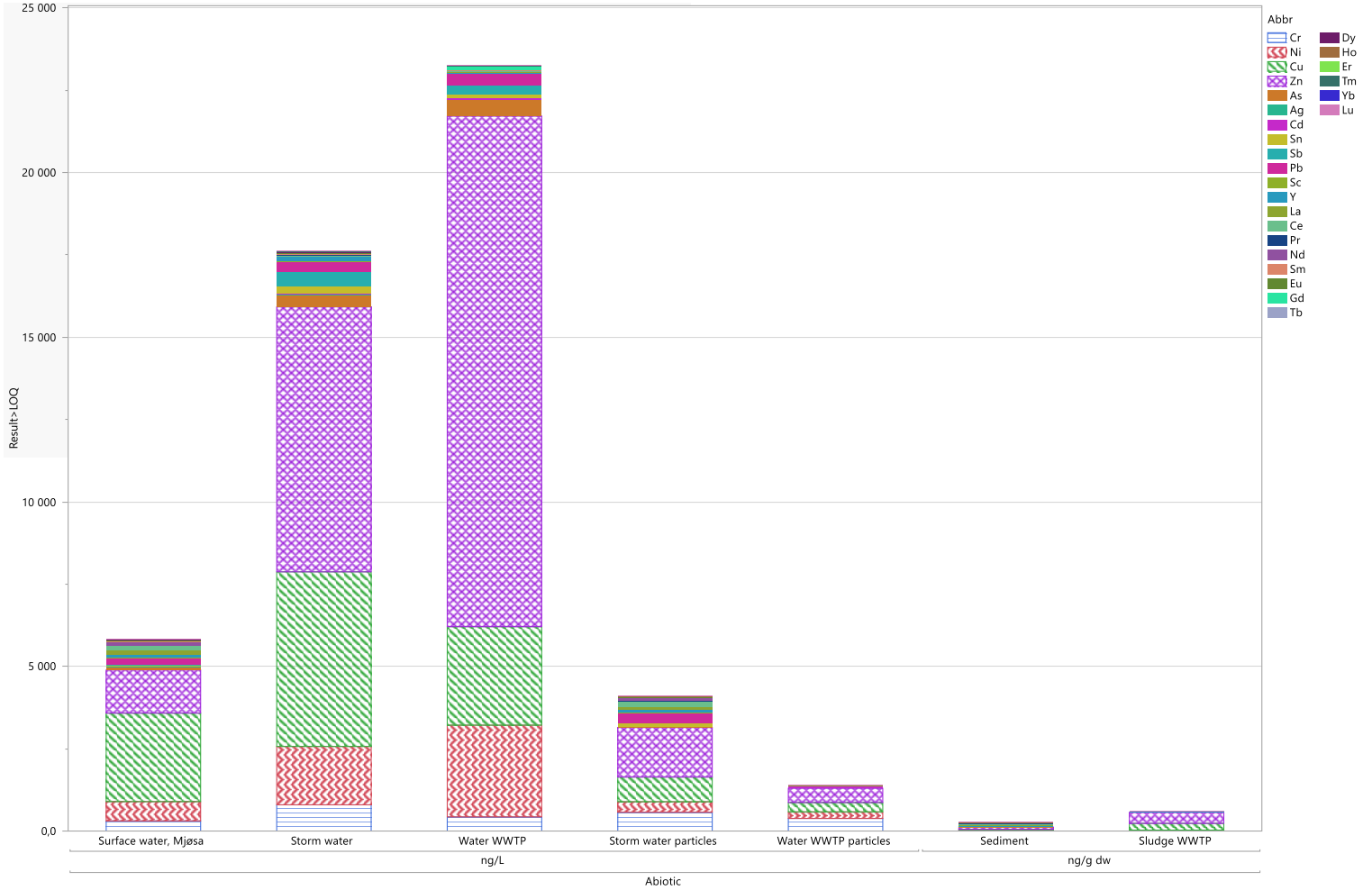

Figure 14. Relative contribution of measured metals (exl. Hg and Fe) to the sum of all measured metals (exl. Hg and Fe) in all abiotic matrices. Concentrations are in ng/L for all water samples, including surface water in Lake Mjøsa, stormwater and stormwater particles from Hamar, as well as in water (water WWTP, water WWTP particles) from the local wastewater treatment plant (WWTP), HIAS, close to Hamar. Concentrations in sediment from Lake Mjøsa and sludge from the local WWTP are in ng/g dry weight (dw). Non-detected concentrations are assigned a value of zero (0).

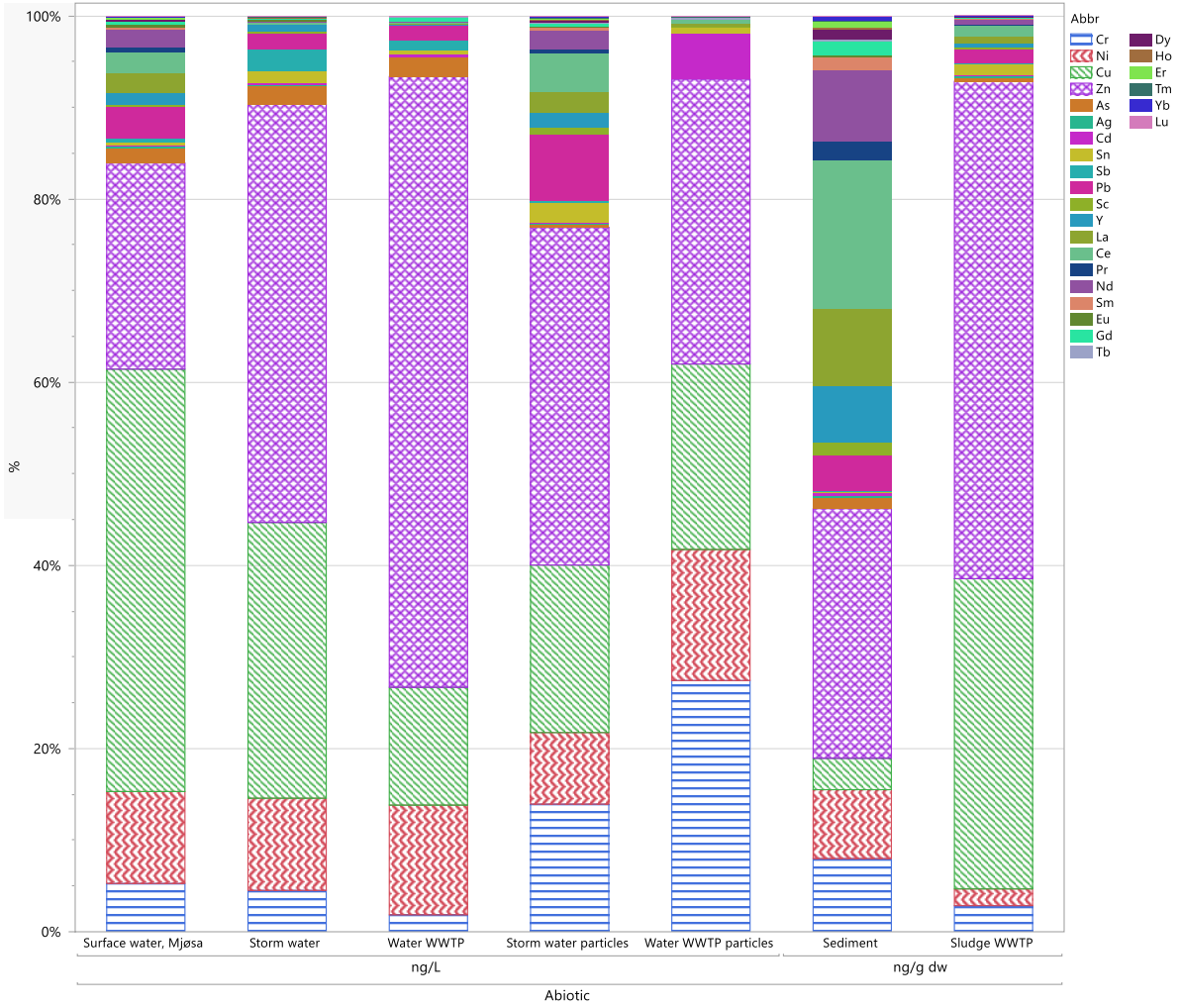

Figure 15. Percentage contribution of metals to the sum of individual metals in all abiotic matrices (sediment, surface water, WWTP effluent, WWTP sludge, stormwater). Concentrations are in ng/g dw for sediments, ng/L for water samples. Non-detected concentrations are assigned a value of zero (0).

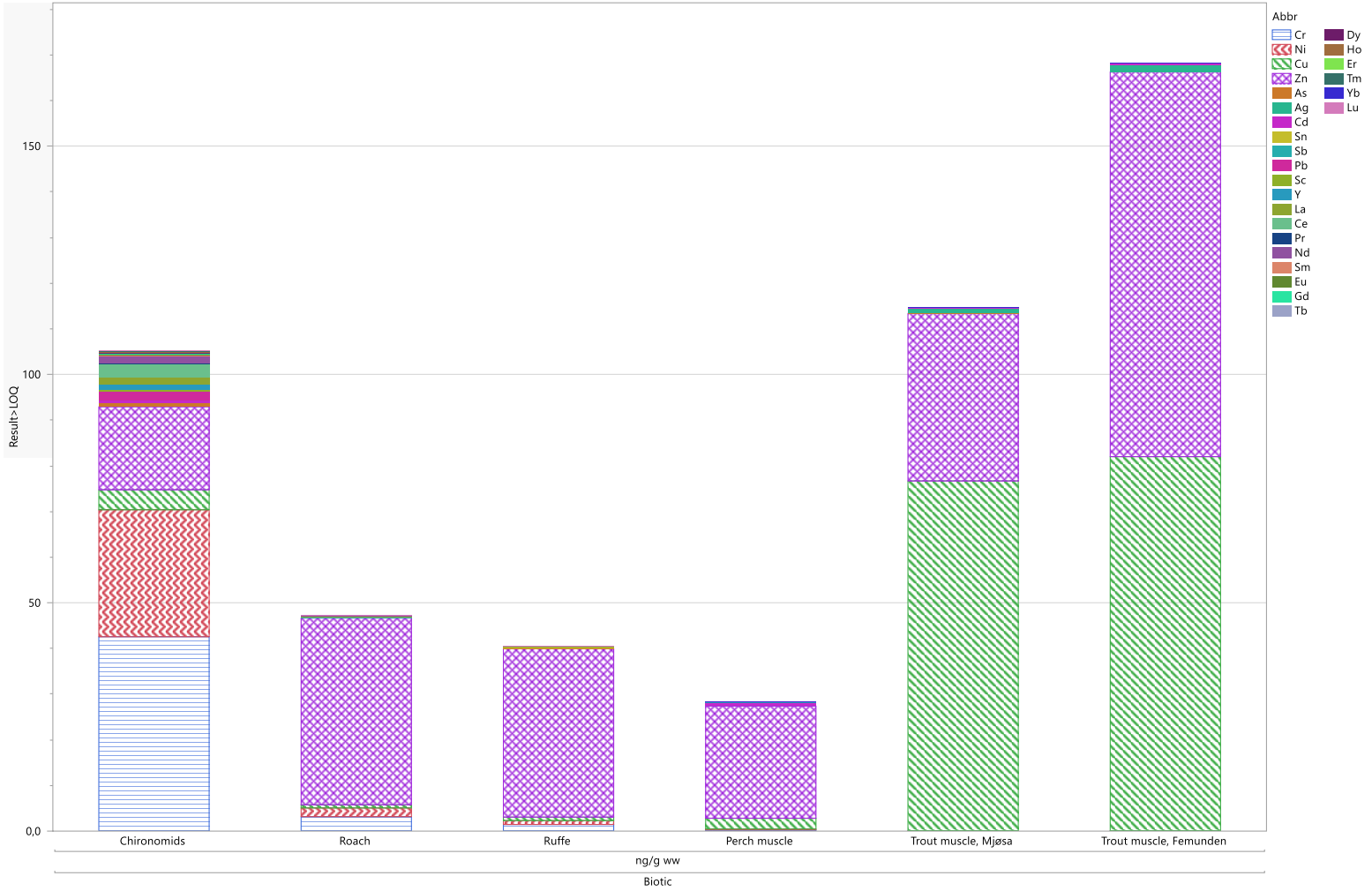

Figure 16. Relative contribution of measured metals (exl. Hg and Fe) to the sum of all measured metals (exl. Hg and Fe) in all biotic matrices. Concentrations in biotic matrices (whole body samples of chironomids (non-biting midges, larvae), roach and ruffe, muscle and liver in perch and trout from Lake Mjøsa, and muscle and liver in trout from Lake Femunden) are in ng/g wet weight (ww). Non-detected concentrations are assigned a value of zero (0).

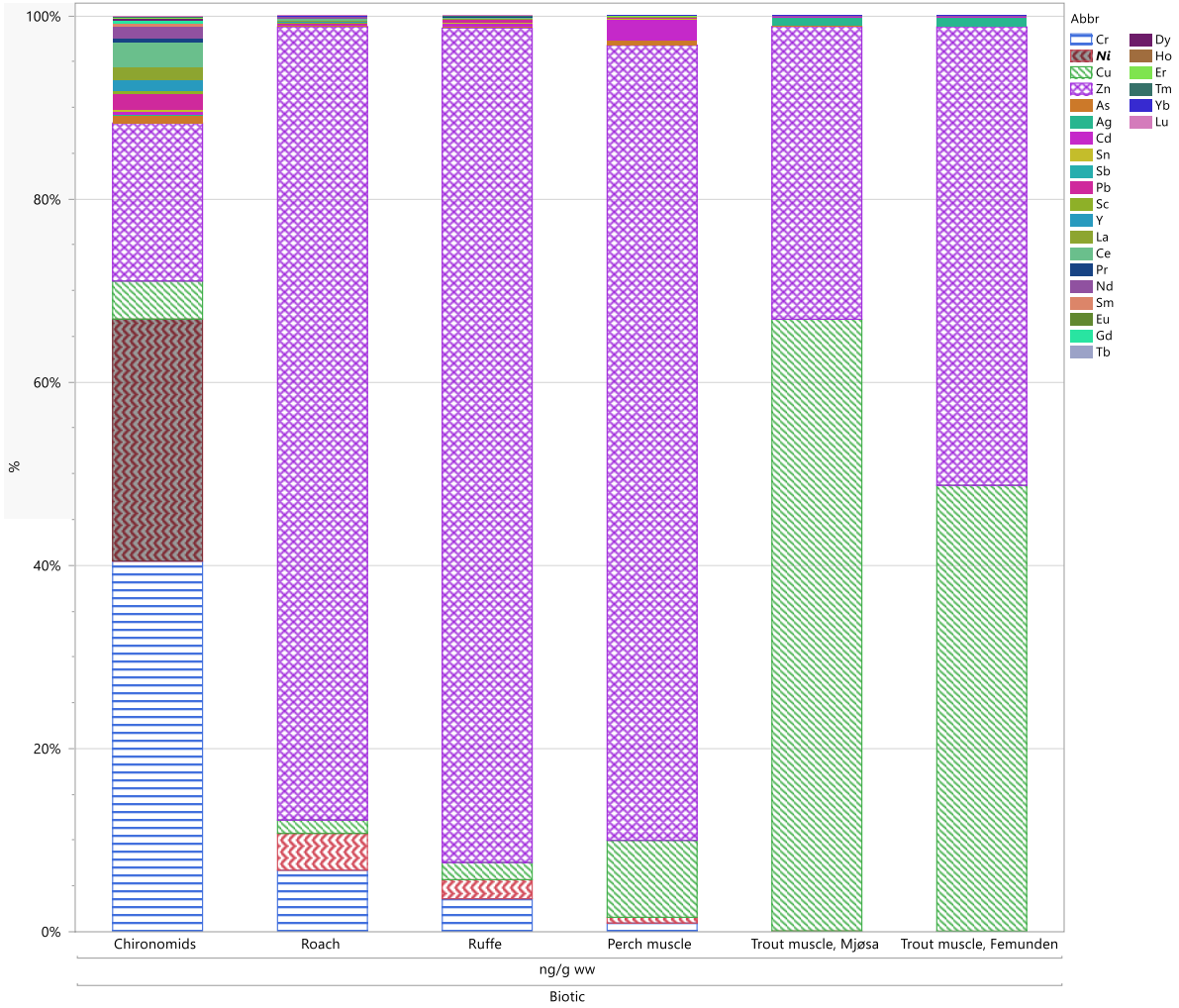

Figure 17. Percentage contribution of metals to the sum of individual metals in all biotic matrices whole body samples of chironomids (non-biting midges, larvae), roach and ruffe, muscle and liver in perch and trout from Lake Mjøsa, and muscle and liver in trout from Lake Femunden) are in ng/g wet weight (ww). Non-detected concentrations are assigned a value of zero (0).

2.3.10 Rare earth metals (REE)

Sedimentary processes in the Earth's crust should result in nearly homogenous distributions of rear earth elements (REE) in sedimentary rocks, and the pattern should reflect upper continental crust abundances (McLennan, 2001). Furthermore, the REE distribution in modern sedimentary environments is similar to that of the post-Archean shales (PAAS; Taylor and McLennan, 1985).

Sediment sample (N=1) concentrations of REE from Lake Mjøsa were compared to the upper crustal abundances of Taylor and McLennan (1985) and McLennan (2001), to calculate the ratio. Concentrations exceeding Taylor and McLennan (1985) and McLennan (2001) could indicate anthropogenic contamination from local sources, i.e. a ratio > 1. Results are provided in Table 3 and Figure 18

Post Archean Australian Shale (PAAS)-normalized ratios (Taylor and McLennan, 1985) of light rear earth elements (LREE), middle REE (MREE) and heavy REE (HREE) and "continental crust"-normalized ratios (from McLennan, 2001) of LREE, MREE and HREE were on average below 1, indicating no significant anthropogenic contamination of these elements.

Table 3. Ratios calculated from sediment concentrations in Lake Mjøsa divided by upper crustal abundances (Taylor and McLennan, 1985; McLennan 2001)

Element	REE	Sediment conc. (µg/g, ppm) Lake Mjøsa	Upper crust McLennan (2001)	Ratio	PAAS Taylor and McLennan, 1985	Ratio
La	LREE	22.1	30	0.74	38	0.58
Ce	LREE	43.1	64	0.67	80	0.54
Pr	LREE	5.4	7.1	0.76	8.9	0.61
Nd	LREE	20.5	26	0.79	32	0.64
Sm	MREE	3.6	4.5	0.80	5.6	0.64
Eu	MREE	0.9	0.88	1.02	1.1	0.82
Gd	MREE	3.9	3.8	1.03	4.7	0.83
Tb	MREE	0.5	0.64	0.78	0.77	0.65
Dy	MREE	2.9	3.5	0.83	4.4	0.66
Ho	HREE	0.5	0.8	0.63	1	0.50
Er	HREE	1.8	2.3	0.78	2.9	0.62
Tm	HREE	0.2	0.33	0.61	0.4	0.50
Yb	HREE	1.3	2.2	0.59	2.8	0.46
Lu	HREE	0.2	0.32	0.63	0.43	0.47

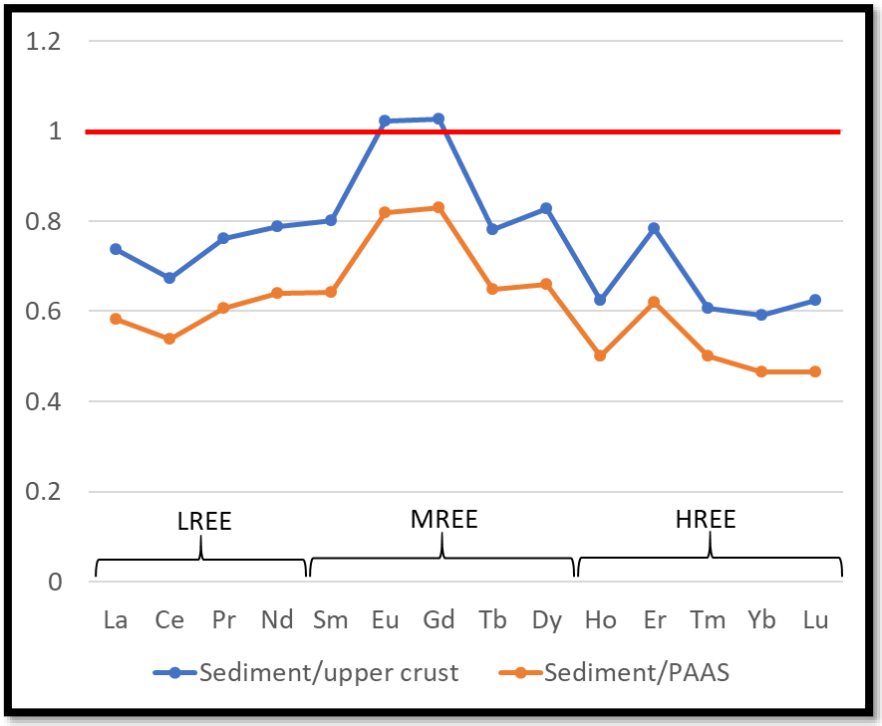

Figure 18. Ratio of lanthanide content in sediments from Lake Mjøsa to lanthanide content in Post Archean Australian Shale (PAAS; Taylor and McLennan; 1985) and continental crust (McLennan, 2001).

Compared to acid soluble concentrations of various metals in overbank sediments from Norway (Ottesen et al., 2000), levels found in sediments from Lake Mjøsa is also below the arithmetic mean (see Table 4).

Table 4. Sediment concentrations of selected elements in Lake Mjøsa compared to concentrations in overbank sediments (regional reference material, Ottesen et al., 2000).

Element	Conc. (µg/g d.w.) ppm Sediments, Lake Mjøsa	Overbank sediments, Mjøsa region	Overbank sediments, Norway
Sc	3.7		4.3
Cr	21.2	45	33
Fe	12577		23200
Ni	19.9	44	23
Cu	9.1	55	23
Zn	72.2	140	54
As	3.3	12	4.1
Pb	10.4	40	22

2.3.11 Indication of biomagnification in the benthic food chain

Samples from a typical benthic food chain were collected in study, including a bulk sample of benthic invertebrates (chironomids), roach, ruffe and perch. Given the low N (N=1 for all specified sample types) in this study, only indications of biomagnification or biodilution can be presented. In addition, the trophic position of roach, ruffe and perch is quite similar (see chapter 2.3.1 and appendix), and the difference in trophic level between chironomids and perch is only 1.4, assuming an increase in $\delta^{15}N$ between integer trophic levels, $\Delta^{15}N$, of 3.4). For these reasons we have not calculated a TMF but will show examples of indication of both biomagnification and biodilution (Figure 19,Figure 21 and Figure 22).

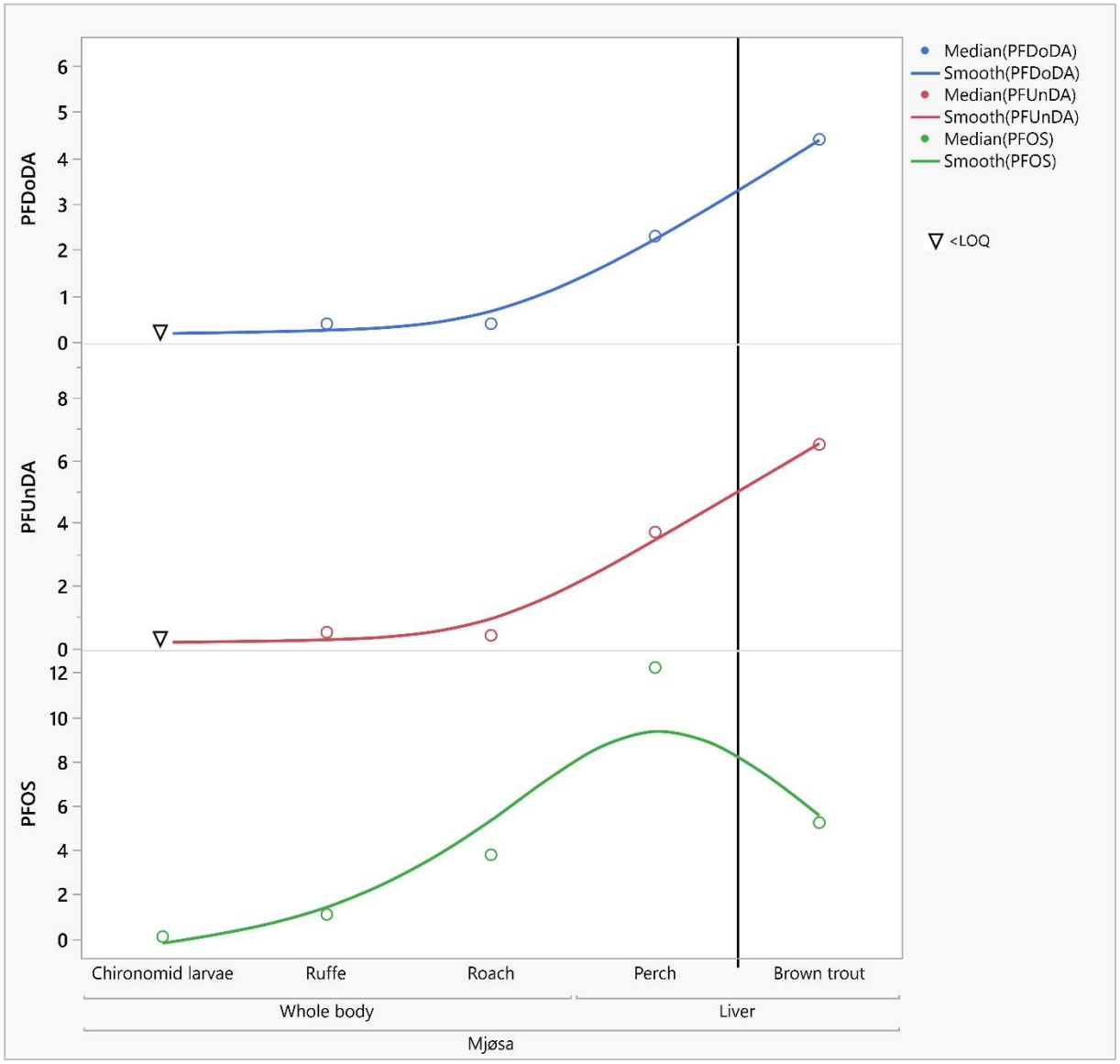

Figure 19. Indication of biomagnification of three PFAS compounds (PFOS, PFUnDA and PFDoDA) in the benthic food chain in Lake Mjøsa. In this figure, median results (ng/g w.w.) are also shown for the pelagic brown trout for comparison. Concentrations below LOQ are indicated with a triangle (▽).

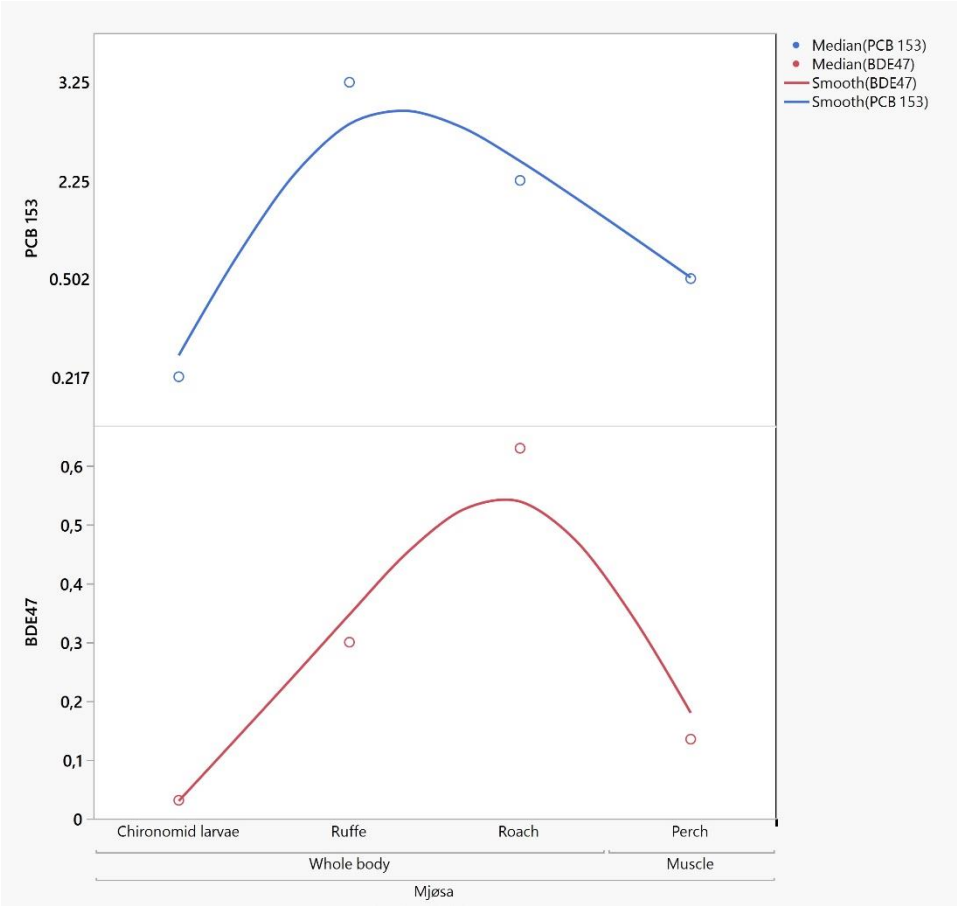

Figure 20. Concentration of BDE47 and PCB 153 (ng/g ww) in trophic levels of the benthic food chain in Lake Mjøsa.

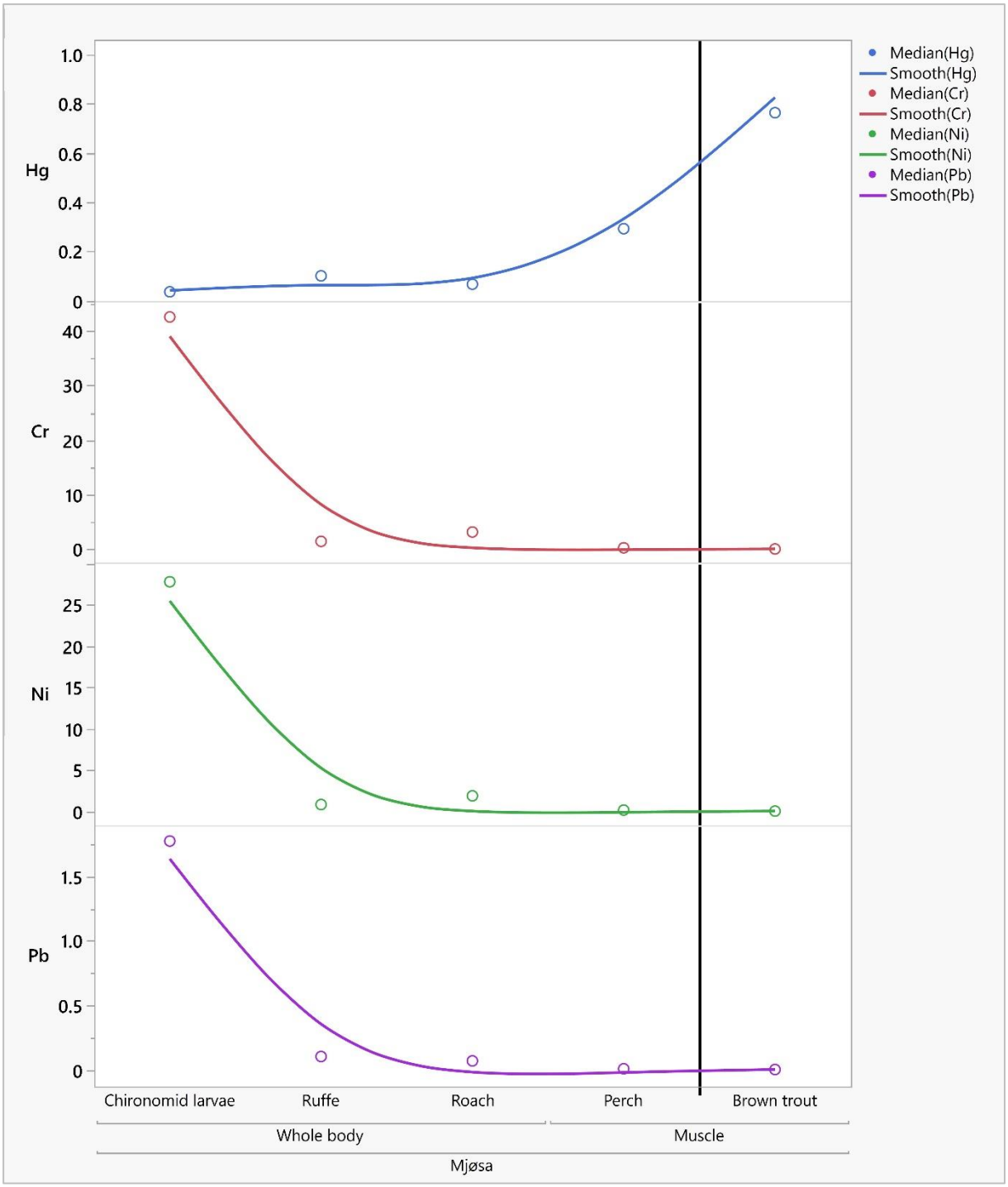

Figure 21. Indication of biomagnification of Hg, and biodilution of Cr, Ni, Pb in the benthic food chain in Lake Mjøsa. In this figure, median results (µg/g w.w.) are also shown for the pelagic brown trout for comparison. Indication of biodilution properties are also seen in the rest of the metals (not shown here).

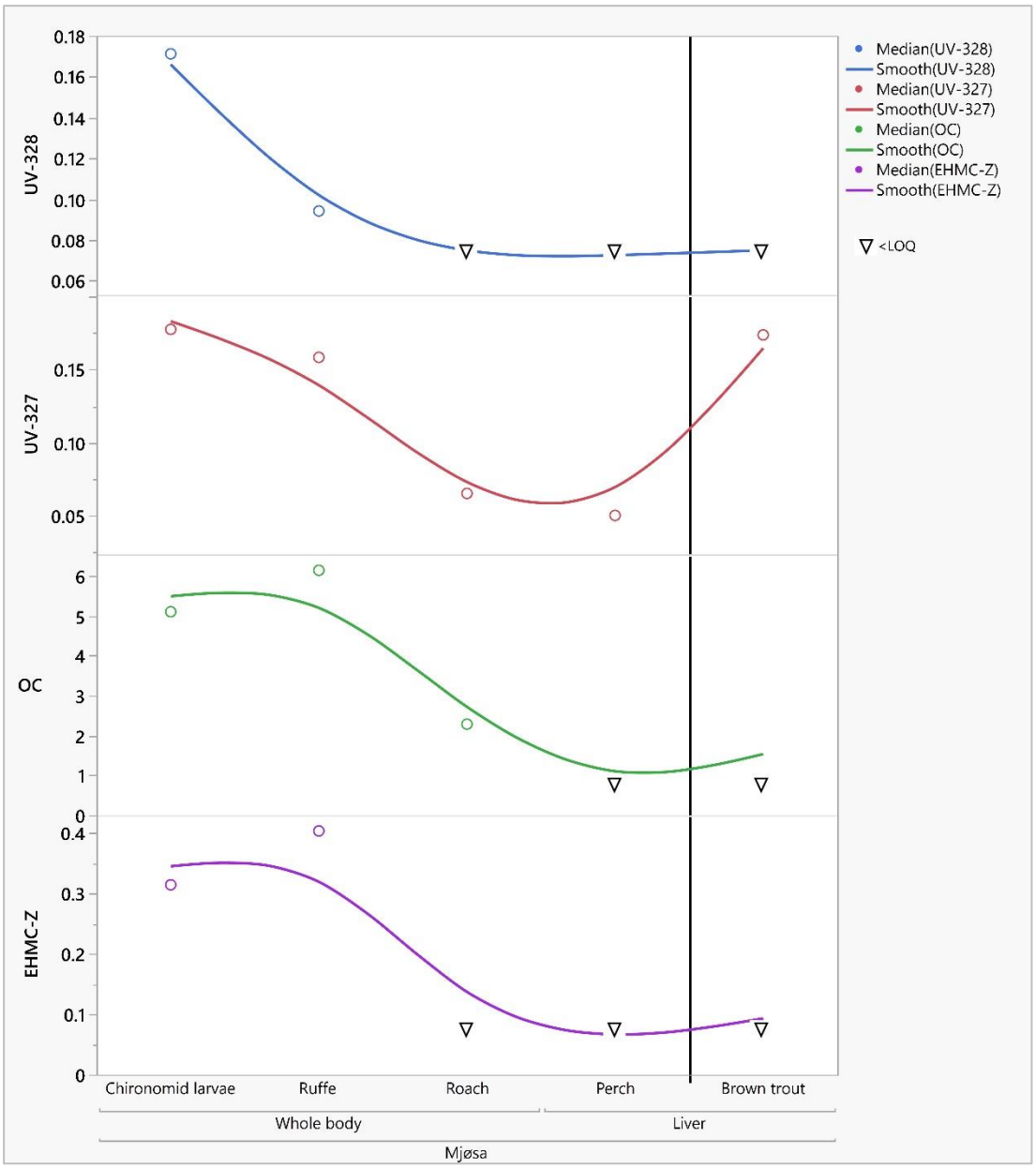

Figure 22. Indication of biomagnification of UV compounds in the benthic food chain in Lake Mjøsa. In this figure, median results (ng/g w.w.) are also shown for the pelagic brown trout for comparison. Concentrations below LOQ are indicated with a triangle (∇). Indication of biodilution properties are also seen for chlorinated paraffins and siloxanes.

2.3.12 Time trends

Several of the contaminants included in this report have been studied in the pelagic food chain for years, constituting a valuable historical time trend. In 2021, only 3 pooled samples of brown trout in Lakes Mjøsa and Femunden were included as representatives of previous studies (individual samples). In that respect, there are some uncertainties to consider when comparing the results from 2021 with previous years. We have however provided some examples of time trends for major contaminant groups in brown trout from both lakes.

2.3.12.1 PBDEs 2000 - 2021

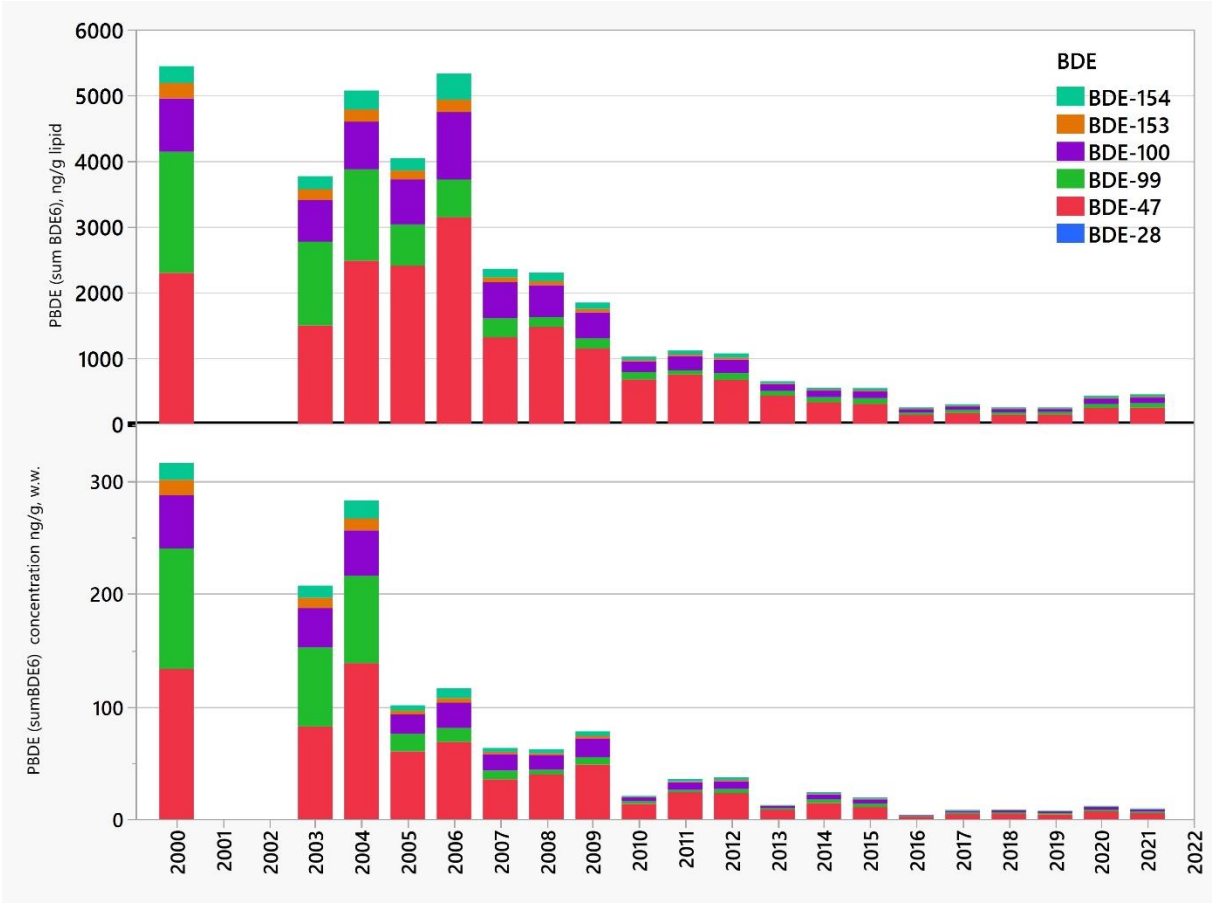

Figure 23. Time trend for PBDEs (ΣBDE_6: 28, 47, 99, 100, 153 and 154) in ng/g lipid (top) and ng/g w.w. (bottom) in brown trout from Lake Mjøsa from 2000 – 2021. In 2021 three pooled samples of five individuals were analysed.

2.3.12.2 PFAS 2014 - 2021

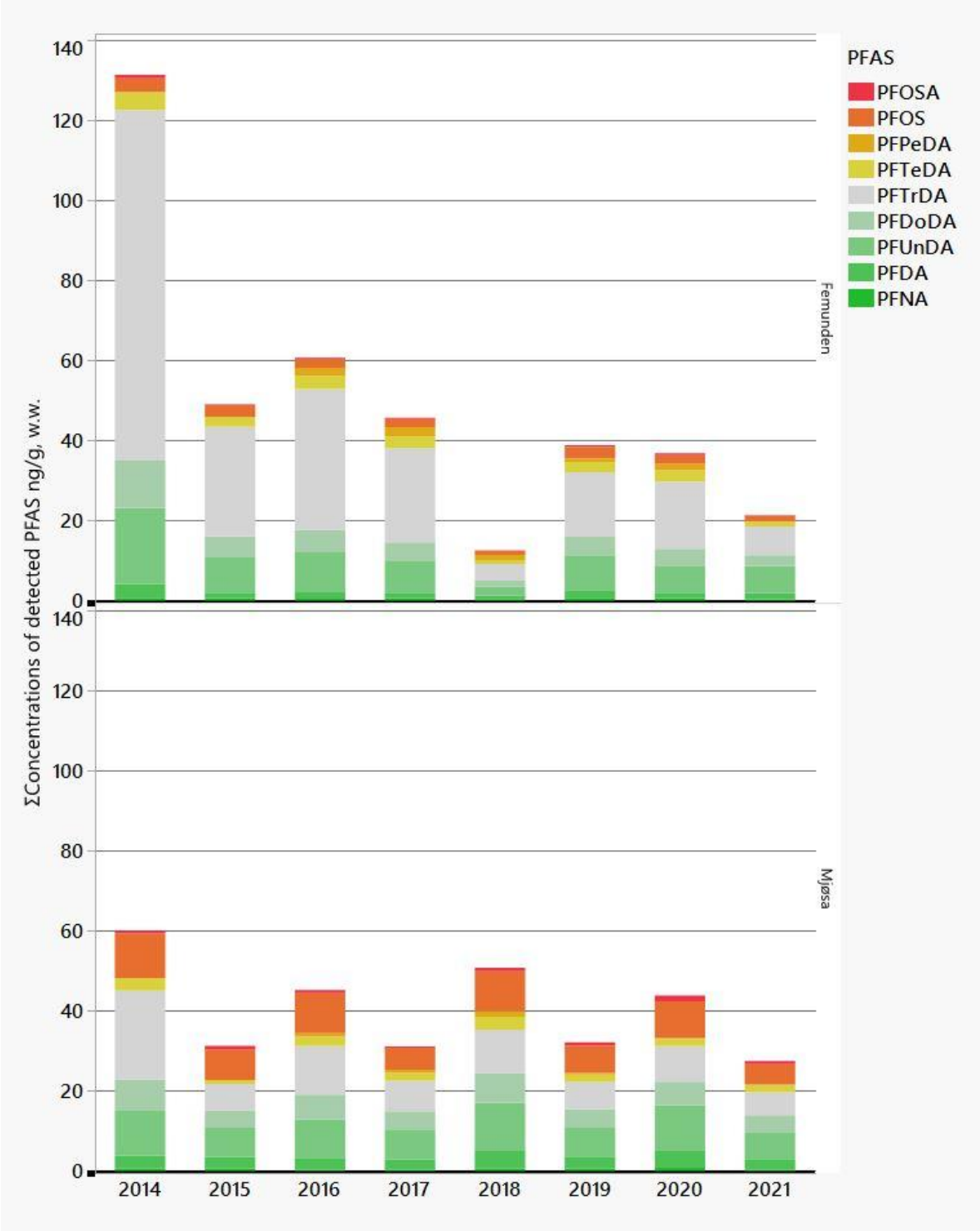

Figure 24. Time trend for PFAS (sum of detected PFASs: PFDA, PFUnDA, PFDoDA, PFTrDA, PFOS, PFOSA) in brown trout from Lake Mjøsa and Femunden (ng/g w.w.) from 2014 – 2021. In 2021 three pooled samples of five individuals were analysed.

2.3.12.3 Siloxane D5 in Lake Mjøsa and Lake Femunden, 2010 - 2021

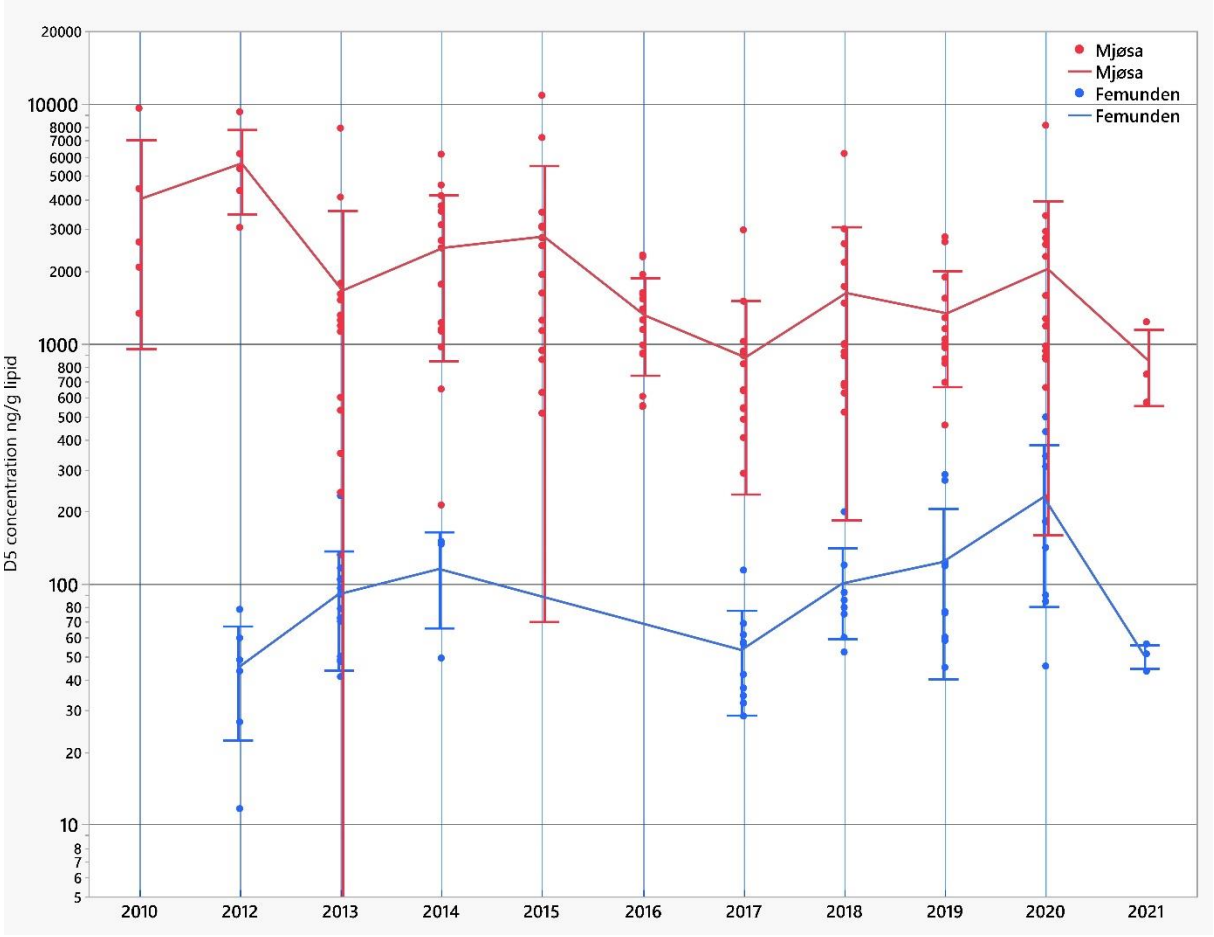

Figure 25. Time trend for D5 (siloxane) in brown trout from Lake Mjøsa and Lake Femunden (ng/g w.w.) from 2010 – 2021. In 2021 three pooled samples were analysed.

2.3.12.4 Mercury (Hg) 2006 - 2021

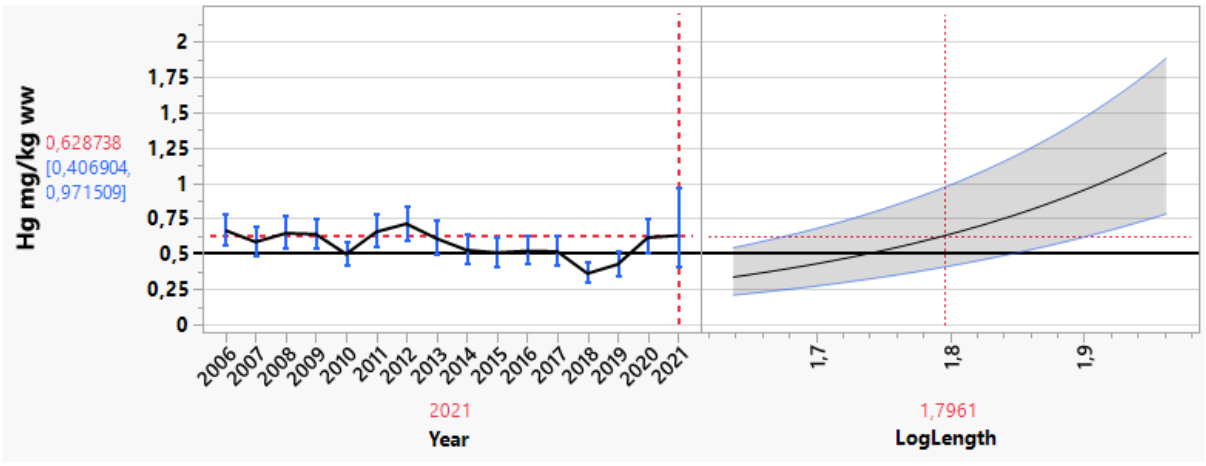

Figure 26. Length adjusted Hg (with 95 % confidence intervals) in trout from Lake Mjøsa 2006-2021. Trout are adjusted to the geometric average length (62.5 cm) in the dataset (~2.6 kg). Horizontal line at 0.5 mg/kg Hg (upper consumption limit) are added. Length adjusted mean Hg concentration (with 95 % confidence limits) for 2021 is marked with a red dashed line and numbers. Note that the 2021 length adjusted Hg, consist of three datapoints, each of which is a pooled sample of five individuals. Estimate for all other years are based on 15 to 22 individual datapoints.

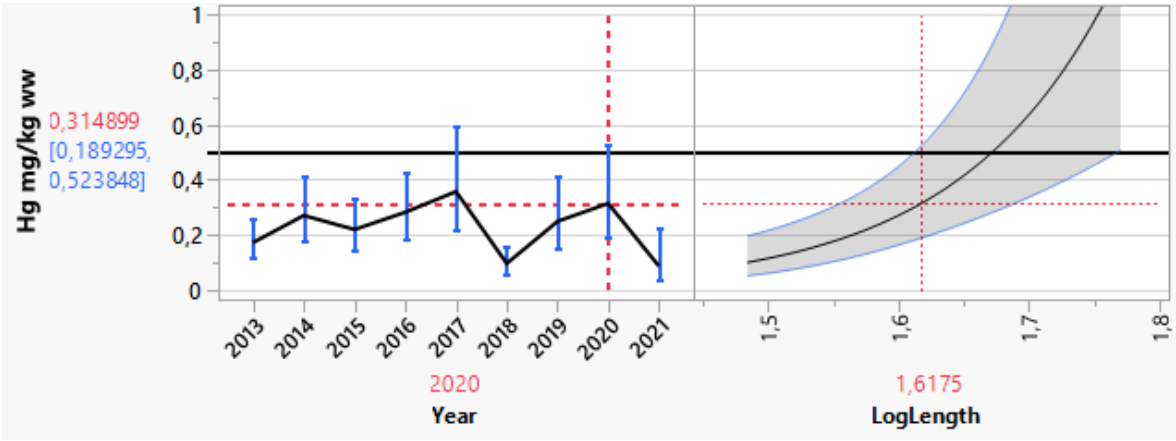

Figure 27. Length adjusted Hg (with 95 % confidence intervals) in trout from Lake Femunden 2013-2021. Trout are adjusted to the geometric average length (41,4 cm) in the dataset (~0.73 kg). Horizontal line at 0.5 mg/kg Hg (upper consumption limit) are added. Length adjusted mean Hg concentration (with 95 % confidence limits) for 2021 is marked with a red dashed line and numbers. Note that the 2021 length adjusted Hg, consist of three datapoints, each of which is a pooled sample of five individuals. Estimate for all other years are based on 10 to 15 individual datapoints.

2.3.13 Results compared to Environmental Quality Standards (EQS)

Levels of individual contaminants have been compared to Environmental quality standards (EQS; Direktoratsgruppen vanndirektivet, 2018) in biota indicated in Table 5. Concentrations of mercury (Hg), PBDEs and PCBs all exceed the EQS in biota (Brown trout) from both Lake Mjøsa and Femunden.

In sediment (Table 6), PCBs are the only contaminants exceeding the EQS for freshwater sediment.

In freshwater (Table 7), no contaminants exceed the AA-EQS in Lake Mjøsa. However, PFOS and zinc (Zn) are found in concentrations above the AA-EQS in effluent water from HIAS WWTP and stormwater runoff from Hamar city.

Table 5. Results of contaminant levels in biota compared to EQS.

	Biota (Brown trout) in Lake Mjøsa and Lake Femunden 2021			
Contaminant	EQS_{biota}	Concentration range (min-max) for Brown trout		$n>EQS_{biota}$
	µg/kg w.w.	µg/kg w.w.		n
Priority substances				
Hg	20	Mjøsa	740 – 1000	3/3
		Femunden	120 – 200	3/3
PBDEs (ΣBDE_6)*	0.0085	Mjøsa	5.7 – 15	3/3
		Femunden	0.16 – 0.30	3/3
PFOS (in liver)	9.1	Mjøsa	3.4 – 6.7	0
		Femunden	0.91 – 2.6	0
SCCPs	6000	Mjøsa	1.07 – 2.2	0
HCB	10	Mjøsa	0.30 – 0.52	0
		Femunden	0.24 – 0.38	0
PeCB	50	Mjøsa	0.021 – 0.038	0
		Femunden	0.015 – 0.019	0
HBCD	167	Mjøsa	<0.12	0
Nonylphenol***	3000	Mjøsa	<40	0
Octylphenol***	0.004	Mjøsa	4	1/1
River basin-specific pollutants				
MCCPs	170	Mjøsa	3.4 – 5.1	0
D5	15000	Mjøsa	11 – 22	0
		Femunden	0.71 – 0.84	0
PFOA (in liver)	91	Mjøsa	<0.5	0
		Femunden	<0.5	0
PCB_7 (ΣPCB_7)**	0.6	Mjøsa	22 – 37	3/3
		Femunden	1.9 – 3.8	3/3
Triclosan (in liver)	15000	Mjøsa	<5	0
		Femunden	<3 - <10	0

* ΣBDE_6: BDE-28, -47, -99, -100, -153 and -154

** ΣPCB_7: PCB 28, 52, 101, 118, 138, 153 and 180

***Perch (not Brown trout)

Table 6. Concentrations of contaminants (mg/kg dw) of which Norwegian quality standards (Direktoratsgruppen vanndirektivet 2018) exist in freshwater sediment from Lake Mjøsa. Red numbers indicate concentrations exceeding the quality standard.

EU priority substances	EQS (mg/kg dw)	Sediment conc. Lake Mjøsa (mg/kg dw)
Lead (Pb)	66	52
Brominated diphenyl ethers *	0.31	<0.0005
PFOS	0.0023	0.00015
River basin specific compounds		
Decamethylcyclopentasiloxane (D5)	0.044	0.0024
Medium chained chloroparafins (MCCPs)	4.6	0.018
Copper (Cu)	84	9.1
PCB_7	0.0041	0.30
PFOA	0.071	<0.0005
Zinc (Zn)	139	72
Arsenic (As)	18	3.3
Chromium (Cr)	620	21
TCEP	0.072	<0.00006
Triclosan	0.009	<0.02
* Sum of BDE-28, -47, -99, -100, -153 and -154.		

Table 7. Concentrations of contaminants (µg/L) in Lake Mjøsa, stormwater (Hamar) and HIAS WWTP effluent water (dissolved fraction of all) of which Norwegian quality standards exist in freshwater. Red numbers indicate concentrations exceeding the quality standard, however water quality in Lake Mjøsa is not set based on concentrations in stormwater or WWTP effluent.

EU priority substances	AA-EQS (µg/L)	Lake Mjøsa (dissolved; µg/L)	Stormwater conc. (dissolved; µg/L)	Effluent water (HIAS WWTP) conc. (dissolved; µg/L)
Cadmium (Cd)	0.08	0.007	0.04	0.06
Lead (Pb)	1.2	0.2	0.03	0.35
Nickel (Ni)	4	0.60	1.8	2.8
Mercury (Hg)	0.07 ***	0.0004	0.0006	0.002
Brominated diphenyl ethers *	0.14 ***	n.a.	<0.0001	<0.0001
Hexachlorobenzene	0.05 ***	n.a.	<0.0001	<0.0001
Pentachlorobenzene	0.007	n.a.	0.000026	<0.00004
PFOS	0.00065	n.a.	0.0008	0.001
DEHP	1.3	<0.01	<0.01	0.053
Nonylphenol	0.3	0.2	<0.008	2.7
Octylphenol	0.1	<0.0008	0.01	0.002
River basin specific compounds	**AA-EQS (µg/L)**	**Lake Mjøsa (dissolved; µg/L)**	**Stormwater conc. (dissolved; µg/L)**	**Effluent water (HIAS WWTP) conc. (dissolved; µg/L)**
Bisphenol A	0.15	<0.0018	0.006	0.2
Decamethylcyclopentasiloxane (D5)	1.7	<0.001	<0.001	<0.001
Medium chained chlorinated paraffins (MCCPs)	0.05	n.a.	0.008	0.008
Copper (Cu)	7.8	2.7	5.3	3.0
PCB_7**	0.0000024	n.a.	<0.00002	<0.00002
PFOA	9.1		0.003	0.006
Zinc (Zn)	11	1.3	8.1	15
Arsenic (As)	0.5	0.10	0.36	0.48
Chromium (Cr)	3.4	0.30	0.80	0.43
TCEP	65	n.a.	0.01	0.09
Triclosan	0.1	n.a.	0.00004	0.001

n.a.: not analyzed
* Sum of BDE-28, -47, -99, -100, -153 and -154.
** Sum of PCB 28, 52, 101, 118, 138, 153 and 180
*** No AA-EQS for these substances, thus this is the MAC-EQS

Appendix A.

3 Appendix - Material and Methods

3.1 Sampling methods

3.1.1 Sediment

Sediment was collected at three stations in a transect from outside WWTP HIAS towards Hamar city (**Figure 1)** by means of a van Veen grab (0.15 m^2) from NIVAs own boat. Four grabs of the top layer (0-2 cm in grab samples with undisturbed surface) were prepared[1] for each station. Upon analysis, the samples from these three stations were pooled into one composite sample.

3.1.2 Surface water

Surface water from Lake Mjøsa was sampled at the same three stations as sediment (**Figure 1**), filling the designated glass and plastic bottles from the side of the boat during slow drift.

3.1.3 Stormwater

Stormwater samples were collected at two occasions in two specific locations representing urban stormwater runoff in Hamar city (Stations 1 and 2, **Figure 1**). The samples were collected from manholes by filling designated bottles for the various analyses directly from the stormwater flow. Subsequently in the lab, the stormwater samples were separated into a filtered fraction (hereafter referred to as "dissolved fraction") and a particulate fraction by means of filtering, using polyethylene (PE) frit, 20 µm porosity prior to analysis of PFAS (at NIVA) and Whatman Glass Microfilters GF, pore size 1.2 µm, prior to analysis of other chemical parameters (at NILU).

3.1.4 Municipal wastewater treatment plant (WWTP)

Flow-proportional 24-hour composite samples of fully treated effluent were collected at HIAS wastewater treatment plant (WWTP, 140 000 PE), see Figure 1, in October 2021. Sample equipment already in use by the WWTP (composite sampler) was used for collecting samples.

Concentration of suspended solids (SS) (the plant's own measurements) and the amount of wastewater that was treated at the plant during each sampling campaign are shown in Table 8.

Table 8. Period for sampling of treated effluent for analysis of environmental contaminants at HIAS WWTP. Measurement of turbidity by means of suspended solids (SS) and amount of treated wastewater is shown.

Start	End	SS mg/L	Total treated volume m^3
13.10.2021	14.10.2021	11-21	38 271
25.10.2021	26.10.2021	8-11	39 298

In addition to effluent samples, dewatered sludge samples were collected. The samples were daily grab samples on weekdays from each of the centrifuges in use at the time of sampling. Each subsample was frozen and transported to NIVA where they were thawed before preparation of the composite sample, which was then frozen again. Sludge was collected from 11.10.2021 to 15.10.2021.

[1] According to the Norwegian Environment Agency guidelines for risk assessment of contaminated sediment (M-409/2015)

3.1.5 Chironomidae larvae

Larvae of the family *Chironomidae* were collected in the outer parts of the Åkersvika delta, see Figure 1. Using a van Veen grab (0.15 m^2), sediment was collected in bulk into a large container. The samples were subsequently sifted through a 2 mm nylon mesh, and the larvae of the *Chironomidae* family (red larvae, length approx. 1 cm, Ø 1mm) were collected manually using tweezers, to a total mass of approx. 100 g. Larvae were allowed approx. 24 hrs in clean water to empty their gastrointestinal system before homogenization and analysis.

3.1.6 Roach, ruffe and perch

Fish representatives of the benthic food chain were collected using a series of bottom nets (12 – 45 mm mesh) in the area specified in Figure 1. 15 specimens of each species were pooled into 1 sample (whole body for roach and ruffe; muscle and liver for perch). Stable isotopes of carbon and nitrogen were performed on individual muscle samples (n=15).

3.1.7 Brown trout

Brown trout (*Salmo trutta*) were collected in an area outside Gjøvik (Lake Mjøsa) and in Lake Femunden (Figure 2) using series of bottom nets during the period July 1st – October 1st. 15 and 13 specimens, respectively, were pooled into 3 pooled samples (5 and 4 individuals in each sample) for chemical analyses. Stable isotopes of carbon and nitrogen were performed on individual muscle samples (n=15).

3.2 QA/QC

In Table 9 (separate tables for each contaminant group) there is a short method description, including LOQ and an assessment and categorization of the uncertainty for every individual compound analyzed. The uncertainty is divides in three groups from 1-3. (descriptions will maybe change before final reporting).

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 have been proven with intercalibration studies and quality parameters are good. Most of these analyses is 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. These group also includes parameters that has 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 others. There will be comments on all these parameters.

Table 9. 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	Three blanks per batch. Blank-subtraction and LOQ based on average signal of blanks + 3*std. Octocylene usually has the highest levels in blanks.	0.16-1.3	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)	5466-77-3		0.02-0.7		2
	Ethylhexylmethoxycinnamate (EHMZ-E)	5466-77-3		0.06-1.3		2
	Octocrylene	6197-30-4		0.5-7		2
	UV-327	3864-99-1		0.01-0.2		2
	UV-328	25973-55-1		0.1-1		2
	UV-329	3147-75-9		0.2-5		3
	homosalate	118-56-9		0.6-6		2
	3-(2H-benzotriazol-2-yl)-5-(1,1-dimethylethyl)-4-hydroxy-benzenepropanoic acid l	84268-36-0	One blank pr batch. LOQ based on 10 x signal-to-noise as measured in each sample	0.5-1	IS added. Solid samples then extracted twice, and water samples pre-concentrated on SPE. LC-MS/MS detection	2

Comments to UV compounds:
Tests of the extraction and analysis recovery of UV-329 based on spiking experiments give results in the range of 60-140%. The measured results of the analysis of complex samples (such as liver) could be overestimates as a consequence. An alternative and more appropriate internal standard will be considered to improve accuracy in future analyses.

Table 9cont. 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	Klorheksidin	55-56-01	One blank per batch. LOQ based on 10 x signal-to-noise as measured in each sample	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
	Brodifacoum	56073-10-0		0.2-0.5		2
	Bromodiolone	28772-56-7		0.2-0.5		2
	Difenacoum	56073-07-5		0.2-0.5		2
	Difethialone	104653-34-1		0.2-0.5		2
	Flocumafen	90035-08-8		0.2-0.5		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		0.4-4	IS added. Samples then extracted twice before clean-up via GPC and/or PSA. GC-MS/MS detection	3
	Permitrin (trans)	52645-53-1		0.4-4		3
	Triclosan	3380-34-5		0.05-100		2

Comment to Permitrin: Tests of the extraction and analysis recovery of Permithrin based on spiking experiments give results in the range of 60-140%. The measured results of the analysis of complex samples could be overestimates as a consequence. An alternative and more appropriate internal standard will be considered to improve accuracy in future analyses.

Table 9 continued. 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	One blank per batch. LOQ as validated and externally controlled in proficiency testing.	10	Internal standard is added and solid samples are extracted twice. Water samples are concentrated by freeze drying. LC-MS/MS detection	2
	PFPrA	422-64-0		1		2
	PFBA	375-22-4		1	Internal standard is added and solid samples are extracted twice. Water samples are concentrated on an SPE column. LC-QTOF-MS detection	2
	PFPA	422-64-0		0,5		2
	PFHxA	307-24-4		0,5		1
	PFHpA	335-67-1		0,5		2
	PFOA	375-95-1		0,5		1
	PFNA	335-76-2		0,5		1
	PFDcA	2058-94-8		0,4		1
	PFUnA	307-55-1		0,4		1
	PFDoA	72629-94-8		0,4		1
	PFTriA	376-06-7		0,4		1
	PFTeA	67905-19-5		0,4		1
	PFHxDA	16517-11-6		0,4		2
	PFOcDA	16517-11-6		0,4		2
	PFSA					
	PMeS	1493-13-6	One blank per batch. LOQ as validated and externally controlled in proficiency testing.	0,5	Same method as for TFA	2
	PFEtS	354-88-1		0,5		2
	PFPrS	423-41-6		0,1		2
	PFBS	375-73-5		0,1	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		0,1		2
	PFHxS	355-46-4		0,1		1
	PFHpS	375-92-8		0,1		1
	PFOS	2795-39-3		0,1		1
	brPFOS	1763-23-1		0,1		2
	PFNS	17202-41-4		0,2		2
	PFDcS	67906-42-7		0,2		1
	PFUnS	441296-91-9		0,2		2
	PFDoS	79780-39-5		0,2		2
	PFTrS	749786-16-1		0,2		2
	PFTS	n/a		0,2		3
	nPFAS					
	PFBSA	30334-69-1		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
	N-MeFBSA	68298-12-4	One blank per batch. LOQ as validated and externally controlled in proficiency testing.	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-EtFBSA	40630-67-9		0,3		2
	PFOSA	754-91-6		0,3		1
	meFOSA	31506-32-8		0,3		2
	etFOSA	4151-50-2		0,1		2
	meFOSE	24448-09-7		1,0		2
	etFOSE	1691-99-2		1,0		2
	etFOSAA	2991-50-6		0,3		2
	newPFAS					
	4:2 FTS	757124-72-4	One blank per batch. LOQ as validated and externally controlled in proficiency testing.	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
	NaDONA	958445-44-8		0,3		2
	PFECHS	67584-42-3		0,3		2
	HFPO-DA (Gen-X)	13252-13-6		0,3		2

Comments to PFAS:
PFTS and 12:2 FTS: Reference standard materials are unavailable for these two compounds. Uncertainty category is therefore reported as 3. However, knowledge from similar compounds provides confidence and we judge the results to be reliable.
Br-PFOS: 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 have not been reported, but the results here present the most significant.

Table 9 continued. 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	Three blanks per batch. Blank-subtraction and LOQ based on average signal of blanks + 3*std.	5	Internal Standard (IS) added. Samples are then extracted twice before clean-up via SPE. LC-MS/MS detection	3
	DADMAC-C10	2390-68-3		50		3
	DADMAC-C12	3282-73-3		5		3
	DADMAC-C14	68105-02-2		1		3
	DADMAC-C16	70755-47-4		5		3
	DADMAC-C18	3700-67-2		5		3
	BAC-C8	959-55-7		5		3
	BAC-C10	965-32-2		5		3
	BAC-C12	139-07-1		25		3
	BAC-C14	139-08-2		25		3
	BAC-C16	122-18-9		25		3
	BAC-C18	122-19-0		25		3
	ATAC-C8	2083-68-3		5		3
	ATAC-C10	2082-84-0		5		3
	ATAC-C12	1119-94-4		5		3
	ATAC-C14	1119-97-7		50		3
	ATAC-C16	57-09-0		50		3
	ATAC-C18	1120-02-1		50		3
	ATAC-C20	15809-05-9		25		3
	ATAC-C22	17301-53-0		5		3

Comments to QACs: Challenges seen with elevated levels of some QACs in blank samples. Carry-over or cross-contamination from a sample to the next one injected on the LCMS has also been observed. This is reflected in the elevated LOQs. Work on improvements to the method is ongoing.

Table 9 continued. 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 mBZT	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 BZT	95-14-7		1,0		2
	Benzothiazole	95-16-9		10,0-50,0		2
	2(3H)-Benzothiazolone (HBT)	934-34-9		10,0		2
	metyl-1H-benzotriazole	29385-43-1		0,5		2
	N-cyclohexylbenzothiazole-2-sulfenamide	95-33-0		1,0		2
	Cl-benzotriazole	94-97-3		0,5		2
	6 PPD quinone	No CAS		0,5		2

Comments to benzothiazoles: Some of the abiotic samples show results outside the range of the method (i.e. greater than 100 ng/g or 100 ng/L). For these results the uncertainty is greater and, it is likely that results are underestimates.

Table 9 continued. Method information. **Metals**

Parameter group	Compound	Cas no	Blank	LOD range (mg/kg)	LOQ range (mg/kg)	Method	Uncertainty category
Metals Biota	Cr	7440-47-3	Method blanks following sample series. LOD/LOQ based on calculation of 3 and 10 stddev respectively	0.0004-0.0006	0.001-0.002	In-house accredited method. Microwave assisted decomposition with HNO3. Analysed by ICP-MS (Agilent 7700x).	1
	Fe	7439-89-6		0.02-0.03	0.07-0.1		1
	Ni	7440-02-0		0,00007-0,0001	0,0002-0,0003		1
	Cu	7440-50-8		0.02-0.04	0.01-0.08		1
	Zn	7440-66-6		0.04-0.06	0.1-0.2		1
	As	7440-38-2		0.0009-0.002	0.003-0.005		1
	Ag	7440-22-4		6,0E-06 - 1,0E-05	0.00002-0.00003		1*
	Cd	7440-43-9		0.0001-0.0002	0.0004-0.001		1
	Sn	7440-31-5		0.0002-0.0003	0.001-0.006		2*
	Sb	7440-36-0		1.0E-05-1,6E-05	3.2E-05-5.4E-05		1
	Ce	7440-00-8		1.1E-05-1.9E-05	3.8E-05-6.3E-05		2*
	Nd	7440-00-8		3.1E-05-5.2E-05	0.0001-0.0002		2*
	Pb	7439-92-1		4.0E-05-6.7E-05	0.0001-0.0002		1
	Hg	7440-02-0		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 9 continued. Method information. **Metals cont.**

Parameter group	Compound	Cas no	Blank	LOD range ng/L water (particles)	LOQ range ng/L water (particles)	Method	Uncertainty category
Metals / Water and particles	Cr	7440-47-3	Method blanks following sample series. LOD/LOQ based on calculation of 3 and 10 stddev respectively	5	17	In-house accredited method. Microwave assisted decomposition with HNO_3. Water samples conserved with HNO_3. Analysed by ICP-HRMS (ELEMENT2)	1
	Fe	7439-89-6		100	333		1
	Ni	7440-02-0		8	27		1
	Cu	7440-50-8		30	100		1
	Zn	7440-66-6		100	333		1
	As	7440-38-2		5	17		1
	Ag	7440-22-4		4	13		1*
	Cd	7440-43-9		1	3		1
	Sn	7440-31-5		5	17		2*
	Sb	7440-36-0		2	7		1
	Ce	7440-00-8		0,3	1		2*
	Nd	7440-00-8		0,4	1		2*
	Pb	7439-92-1		10	33		1
Mercury/ Particles	Hg	7440-02-0		(0,2-0,3)	(1-2)	In-house accredited method. Filtration of water. Microwave assisted decomposition of particles on filter with HNO_3. Digestate stabilizased with HCl. Analysed by ICP-MS (Agilent 7700x).	1
Mercury/ Water	Hg	7440-02-0	Method blanks following sample series. LOD/LOQ based on calculation of 3 and 10 stddev respectively	0,5	2	Water samples stabilized with HCl. BrCl added. Analysed by CV-AFS (Tekran).	1

*Not accredited

Table 9 continued. 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	0,02-0,2	0,04-0,4	In-house, accredited method. Internal standard addition, extraction, GPC and/or H2SO4 cleanup followed by adsorption chromatography. GC/HRMS (autspec)	1	Y
	HCB	118-74-1		0,05-0,1	0,006-0,2		1	Y
	HCBD	87-68-3		0,1-0,5			3	N
	PCB 28	7012-37-5		0,001-0,03	0,003-0,1		1	y
	PCB 52	35693-99-3		0,002-0,07	0,004-0,2		1	y
	PCB 101	37680-73-2		0,001-0,1	0,003-0,3		1	y
	PCB 118	31508-00-6		0,001-0,1	0,003-0,4		1	y
	PCB 138	35065-28-2		0,001-0,5	0,004-1,4		1	y
	PCB 153	35065-27-1		0,002-0,7	0,006-2		1	y
	PCB 180	35065-29-3		0,001-0,2	0,004-0,5		1	y

Table 9 continued. Method information. **Dechloranes**.

Parameter group	Navn 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	0,03-0,2	0,1-0,4	In-house method. Internal standard addition, extraction, GPC and/or H2SO4 cleanup followed by adsorption chromatography. GCGC-qToF 7200 in ECNI	2	N
	Dechlorane 602	31107-44-5		0,008-0,03	0,02-0,1		2	y
	Dechlorane 603	13560-92-4		0,01-0,04	0,03-0,1		2	N
	Dechlorane 604	34571-16-9		0,2-0,7	0,4-2		2	N
	Dechlorane 601	13560-90-2		0,02-0,7	0,04-0,4		2	N
	Dechlorane plus syn	135821-03-3		0,04-0,2	0,1-0,4		2	y
	Dechlorane plus anti	135821-74-8		0,03-0,1	0,07-0,3		2	N
	1,3-DPMA	N/A		0,03-0,1	0,08-0,3		2	N
	1,5-DPMA	N/A		0,06-0,2	0,1-0,5		2	N
	Chlordene Plus	13560-91-3		0,02-0,08	0,05-0,2		2	N
	Chlorendic anhydrid (nytt alternativ fra Velsicol)	115-27-5					3	N

Table 9 continued. Method information. **PBDEs**

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
PBDE	TBA	607-99-8	Method blanks following sample series. LOD/LOQ based on calculation of 3 and 10 stddev respectively	0.003-0.02	0.006-0.04	In-house method. Internal standard addition. extraction. GPC and/or H2SO4 cleanup followed by adsorption chromatography. GC/HRMS (autspec)	2	N
	BDE-17	147217-75-2		0.003-0.02	0.01-0.05		2	N
	BDE-28	41318-75-6		0.003-0.02	0.01-0.05		1	Y
	BDE-47	5436-43-1		0.03-0.2	0.07-0.6		2	N
	BDE-49	123982-82-3		0.002-0.02	0.006-0.05		2	N
	BDE-66	189084-61-5		0.006-0.07	0.02-0.2		2	N
	BDE-71	189084-62-6		0.001-0.01	0.003-0.02		2	N
	BDE-77	93703-48-1		0.002-0.01	0.006-0.02		2	N
	BDE-85	446254-52-0		0.003-0.01	0.01-0.02		2	N
	BDE-99	60348-60-9		0.006-0.1	0.01-0.2		1	Y
	BDE-100	189084-64- 8		0.003-0.03	0.007-0.08		2	N
	BDE-119	189084-66-0		0.002-0.01	0.006-0.03		2	N
	BDE-126	366791-32-4		0.001-0.01	0.003-0.02		2	N
	BDE-138	182677-30-1		0.005-0.02	0.01-0.05		2	N
	BDE-153	68631-49-2		0.004-0.03	0.01-0.09		1	Y
	BDE-154	207122-15-4		0.004-0.02	0.01-0.05		2	N
	BDE-156	405237-85-6		0.007-0.03	0.02-0.07		2	N
	BDE-183	207122-16-5		0.004-0.02	0.01-0.05		1	Y
	BDE-184	117948-63-7		0.003-0.02	0.01-0.04		2	N
	BDE-191	446255-30-7		0.003-0.02	0.01-0.06		2	N
	BDE-196	32536-52-0		0.005-0.04	0.01-0.1		2	N
	BDE-197	117964-21-3		0.004-0.04	0.01-0.1		2	Y
	BDE-202	67797-09-5		0.006-0.04	0.02-0.1		2	N
	BDE-206	63387-28-0		0.04-0.1	0.1-0.3		2	Y
	BDE-207	437701-79-6		0.02-0.1	0.07-0.2		2	N
	BDE-209	1163-19-5		0.5-1.2	1.4-3.3		2	Y

Table 9 continued. Method information. **Other BFRs (EBF).**

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
EBF	ATE (TBP-AE)	3278-89-5	Method blanks following sample series. LOD/LOQ based on calculation of 3 and 10 stddev respectively	0.003-0.03	0.01-0.07	In-house method. Internal standard addition, extraction, GPC and/or H2SO4 cleanup followed by adsorption chromatography. GC/HRMS (autspec)	2	N
	a-TBECH	3322-93-8		0.02-0.2	0.05-0.5		2	N
	b-TBECH	3322-93-8		0.05-0.2	0.04-0.4		2	N
	g/d-TBECH	3322-93-8		0.008-0.09	0.01-0.09		2	N
	BATE	99717-56-3		0.003-0.03	0.01-0.8		2	N
	PBT	87-83-2		0.006-0.06	0.01-0.2		2	N
	PBEB	85-22-3		0.003-0.03	0.008-0.09		2	N
	PBBZ	608-90-2		0.05-0.5	0.2-2		2	y
	HBB	87-82-1		0.02-0.2	0.04-0.4		2	y
	DPTE	35109-60-5		0.004-0.03	0.01-0.07		2	N
	EHTBB	183658-27-7		0.04-0.06	0.1-0.2		2	y
	BTBPE	37853-59-1		0.008-0.06	0.03-0.2		2	y
	TBPH (BEH/TBP)	26040-51-7		0.06-0.1	0.2-0.4		2	N
	DBDPE	84852-53-9		2.6-28	7.76		2	y

Table 9 continued. Method information. **Other BFRs - HBCD**.

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
HBCD	a-HBCD	25637-99-4	Method blanks following sample series. LOD/LOQ based on calculation of 3 and 10 stddev respectively	0,005-0,05	0,02-0,1	In-house method. Internal standard addition, extraction, GPC and/or H2SO4 cleanup followed by adsorption chromatography. LC/HRMS	2	Y
	b-HBCD	25637-99-4		0,004-0,04	0,01-0,1		2	y
	g-HBCD	25637-99-4		0,005-0,05	0,02-0,1		2	y

Table 9 continued. Method information. **S/MCCPs**.

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. SCCP og MCCP 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 respectivly	4-16	13-51	In-house method. Internal standard addition, exctraction, GPC and/or H2SO4 cleanup followed by adsporption chromatography. GC-qToF 7200 in ECNI	3	13C-hexachlorodecane
	MCCP	85535-85-9		13-51	43-168		3	

Table 9 continued. 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	DEHP	117-81-7	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	10-20	40-60	100mL water is cleaned up on HLB column, extracted with ACN, concentrated and analysed on LCMSMS	2	D4-DEHP
	DINP	28553-12-0		10-20	40-60		2	
	Diisodecyl phthalate (DIDP)	68515-49-1		5-20	20-60		2	
	Dioctyl phthalate	117-84-0		1-5	5-15		2	
	BBzP	85-68-7		1-5	5-15		2	
	DEP	84-66-2	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	30-100	50-200	100mL water is cleaned up on HLB column, extracted with ACN, concentrated and analysed on LCMSMS	2	
	diundecyl phthalate, branched and linear	85507-79-5		5-20	20-60		2	
	DHP	84-75-3		1-3	3-9		2	
	DcHP	84-61-7		1-3	3-9		2	
	DIBP	84-69-5		5-20	20-40		2	
	Diundecyl phthalate	3648-20-2		1-5	5-15		2	
	DBP	84-74-2		2-6	6-12		2	

Table 9 continued. Method information. **Phthalates cont**.

Parameter group	Compound	Cas no	Blank	LOD range (ng/g)	LOQ range (ng/g)	Method	Uncertainty category	Stable isotope labeled (SIL) analogue
Phthalate Biota	DEHP	117-81-7	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	2-10	10-30	1-2 g of biota was homogenized and added deuterated internal standard and later extracted with acetone three times with vortexing and sonication for 10min. Extract was evaporated and added acetic acid/water and later extracted three times with hexane using vortex and 10min sonication and centrifugation. Extract was evaporated and transferred to analytical glass. Recovery standard added and analysis on LC-MSMS.	2	D4-DEHP
	DINP	28553-12-0		1-3	3-6		2	
	Diisodecyl phthalate (DIDP)	68515-49-1		1-3	3-6		2	
	Dioctyl phthalate	117-84-0		0.5-2	2-5		2	
	BBzP	85-68-7		0.5-2	2-5		2	
	DEP	84-66-2	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	0.5-3	3-9	1-2 g of biota was homogenized and added deuterated internal standard and later extracted with acetone three times with vortexing and sonication for 10min. Extract was evaporated and added acetic acid/water and later extracted three times with hexane using vortex and 10min sonication and centrifugation. Extract was evaporated and transferred to analytical glass. Recovery standard added and analysis on LC-MSMS.	2	
	diundecyl phthalate, branched and linear	85507-79-5		0.5-2	2-5		2	
	DHP	84-75-3		0.1-1	1-3		2	
	DcHP	84-61-7		0.1-1	1-3		2	
	DIBP	84-69-5		0.5-2	2-5		2	
	Diundecyl phthalate	3648-20-2		0.1-1	1-3		2	
	DBP	84-74-2		0.5-2	2-5		2	

Table 9 continued. Method information. **Phthalates cont.**

Parameter group	Compound	Cas no	Blank	LOD range (ng/g)	LOQ range (ng/g)	Method	Uncertainty category	Stable isotope labeled (SIL) analogue
Phthalate sediment	DEHP	117-81-7	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	5-15	15-30	2-4g sediment/soil was dried in a clean cabinet over night. 1g was taken and extracted with acetone by vortex and sonication for 10 min. Extract was evaporated and redissolved in ACN and centrifuged and portion of extract was analysed on LCMSMS	2	D4-DEHP
	DINP	28553-12-0		3-5	5-15		2	
	Diisodecyl phthalate (DIDP)	68515-49-1		3-5	5-15		2	
	Dioctyl phthalate	117-84-0		0.5-2	2-6		2	
	BBzP	85-68-7		0.3-1	1-3		2	
	DEP	84-66-2	Three blanks pr 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	10-20	20-50	2-4g sediment/soil was dried in a clean cabinet over night. 1g was taken and extracted with acetone by vortex and sonication for 10 min. Extract was evaporated and redissolved in ACN and centrifuged and portion	3	
	diundecyl phthalate, branched and linear	85507-79-5		3-5	5-15		2	
	DHP	84-75-3		0.3-1	1-3		2	
	DcHP	84-61-7		0.3-1	1-3		2	
	DIBP	84-69-5		0.5-2	1-3		2	
	Diundecyl phthalate	3648-20-2		0.5-2	2-6		2	
	DBP	84-74-2		0.5-2	1-3		2	

Table 9 continued. 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	100mL water is cleaned up on HLB column, extracted with ACN, concentrated and analysed on LCMSMS	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
	TPP	115-86-6		0.5-2	2-4		2	Y
	TnBP	126-73-8		0.5-2	2-4		2	Y
	BdPhP	2752-95-6		0.5-2	2-4		2	N
	TDCPP	13674-87-8		2-4	4-10		2	Y
	TBOEP	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
	EHDP	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	64532-95-2		1-3	2-5		2	Y
	TEHP	78-42-2		1-3	2-5		2	Y
	TTBPP	78-33-1		1-3	2-5		2	N

Table 9 continued. Method information. **oPFRs cont.**

Parameter group	Name of parameter	Cas no	Blank	LOD range (ng/g)	LOQ range (ng/g)	Method	Uncertainty category	Stable isotope labeled (SIL) analogue
OPFR sediment	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		5-10	2-5 g of soil was dried overnight and 2 g of dry material and deuterated internal standard was added and was taken for extraction with acetone using vortex and sonication for 10min done three times. Samples was centrifuged and sample was evaporated and transferred to analytical glass. Recovery standard added and analysis on LC-MSMS.	2	Y
	TCEP	115-96-8			2-3		2	Y
	TPrP	513-08-6			1-2		2	N
	TCPP	13674-84-5			1-2		2	Y
	TiBP	126-71-6			2-3		2	N
	DBPhP	2528-36-1			1-2		2	N
	TPP	115-86-6			1-2		2	Y
	TnBP	126-73-8			2-3		2	Y
	BdPhP	2752-95-6			1-2		2	N
	TDCPP	13674-87-8			1-2		2	Y
	TBOEP	78-51-3			1-2		2	N
	2-IPPDPP	64532-94-1			1-2		2	N
	4-IPPDPP	55864-04-5			1-2		2	N
	TCP	1330-78-5			1-2		2	N
	EHDP	1241-94-7			1-2		2	N
	IDDPP	29761-21-5			1-2		2	N
	B4IPPPP	55864-07-8			1-2		2	N
	TXP	25155-23-1			1-2		2	N
	TIPPP	64532-95-2			1-2		2	Y
	TEHP	78-42-2			1-2		2	Y
	TTBPP	78-33-1			1-2		2	N

Table 9 continued. Method information. **oPFRs cont.**

Parameter group	Name of parameter	Cas no	Blank	LOD range (ng/g)	LOQ range (ng/g)	Method	Uncertainty category	Stable isotope labeled (SIL) analogue
OPFR biota	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	2-5	5-10	1-2 g of biota was homogenized and added deuterated internal standard and later extracted with acetone three times with vortexing and sonication for 10min. Extract was evaporated and added acetic acid/water and vortex and later extracted three times with hexane using vortex and 10min sonication and centrifugation. Extract was evaporated and transferred to analytical glass. Recovery standard added and analysis on LC-MSMS.	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		0.5-1	1-2		2	Y
	TiBP	126-71-6		1-2	2-3		2	N
	DBPhP	2528-36-1		0.5-1	1-2		2	N
	TPP	115-86-6		0.5-1	1-2		2	Y
	TnBP	126-73-8		1-2	2-3		2	Y
	BdPhP	2752-95-6		0.5-1	1-2		2	N
	TDCPP	13674-87-8		0.5-1	1-2		2	Y
	TBOEP	78-51-3		0.5-1	1-2		2	N
	2-IPPDPP	64532-94-1		0.5-1	1-2		2	N
	4-IPPDPP	55864-04-5		0.5-1	1-2		2	N
	TCP	1330-78-5		0.5-1	1-2		2	N
	EHDP	1241-94-7		0.5-1	1-2		2	N
	IDDPP	29761-21-5		0.5-1	1-2		2	N
	B4IPPPP	55864-07-8		0.5-1	1-2		2	N
	TXP	25155-23-1		0.5-1	1-2		2	N
	TIPPP	64532-95-2		0.5-1	1-2		2	Y
	TEHP	78-42-2		0.5-1	1-2		2	Y
	TTBPP	78-33-1		0.5-1	1-2		2	N

Table 9 continued. 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. For paticles, the sample was filtrated before the particles were extracted according to the sediment method.	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)			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
	D3F - tris-(trifluoropropyl)trimethylcyclotrisiloxane			2-50		2	N
	D4F - tetrakis-(trifluoropropyl)tetramethylcyclotetrasiloxane			3-30		2	N
Siloxanes, water	D4 - octamethylcyclotetrasiloxane	556-67-2	Three blanks pr batch. Blank subtraction for each batch based on the blank average. LOQ calculated from 10 x	6.44-14.7	To 100 mL of water, 13C D4, D5 and D6 were added as internal standard, before addition of 40 mL dichloromethane (DCM). The sample was stirred for 1 h before	2	Y
	D5 - decamethylcyclopentasiloxane	541-02-6		12.3-35.0		2	y
	D6 - dodecamethylcyclohexasiloxane	540-97-6		18		2	y
	M3T (Ph)			18		2	N
	L3 - octamethyltrisiloxane	107-		6.75-14.9		2	N

		51-7	stdev. From blanks		20 mL was transferred to a vial containing Na_2SO4. No further cleanup before analysis.		
	L4 - decamethyltetrasiloxane	141-62-8		52.8-109		2	N
	L5 - dodecamethylpentasiloxane	141-63-9		166-272		2	N
	D3F - tris-(trifluoropropyl)trimethylcyclotrisiloxane			30-100		2	N
	D4F - tetrakis-(trifluoropropyl)tetramethylcyclotetrasiloxane			25-130		2	N

Comments on siloxanes: D3F and D4F; The sensitivity for these two compounds in the GC/MSD system are up to 100 lower compared to the cyclic volatile methyl siloxanes.

Table 9 continued. 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, biota/sediment	Traseolide	68857-95-4	Siloxane method: three blanks per batch. Non of the native musk compounds were detected in blank samples. This could be due to the strict regime during sample preparation (siloxane method). LOQ based on calculation of background in the instrument analysis.	0.132-1.24	Took a subsample of the siloxane extract, used ^{13}D6 as internal standard for quantification. Some samples were upconcentrated and 5 µL sample injected for analysis on a GC/MSD.	3	N
	Phantolide	15323-35-0		0.029-0.28		3	N
	Otne	54464-57-2		0.132-1.24		3	N
	Acetyl cedrene	32388-55-9		0.132-1.24		3	N
	Galaxolide	1222-05-5		0.068-0.64		3	N
	AHMT	21145-77-7		0.132-1.24		3	N
	Celestolide	13171-00-1		0.021-0.18		3	N
	Tonalide	21145-77-7		0.052-0.49		3	N
Musk, water	Traseolide	68857-95-4	Siloxane method: three blanks per batch. Non of the native musk compounds were detected in blank samples. This could be due to the strict regime during sample preparation (siloxane method). LOQ based on calculation of background in the instrument analysis.	12,61	Took a subsample of the siloxane extract, used ^{13}D6 as internal standard for quantification. Some samples were upconcentrated and 5 µL sample injected for analysis on a GC/MSD.	3	N
	Phantolide	15323-35-0		3,81		3	N
	Otne	54464-57-2		12,61		3	N
	Acetyl cedrene	32388-55-9		12,61		3	N
	Galaxolide	1222-05-5		6,48		3	N
	AHMT	21145-77-7		12,61		3	N
	Celestolide	13171-00-1		2,48		3	N
	Tonalide	21145-77-7		5,01		3	N

Comments to Musk compounds:
To avoid contamination from regular laboratory air, the same extract used for siloxanes analysis was used for musk analysis. No musk internal standard added (a siloxane, ^{13}D6, was used as internal standard for quantification) since the risk of contamination of native siloxanes was assumed to be too high. Some musk was detected in samples where the solvent extract was up concentrated and 5 µL sample injected. A higher sample amount for biota and sediment is recommended. There is a process to find a more suitable internal standard for the musks.

Table 9 **cont.** Method information. Phenolic compounds (biota and sediment).

Parameter group	Name parameter	Cas nr	Blank	Method	LOD range (ng/g)	LOQ range (ng/g)	Uncertainty category	Stable isotope labelled (SIL) analogue
Bisphenols biota/sediment	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, extraction using supramolecular solvents, clean-up using molecularly imprinted polymer SPE (when necessary). LC/HRMS (orbitrap)	3.5-4.6	8.5-12	3	Y
	2,4-bisphenol A	837-08-1			1.9-2.6	5.5-7.7	3	N
	bisphenol G	127-54-8			0.8-1.1	2.4-3.3	3	N
	4,4-Bisphenol S	80-09-1			0.4-0.5	0.9-1.2	3	Y
	2,4-bisphenol S	5397-34-2			0.3-0.4	0.7-1.0	3	Y
	4,4-bisphenol F	620-92-8			0.6-0.8	1.6-2.1	3	Y
	2,4-bisphenol F	2467-03-0			1.5-2.1	4.2-5.9	3	N
	2,2-bisphenol F	2467-02-9			0.2-0.3	0.7-0.9	3	Y
	bisphenol P	2167-51-3			0.1-0.2	0.4-0.8	3	Y
	Bisphenol Z	843-55-0			1.3-1.8	3.7-5.1	3	Y
	TBBPA	79-94-7			5.0-5.8	14-16	3	Y
	Bisphenol TMC	129188-99-4			0.9-1.2	2.5-3.5	3	N
	Bisphenol FL	3236-71-3			0.9-1.2	2.6-3.5	3	N
	Bisphenol B	77-40-7			0.8-1.1	2.3-3.1	3	Y
	Bisphenol E	2081-08-5			0.6-0.8	1.7-2.3	3	N
	Bisphenol M	13595-25-0			0.05-0.1	0.2-0.5	3	N
	Bisphenol AF	1478-61-1			0.3-0.4	0.8-1.0	3	Y
	Bisphenol AP	1571-75-1			0.7-0.9	1.9-2.7	3	N
Alkylphenols biota/sediment	4-tert-octylphenol	140-66-9		In-house methods. Internal standard addition, extraction using supramolecular solvents, clean-up using molecularly imprinted polymer SPE (when necessary). LC/HRMS (orbitrap)	1.1-1.4	2.9-3.6	3	Y
	Dodecylphenol (branched)	27193-86-8			6.9-9.2	20-26	3	N
	Dodecylphenol	104-43-8			0.8-1.2	2.4-3.9	3	N
	4-octylphenol	1806-26-4			1.6-2.3	4.6-6.6	3	N
	Nonylphenol (branched)	84852-15-3			30-34	63-80	3	N
	4-nonylphenol	104-40-5			2.2-3.0	6.7-8.8	3	Y
Other phenolic compounds biota/sediment	MB1	118-82-1		In-house method. Internal standard addition, extraction. LC/MS	1.9-2.6	5.0-6.6	3	N
	4-[2-(4-{[benzyl(triphenyl)-lambda~5~-phosphanyl]oxy}phenyl)-1,1,1,3,3,3-hexafluoropropan-2-yl]phenol	75768-65-9			0.3-0.4*	0.8-1.0*	3	N

*Based on the analysis of Bisphenol AF

cont. Method information. Phenolic compounds (water).

Parameter group	Name parameter	Cas nr	Blank	Method	LOD range (ng/L)	LOQ range (ng/L)	Uncertainty category	Stable isotope labelled (SIL) analogue
Bisphenols water	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, extraction using SPE discs, clean-up using molecularly imprinted polymer SPE. LC/HRMS (orbitrap)	1.8-3.7	3.8-8.0	3	Y
	2,4-bisphenol A	837-08-1			0.07-0.2	0.1-0.7	3	N
	bisphenol G	127-54-8			0.03-0.09	0.07-0.3	3	N
	4,4-Bisphenol S	80-09-1			0.9-1.8	2.2-4.3	3	Y
	2,4-bisphenol S	5397-34-2			0.05-0.5	0.1-1.7	3	Y
	4,4-bisphenol F	620-92-8			13-26	39-78	3	Y
	2,4-bisphenol F	2467-03-0			16-31	47-94	3	N
	2,2-bisphenol F	2467-02-9			1.9-3.8	5.7-11	3	Y
	bisphenol P	2167-51-3			0.04-0.3	0.1-0.9	3	Y
	Bisphenol Z	843-55-0			0.3-0.7	1.0-2.0	3	Y
	TBBPA	79-94-7			1.5-4.2	4.3-13	3	Y
	Bisphenol TMC	129188-99-4			0.04-0.09	0.08-0.3	3	N
	Bisphenol FL	3236-71-3			0.05-0.1	0.1-0.4	3	N
	Bisphenol B	77-40-7			0.05-0.2	0.1-0.6	3	Y
	Bisphenol E	2081-08-5			0.05-0.1	0.1-0.5	3	N
	Bisphenol M	13595-25-0			0.02-0.2	0.04-0.5	3	N
	Bisphenol AF	1478-61-1			0.01-0.05	0.03-0.2	3	Y
	Bisphenol AP	1571-75-1			0.04-0.1	0.07-0.3	3	N
Alkylphenols water	4-tert-octylphenol	140-66-9		In-house methods. Internal standard addition, extraction using SPE discs, clean-up using molecularly imprinted polymer	0.8-1.6	2.1-4.2	3	Y
	Dodecylphenol (branched)	27193-86-8			2.3-4.5	6.1-12	3	N
	Dodecylphenol	104-43-8			0.2-1.1	0.4-3.6	3	N
	4-octylphenol	1806-26-4			0.2-0.4	0.5-1.0	3	N
	Nonylphenol (branched)	84852-15-3			44-88	115-231	3	N

	4-nonylphenol	104-40-5		SPE. LC/HRMS (orbitrap)	0.2-0.7	0.4-2.2	3	Y
Other phenolic compounds water	MB1	118-82-1		In-house method. Internal standard addition, extraction. LC/MS	0.1-0.2	0.3-0.6	3	N
	4-[2-(4-{[benzyl(triphenyl)-lambda~5~-phosphanyl]oxy}phenyl)-1,1,1,3,3,3-hexafluoropropan-2-yl]phenol	75768-65-9			0.01-0.05*	0.03-0.2*	3	N

*Based on the analysis of Bisphenol AF

3.3 List of analytes and support parameters

Table 10. Analytes and support parameters included in the programme.

Substances	Abbreviation	CAS
Metals		
Mercury	Hg	7440-02-0
Chromium	Cr	7440-47-3
Nickel	Ni	7440-02-0
Copper	Cu	7440-50-8
Zinc	Zn	7440-66-6
Arsenic	As	7440-38-2
Silver	Ag	7440-22-4
Cadmium	Cd	7440-43-9
Lead	Pb	7439-92-1
Antimony	Sb	7440-36-0
Tin	Sn	7440-31-5
Iron	Fe	7439-89-6
Rare earth metals	Sc, Y, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu	
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
dicyclopentylsilanediol		74-31-7

Substances	Abbreviation	CAS
2.4.6-Trimethyl-2.4.6-tris(3.3.3-trifluoropropyl)cyclotrisiloxane (D3F)	D3F	2374-14-3
2.4.6.8-tetramethyl-2.4.6.8-tetrakis(3.3.3-trifluoropropyl)cyclotetrasiloxane (D4F)	D4F	429-67-4
Polychlorinated biphenyls (PCB)		
2.4.4'-Trichlorobiphenyl 28	PCB-28	7012-37-5
2.2'.5.5'-Tetrachlorobiphenyl 52	PCB-52	35693-99-3
2.2'.4.5.5'-Pentachlorobiphenyl 101	PCB-101	37680-73-2
2.3'.4.4'.5-Pentachlorobiphenyl 118	PCB-118	31508-00-6
2.2'.3.4.4'.5'-Hexachlorobiphenyl 138	PCB-138	35065-28-2
2.2'.4.4'.5.5'-Hexachlorobiphenyl 153	PCB-153	35065-27-1
2.2'.3.4.4'.5.5'-Heptachlorobiphenyl 180	PCB-180	35065-29-3
Other congeners	PCB-18. -31. -33. -37. -47. -66. -74. -99. -105. -114. -122. -123. -128. -141. -149. -156. -157. -167. -170. -183. -187. -189. -194. -206. -209	
PBDEs ***Polybrominated diphenyl ethers***		
2.2'.4-Tribromodiphenyl ether	BDE-17	147217-75-2
2.4.4'-Tribromodiphenyl ether	BDE-28	41318-75-6
2.2'.4.4'-Tetrabromodiphenyl ether	BDE-47	5436-43-1
2.2'.4.5'-Tetrabromodiphenyl ether	BDE-49	123982-82-3
2.3'.4.4'-Tetrabromodiphenyl ether	BDE-66	189084-61-5
2.3'.4'.6-Tetrabromodiphenyl ether	BDE-71	189084-62-6
3.3'.4.4'-Tetrabromodiphenyl ether	BDE-77	93703-48-1
2.2'.3.4.4'-Pentabromodiphenyl ether	BDE-85	182346-21-0
2.2'.4.4'.5-Pentabromodiphenyl ether	BDE-99	60348-60-9
2.2'.4.4'.6-Pentabromodiphenyl ether	BDE-100	189084-64- 8
2.3'.4.4'.6-Pentabromodiphenyl ether	BDE-119	189084-66-0

Substances	Abbreviation	CAS
3.3'.4.4'.5-Pentabromodiphenyl ether	BDE-126	366791-32-4
2.2'.3.4.4'.5'-Hexabromodiphenyl ether	BDE-138	182677-30-1
2.2'.4.4'.5.5'-Hexabromodiphenyl ether	BDE-153	68631-49-2
2.2'.4.4'.5.6'-Hexabromodiphenyl ether	BDE-154	207122-15-4
2.3.3'.4.4'.5-Hexabromodiphenyl ether	BDE-156	405237-85-6
2.2'.3.4.4'.5'.6-Heptabromodiphenyl ether	BDE-183	207122-16-5
2.2'.3.4.4'.6.6'-Heptabromodiphenyl ether	BDE-184	117948-63-7
2.3.3'.4.4'.5'.6-Heptabromodiphenyl ether	BDE-191	446255-30-7
2.2'.3.3'.4.4'.5'.6-Octabromodiphenyl ether	BDE-196	32536-52-0
2.2'.3.3'.4.4'.6.6'-Octabromodiphenyl ether	BDE-197	117964-21-3
2.2'.3.3'.5.5'.6.6'-Octabromodiphenyl ether	BDE-202	67797-09-5
2.2'.3.3'.4.4'.5.5'.6-Nonabromodiphenyl ether	BDE-206	63387-28-0
2.2'.3.3'.4.4'.5.6.6'-Nonabromodiphenyl ether	BDE-207	437701-79-6
Decabromodiphenyl ether	BDE-209	1163-19-5
EBFs – Emerging brominated flame retardants		
2.4.6-tribromophenyl ether	ATE (TBP-AE)	3278-89-5
α-1.2-Dibromo-4-(1.2-di-bromo-ethyl)cyclohexane	α-TBECH	3322-93-8
β-1.2-Dibromo-4-(1.2-di-bromo-ethyl)cyclohexane	β-TBECH	n/a
γ/δ- 1.2-Dibromo-4-(1.2-di-bromo-ethyl)cyclohexane	γ/δ-TBECH	n/a
2-bromoallyl 2.4.6-tribromophenyl ether	BATE	99717-56-3
Pentabromotoluene	PBT	87-83-2
Pentabromoethylbenzene	PBEB	85-22-3
1.2.3.4.5 Pentabromobenzene	PBBZ	608-90-2
Hexabromobenzene	HBB	87-82-1
2.3-dibromopropyl 2.4.6-tribromophenyl ether	DPTE	35109-60-5
2-Ethylhexyl 2.3.4.5-tetrabromobenzoate	EHTBB	183658-27-7
1.2-Bis(2.4.6-tribromophenoxy)ethane	BTBPE	37853-59-1
2.3.4.5-tetrabromophthalate	TBPH (BEH /TBP)	26040-51-7

Substances	Abbreviation	CAS
Decabromodiphenyl ethane	DBDPE	84852-53-9
Pentachlorobenzene	PECB	608-93-5
Hexachlorobenzene	HCB	118-74-1
hexachlorobutadiene	HCBD	87-68-3
oPFRs ***Organophosphorus flame retardants***		
Tetraethyl diphosphate	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	TPP	115-86-6
Tri-n-butyl phosphate	TnBP	126-73-8
Tris(1.3-dichloro-2-propyl)phosphate	TDCPP	13674-87-8
Tris(2-butoxyethyl) phosphate	TBEP	78-51-3
Tricresyl phosphate	TCP	1330-78-5
2-Ethylhexyl diphenyl phosphate	EHDP	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)	TDTBPP	95906-11-9
O.O.O-triphenylphosphorothiate (TPPT)	TPPT	957-82-0
Phenols		
4-[2-(4-hydroxyphenyl)propan-2-yl]phenol	Bisphenol A	80-05-7
2-[2-(4-hydroxyphenyl)propan-2-yl]phenol	2.4-Bisphenol A	837-08-1

Substances	Abbreviation	CAS
4-[2-(4-hydroxy-3-propan-2-ylphenyl)propan-2-yl]-2-propan-2-ylphenol	Bisphenol G	127-54-8
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
4-[2-[4-[2-(4-hydroxyphenyl)propan-2-yl]phenyl]propan-2-yl]phenol	Bisphenol P	2167-51-3
4-[1-(4-hydroxyphenyl)cyclohexyl]phenol	Bisphenol Z	843-55-0
2.6-dibromo-4-[2-(3.5-dibromo-4-hydroxyphenyl)propan-2-yl]phenol	TBBPA	79-94-7
4-[1-(4-hydroxyphenyl)-3.3.5-trimethylcyclohexyl]phenol	Bisphenol TMC	129188-99-4
4-[9-(4-hydroxyphenyl)fluoren-9-yl]phenol	Bisphenol FL	3236-71-3
4-[2-(4-hydroxyphenyl)butan-2-yl]phenol	Bisphenol B	77-40-7
4-[1-(4-hydroxyphenyl)ethyl]phenol	Bisphenol E	2081-08-5
4-[2-[3-[2-(4-hydroxyphenyl)propan-2-yl]phenyl]propan-2-yl]phenol	Bisphenol M	13595-25-0
4-[1.1.1.3.3.3-hexafluoro-2-(4-hydroxyphenyl)propan-2-yl]phenol	Bisphenol AF	1478-61-1
4-[1-(4-hydroxyphenyl)-1-phenylethyl]phenol	Bisphenol AP	1571-75-1
2.6-ditert-butyl-4-[(3.5-ditert-butyl-4-hydroxyphenyl)methyl]phenol	AO-MB1	118-82-1
4-[2-(4-{[benzyl(triphenyl)-lambda~5~-phosphanyl]oxy}phenyl)-1.1.1.3.3.3-hexafluoropropan-2-yl]phenol		75768-65-9
4-(2.4.4-trimethylpentan-2-yl)phenol	4-tert-octylphenol	140-66-9
4-octylphenol	p-octylphenol	1806-26-4
4-(7-methyloctyl)phenol	4-Nonylphenol. branched and linear	104-40-5. 84852-15-3*
Dodecylphenol branched and linear	Dodecylphenol	27193-86-8. 104-43-8. 121158-58-5
Per- and polyfluoroalkyl substances (PFAS)		

Substances	Abbreviation	CAS
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	335-85-9
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	1763-23-1
Perfluorinated octane sulfonic acid (branched)	brPFOS	2795-39-3
Perfluorinated nonane sulfonic acid	PFNS	474511-07-4

Substances	Abbreviation	CAS
Perfluorinated decane sulfonic acid	PFDS	335-77-3
Perfluoroundecane sulfonic acid	PFUnDS	749786-16-1
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	meFOSA	31506-32-8
N-Ethyl perfluorooctane sulfonamide	etFOSA	4151-50-2
N-Methyl perfluorooctane sulfonamidoethanol	meFOSE	24448-09-7
N-Ethyl perfluorooctane sulfonamidoethanol	etFOSE	1691-99-2
N-Ethyl perfluorooctane sulfonamidoacetic acid	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	39108-34- 4
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	NaDONA	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
Perfluoro-3.6-dioxaheptanoic acid	3.6-OPFHpA (Gen-X. NFDHA)	N/A
Perfluoro-5-oxahexanoic acid	PF5OHxA (Gen-X. PFMBA)	N/A
Total fluor	TOF	

Substances	Abbreviation	CAS
UV chemicals		
Benzophenone-3	BP3	131-57-7
Ethylhexylmethoxycinnamate	EHMC	5466-77-3
Octocrylene	OC	6197-30-4
UV-327	UV-327	3864-99-1
UV-328	UV-328	25973-55-1
UV-329	UV-329	3147-75-9
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 601	Dec-601	3560-90-2
Dechlorane 602	Dec-602	31107-44-5
Dechlorane 603	Dec-603	13560-92-4
Dechlorane 604	Dec-604	34571-16-9
Dechlorane plus syn	syn-DP	135821-03-3
Dechlorane plus anti	anti-DP	135821-74-8
1.5-Dechlorane Plus monoadduct	1.5-DPMA	Not available
1.3-Dechlorane Plus monoadduct	1.3-DPMA	Not available
Chlordene Plus		13560-91-3
Quaternary ammonium compounds		
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

Substances	Abbreviation	CAS
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
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		15809-05-9
ATAC-C22		17301-53-0
Pesticides/Fungicides		
Chlorohexidine		55-56-01
Brodifacoum		56073-10-0
Bromodiolone		28772-56-7
Difenacoum		56073-07-5
Difethialone		104653-34-1
Flocumafen		90035-08-8
Chlorpyrifos		2921-88-2
Tebuconazole		107534-96-3
Permethrin		52645-53-1
Triclocarban		101-20-2
Triclosan		3380-34-5
Musks		
Traseolide		68140-48-7
Phantolide		15323-35-0

Substances	Abbreviation	CAS
OTNE		54464-57-2
Acetyl cedrene		32388-55-9
Galaxolide		1222-05-5
AHMT		1506-02-1
Celestolide		13171–00–1
Tonalide		21145–77–7
Benzothiazoles		
Mercaptobenzothiazole	MBT	149-30-4
Benzotriazole BZT	C6H5N3 (BZT)	95-14-7
Benzothiazole	C7H5NS (BT)	95-16-9
2(3H)-Benzothiazolone	OHBT	934-34-9
metyl-1H-benzotriazole	MeBZT	29385-43-1
N-cyclohexylbenzothiazole-2-sulfenamide	CBS	95-33-0
Cl-benzotriazole	Cl-BZT	21050-95-3
6PPD quinone		8026-48-0
Phthalates		
DEHP		117-81-7
DPHP		53306-54-0
DINP		28553-12-0
Diisodecyl phthalate (DIDP)		68515-49-1
1.2-Benzenedicarboxylic acid. di-C7-9-branched and linear alkyl esters		68515-41-3
Dioctyl phthalate		117-84-0
BBzP		85-68-7
Dimethylphthalate		131-11-3
DMP		131-11-3
DEP		84-66-2
DPP		131-16-8
DAIP		131-17-9

Substances	Abbreviation	CAS
Diundecyl phthalate. branched and linear		85507-79-5
DHP		84-75-3
DcHP		84-61-7
butylbenzylphthalate		85-68-7
DIBP		84-69-5
Diundecyl phthalate		3648-20-2
DBP		84-74-2
C7-C9 phthalate		68515-41-3
1.2-Benzenedicarboxylic acid. di-C7-9-branched and linear alkyl esters		68515-40-2
1.2-Benzenedicarboxylic acid. di-C9-11-branched alkyl esters. C10-rich		68515-42-4
Chlorinated paraffins		
Short-chain chlorinated paraffins (C10-C13)	SCCP	85535-84-8
Medium-chain chlorinated paraffins (C14-C17)	MCCP	85535-85-9
Support parameters		
Stable isotopes $\delta^{15}N$. $\delta^{13}C$		
Lipid content (biota)		
Age determination (fish)		
Length/weight (fish)		
TOC (sediment) and pH		
Grain size distribution (sediment)		

4 Appendix - Results

Complete results are provided in electronic appendix files (overview in a searchable Excelsheets, data figures are provided in Word format).

4.1 Biota metadata

Table 11 and Table 12 provides information on individual biota samples.

Table 11. Summary of biota metadata 2021.

Lake	Species	n	Length (cm) mean (min-max)	Weight (g) mean (min-max)	$\delta^{13}C$ mean	$\delta^{15}N$ mean
Mjøsa	Chironomidae larvae	1	-	-	-31.52	9.17
	Roach *Rutilus rutilus*	15	14.5 (13.0 - 16.0)	33 (25 - 44)	-29.2	13.09
	Ruffe *Gymnocephalus cernua*	15	10.6 (8.5 - 13.0)	13.1 (7 - 20)	-25.4	12.98
	Perch *Perca fluviatilis*	15	29.3 (25.8 - 32.3)	278 (172 - 399)	-25.4	13.13
	Brown trout *Salmo trutta*	15	74 (70 - 91)	4120 (2700 - 8600)	-27.9	14.57
Femunden	Brown trout *Salmo trutta*	13	48 (43 - 53)	1060 (740 -1521)	-22.4	8.01

Table 12. Metadata – biota samples 2021

Lake	Species	Latin name	Field ID	Analytical sample	Length (cm)	Weight (g)	$\delta^{13}C$	$\delta^{15}N$
Mjøsa	Chironomidae	Chironomidae	1		-	-	-31.52	9.17
	Roach	*Rutilus rutilus*	1	1	14.5	33	-28.70	13.21
			2		16.5	40	-29.27	12.90
			3		16.5	44	-29.84	12.63
			4		14.5	33	-30.23	13.95
			5		15.5	39	-29.26	13.62
			6		14	28	-29.05	11.91
			7		12.5	26	-29.75	13.21
			8		13	30	-26.32	12.42
			9		13.5	28	-30.99	14.09
			10		13	25	-29.01	12.94
			11		16	41	-28.08	11.94
			12		14	27	-29.59	13.00
			13		13.5	26	-29.50	13.38
			14		14.5	36	-29.62	13.42
			15		16	44	-28.60	13.84
	Ruffe	Gymnocephalus cernua	1	1	12.5	20	-29.95	14.78
			2		11.5	16	-25.89	13.70
			3		13	20	-24.13	12.80
			4		9	9	-25.23	12.95
			5		9.5	10	-23.53	13.24
			6		11.5	17	-24.56	11.92
			7		9.5	8	-23.73	13.26
			8		11	13	-24.09	12.45
			9		9	10	-22.65	12.46
			10		8.5	7	-25.05	12.65
			11		12	15	-25.57	12.48
			12		12	16	-29.70	14.69
			13		11	16	-22.90	11.75
			14		8.5	10	-23.53	12.26
			15		10	10	-30.27	13.30
	Perch	Perca fluviatilis	1	1	32.3	374	-26.03	13.94
			2		32.1	385	-24.63	14.19
			3		29.4	287	-25.53	13.48
			4		31.5	334	-24.81	14.23
			5		28	238	-26.34	11.34
			6		27.1	203	-24.18	12.47
			7		27	212	-24.10	13.38
			8		34	399	-26.00	13.89
			9		32.1	353	-23.06	12.94
			10		29.6	303	-24.47	12.89
			11		26.5	203	-27.00	11.77
			12		29.5	231	-26.20	13.49
			13		26.4	211	-25.04	10.56
			14		28.7	260	-24.36	13.25

Lake	Species	Latin name	Field ID	Analytical sample	Length (cm)	Weight (g)	$\delta^{13}C$	$\delta^{15}N$
			15		25.8	172	-29.26	15.19
	Brown trout	Salmo trutta	6	1	60	2700	-28.14	15.83
			13		66	2700	-27.46	14.86
			9		66	3100	-29.95	14.51
			12		70	2800	-26.86	12.76
			3		70	3300	-27.52	12.26
			10	2	70	3400	-28.44	14.86
			15		72	3100	-27.91	14.29
			8		72	3900	-29.40	14.72
			7		73	4000	-26.94	14.30
			14		74	4100	-28.03	13.70
			1	3	76	4500	-26.20	14.87
			2		77	6000	-26.76	14.69
			11		79	4200	-28.33	16.13
			4		90	8600	-28.25	14.95
			5		91	5400	-28.26	15.92
Femunden	Brown trout	Salmo trutta	1	1	44.5	740	-24.11	8.94
			2		43.0	803	-21.75	6.11
			3		46.0	875	-24.47	9.16
			4		46.0	880	-22.53	8.36
			5		45.0	935	-21.43	7.06
			6	2	46.5	1097	-24.74	7.43
			7		47.5	1026	-23.73	9.14
			8		49.5	1036	-23.36	8.24
			9		48.5	1080	-17.03	7.70
			10	3	49.5	1138	-22.99	8.70
			11		50.5	1301	-22.93	6.56
			12		50.5	1346	-20.33	7.92
			13		53.0	1521	-22.15	8.84

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NIVA
Norwegian Institute for Water Research

Økernveien 94 • NO-0579 Oslo, Norway
Telephone: +47 22 18 51 00
www.niva.no • post@niva.no