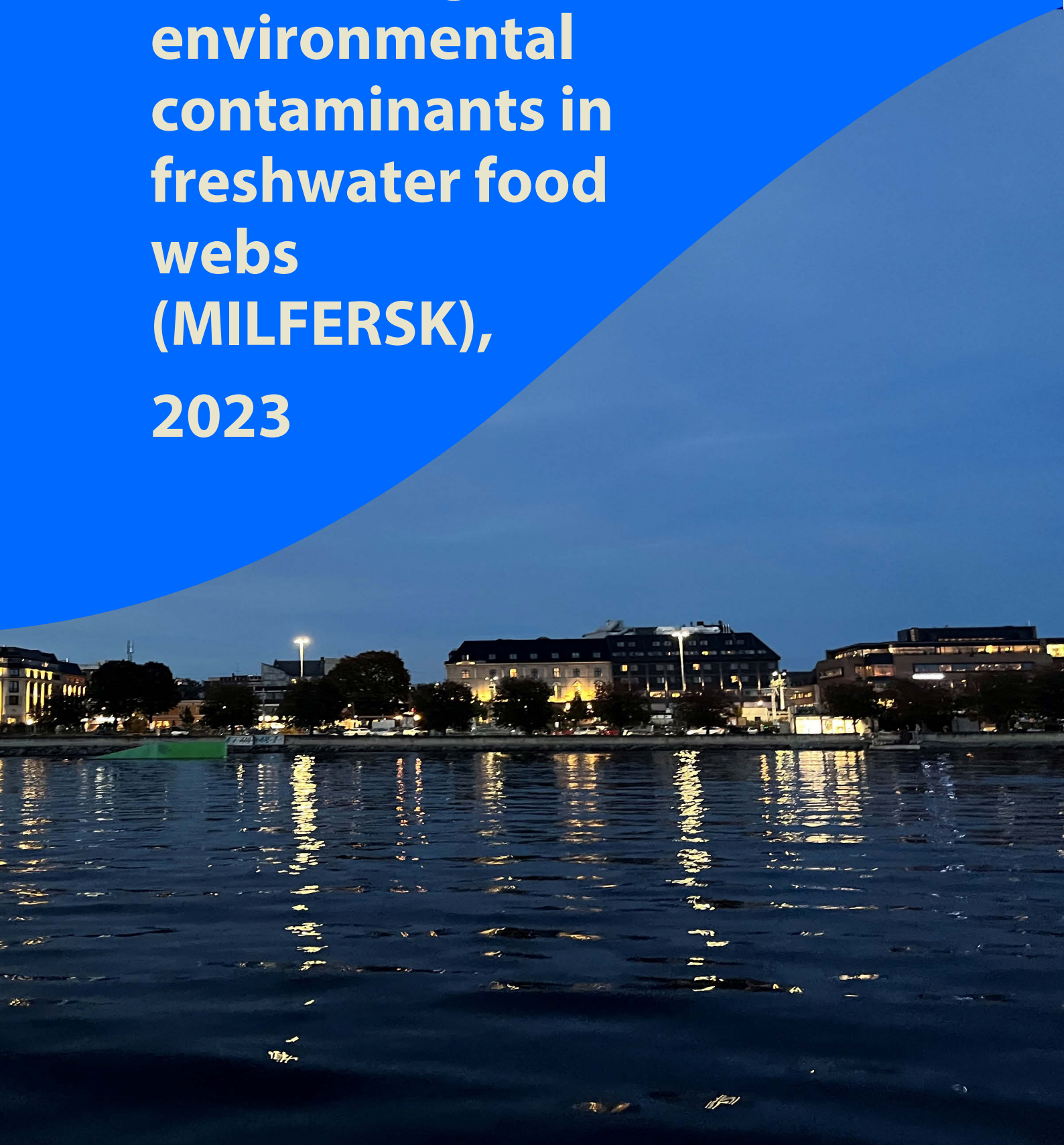
Norsk institutt for vannforskning

7997-2024

Monitoring of environmental contaminants in freshwater food webs (MILFERSK), 2023



Report

Norwegian Institute for Water Research

Serial no: 7997-2024

ISBN 978-82-577-7734-0
NIVA report
ISSN 1894-7948

This report has been quality assured according to NIVA's quality system and has been approved by:

Asle Økelsrud
Project Manager

Anders Ruus
Quality Assurer

Morten Jartun
Research Manager

www.niva.no

Title
Monitoring of environmental contaminants in freshwater food webs (MILFERSK), 2023

Overvåkning av miljøgifter i ferskvann (MILFERSK), 2023

Pages
89 + appendix

Date
27.06.2024

Author(s)
Asle Økelsrud, Merete Grung, Kine Bæk, Thomas Rundberget, Sigurd Øxnevad, Ellen Katrin Enge (NILU), Linda Hanssen (NILU), Ingar Johansen (IFE)

Topic group
Environmental toxins - freshwater

Distribution
Open

Client(s)
Miljødirektoratet

Client's contact person
Eivind Farmen

Published by NIVA
Project number 210136

Client's publication:
M-2813|2024

Abstract

This report presents data from the third year of a 5-year period of the MILFERSK program. In 2023 the monitoring program reports on the sampling and analyses of the pelagic food chain in Lake Mjøsa, with the following sample types: zooplankton, Mysis, E. smelt, vendace, and brown trout, in addition to brown trout from Lake Femunden. A total of 205 single compounds/isomers were determined, and frequent detections were found of specific PFAS, PBDEs, Hg and siloxanes through the food chain with biomagnifying properties. Some contaminants, such as octocrylene is found in higher concentrations in the lower trophic levels. A slight downwards trend is observed from 2014 – 2023 for PFOS in Lake Mjøsa. We also observe a lower length adjusted mercury concentration for brown trout in Lake Mjøsa for the period 2014 to 2023, compared to the 9 years prior (2006 – 2014).

Keywords: Contaminants, freshwater, biomagnification, timetrends
Emneord: Miljøgifter, ferskvann, biomagnifisering, tidstrender

Table of contents

Preface

This report presents data from freshwater ecosystems in Lakes Mjøsa and Femunden (MILFERSK) in Innlandet County, Norway. Studies of environmental contaminants in food webs of great Norwegian lakes date back several years, and the current monitoring program runs from 2021-2025 and provides new insight in the environmental risk posed by local contaminant sources on both the pelagic and benthic food webs of Lake Mjøsa.

In 2023 a sampling campaign from the pelagic food chain in Lake Mjøsa was carried out by NIVA, with help from local sport anglers (brown trout by Heidi Jøranli) and Lake Femunden (local sport anglers in the competition "Femunddraget 2023"). 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 data provided through the MILFERSK 2023 campaign. Scientific quality assurance (QA/QC) have been performed throughout the different parts of the project by Kine Bæk, Anders Ruus and Morten Jartun. Final approval of the report was given by research manager Morten Jartun.

Asle Økelsrud

NIVA Innlandet, Ottestad, 25.06.2024

Summary

In 2023, under the program "Monitoring of environmental contaminants in freshwater food webs (MILFERSK)" samples of the pelagic food chain were collected from Lake Mjøsa, in addition to the top predator brown trout from Lake Femunden. Biological samples from Lake Mjøsa included samples of zooplankton and *Mysis relicta*, in addition to fish species European smelt (*Osmerus eperlanus*) and vendace (*Coregonus albula*) from the area between Helgøya and Hamar. Top predator brown trout was caught from an area close to the city of Gjøvik. From vendace, samples from gut (stomach) content were also collected. From Lake Femunden, brown trout were caught from the central and northern part of the lake.

From most of the sample types, a total of 205 single compounds/isomers were determined in the analytical program. The major compound groups included:

- Per- and polyfluorinated alkyl substances (PFAS)
- UV-compounds
- Brominated flame retardants (PBDEs)
- Siloxanes
- Benzothiazoles
- Musk compounds
- Chlorinated paraffins (CP)
- Quaternary ammonium compounds (QAC)
- Metals (incl. Hg)
- Phtalates
- Phenolic compounds
- Organophosphorous flame retardants (oPFR)

In 2023, the dominant contaminant group at the bottom of the pelagic food chain (zooplankton and mysis) was phthalates, while phenols dominated in vendace whole body and stomach contents. One of the phenols, 4-tert-butylphenol was the dominant of the phenols, but the result is somewhat uncertain due to variable levels in the blanks used in the analysis. Higher up the food chain (E. smelt and brown trout), siloxane D5, PBDEs and PFAS dominate. We see a clear increase in concentrations of the UV compound octocrylene in the lower part of the pelagic food chain compared to 2020 when the pelagic food chain was last studied.

In the top pelagic predator in Mjøsa, brown trout, PBDEs and siloxanes (in muscle) dominate, as these two substance groups biomagnify in the pelagic food chain. Trophic magnification factors (TMF) have been calculated for contaminants with a detection frequency of > 50%, distributed in multiple trophical levels. High biomagnifying properties, indicated by a TMF > 1, was observed for Hg, BDE47, D5, and PFOS. Data from 2023 for these individual components fits well with the previous TMFs, with data from 2013 and onwards (Hg, BDE47, D5) and 2014 and onwards (for PFOS and other PFAS). In addition, we did a TMF calculation for the musk component galaxolide, where the results suggest biomagnifying properties. This calculation is still very uncertain, because of the small dataset that covers only a limited part of the food chain. Higher concentrations in lower trophic levels compared to top predators such as trout (TMF < 1), indicate metabolism or excretion in some substance groups, such as for the UV compound octocrylene.

Compared to results from previously investigated organisms in a benthic food chain in Mjøsa (2022), we see large variations in some of the contaminant groups. E.g. octocrylene, as described above, has two to three times higher levels in pelagic organisms at a low trophic level, compared to organisms at a low trophic level in nearshore areas. For QAC, we see the opposite pattern, here the levels are significantly higher in littoral organisms compared to the pelagic ones.

Lake Mjøsa experienced a large discharge of brominated flame retardants from local industry towards the end of 1990's resulting in rocketing concentrations of PBDEs in top predators in the years after. Between 2000 and 2023 there is a significant decrease in BDE_6-concentrations in brown trout, although the concentrations still are way above the environmental quality standards (EQS biota) set by the Water Framework Directive. A downwards trend in brown trout concentrations in Lake Mjøsa has also been observed for PFOS and PFTrDA in the last decade (2014-2023). These regressions are weak (low R^2), but significant.

As for mercury (Hg), based on the entire dataset for Lake Mjøsa from 2006-2023, brown trout from Lake Mjøsa will reach the EU's and the Norwegian upper limit for placement on the market of 0.5 mg/kg w.w. in fish muscle at length of around 56 cm, which corresponds to ~ 2.1 kg weight. The average length-adjusted Hg concentration is, however, lower in the last 9 years (2015 – 2023: 0.49 mg/kg) of the dataset compared to the 9 years prior (2006 – 2014: 0.62 mg/kg), indicating a decreasing Hg concentration for fish at the same length.

Sammendrag

I 2023 ble det i programmet «Overvåking av miljøgifter i ferskvannsnæringsnett (MILFERSK)» samlet inn prøver av den pelagiske næringskjeden fra Mjøsa, i tillegg til ørret fra Femunden. Biologiske prøver fra Mjøsa inkluderte prøver av zooplankton og *Mysis relicta*, i tillegg til fiskeartene krøkle (*Osmerus eperlanus*) og lagesild(*Coregonus albula*) fra området mellom Helgøya og Hamar. Toppredatoren ørret ble fanget fra et område nær Gjøvik. Fra lågåsild ble det også analysert prøver av mage-tarminnholdet. Fra Femunden ble det analysert prøver av ørret fra den sentrale og nordlige delen av innsjøen.

Fra de fleste av prøvetypene ble totalt 205 enkeltforbindelser/isomerer bestemt i analyseprogrammet. De viktigste sammensatte gruppene inkluderte:

- Per- og polyfluorerte alkylstoffer (PFAS)
- UV-forbindelser
- Bromerte flammehemmere (PBDE)
- Siloksaner
- Bensotiazoler
- Muskforbindelser
- Klorparafiner (CP)
- Kvaternære ammoniumforbindelser (QAC)
- Metaller (inkl. Hg)
- Ftalater
- Fenoliske forbindelser
- Fosfororganiske flammehemmere (oPFR)

I 2023, var ftalater den dominerende stoffgruppen nederst i den pelagiske næringskjeden (zooplankton og mysis), mens fenoler dominerte i lagesild helkropp og mageinnhold. En av fenolene, 4-tert-butylfenol var den dominerende av fenolene, men resultatet er usikkert på grunn av variable nivåer i blankprøvene benyttet i analysen. Forbindelsen er detektert uten interfererende komponenter, men kvantifiseringa er usikker. Høyere opp i næringskjeden (krøkle og ørret), dominerer siloksan D5, PBDE-forbindelser og PFAS. Vi ser en tydelig økning i konsentrasjoner av UV-forbindelsen oktokrylen i nedre del av den pelagiske næringskjeden sammenlignet med det som ble funnet i 2020, da samme prøvetypene sist ble analysert.

Trofisk magnifiseringsfaktor (TMF) er beregnet for enkeltkomponenter med en deteksjonsfrekvens > 50 % spredt over så stor del av næringskjeden som mulig. Høy grad av biomagnifiserende egenskaper, vist som TMF > 1, er påvist for enkeltstoffene Hg, BDE47, D5, og PFAS, inkl. PFOS, spesifikt. Dataene fra 2023 endrer i liten grad TMF for disse enkeltkomponentene, som har data tilbake fra 2013 (Hg, BDE47, D5) og 2020 (PFOS). I tillegg gjorde vi en TMF beregning for musk-komponenten galaxolide, der resultatene antyder biomagnifiserende egenskaper. Denne beregninga er likevel svært usikker, pga. få data som kun dekker en begrenset del av næringskjeden.

Sammenlignet med resultater fra tidligere undersøkte organismer i en bentisk næringskjede i Mjøsa (2022), ser vi store variasjoner i noen av stoffgruppene. F.eks. har oktokrylen, som beskrevet over, to til tre ganger høyere nivåer i pelagiske organismer på lavt trofisk nivå, sammenligna med organismer på lavt trofisk nivå i strandnære områder. For QAC ser vi det motsatte mønsteret, her er nivåene vesentlig høyere i strandnære organismer sammenligna med de pelagiske.

Mot slutten av 90-tallet fikk Mjøsa et stort utslipp av bromerte flammehemmere fra lokal industri, noe som resulterte i skyhøye konsentrasjoner av PBDE i fisk fra Mjøsa i de kommende åra. Fra 2000 til 2023 er

det en signifikant nedgang i BDE6-konsentrasjoner i ørret, selv om konsentrasjonene fortsatt er langt over miljøkvalitetsstandardene (EQS) fastsatt i vanndirektivet. Det er også observert en nedadgående trend i konsentrasjoner av ørret i Mjøsa for PFOS og PFTrDA det siste tiåret (2014-2023). Disse regresjonene er imidlertid svake, men signifikante. Det samme gjelder for siloksan D5, hvor det er en svak men signifikant nedgang fra 2012 til 2023.

For kvikksølv (Hg), vil en ørret i Mjøsa i gjennomsnitt nå EUs og den norske øvre grensa for omsetning på 0.5 mg/kg w.w. i fiskemuskel når den er ca. 56 cm lang, som tilsvarer ~ 2,1 kg (basert på hele datasettet for Mjøsa fra 2006-2023). Den gjennomsnittlige lengdejusterte Hg-konsentrasjonen er imidlertid lavere de siste 9 åra (2015-2023: 0.49 mg/kg) av datasettet sammenlignet med de 9 årene før (2006-2014: 0.62 mg/kg), noe som indikerer en synkende Hg-konsentrasjon for fisk ved samme lengde.

1 Introduction

"Environmental contaminants in freshwater food webs (MILFERSK)" is a program designed to provide an early warning knowledge of potential harmful contaminants in Norwegian lakes. This means that we need to monitor the presence and potential sources of contaminants in a lake with a high anthropogenic impact such as Lake Mjøsa, the largest lake in Norway. In addition, monitoring of contaminants in brown trout from the rural Lake Femunden, serves as a reference to the more urban Lake Mjøsa. Key information of the sample program is presented in Table 1

1.1 Locations

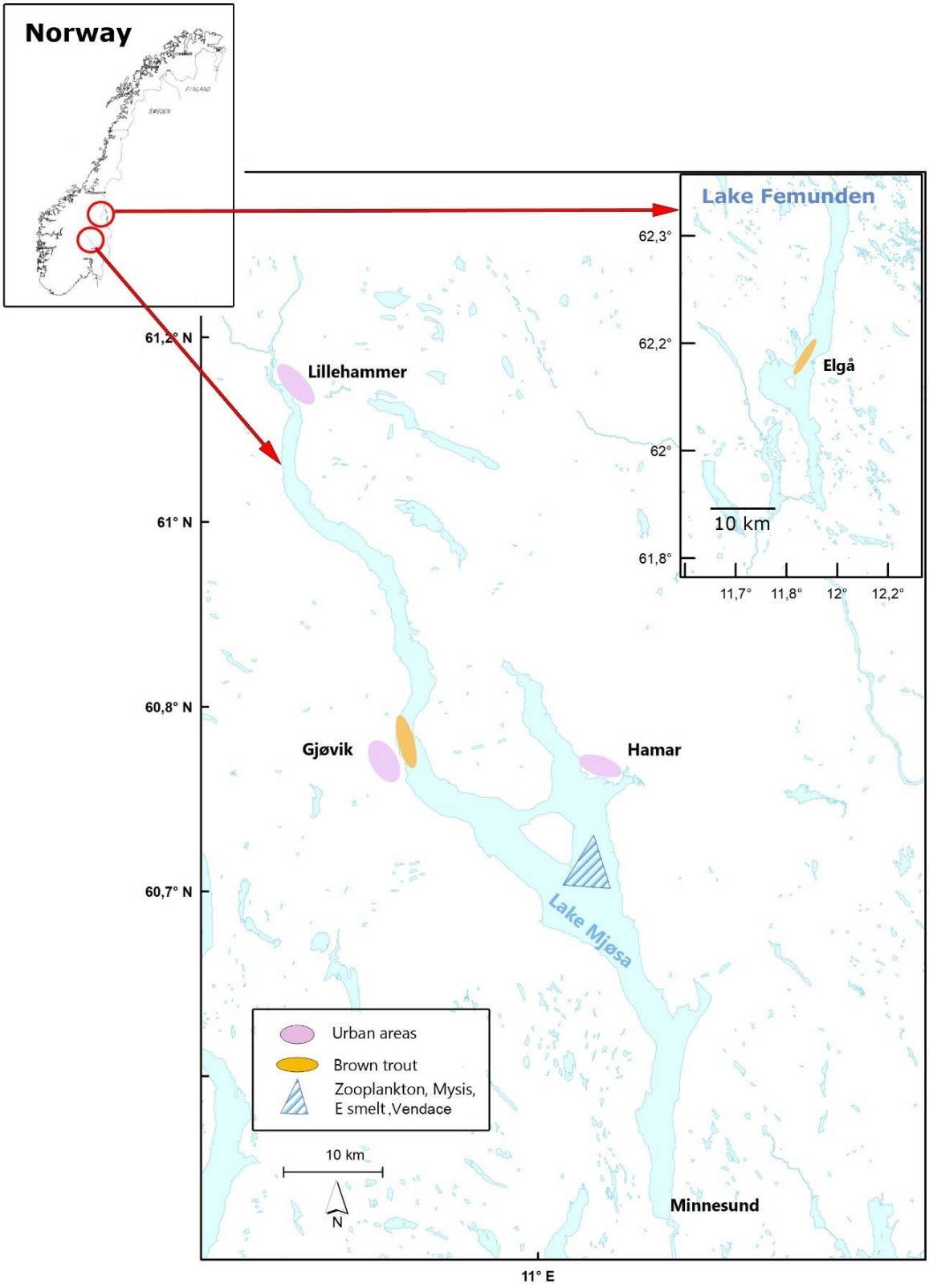


Figure 1 Map over sampling stations in Lake Mjøsa and Lake Femunden in 2023.

Table 1 Key information of the sampling program in MILFERSK 2023.

Species/sample	Matrix	Lake	Locality	Station code	Depth	Coordinates UTM 33	No. for analysis
Zooplankton	Whole body	Mjøsa	South/east of Helgøya	ZM-H	0 - 15 m	N: 6735833 E: 283365	3
Mysis (*Mysis relicta*)	Whole body	Mjøsa	South/east of Helgøya	MM-H	80 - 100 m	N: 6735833 E: 283365	3
E. smelt (*Osmerus eperlanus*)	Whole body	Mjøsa	North of Gjøvik	AM-M/L	30 - 50 m	N: 6738520 E: 285438	3 pooled samples of 40 individuals per sample
Vendace (*Coregonus albula*)	Whole body and stomach	Mjøsa	North of Gjøvik	GM-M/L	10 - 50 m	N: 6749473 E: 265847	3 pooled samples of 10 individuals per sample, and 3 samples of stomach content
Brown trout (*Salmo trutta*)	Muscle and liver	Mjøsa	North of Gjøvik	ØM-M/L	10 - 50 m	N: 6749473 E: 265847	15
Brown trout (*Salmo trutta*)	Muscle and liver	Femunden	Area of Elgå	ØF-M/L	10 - 30 m	N: 6898700 E: 338500	3 pooled samples of 15 individuals

1.1.1. Food webs of Lake Mjøsa and Lake Femunden

The (pelagic) food webs established within the two lakes are quite different. Lake Mjøsa is the largest lake in Norway, holding over 20 different fish species, such as brown trout (*Salmo trutta*), pike (*Esox Lucius*), perch (*Perca fluviatilis*) and burbot (*Lota lota*) to mention a few of the common species popular for recreational fishing. These species interact in two relatively distinct food webs; the pelagic, open water food web and the food web in the littoral/profundal zone. In Lake Mjøsa the pelagic food web has been well defined and studied over several years (Spikkeland et al., 2016; Sandlund et al., 2017; Fjeld et al., 2017; Jartun et al., 2021), and has contained the preferred sampling material in this monitoring program between 2017 – 2020. However, the pelagic food web is linked to the species in the littoral zone as described in Figure 2**Error! Reference source not found.**. Representatives of a benthic food chain/ littoral species were included in the 2021 and 2022 MILFERSK monitoring program (Jartun et al. 2022; Jartun et al. 2023).

On the lower trophic level there is a large variation of zooplankton populations, some being true primary consumers such as *Daphnia* and some are being omnivorous and potentially on a higher trophic level such as *Limnocalanus macrurus*. The opossum shrimp *Mysis* is an important part of the pelagic food web, as it feeds on zooplankton, and is an important prey for European smelt, E. smelt (*Osmerus eperlanus*). E. smelt is, together with brown trout (*Salmo trutta*), considered a top predator in Lake Mjøsa as they tend to be cannibalistic after reaching approx. 15 cm. In addition, vendace (*Coregonus albula*) is a part of this food web as a central planktivore species. The biodiversity of Lake Mjøsa is high which causes the top-predator brown trout and European smelt to be at a higher trophic level in this lake compared to similar lakes in Norway.

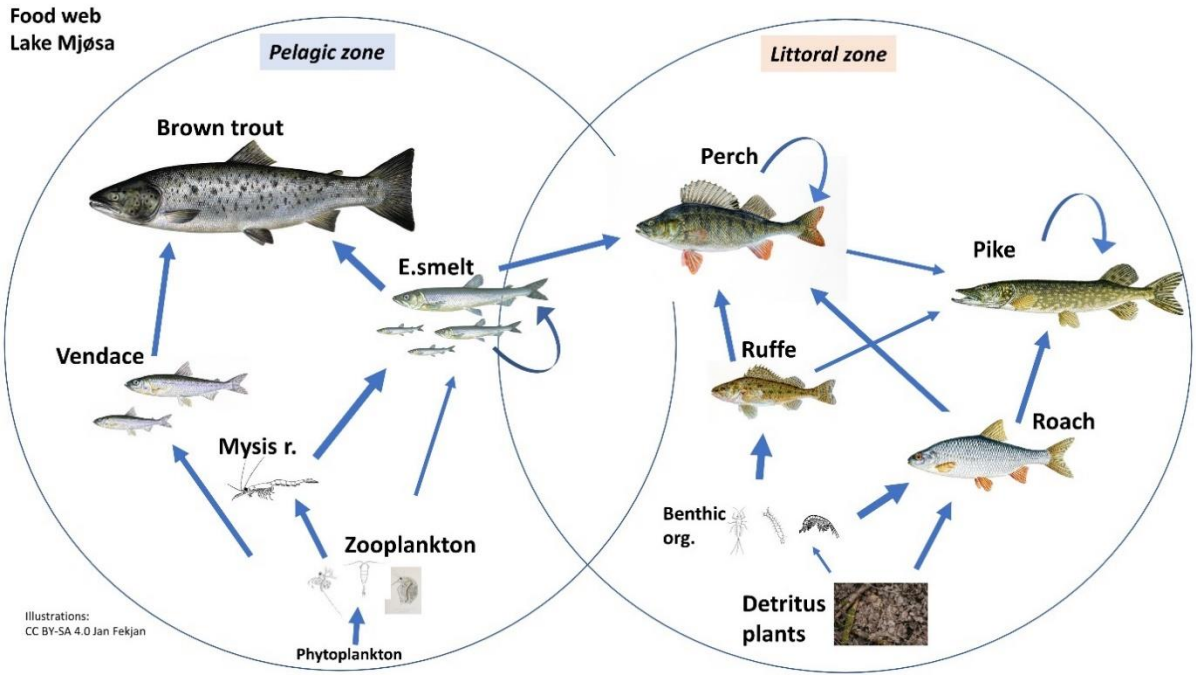


Figure 2 Illustration of the pelagic and littoral food web of Lake Mjøsa sampled in this study. Thickness of arrows indicate main prey, i.e. a thicker arrow means major food source.

Samples of brown trout from Lake Femunden were also studied. The ecosystem in Femunden consist of eight species of fish including brown trout, European whitefish (*Coregonus lavaretus*) and Arctic char (*Salvelinus alpinus*), Figure 3. European whitefish is the main prey for brown trout as they become piscivorous at the age of 3 - 9 years, or approximately 30 cm (Sandlund et al., 2012). Only a small proportion of the brown trout population in Lake Femunden is pelagic; the majority prey in the littoral zone on benthic or terrestrial organisms, such as insects. For brown trout in Lake Femunden to become large, they need to be opportunistic and undergo changes in diet with increasing prey size (Næsje et al., 1996). The size of European whitefish population will have a relatively large impact on the production of large brown trout in Lake Femunden.

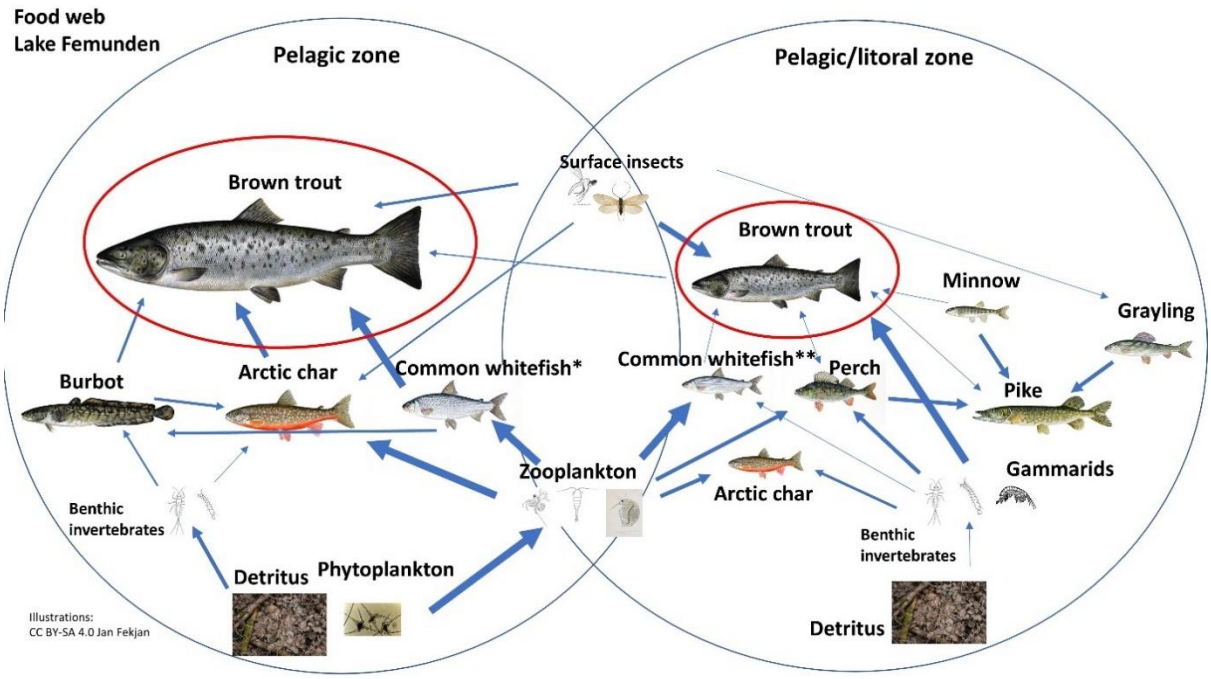


*Figure 3. Illustration of the pelagic and littoral food webs of Lake Femunden, indicating the potential main prey of brown trout (only species sampled in this lake, marked with red circle). Thickness of arrows indicate main prey, i.e. a thicker arrow means major food source. *Pelagic population, in deep waters. **Littoral/benthic population, also in rivers.*

1.2 Samples and analytical program

	Parameters	Zooplankton[1, 2.]	Mysis[2]	E. smelt[2]	Vendace[2]	Vendace, stomach[2]	Brown trout. Mjøsa[2]	Brown trout. Femunden[2]	N analyses
NILU	Mercury (Hg)	3	3	3	3	3	15	3	33
	Metals	3	3						6
	Rare earth metals	3	3						6
	Siloxanes	3	3	3	3	3	15	3	33
	PBDEs	3	3	3	3	3	15	3	33
	Chlorinated paraffins (S/MCCP)	3	3	3	3	3	15	3	33
	Chlorinated paraffins (LCCP)						15	3	18
	Organic phosphorus flame retardants (oPFR)	3	3						6
	Phenols	3	3	3	3	3	3	3	21
	Musk	3	3	3	3	3			15
	Phthalates	3	3						6
NIVA	PFCA (perfluorinated carboxylate acids)			3	3	3	15	3	27
	PFSA (Perfluorinated sulfonates)			3	3	3	15	3	27
	nPFAS (polyfluorinated neutral compounds)			3	3	3	15	3	27
	newPFAS			3	3	3	15	3	27
	UV-compounds	3	3	3	3	3	15	3	33
	Benzothiazoles	3	3						6
	Quaternary Ammonium Compounds (QAC)	3	3	3	3	3			15
IFE	Isotopes ($\delta^{13}C$. $\delta^{15}N$)	3	3	3	3	3	15	15	45

[1] Samples of epipelagic zooplankton consisted of between 50 and 90 % *Daphnia* spp. [2]Zooplankton, mysis, E. smelt, vendace, and stomach: whole body samples. For trout: samples of muscle and liver.

2 Main findings

Stable isotopes of carbon and nitrogen are useful indicators of food origin and trophic levels, $\delta^{13}C$ provides 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 4. It should be noted that the samples of stomach content of vendace had high lipid concentrations (16-36 %), as well as a diluted $\delta^{13}C$ signatures (-34.60 - -35.33). The results of stable isotopes in individual biota samples are given in the Appendix (4.2). Note that there are more determinations of stable isotopes (individual fish samples) than chemical analyses in this study, to establish the properties and trophic levels of the benthic food chain in Lake Mjøsa (see metadata in Appendix, 4.2).

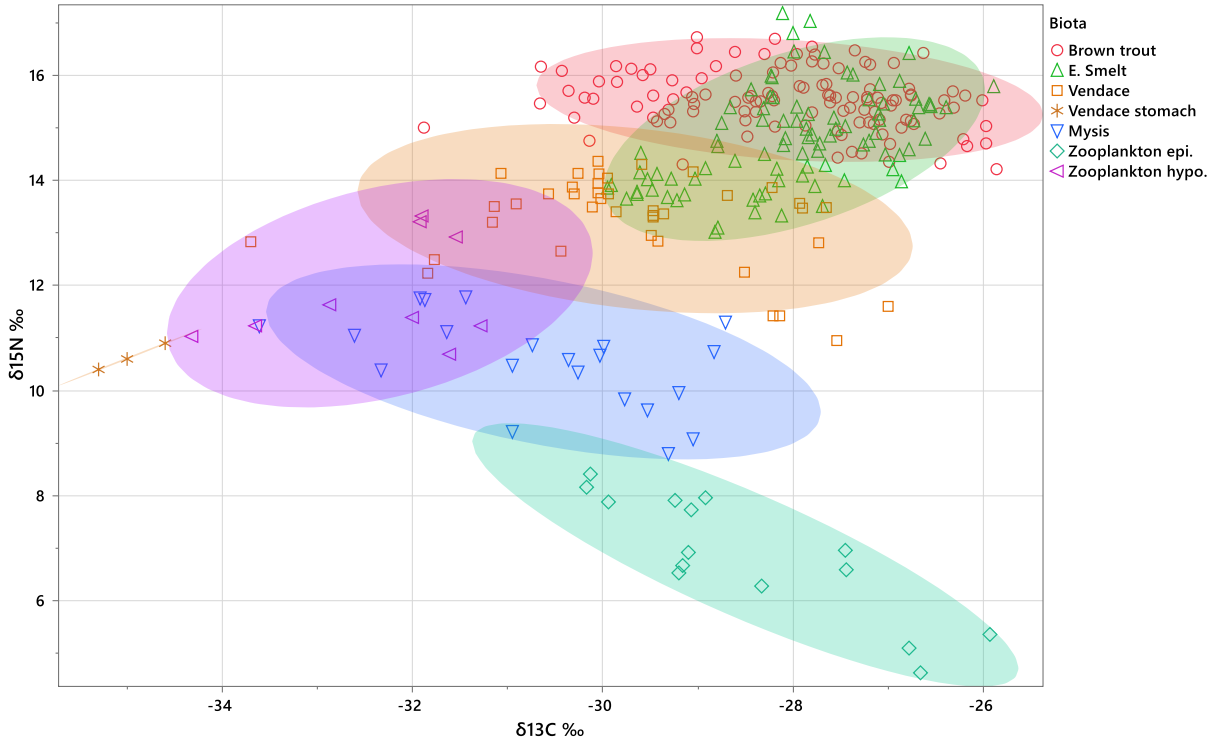


Figure 4 Relationships between measured δ15N and δ13C ‰ in biota sampled in Lake Mjøsa from 2013 to 2023 (except for the years 2021 and 2022 for biota other than brown trout). Zooplankton sampled from the upper strata (down to ~ 10 m) of the lake are defined as epilimnetic zooplankton (Zooplankton epi.), while zooplankton sampled from the deeper parts of the lake (50-80 m) are defined as hypolimnetic zooplankton (Zooplankton hypo.). I addition samples of zooplankton in the upper strata with an inclusion of above 50 % copepods are termed Zooplankton hypo.

2.1 Detection frequency of individual compounds

A total of 205 single compounds/isomers were determined in 7 different sample types in this study. Figure 5 gives the detection frequencies of the various individual compounds from each of the main contaminant groups in the different samples, divided into three tables. Detection frequency is calculated as a fraction of the total positive detection of all compounds in the different species/matrices in this study, indicated by a number from 0 – 1 and a colored scale from blue (0 detections) to red (100 % detection for the given sample type). Grey cells: not analyzed.

Figure 5 is divided into three tables:

A: PBDEs, oPFR, chlorinated paraffins (CP), musk, benzothiazoles, quaternary ammonium compounds (QAC) and UV-compounds.

B: Siloxanes, phenols, phthalates and PFAS

C: Hg, rare earth metals and other metals

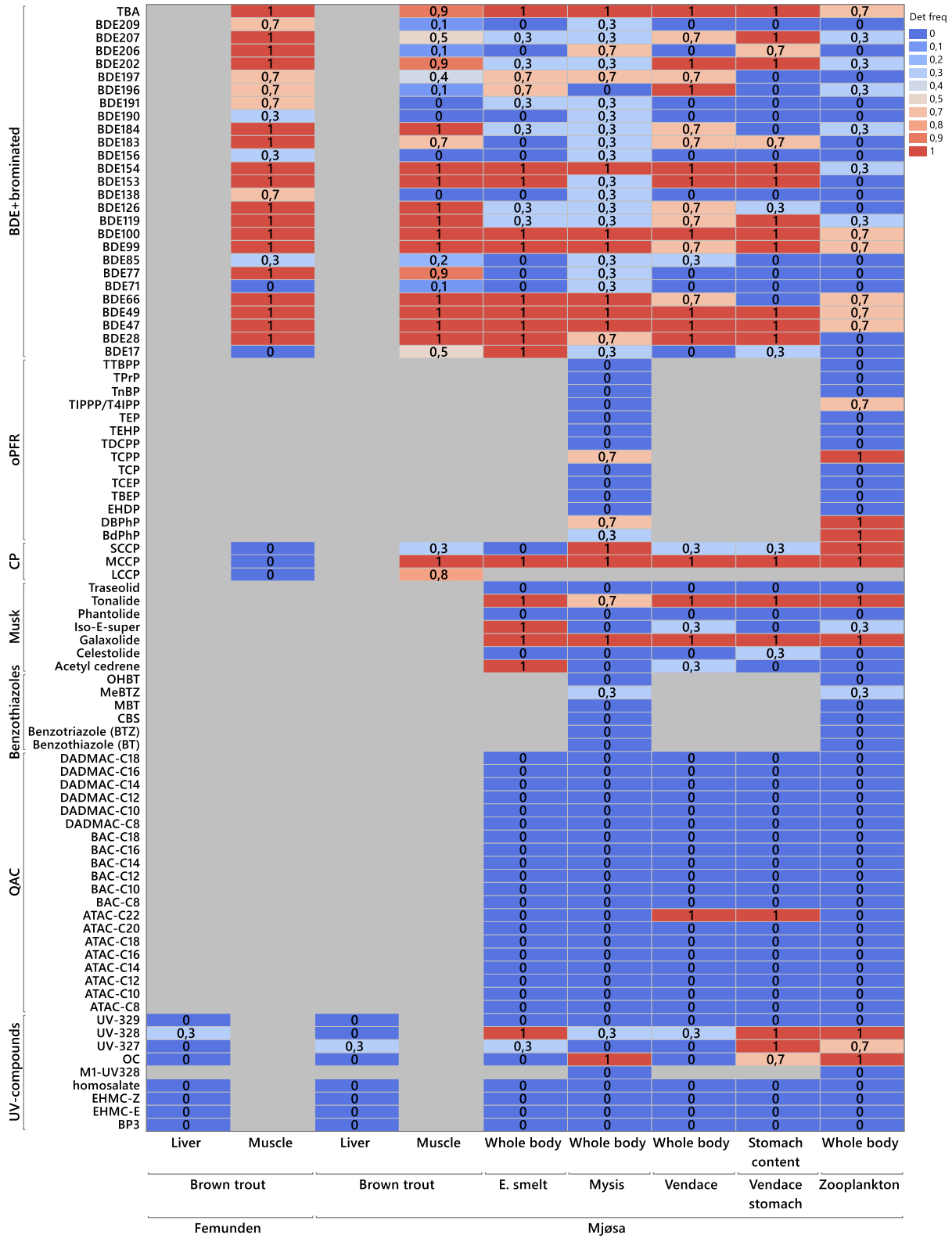


Figure 5 Detection frequencies.

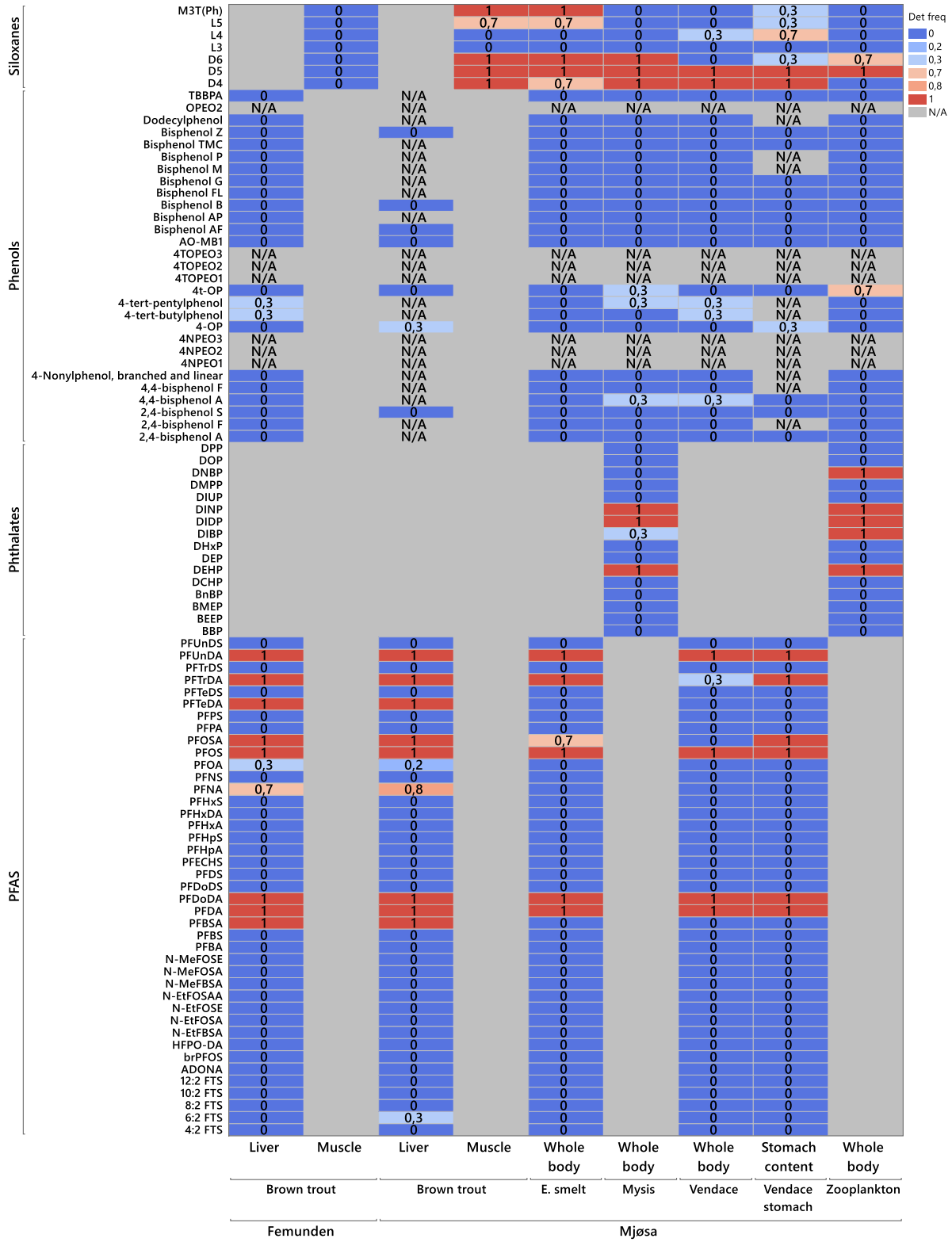


Figure 5. Detection frequencies.

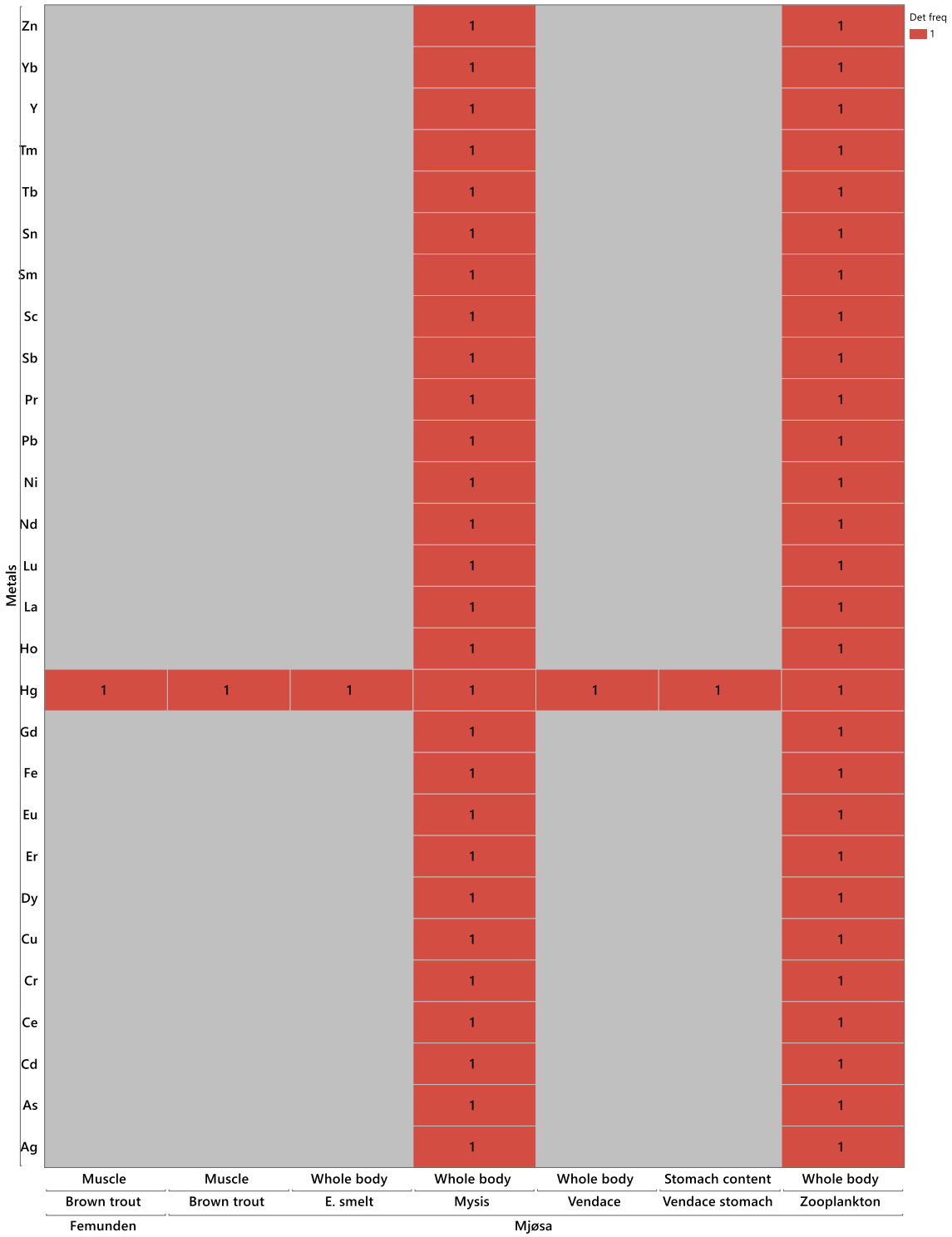


Figure 5. Detection frequencies.

2.2 Overview of main results

Major overview of the results is presented in Figure 6 and Figure 7. 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.

Graphs for the main contaminant groups are provided in chapter 2.3 to 2.14 (Figure 8 to Figure).

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.

In figure 6 we have included phenols and phthalates. These two contaminant groups dominate the total concentration of contaminants in liver of brown trout and stomach content of vendace. However, there are at this stage some uncertainties regarding the results from the analysis of one of these phenolic compounds, 4-tert-butylphenol (Figure 17). To visualize this, we have removed these two component groups (phenols and phthalates) in figure 7.

In the pelagic top predator brown trout in Lake Mjøsa, PBDEs and siloxanes are dominating, as these two compound groups also tend to biomagnify in the pelagic food chain. whereas in the lower trophic levels (zooplankton and mysis) phthalates dominate (in whole body samples). Note also that PFOA is above LOQ for brown trout in Lake Mjøsa in 2023 for the first time.

Stomach content of vendace had high lipid concentrations (16-36 %), which resulted in high concentrations of lipophilic contaminants such as PBDEs, siloxanes, and chlorinated paraffins (CP). These compound groups are therefore lipid normalized in bar charts and in biomagnification models for PBDEs, CPs and siloxanes. The high lipid concentrations found in stomach of vendace may be an artifact of high fat content in the gut tissue itself rather than in the actual stomach (prey) content. This corresponds with findings of high lipid content in intestines of fish species such as gilthead sea bream (Kandyliari et al., 2020). As the stomach content of vendace of our size (total individual weight of approx. 25 g) is very low in volume, some remains of the stomach tissue will accidentally be included in the dissection process.

In brown trout from rural Lake Femunden, long-chained PFAS (e.g. PFUnDa and PFTrDA) are dominating. Cyclic D5 is the dominating contaminant in the siloxane group, found in stomach content of vendace and in the top predator brown trout in Lake Mjøsa, with concentrations 100 times above what is found in brown trout from Lake Femunden.

There were no EOF (Extractable Organic Fluorine) results above LOQ. The LOQ for EOF will be significantly higher than for the target analysis, due to a combination of the method used and issues with blank levels. The LOQ was extra high this time due to unusually high blank levels and for the reanalysis done the amount of sample available.

For more details and discussions on results, see under each specific section.

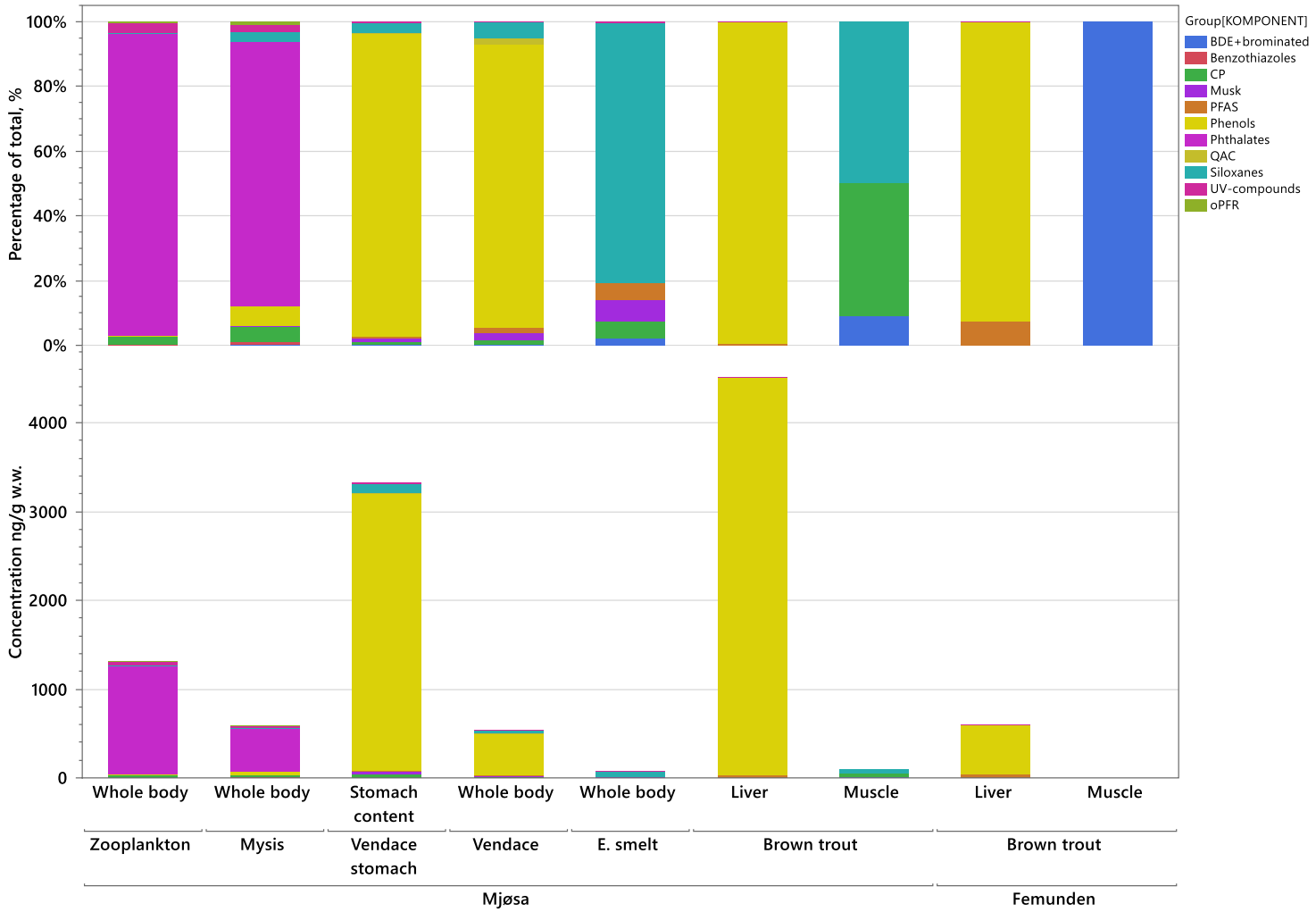


Figure 6 (Top) Individual compound groups as percentage contribution to the sum of all groups. (Bottom) Sum of mean concentrations of substances in each contaminant group in studied species and tissues (all biotic matrices). Concentrations are in ng/g w.w. for all sample types. Non-detected concentrations are assigned a value of zero (0). See Table 2 for analytical program. Metals have been removed from this overview, see chapter 2.14.

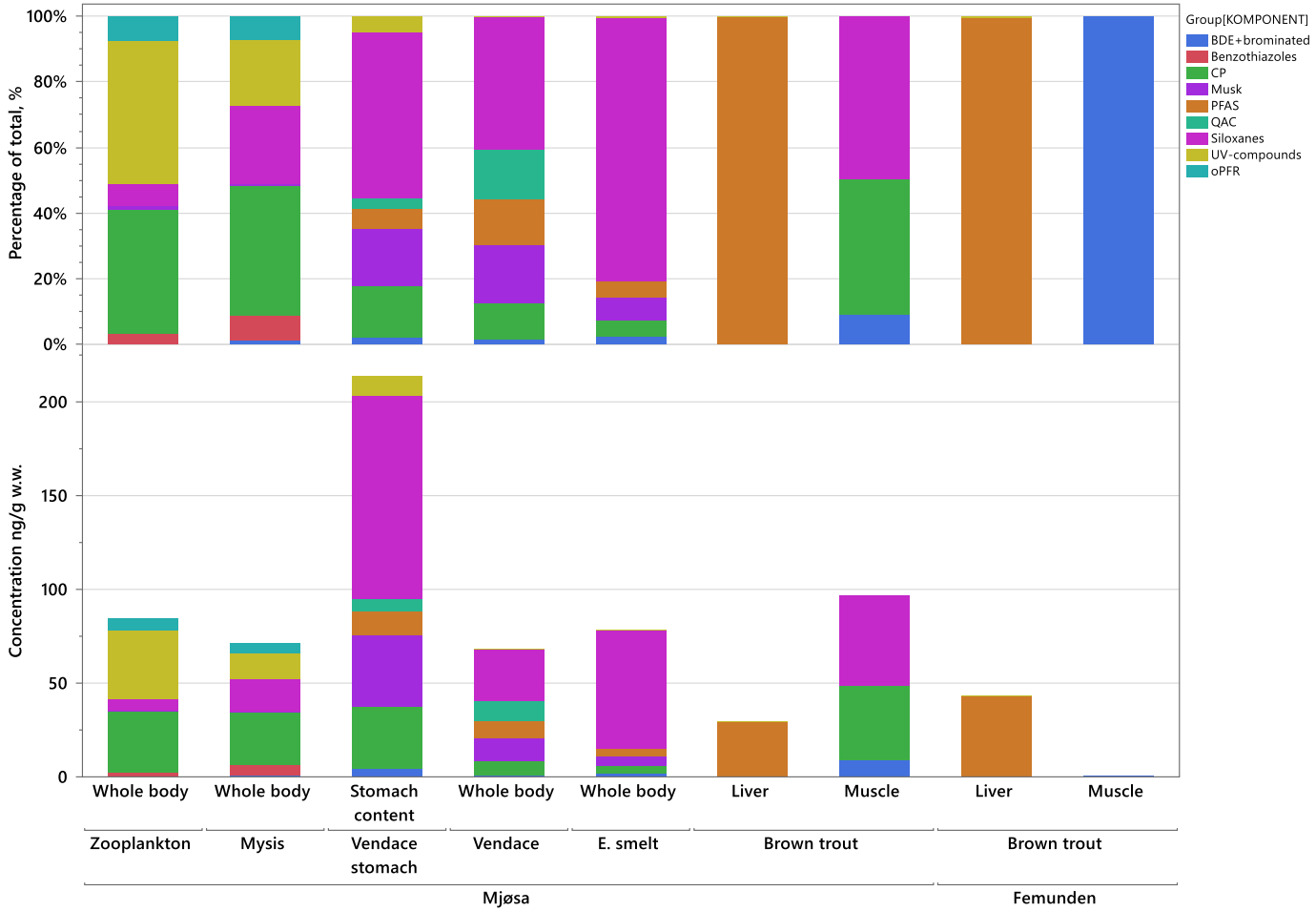


Figure 7 (Top) Individual compound groups as percentage contribution to the sum of all groups. (Bottom) Sum of mean concentrations of substances in each contaminant group in studied species and tissues (all biotic matrices). Concentrations are in ng/g w.w. for all sample types. Non-detected concentrations are assigned a value of zero (0). See Table 2 for analytical program. Metals have been removed from this overview, see chapter 2.10 and 2.11. Note that phenols and phthalates have been excluded from the chart.

2.3 PFAS

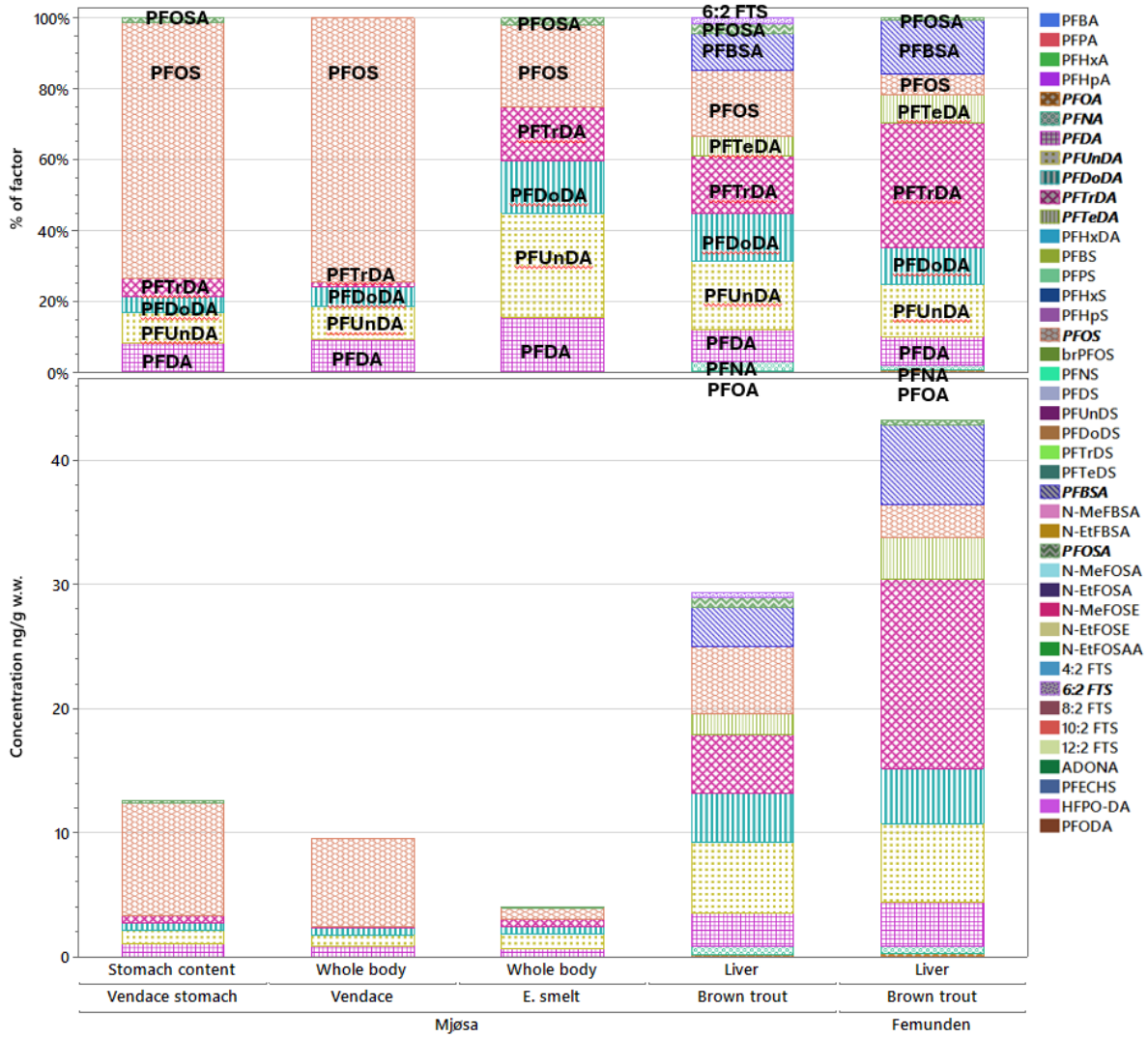


Figure 8 (Top) PFAS compounds as percentage contribution to the sum of PFAS. (Bottom) Concentrations, sum of means (ng/g ww in biota) of individual PFAS compounds for all matrices. Non detects are assigned a value of zero.

2.4 UV compounds

Of the UV-compounds, octocrylene (OC) dominates in the lower trophic levels in the pelagic food chain. This was also found in the benthic food chain in 2022 (Jartun et. al.,2023). The levels are about two to three times higher in the pelagic species. We also observe a substantial increase in mean concentration at the lowest trophic level, zooplankton, compared to in 2020, with an increase from 2,16 ng/g in 2020 to 36,2 ng/g in 2023 (Jartun et al. 2021), However, the substance does not biomagnify, neither in the benthic nor the pelagic food chain.

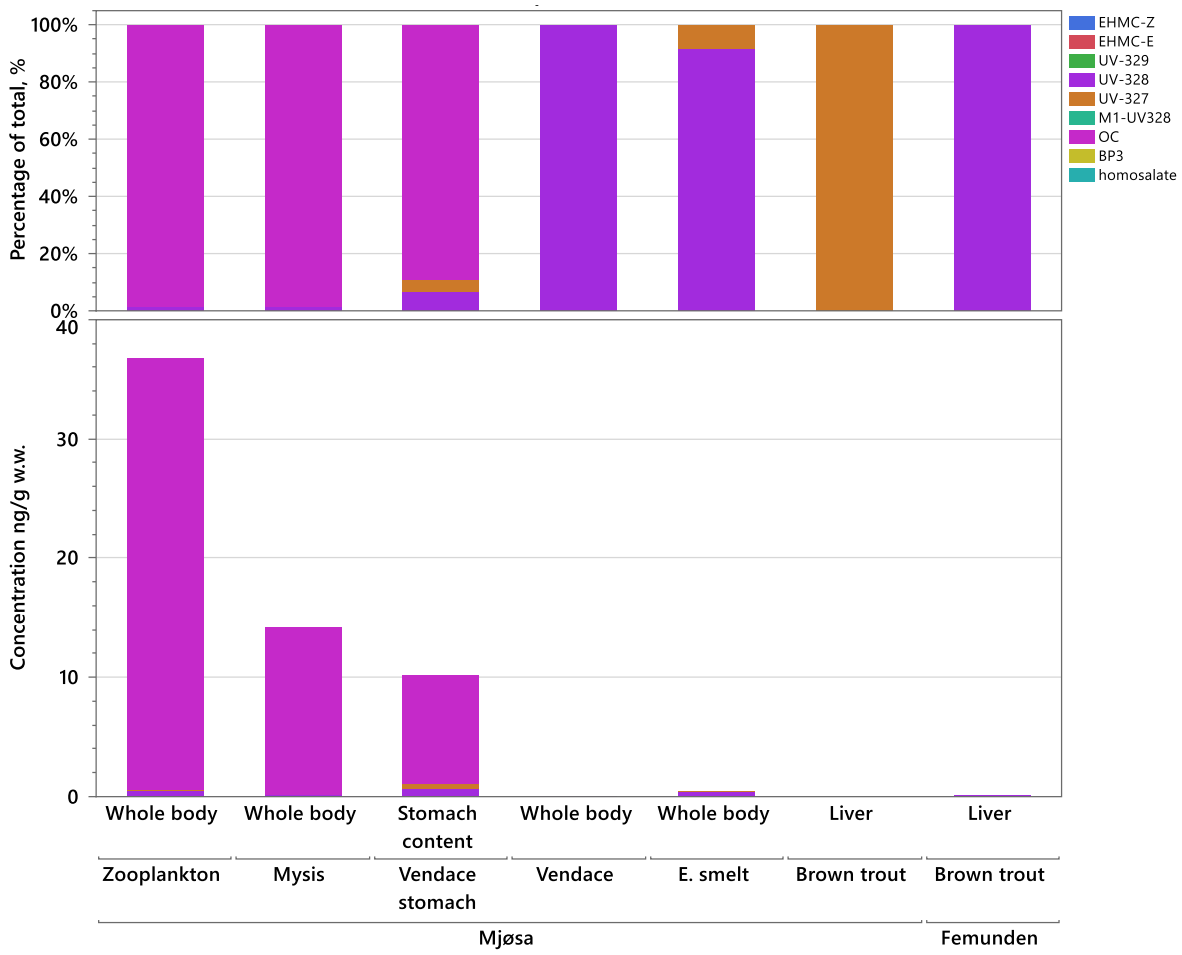


Figure 9 (Top) UV-compounds as percentage contribution to the sum of UV. (Bottom) Concentrations, sum of means (ng/g ww in biota) of individual UV compounds for all matrices. Non detects are assigned a value of zero.

2.5 Quaternary ammonium compounds (QAC)

For QACs, only the compound ATAC-22 was detected, in vendace and in vendace stomach content. This contrasts with the result from the benthic food chain investigated in 2022, where several of the QAC compounds were detected through the food chain, and at higher concentrations (Jartun et al., 2023).

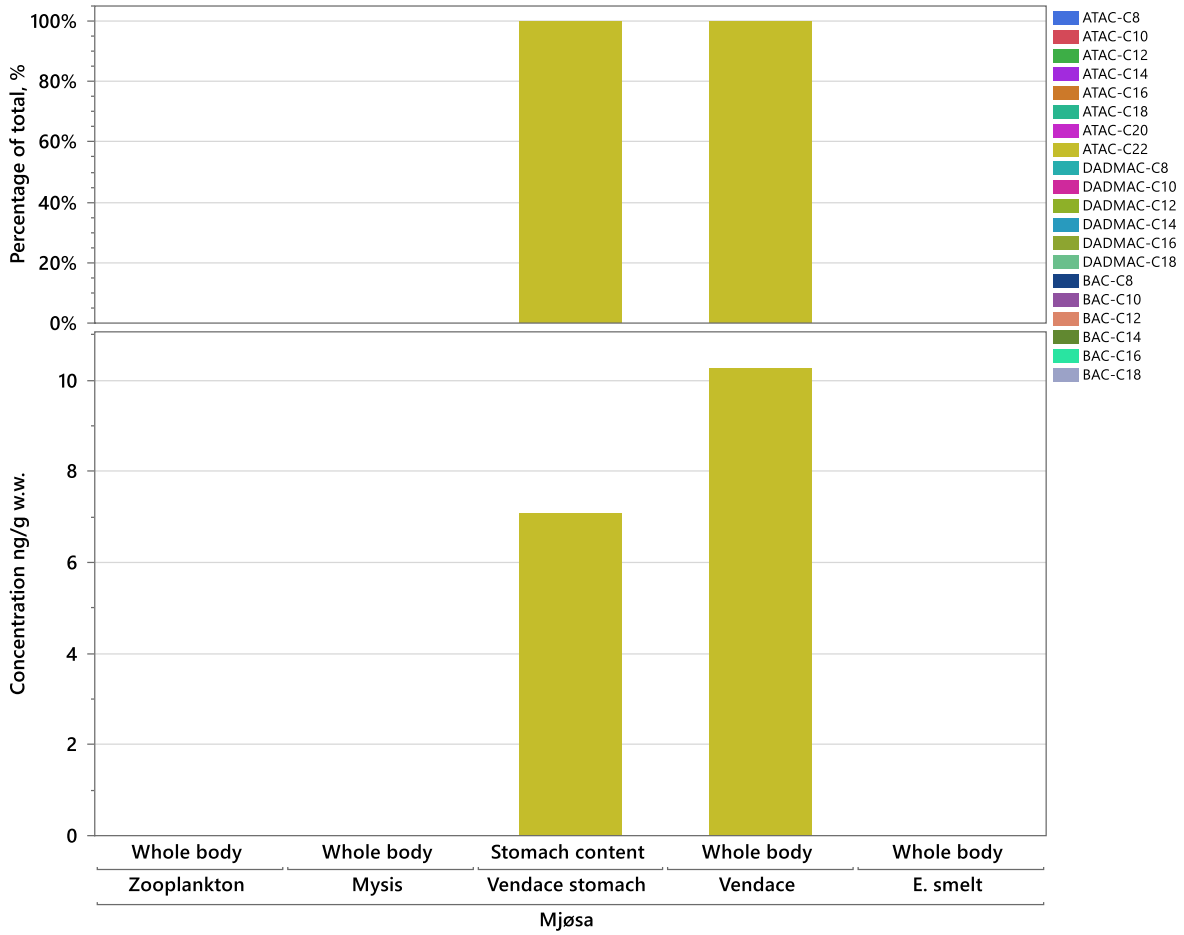


Figure 10 (Top) QAC compounds as percentage contribution to the sum of QAQs. (Bottom) Concentrations, sum of means (ng/g ww in biota) of individual QAC compounds for all matrices. Non detects are assigned a value of zero.

2.6 PBDEs

As can be seen in Figure 11., PBDEs are shown on a wet weight (w.w.) basis, while in figure 12., concentrations are lipid normalized. Because of the high lipid concentrations in stomach content of vendace, concentrations of PBDEs are greatly reduced when lipid normalized.

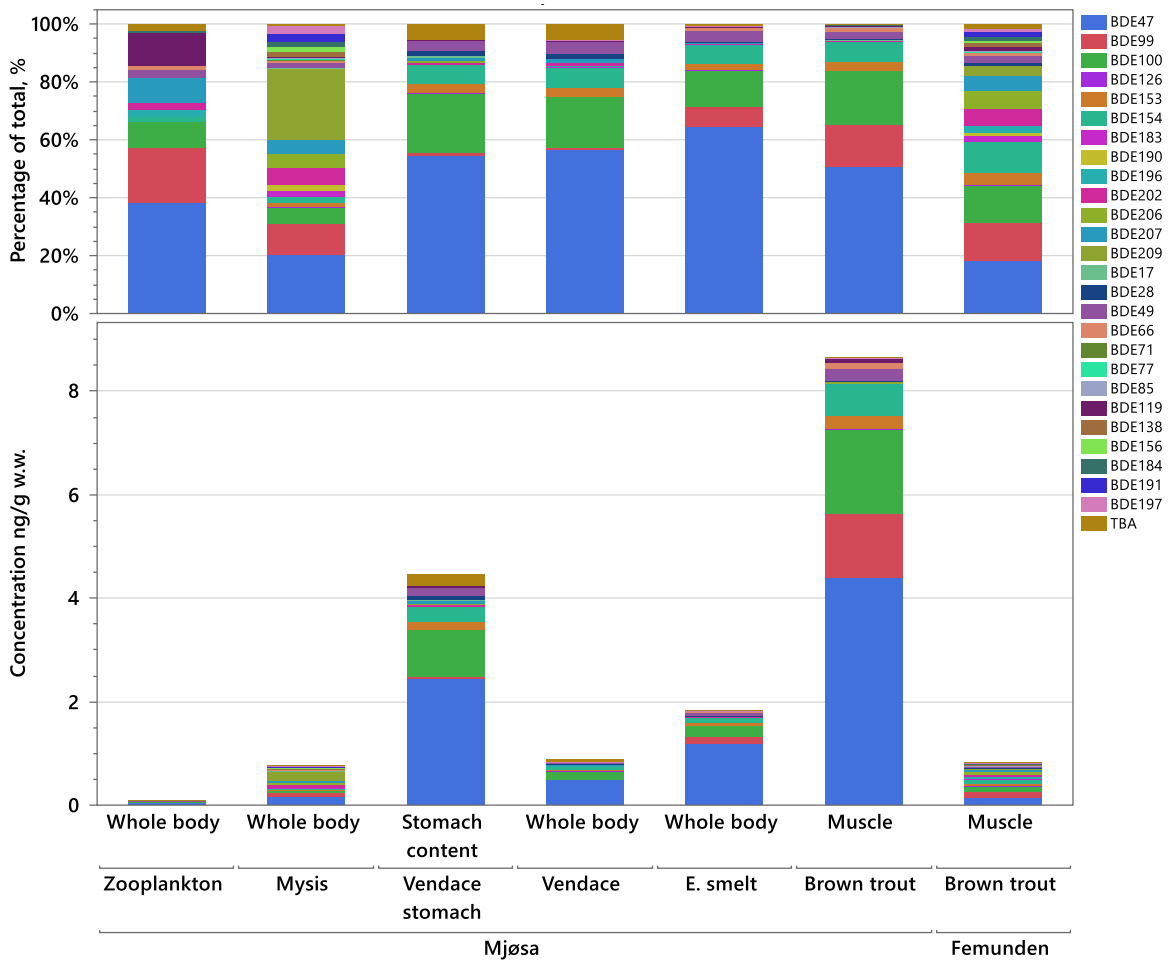


Figure 11 (Top) PBDE compounds as percentage contribution to the sum PBDEs. (Bottom) Concentrations, sum of means (ng/g ww in biota) of individual PBDEs for all matrices. Non detects are assigned a value of zero.

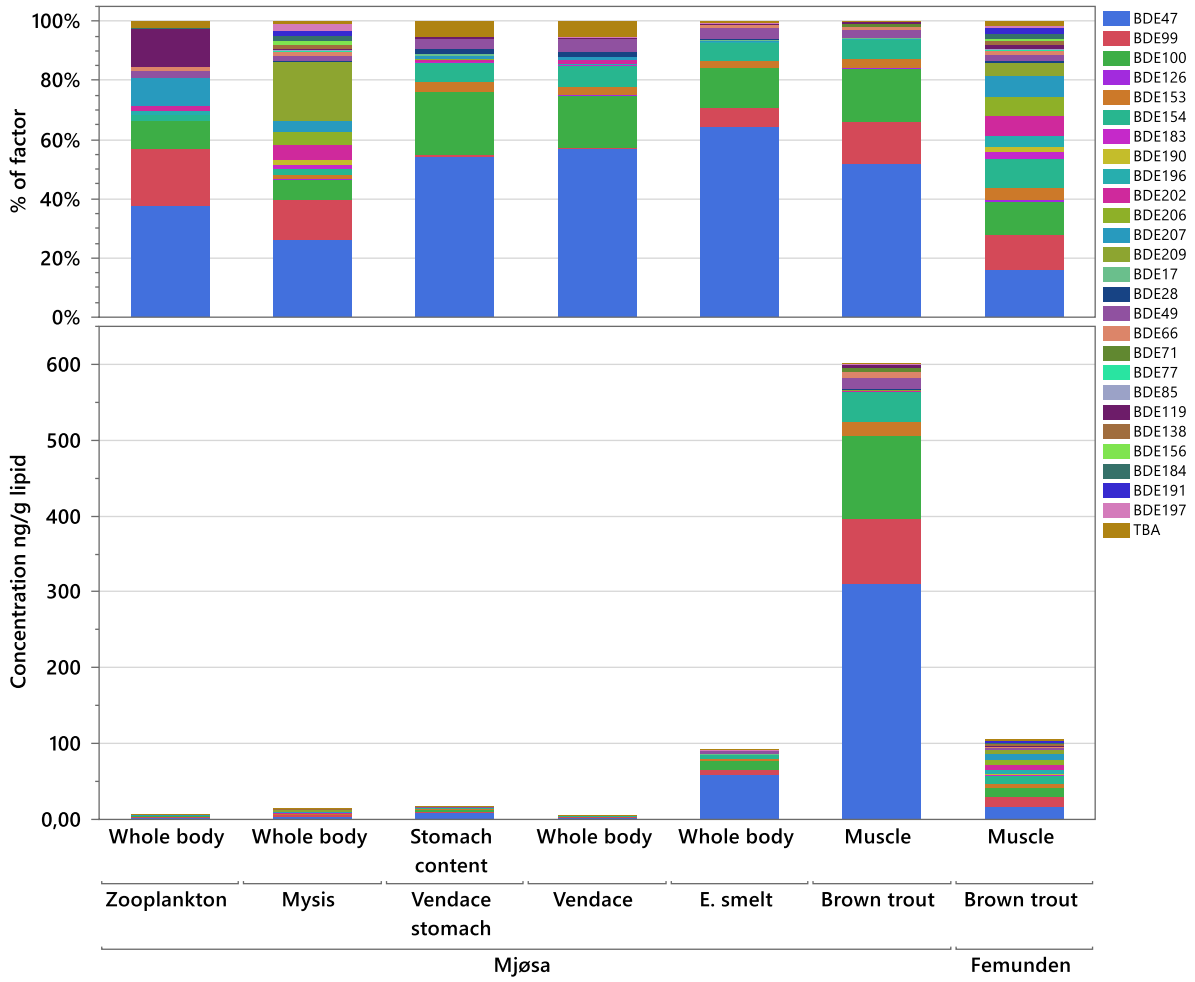


Figure 12 (Top) PBDE compounds as percentage contribution to the sum PBDEs. (Bottom) Concentrations (ng/g lipid in biota) of individual PBDEs for all matrices. Non detects are assigned a value of zero.

2.7 Chlorinated paraffins (CP)

As can be seen in Figure 13., CPs are shown on a wet weight (w.w.) basis, while in figure 14., concentrations are lipid normalized. Because of the high lipid concentrations in stomach content of vendace, concentrations of CPs are greatly reduced when lipid normalized.

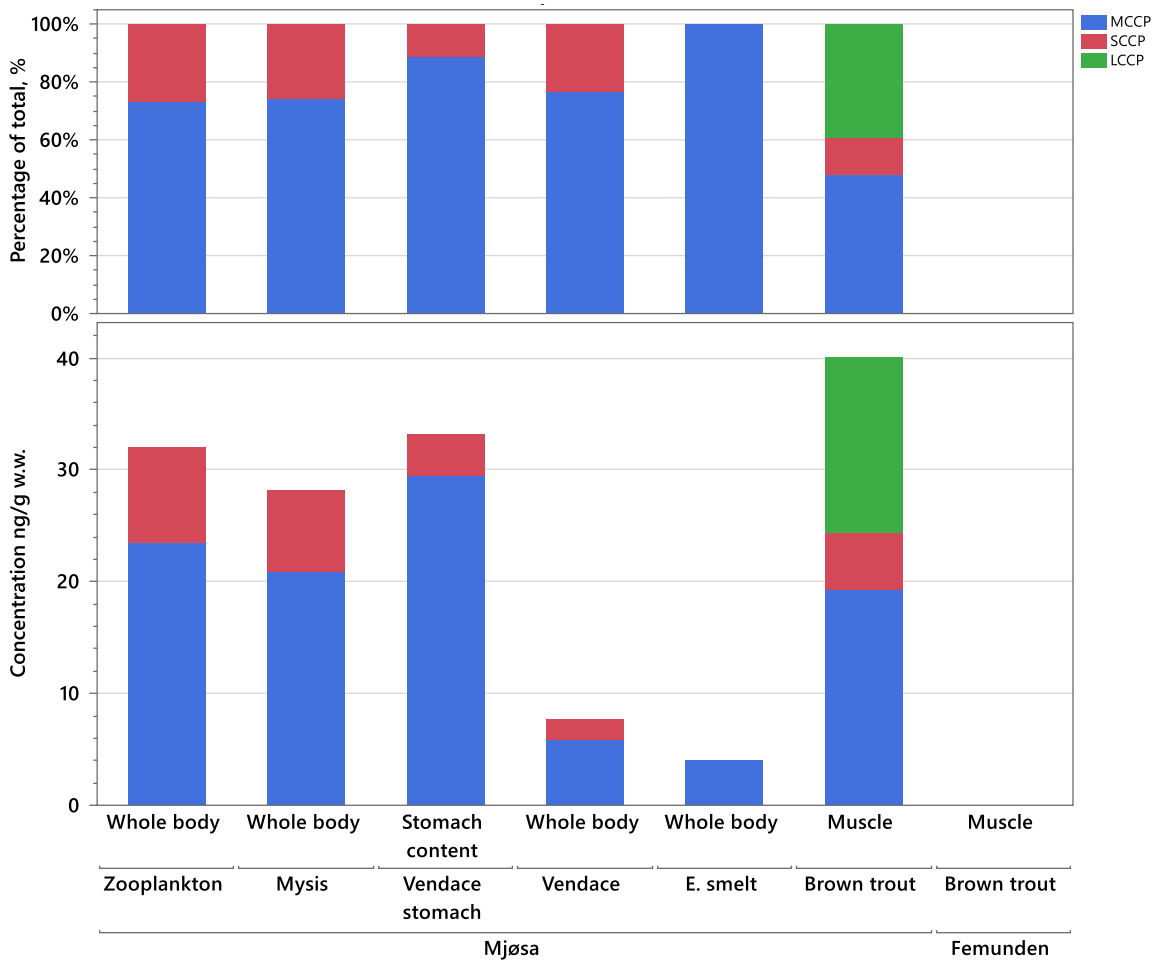


Figure 13 (Top) CPs as percentage contribution to the sum CPs. (Bottom) Concentrations, sum of means (ng/g lipid in biota) of individual CPs for all matrices. Non detects are assigned a value of zero.

Chlorinated paraffins is a contaminant group of some concern, as they are extensively used in common products, e.g., as plastic additives. This makes field and lab blanks sensitive to potential contamination. In this study, SCCP, MCCP and LCCP is detected independently in different sample types. Results suggest that SCCP and MCCP were detected in lower trophic levels. LCCP was only included in analysis of the top predator brown trout but was detected in rather high frequency. It is important to note that all CPs fall under uncertainty category 3 in this study, in terms of precision and accuracy for the quantification. There were no detections above LOQ for LCCP in the Femunden trout.

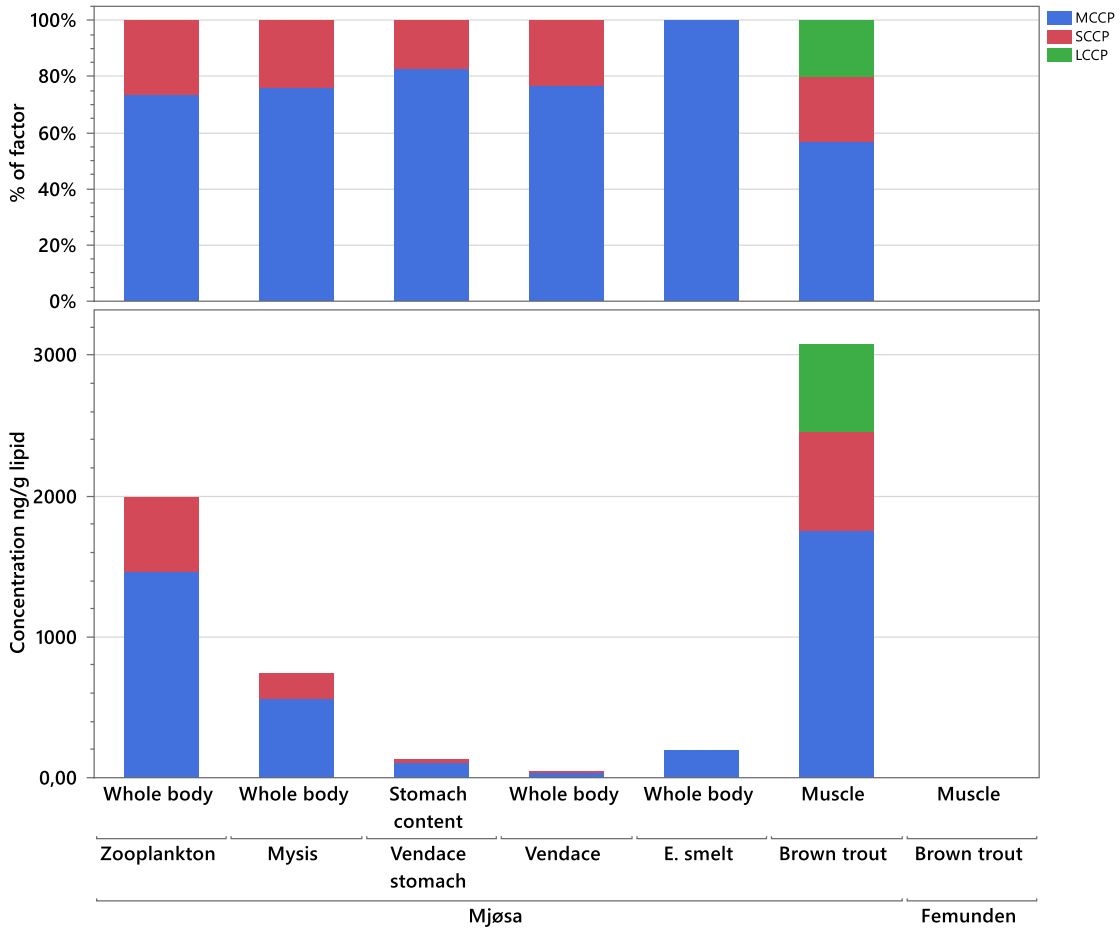


Figure 14 (Top) CP compounds as percentage contribution to the sum CPs. (Bottom) Concentrations (ng/g lipid in biota) of individual CPs for all matrices. Non detects are assigned a value of zero.

2.8 Siloxanes

As can be seen in Figure 15., siloxanes are shown on a wet weight (w.w.) basis, while in figure 16., concentrations are lipid normalized. Because of the high lipid concentrations in stomach content of vendace, concentrations of siloxanes are greatly reduced when lipid normalized.

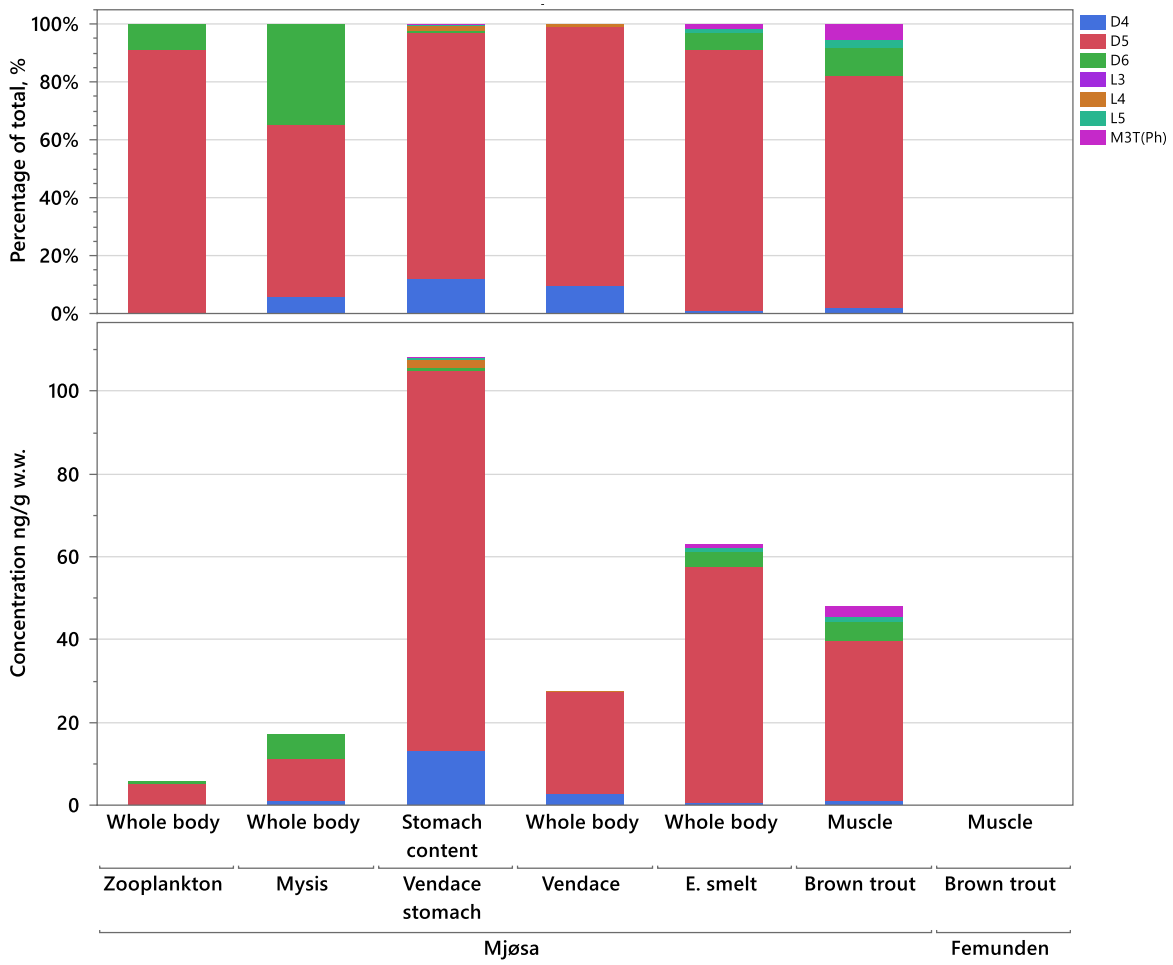


Figure 15 (Top) Siloxane compounds as percentage contribution to the sum of Siloxanes. (Bottom) Concentrations, sum of means (ng/g ww in biota) of individual siloxanes for all matrices. Non detects are assigned a value of zero.

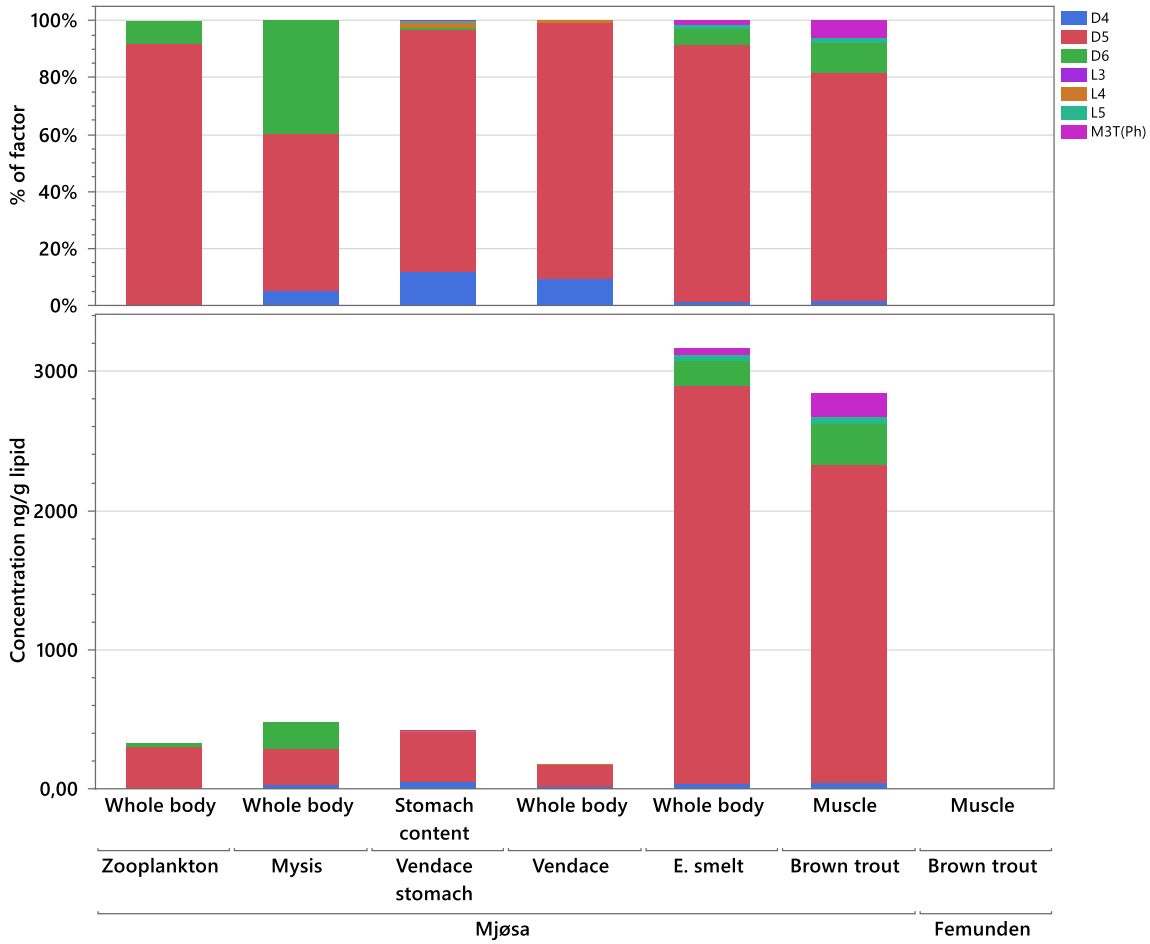


Figure 16 (Top) Siloxane compounds as percentage contribution to the sum of Siloxanes. (Bottom) Concentrations, sum of means (ng/g lipid in biota) of individual siloxanes for all matrices. Non detects are assigned a value of zero.

2.9 Phenols

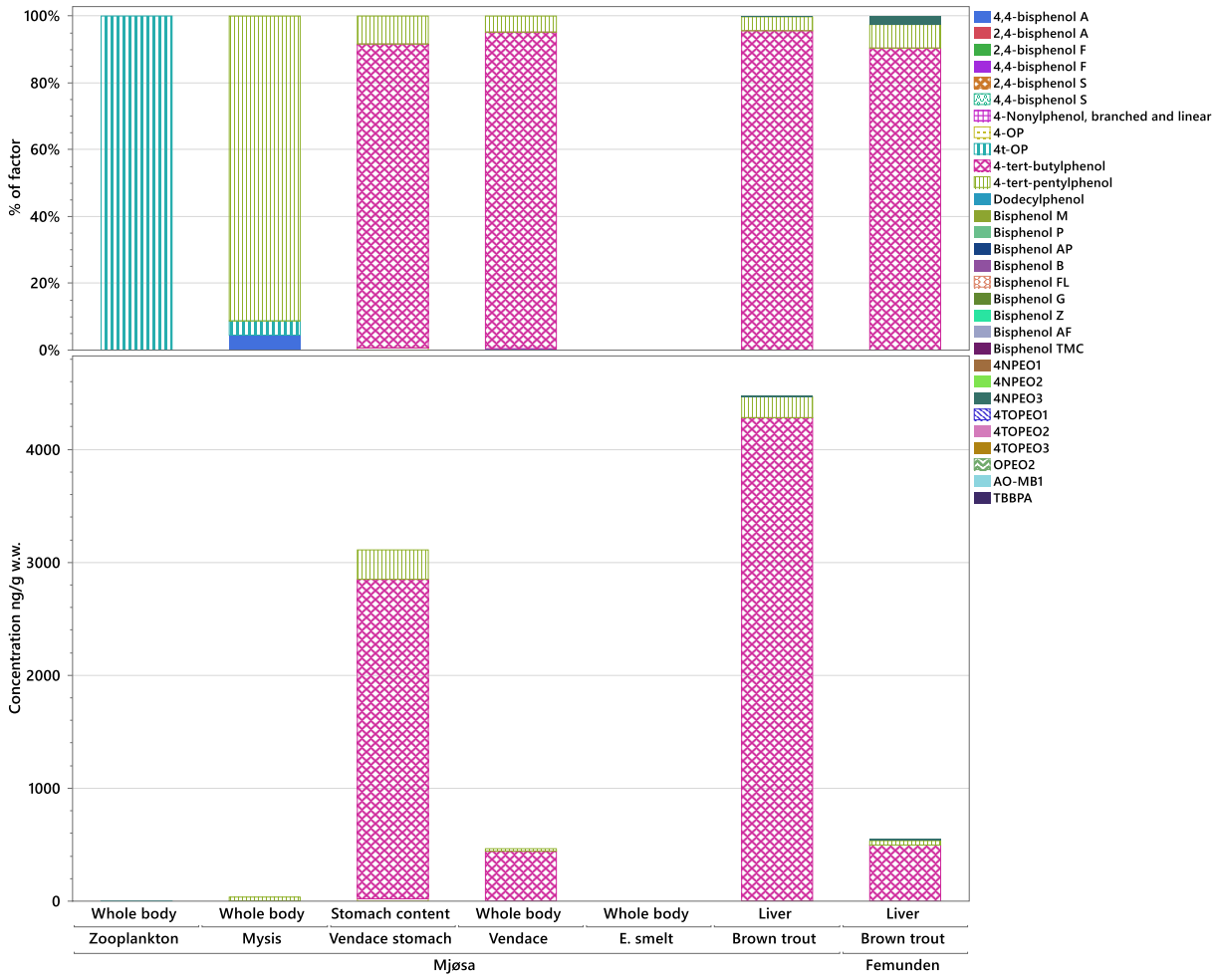


Figure 17 (Top) Phenolic compounds as percentage contribution to the sum of phenols. (Bottom) Concentrations, sum of means (ng/g w.w. in biota) of individual phenols for all matrices. Non detects are assigned a value of zero.

The LOQ and levels of 4-tertbutylphenol are high and the compound is detected in variable levels in several blank samples from the lab. The results should therefore be assessed with caution.

2.10 Benzothiazoles

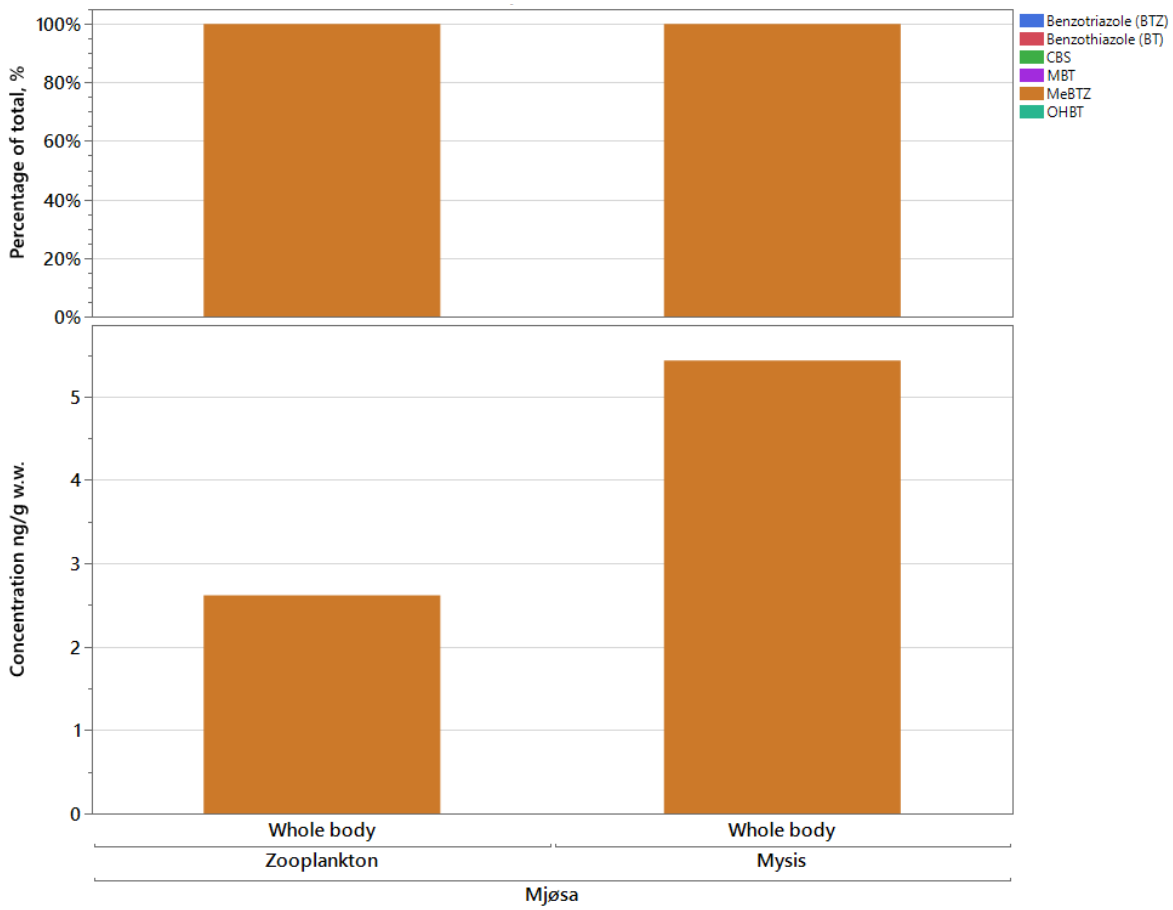


Figure 18 (Top) Benzothiazole compounds as percentage contribution to the sum of benzothiazoles. (Bottom) Mean concentrations (ng/g w.w. in biota) of individual benzothiazoles for all matrices. Non detects are assigned a value of zero.

2.11 Phthalates

One of the phthalates DEHP, are found in high concentrations, compared to the others, in the lower food chain organisms investigated (zooplankton and mysis). DEHP is known to adsorb to organic matter, and to bioaccumulate in aquatic organisms at lower trophic levels, such as gammarids. Due to more effective metabolism, DEHP does not biomagnify in fish, (JRC, 2008).

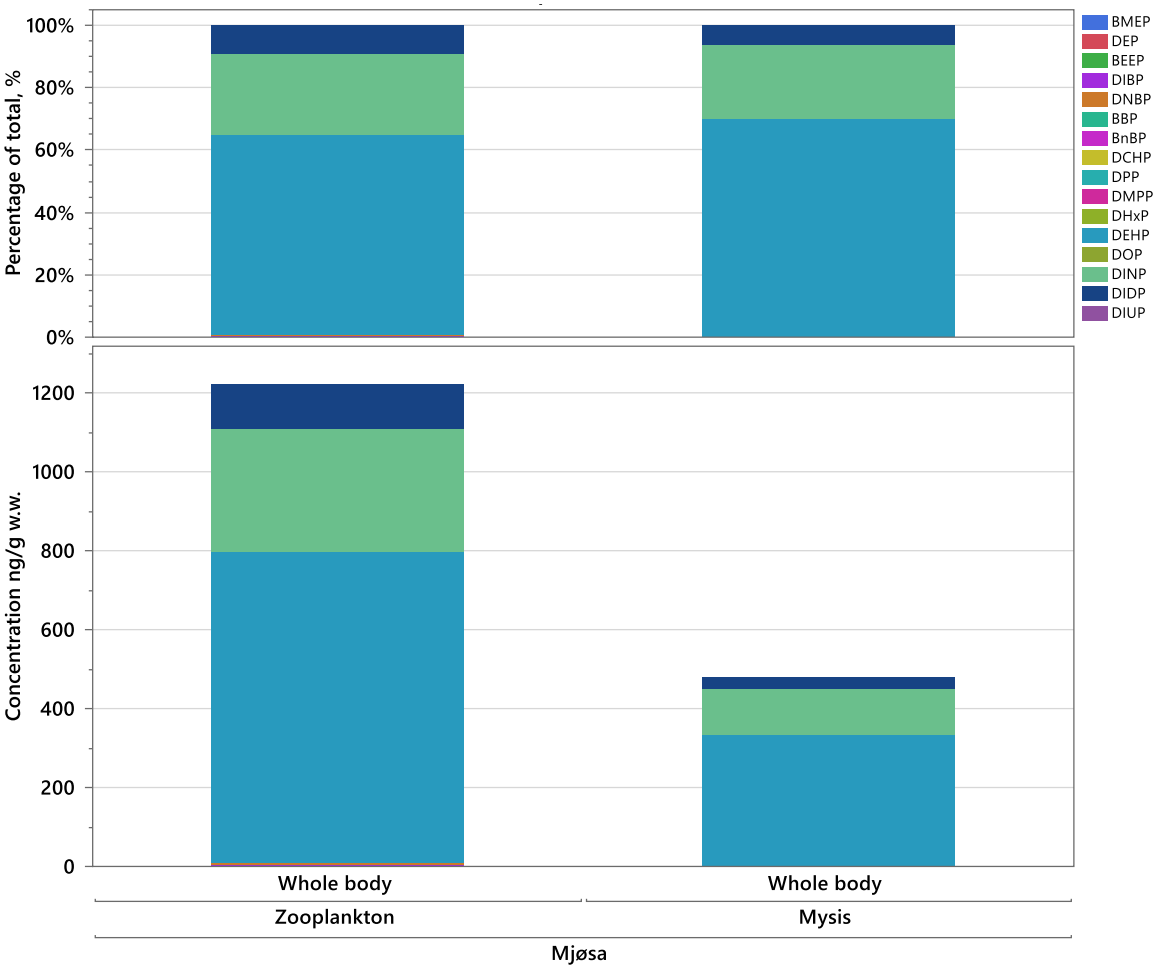


Figure 19 (Top) Phtalate compounds as percentage contribution to the sum of phtalates. (Bottom) Concentrations, sum of means (ng/g w.w. in biota) of individual phtalates for all matrices. Non detects are assigned a value of zero.

2.12 oPFR

oPFRs were only determined in zooplankton and Mysis of the lower trophic levels. The dominating compounds in zooplankton were tris(1-chloropropyl)phosphate (TCPP) and dibutylphenylphosphate (DBPhP), with mean concentrations of 2.0 and 2.2 ng/g w.w., respectively. Both of these compounds were detected, but found in lower concentrations in Mysis, as triisobutyl phosphate (TiBP) dominated in Mysis. TiBP was however detected in 1 out of 3 parallel samples, with a high single detection of 11 ng/g w.w (<LOQ of 1 for the other two parallels).

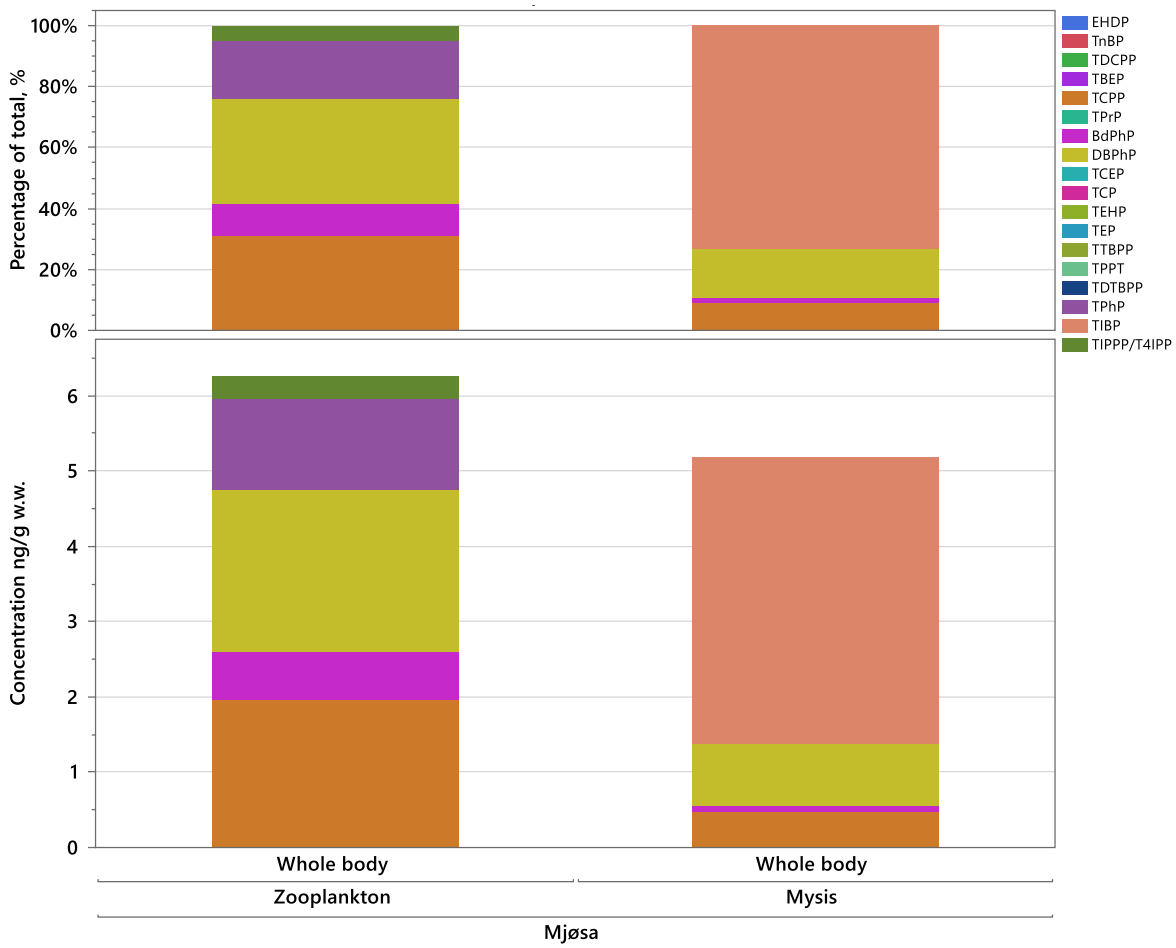


Figure 20 (Top) oPFR compounds as percentage contribution to the sum of oPFRs. (Bottom) Concentrations (ng/g w.w. in biota) of individual oPFRs for all matrices. Non detects are assigned a value of zero.

2.13 Musk

One of the musk compounds that dominated in the results, were galaxolide (Figure 21). Synthetic musk's such as galaxolide are lipophilic (log Kow = 5.90), we have therefore added a lipid-normalized bar chart (Figure 22).

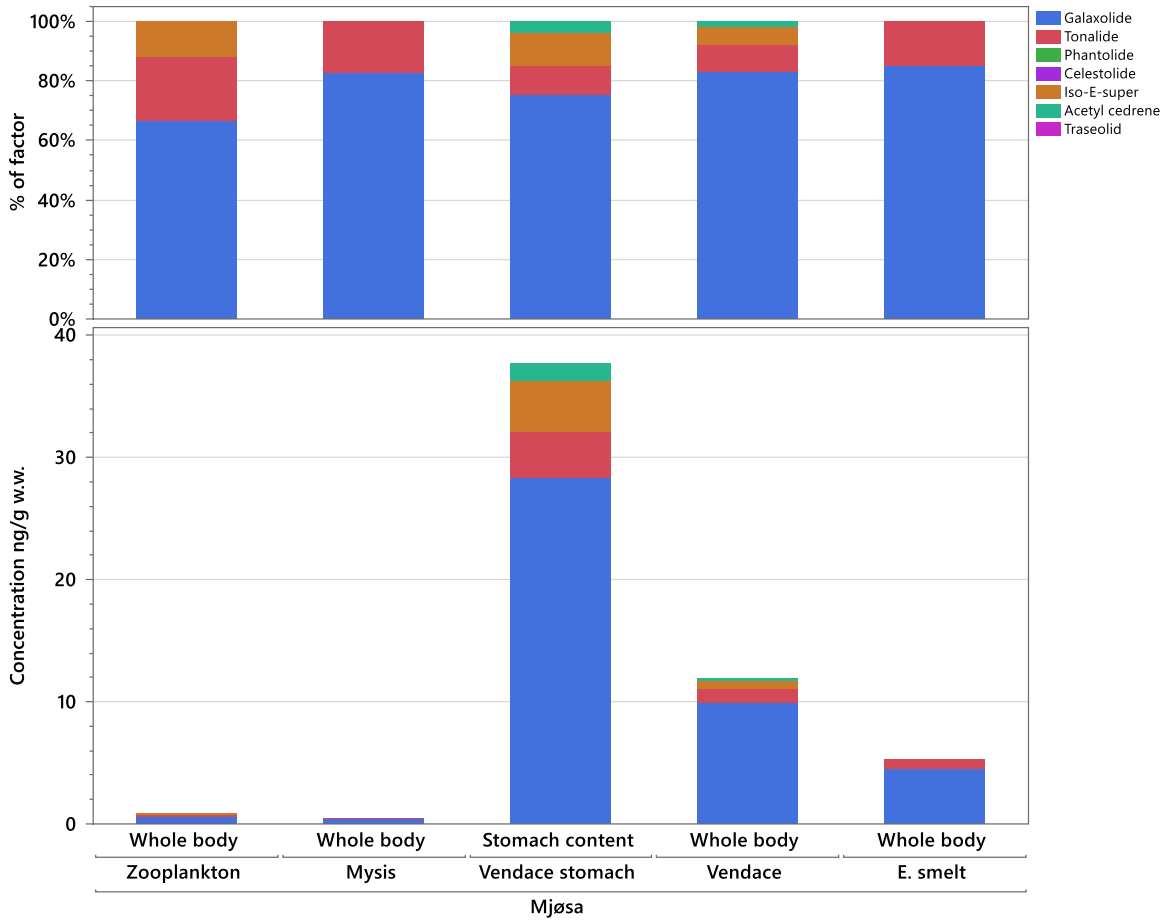


Figure 21 (Top) Musk compounds as percentage contribution to the sum of musks. (Bottom) Concentrations, sum of means (ng/g w.w. in biota) of individual musks for all matrices. Non detects are assigned a value of zero.

Galaxolide are used in personal care products such as perfumes, moisturizers, and soap (https://pubchem.ncbi.nlm.nih.gov/compound/Galaxolide). It readily enters waterways, together with a range of other compounds, through waste-water treatment plant (WWTP) discharges, combined sewer overflows, leaking septic and municipal sewer systems, urban and agricultural run-off, industrial discharges, and atmospheric deposition, among others (Barber et al., 2015; Kolpin et al., 2002, In: Baldwin et al., 2016). Acute and chronic toxicity effects have been reported for polycyclic musk's, such as galaxolide. Wollenberger et al. (2003), reported inhibitions of larval development in the calanoid copepod *Acartia tonsa,* at 0.059 mg/l over a 5-day exposure period, and 48-h-LC50-values for adults at 0.47 mg/l. Parolini et al., 2015, reported oxidative and genetic damage in zebra mussel in a 21-days exposure experiment, at concentrations frequently measured in aquatic ecosystems.

Galaxolide was not detected (LOQ ranging from 0.068-0.64 ng/g w.w.) in our sampled biota (composite samples of chironomids, roach, ruffe, and perch liver) in 2021 from the sampled benthic area of Lake Mjøsa (Jartun et al., 2022). In the samples from 2022, collected in the same area, galaxolide was detected (LOQ

ranging from 0.068-0.64 ng/g w.w.) in composite samples of ruffe, ruffe stomach content and in pike liver (Jartun et al. 2023). Galaxolide were found in much higher concentrations in the pelagic species such E. smelt and vendace (mean 4,48 and 9,94 ng/g, respectively) in this study, compared to what was measured in the benthic organisms such as ruffe (mean 0,067 ng/g) in 2022 (Jartun et al. 2023). Especially high were the concentrations in stomach content of vendace.

Median concentrations of galaxolide (HHCB) were reported to vary from <1.2 to 28.9 ng/g dry weight (d.w.) in 14 fish species and one shrimp species in Lake Chaohu in China (Lyu et al., 2021), measured in muscle of larger fish and in whole body samples (composite samples) of smaller fish and shrimp. If we apply a conversion ratio of 4.5 from wet to dry weight, the median concentrations of galaxolide in pelagic biota from Lake Mjøsa in 2023 range from 2.8 in zooplankton to 128.7 ng/g (d.w.) in stomach content of vendace. As discussed previously, the stomach content of vendace had much higher lipid content than all the other biotic matrices, it is therefore more realistic to compare the concentrations measured in the composite samples of the two fish species vendace (median 44.3 ng/g d.w.) and E. smelt (20.6 ng/g d.w.) from Lake Mjøsa to the results from Lake Chaohu. As the results indicate, concentrations measured in vendace and E. smelt is above and in the upper range of concentrations measured in the fish from Lake Chaohu. However, some caution should be made in this assessment, as Lyu et al (2021), reported that concentrations were higher in liver than in muscle, with an accumulation ratio in liver relative to muscle tissue of 0,87. Nevertheless, the livers make up a small proportion of the composite samples from Lake Mjøsa.

Another study that measured galaxolide in water, sediment, and fish (white perch, catfish, smallmouth bass, and largemouth bass), from the upper reaches of the Hudson River, USA (Reiner and Kannan, 2010), measured lower concentrations (range <1–125 ng/g, lipid) than that found in vendace (46 - 78 ng/g, lipid) and E. smelt (135 – 296 ng/g, lipid) from Lake Mjøsa. The results from the Hudson River study (Reiner et al., 2010), is based om data collected more than 14 years ago, which suggests that present concentrations in biota in that river system may be higher, given that the production and use of galaxolide have been steadily increasing (USEPA 2018).

It appears, from these results that our measured galaxolide concentrations are relatively high, and comparable and above those reported in other studies. Additionally, our results show an increase up the food chain, indicating a potential for biomagnification, which is further discussed in chapter 2.15.

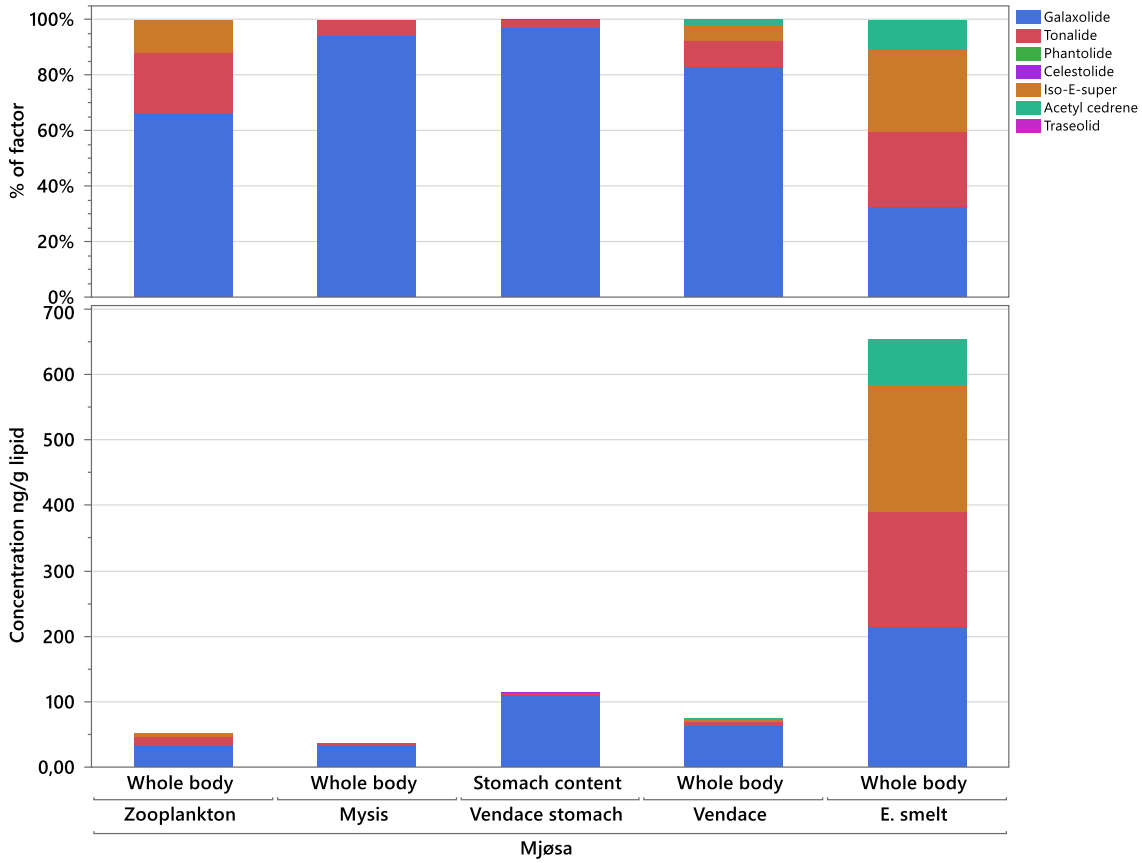


Figure 22 (Top) Musk compounds as percentage contribution to the sum of musks. (Bottom) Concentrations (ng/g lipid. in biota) of individual musks for all matrices. Non detects are assigned a value of zero.

2.14 Metals

Rare earth element (REE) concentrations in sediments from Lake Mjøsa were studied in 2021, indicating lower concentrations in Lake Mjøsa sediments compared to post-Archean Australian shale (PAAS) concentrations (Taylor and McLennan, 1985).

In the present study from 2023, REE concentrations in zooplankton were normalized to the European shale data set (Bau et al., 2018), see Figure 23. Results indicate a minor anomaly for Nd (LREE) and an indication of LREE enrichment from La to Nd.

We have calculated the biomagnification factor (BMF) between *Mysis* and zooplankton, see Table 2. The calculation was performed on a lipid weight basis (C_{Mys}/C_{zoo}), indicating no biomagnification of the studied metals, except for selenium (Se). No biomagnification potential was observed for REEs.

Table 2 BMF between zooplankton and Mysis relicta, on a lipid weight basis (data from 2023) in Lake Mjøsa.

	Sc	Se	Sn	La	Ce	Pr	Nd	Sm	Eu
BMF	0.628	1.185	0.370	0.704	0.593	0.626	0.614	0.624	0.746

	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
BMF	0.615	0.595	0.598	0.623	0.609	0.573	0.619	0.590

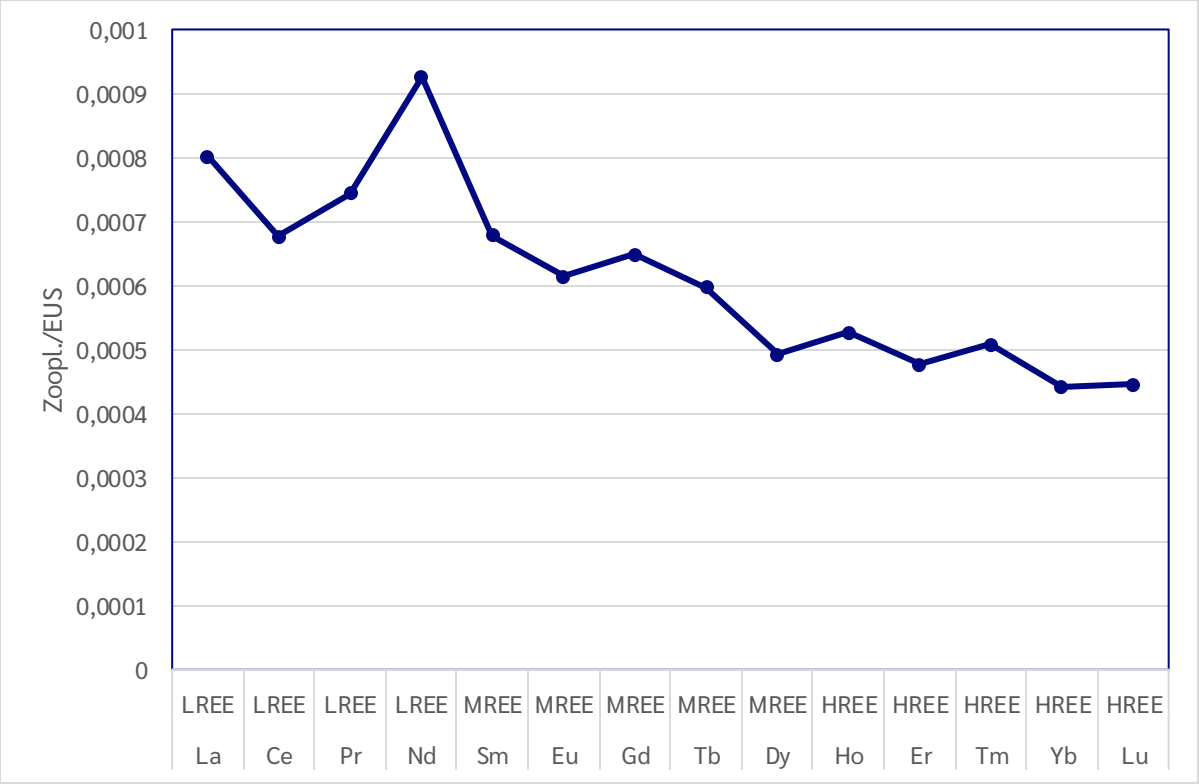


Figure 23 REE patterns of zooplankton concentrations from Lake Mjøsa normalized to European shale (EUS) (Bau et al., 2018).

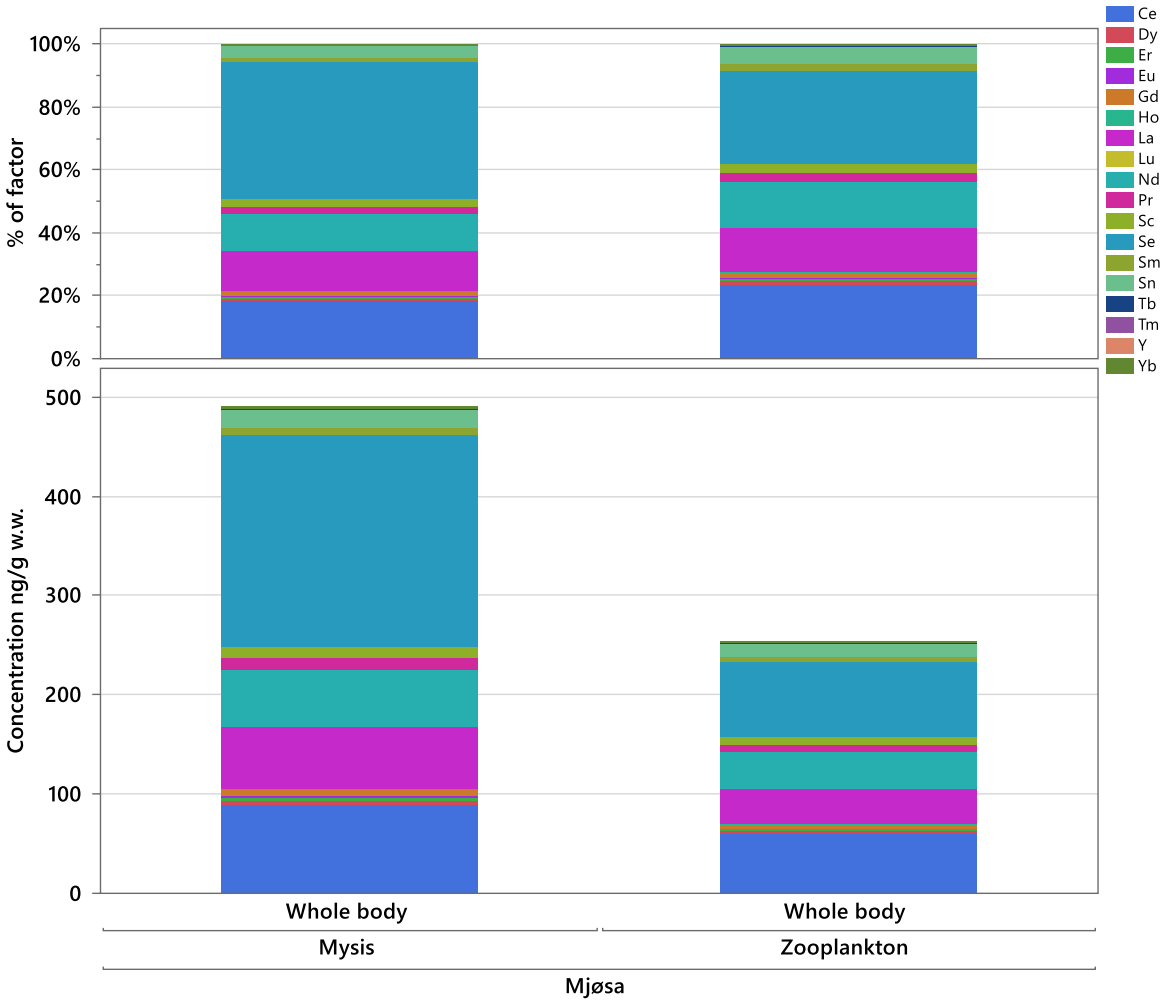


Figure 24 (Top) Rare earth metals as percentage contribution to the sum of metals. (Bottom) Concentrations (ng/g w.w. in biota) of metals for all matrices. Non detects are assigned a value of zero.

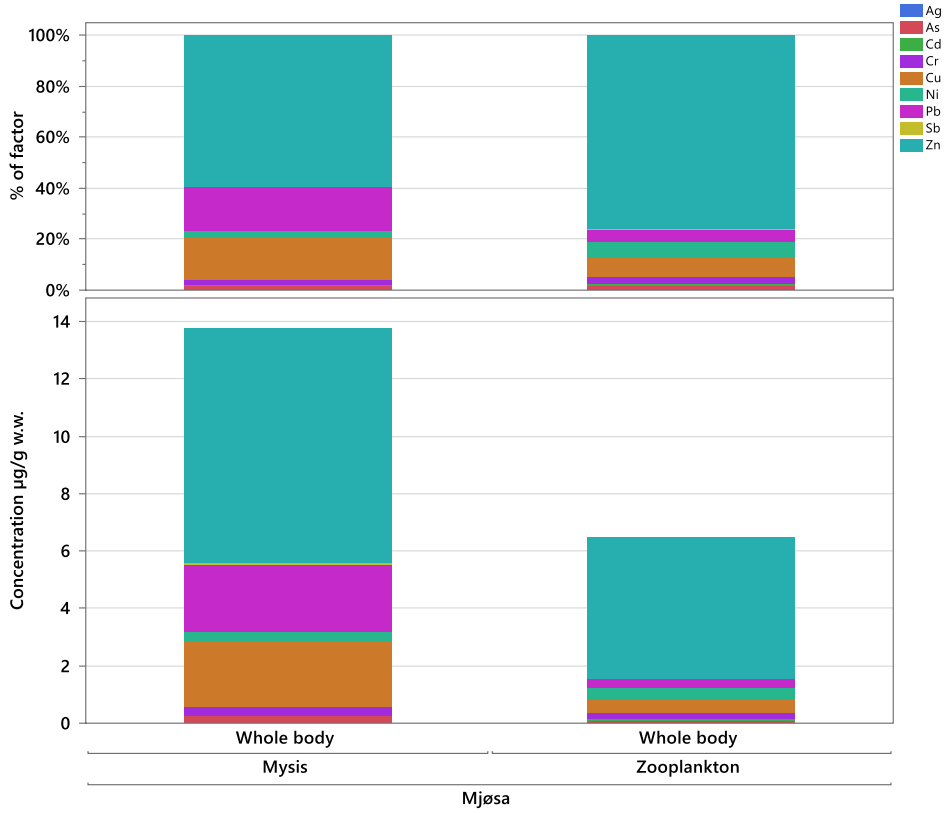


*Figure 25 (Top) Metals as percentage contribution to the sum of metals. (Bottom) Concentrations (ng/g w.w. in biota) of metals for all matrices. Non detects are assigned a value of zero. Note that Fe is **not** included.*

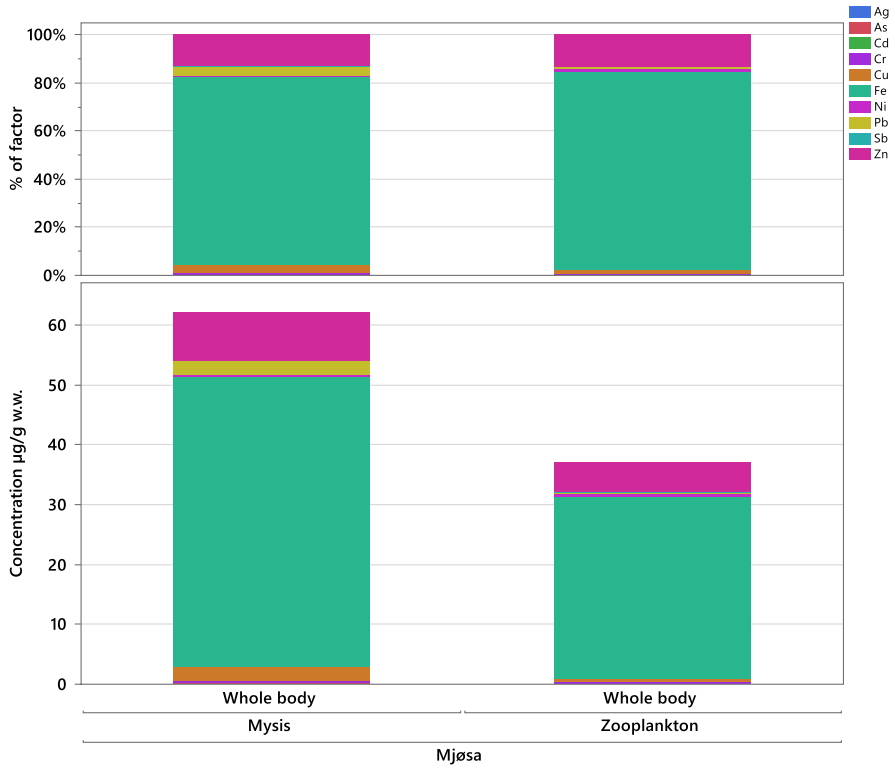


Figure 25 (Top) Metals as percentage contribution to the sum of metals. (Bottom) Concentrations (ng/g w.w. in biota) of metals for all matrices. Non detects are assigned a value of zero. Note that Fe is included.

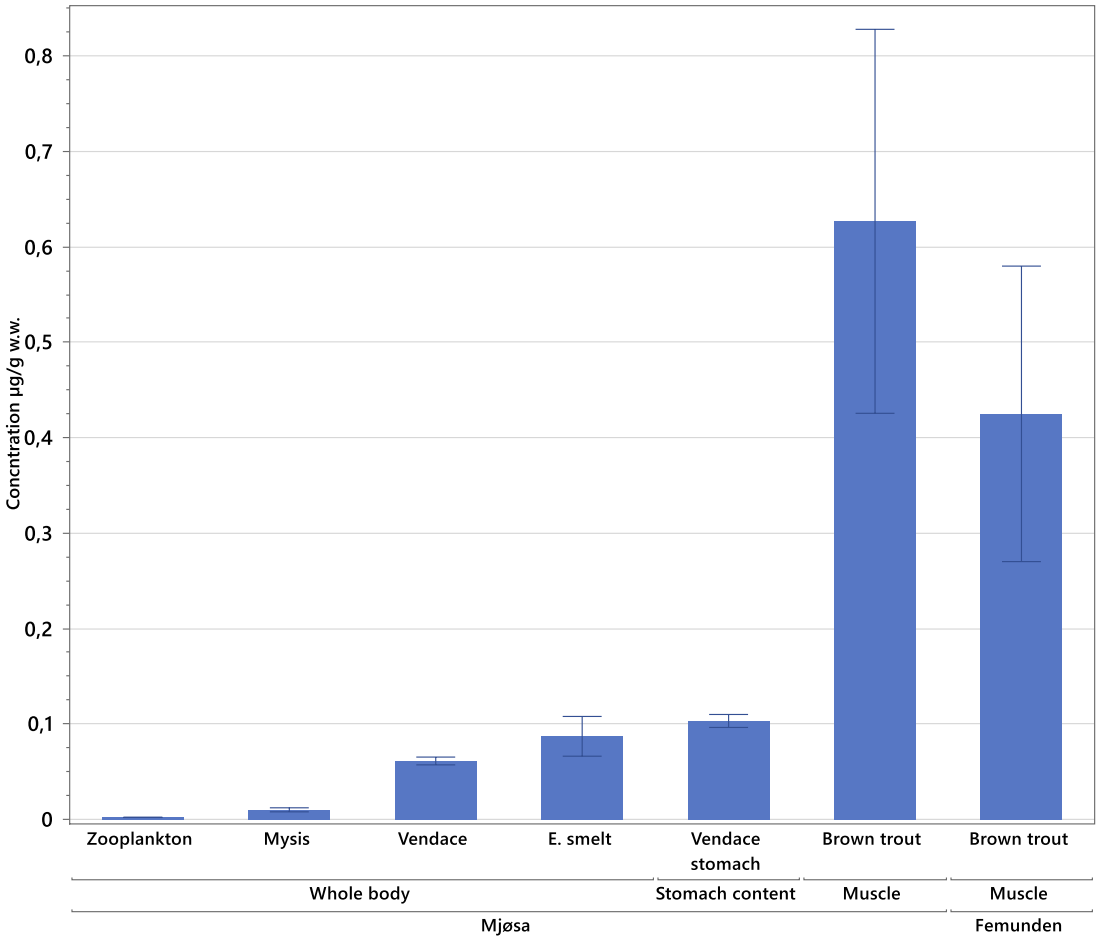


Figure 26 Mean concentrations ± SD of Hg µg/g w.w., in whole body samples (zooplankton, mysis, vendace stomach content, vendace and E. smelt), and in muscle tissue for brown trout.

2.15 Biomagnification – contaminant flow through the pelagic food chain

Table 3 Trophic magnification factors (TMF) for all contaminants with detections >LOQ through the food chain. Slope of the regression between ln-normalized concentrations (wet weight or lipid weight) and $\delta^{15}N$, and R^2 for the equation is given. A positive slope indicates biomagnification potential, i.e. a TMF>1. Concentrations <LOQ has been removed from the models. Some models with TMF>1, marked in bold in the table, are exemplified in regression models below (chapter 2.15.1).

Group	Years	Identifier	Slope	R^2	TMF	Normalization
BDE+brominated	2013-2020 +2023	BDE17	0.04841	0.005	1.18	Lipid
		BDE28	0.3963	0.435	3.85	Lipid
		BDE47	**0.5308**	**0.593**	**6.08**	**Lipid**
		BDE49	0.5033	0.561	5.54	Lipid
		BDE66	0.4879	0.367	5.25	Lipid
		BDE77	0.2712	0.093	2.51	Lipid
		BDE85	0.3117	0.089	2.89	Lipid
		BDE99	**0.3660**	**0.281**	**3.47**	**Lipid**
		BDE100	0.6408	0.633	8.83	Lipid
		BDE119	0.5384	0.342	6.24	Lipid
		BDE126	0.3356	0.118	3.13	Lipid
		BDE153	0.6466	0.537	9.01	Lipid
		BDE154	0.6425	0.6425	8.89	Lipid
		BDE183	0.1805	0.09	1.85	Lipid
		BDE184	0.4008	0.183	3.91	Lipid
		BDE197	-0.1107	0.018	0.69	Lipid
		BDE202	0.6416	0.007	8.86	Lipid
		BDE206	0.01308	0.001	1.05	Lipid
		BDE207	-0.07813	0.017	0.77	Lipid
		BDE209	-0.1658	0.078	0.57	Lipid
		BTBPE	-0.2658	0.151	0.41	Lipid
		DBDPE	-0.1028	0.022	0.71	Lipid
		HBB	-0.3107	0.219	0.35	Lipid
		PBBZ	-0.3818	0.265	0.27	Lipid
		TBA	0.0646	0.015	1.25	Lipid
Chlorinated	2014-2020 +2023	HCB	0.1673	0.437	1.77	Lipid
CP		MCCP	-0.2028	0.14	0.5	Lipid
		SCCP	-0.1864	0.337	0.53	Lipid
Metals	2013-2020 +2023	**Hg**	**0.568**	**0.762**	**6.89**	**w.w.**
oPFR	2013-2020 +2023	TCPP	-0.1655	0.205	0.57	Lipid
		TnBP	-0.1791	0.487	0.54	Lipid
		TPP	-0.3541	0.312	0.3	Lipid
PFAS	2014-2020 +2023	PFNA	0.02859	0.004	1.1	w.w.
		PFDA	0.358	0.312	3.38	w.w.
		PFUnDA	**0.4883**	**0.523**	**5.27**	**w.w.**
		PFDoDA	0.4993	0.421	5.46	w.w.

Group	Years	Identifier	Slope	R^2	TMF	Normalization
	2014-2020 +2023	**PFTrDA**	**0.4878**	**0.490**	**5.25**	**w.w.**
		PFTeDA	0.1553	0.034	1.7	w.w.
		PFOS	**0.4747**	**0.503**	**5.02**	**w.w.**
		PFBSA	0.7138	0.181	11.32	w.w.
		PFOSA	0.4247	0.271	4.24	w.w.
Siloxanes	2013-2020 +2023	D4	-0.008898	0.00001	0.97	Lipid
		D5	**0.2333**	**0.224**	**2.21**	**Lipid**
		D6	0.1705	0.124	1.79	Lipid
UV-compounds	2017-2020+2023	OC	-0.1874	0.137	0.53	Lipid
		UV-327	-0.05977	0.012	0.82	Lipid
		UV-328	0.1096	0.042	1.45	Lipid
Musk	2023 (pelagic data)	**Galaxolide**	**0.5557**	**0.355**	**6.64**	**Lipid**
Musk	2022 (benthic data)	**Galaxolide**	**0.2769**	**0.664**	**2.56**	**Lipid**

2.15.1. Contaminants with TMF>1

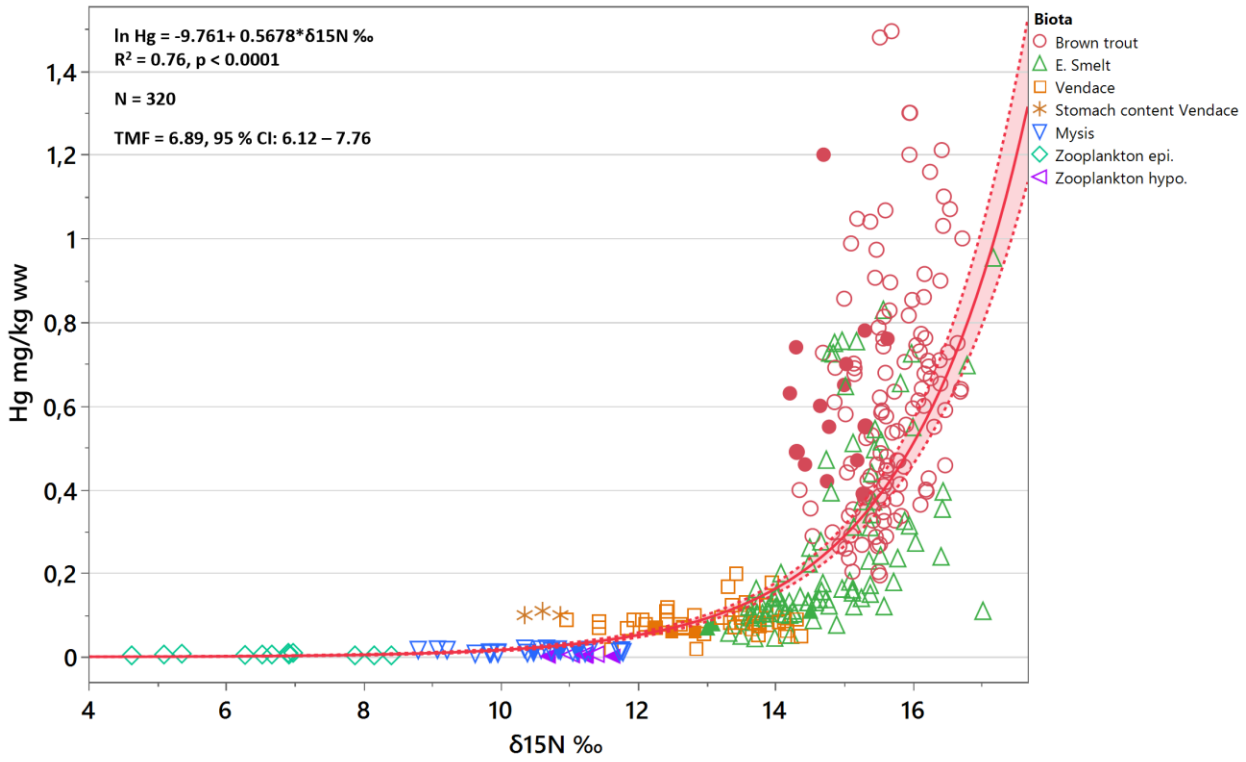


Figure 27 Trophic magnification of Hg in the pelagic food chain from Lake Mjøsa (2013-2020 + 2023). Symbols marked in bold represents data from 2023.

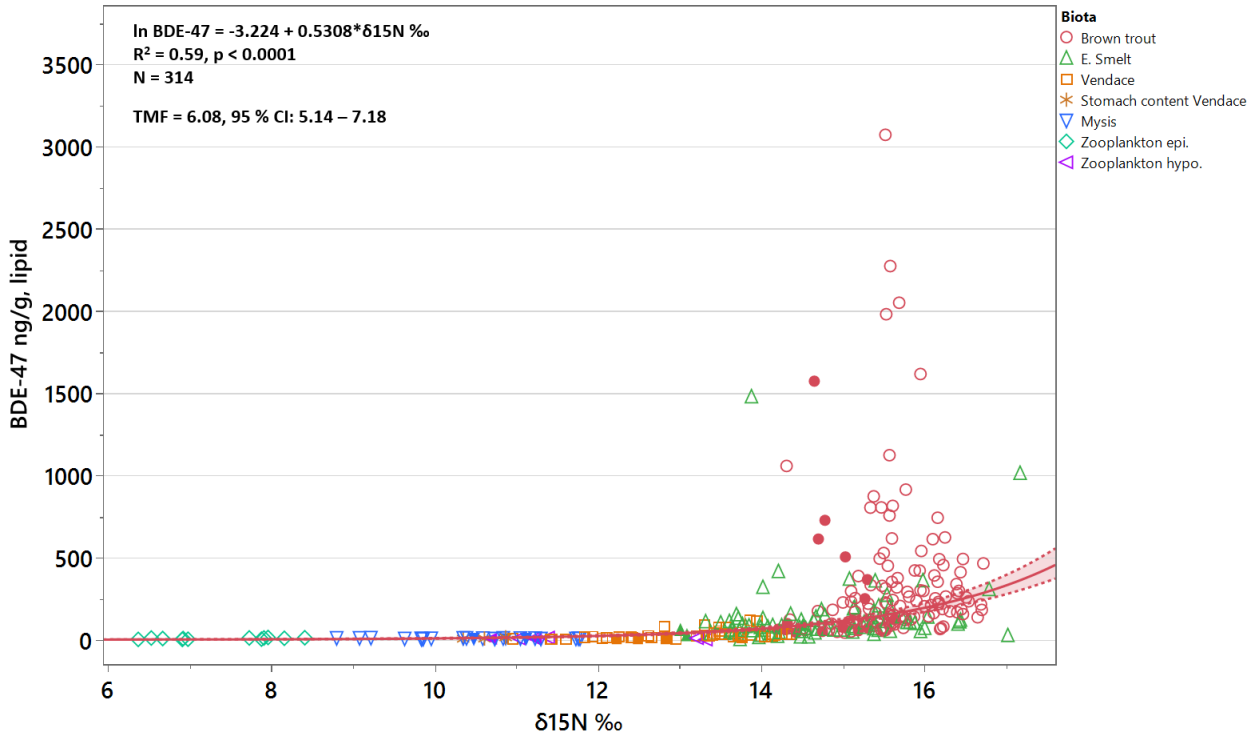


Figure 28 Trophic magnification of BDE-47 in the pelagic food chain from Lake Mjøsa (2013-2020 + 2023). Symbols marked in bold represents data from 2023.

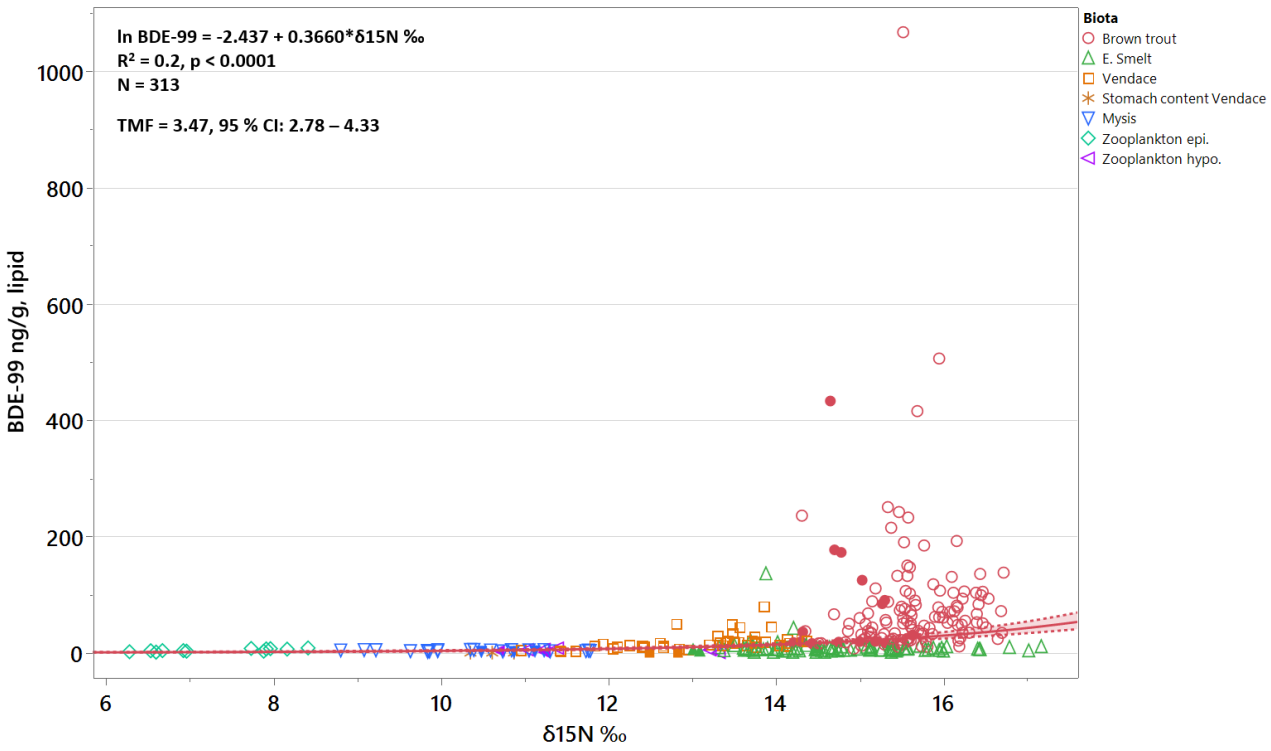


Figure 29 Trophic magnification of BDE-99 in the pelagic food chain from Lake Mjøsa (2013-2020 + 2023). Symbols marked in bold represents data from 2023.

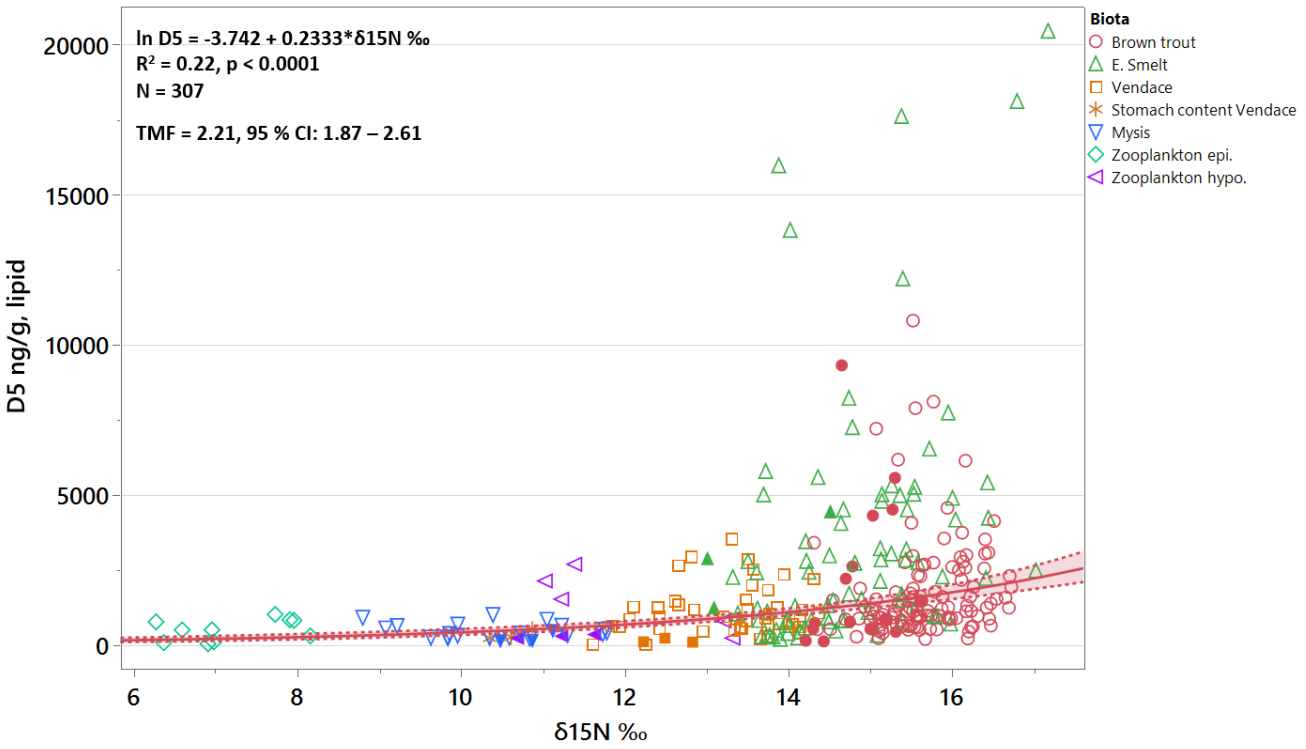


Figure 30 Trophic magnification of D5 in the pelagic food chain from Lake Mjøsa (2013-2020 + 2023). Symbols marked in bold represents data from 2023.

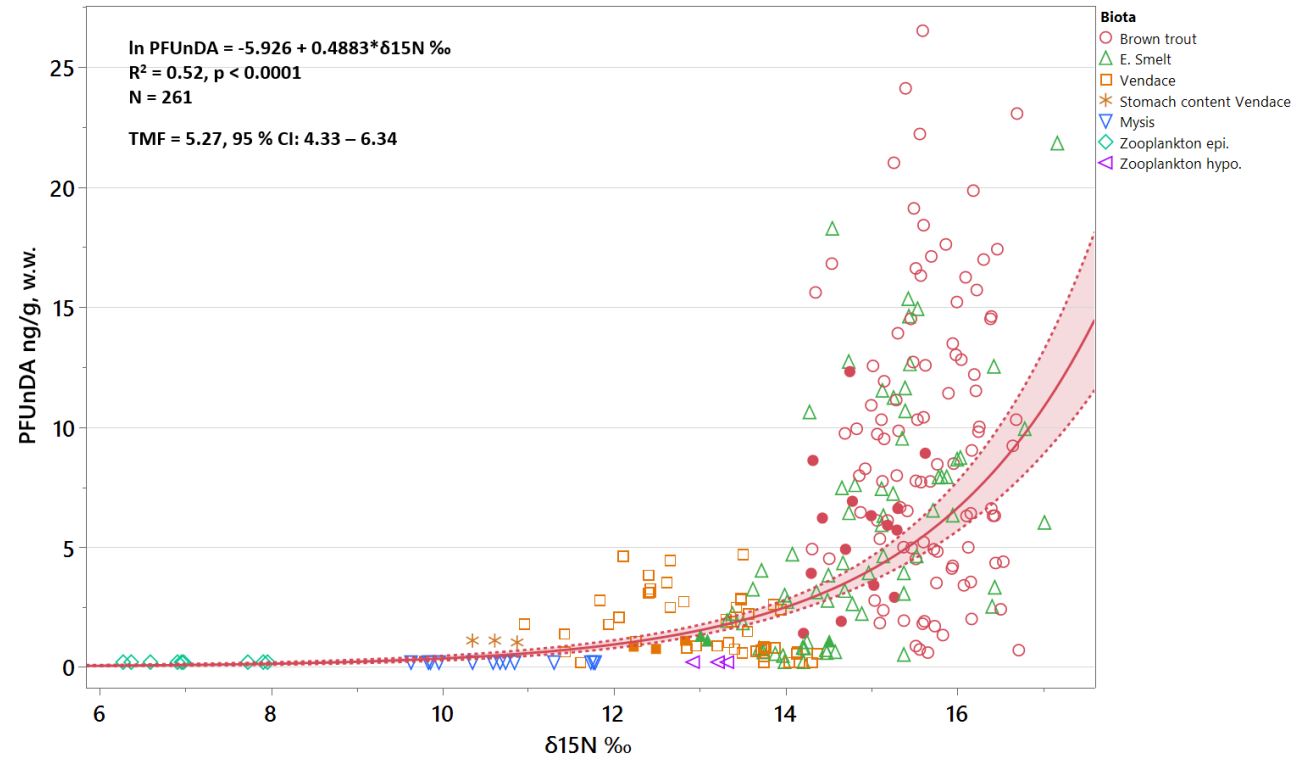


Figure 31 Trophic magnification of PFUnDA in the pelagic food chain from Lake Mjøsa (2014-2020 + 2023). Symbols marked in bold represents data from 2023.

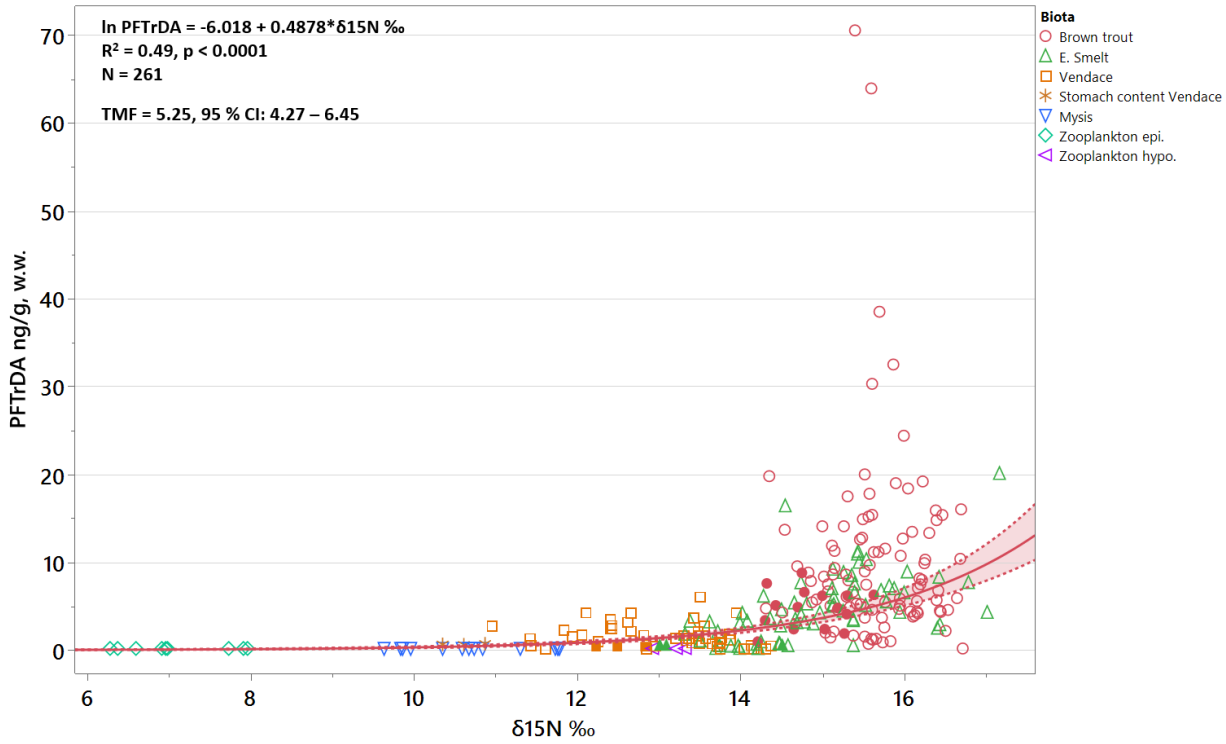


Figure 32 Trophic magnification of PFTrDA in the pelagic food chain from Lake Mjøsa (2014-2020 + 2023). Symbols marked in bold represents data from 2023.

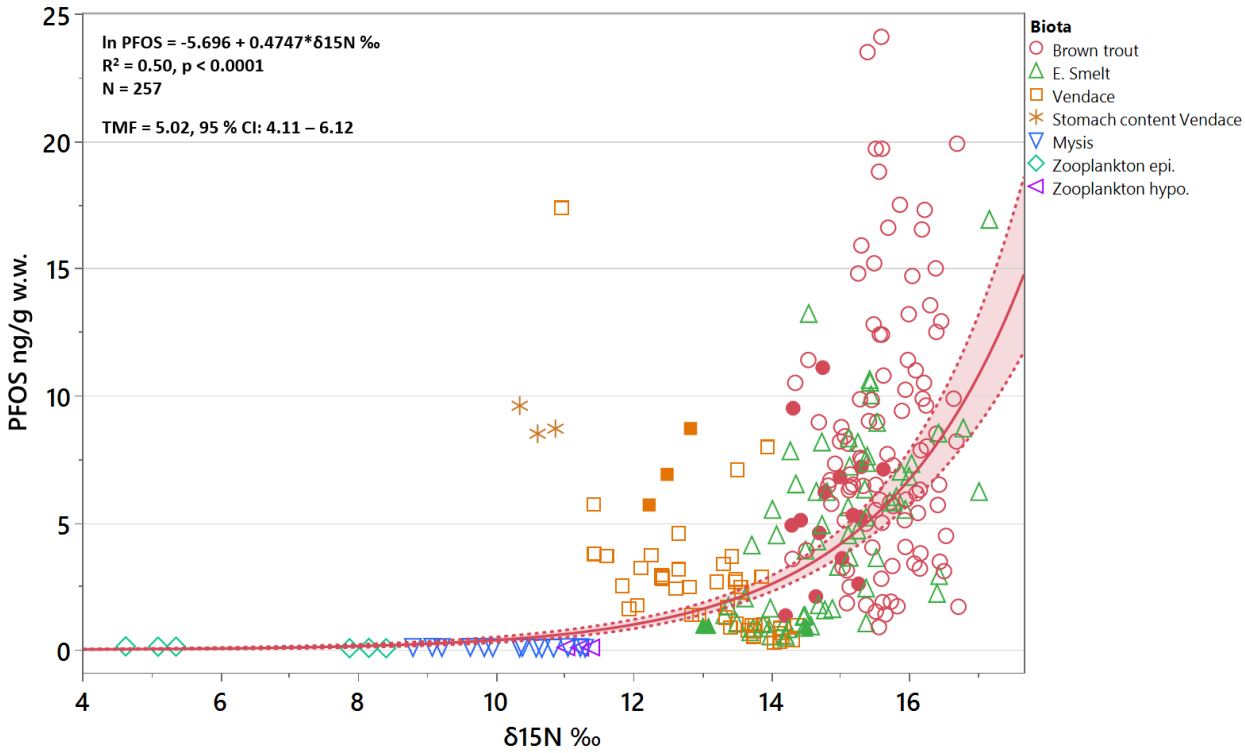


Figure 33 Trophic magnification of PFOS in the pelagic food chain from Lake Mjøsa (2014-2020 + 2023). Symbols marked in bold represents data from 2023.

As discussed in chapter 2.3, and under figure 2.13, the musk-compound, galaxolide were in higher concentrations compared to the other musk's. The results show that galaxolide increase up the food chain (Figure 33), indicating an obvious biomagnification potential (TMF~6.49). However, the result should be interpreted with caution, since the dataset consists of only a few samples covering approximately one trophic level (~1,2 TL), and below the recommended ~3 trophic levels for proper TMF calculation (Borgå et al., 2011).

For comparison we have added a model based on data from the benthic food chain collected in 2022. As can be seen in the model there are very few datapoints, covering approximately 1.4 trophic levels. As with the estimate for the pelagic biota, the estimate of the TMF (2,56) for the benthic biota is therefore very uncertain as signified by the wide confidence band (95 % CI). However, this result supports the biomagnifying properties shown for galaxolide in the pelagic data.

The study of 14 fish species and one shrimp species in Lake Chaohu in China (Lyu et al., 2021), reported a weak trend of increasing concentrations of galaxolide up the food chain, however not statistically significant (thus they did not calculate a TMF). Results from other studies that have investigated the trophic transfer of galaxolide vary from no biomagnification in a marine food chain in Bohai Sea, China (Chen et al., 2024) and in freshwater biota from the Geum River, South Korea (Kim et al., 2022), to modest a modest trophic transfer such as in the study by Zhang et al.(2013), where the calculated TMF for 24 fish species from Lake Taihu, China was. 1,12.

Our results are therefore somewhat surprising, with the estimated high TMFs. The results, however, should be interpreted with caution due to the low number of datapoints and corresponding wide confidence intervals, as mentioned above. It would be of interest to add more data to both the pelagic and benthic biomagnification models, especially, on the top end of the food chains in order to strengthen the assertions of trophic transfer of galaxolide.

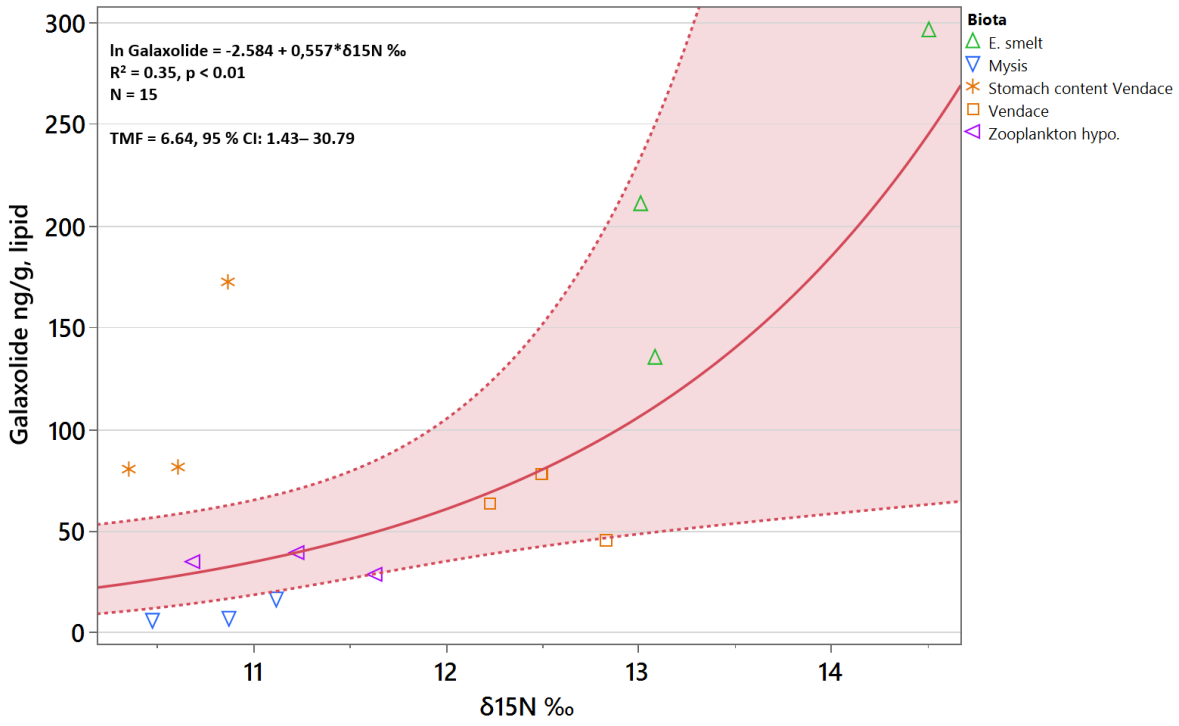


Figure 34 Trophic magnification of galaxolide in the pelagic food chain from Lake Mjøsa in 2023.

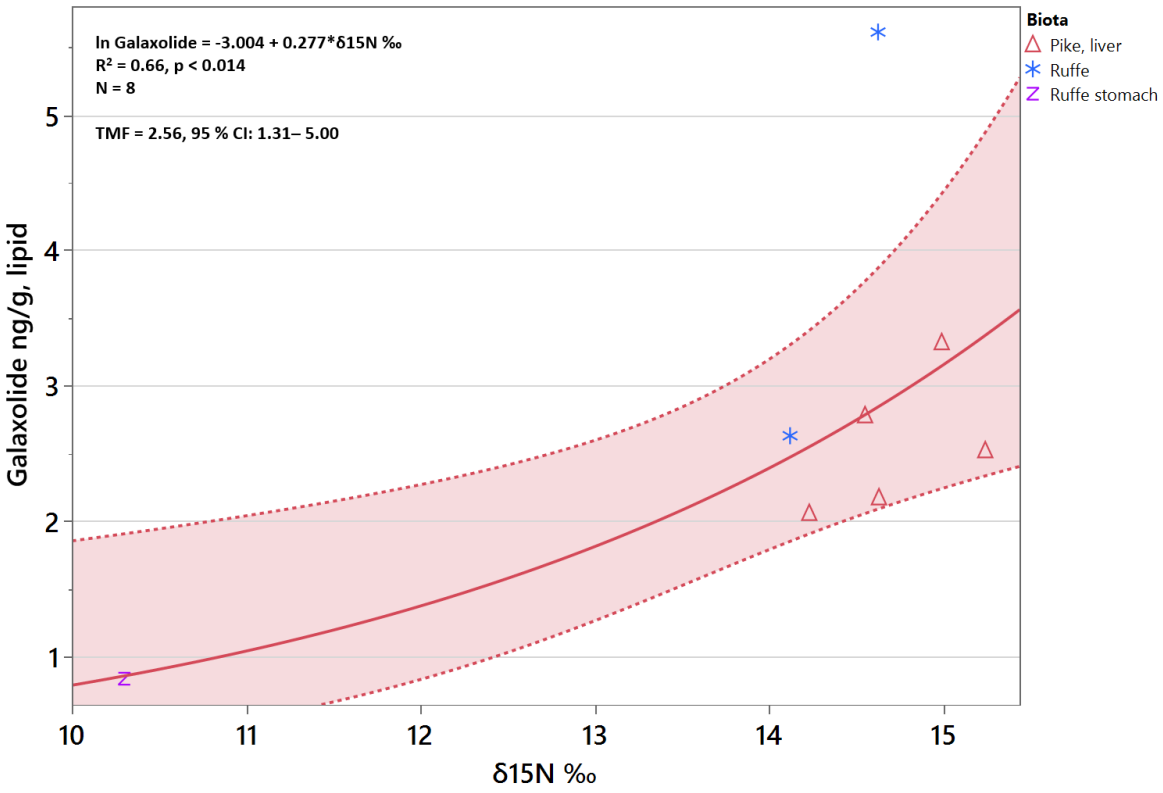


Figure 35 Trophic magnification of galaxolide in the benthic food chain from Lake Mjøsa in 2022.

2.16 Time trends for contaminants

Several of the contaminants included in this report have been studied in the pelagic food chain for years, constituting a valuable historical time trend for contaminant levels in the top predator brown trout. In this chapter we provide some examples of time trends for major contaminant groups in brown trout from Lakes Mjøsa and Femunden. For PBDEs (sum of BDE6: BDE-28, -47, -99, -100, -153 and -154) there is a significant decrease in muscle concentration in brown trout in Lake Mjøsa from the peak in the early 2000s to 2023, and the regression is strong. As for PFAS, and the sum of detected PFASs (PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTeDA, PFPeDA, PFOS and PFOSA), the decreasing trend in liver concentrations in brown trout in Lake Mjøsa is significant, but the regression is weak.

For the siloxane D5, there is a weak, but significant decrease in Lake Mjøsa brown trout (2010-2023, while the trend for Lake Femunden brown trout shows a minor increase 2012-2023), however not significant (P>0.05).

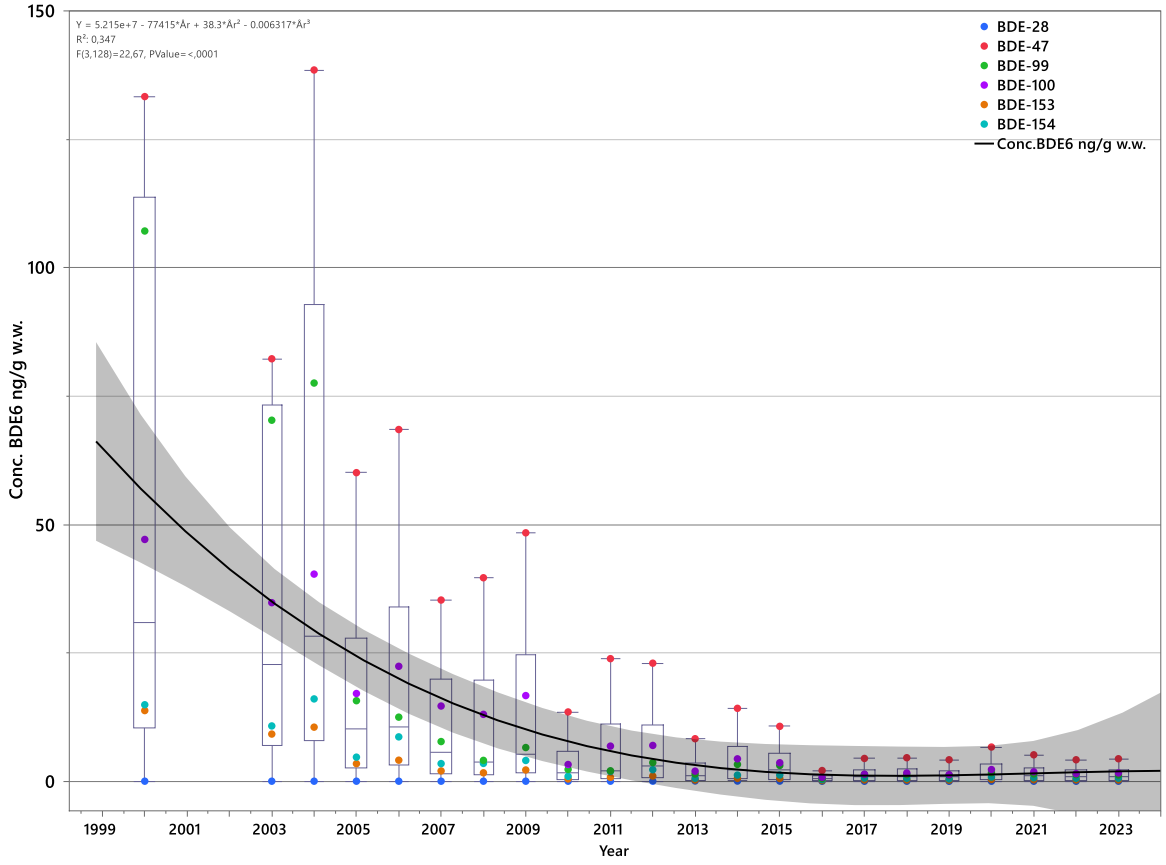


Figure 3613 BDE6 Brown trout, Lake Mjøsa 2000-2023.

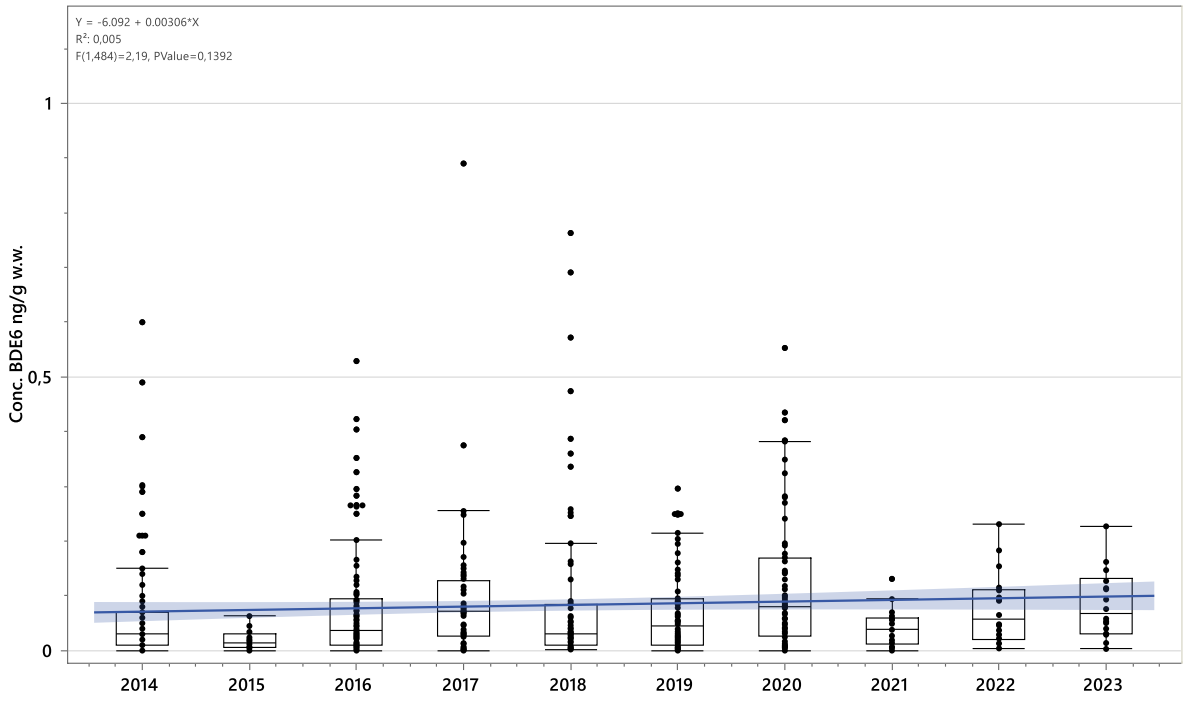


Figure 37 BDE6 Brown trout, Lake Femunden 2014-2023

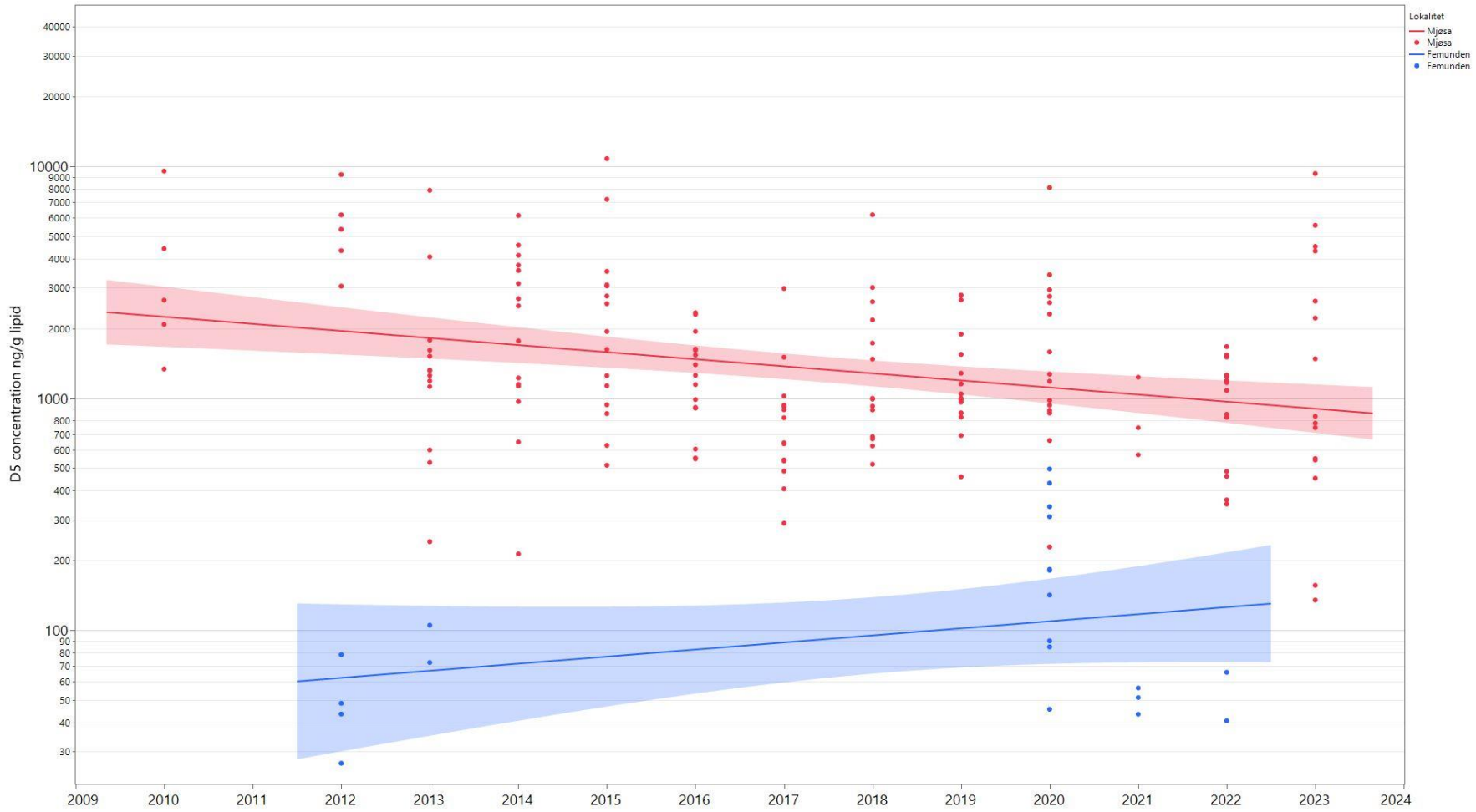


Figure 38 Time trend for siloxane D5 in Lake Mjøsa (top, 2010 -2023) and Lake Femunden (bottom, 2012-2023), in ng/g lipid. Note the logarithmic scale on the y-axis. For concentrations below LOQ, 0 is used. For Lake Femunden trout all samples were below LOQ in the years 2014, 2017, 2018, 2019, and 2023.

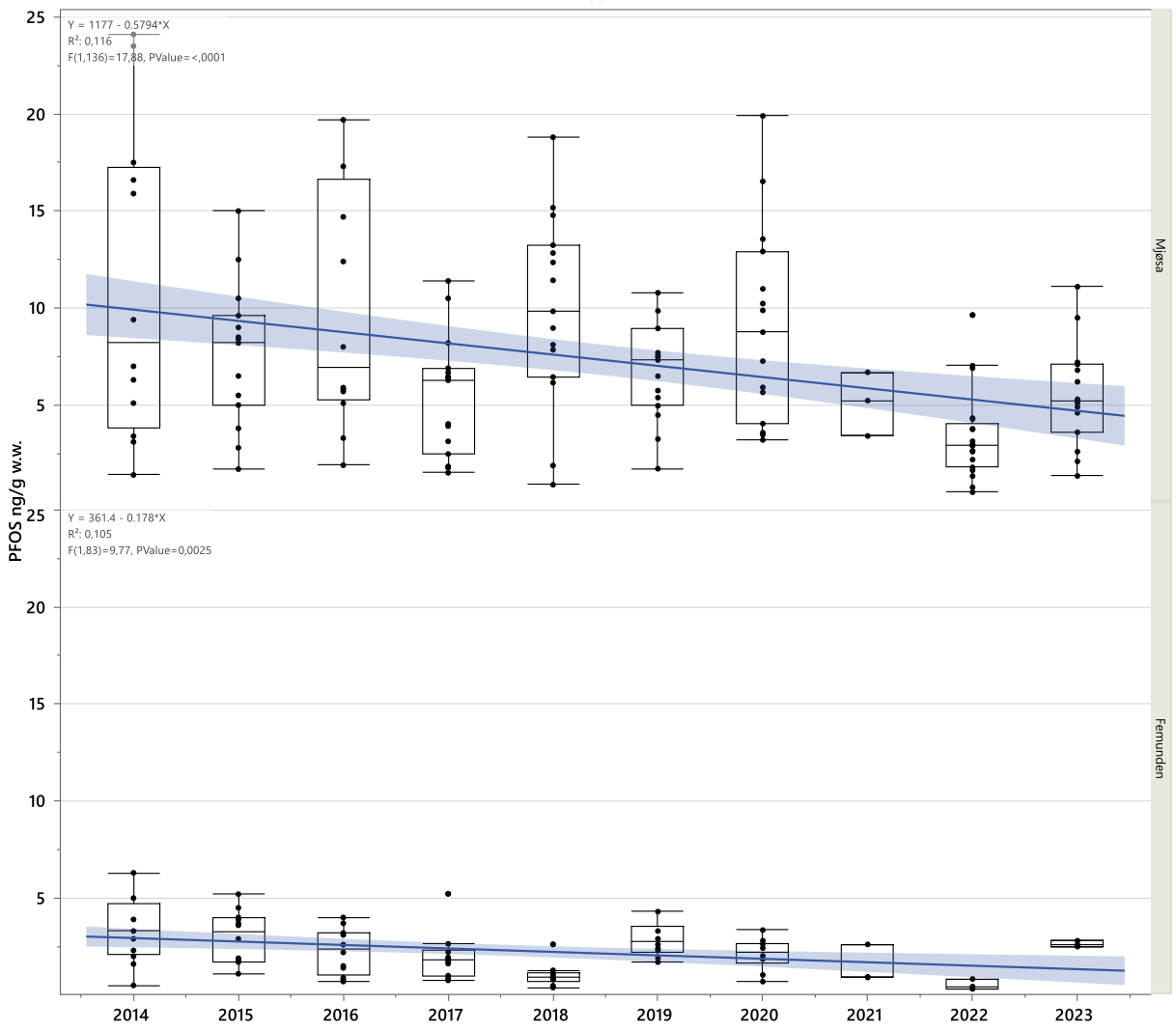


Figure 39 Time trend for PFOS in brown trout liver from Lake Mjøsa (top) and Lake Femunden, shown in ng/g w.w. For concentrations below LOQ, 0 is used.

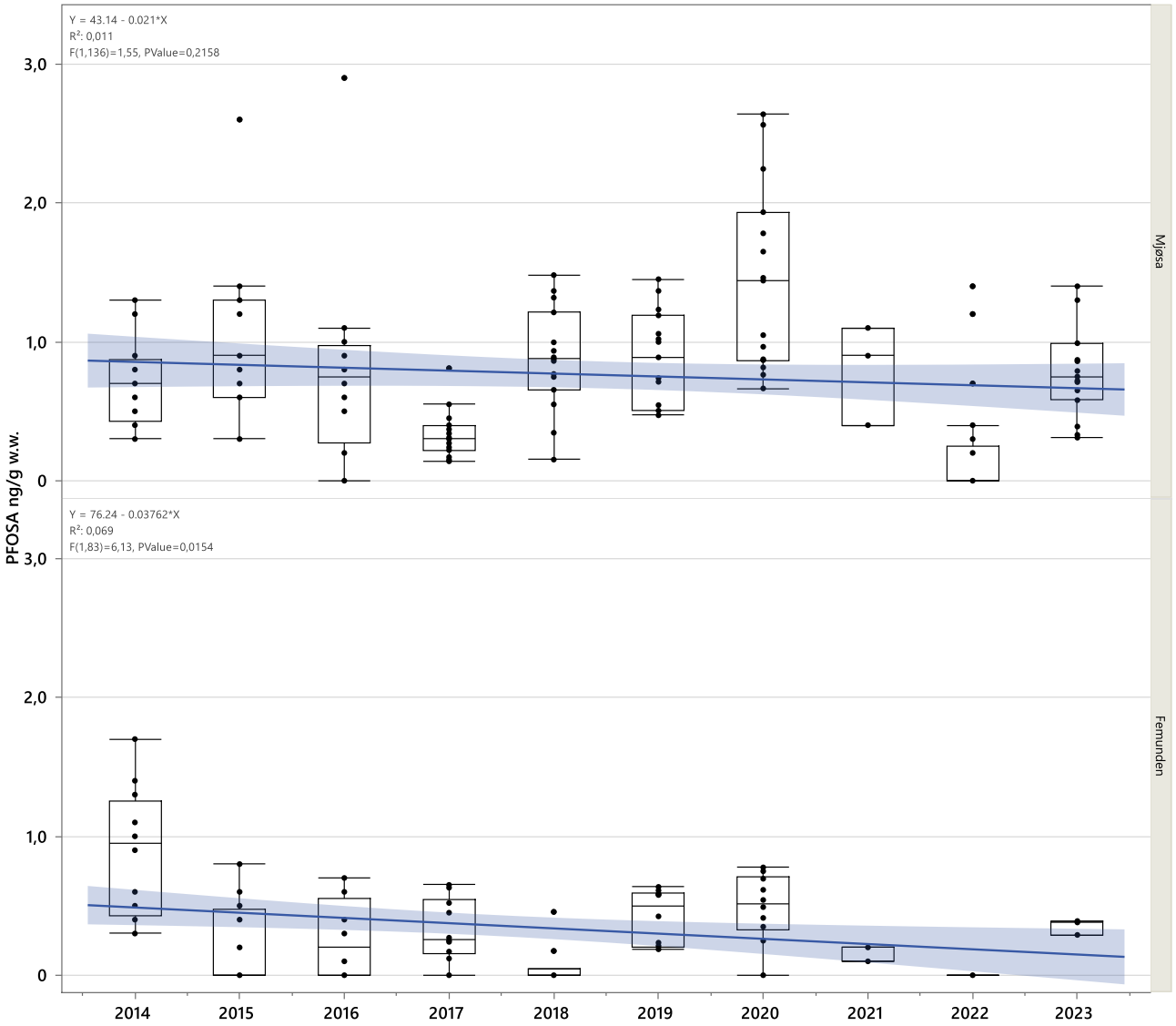


Figure 40 Time trend for PFOSA in brown trout liver from Lake Mjøsa (top) and Lake Femunden, shown in ng/g w.w.For concentrations below LOQ, 0 is used.

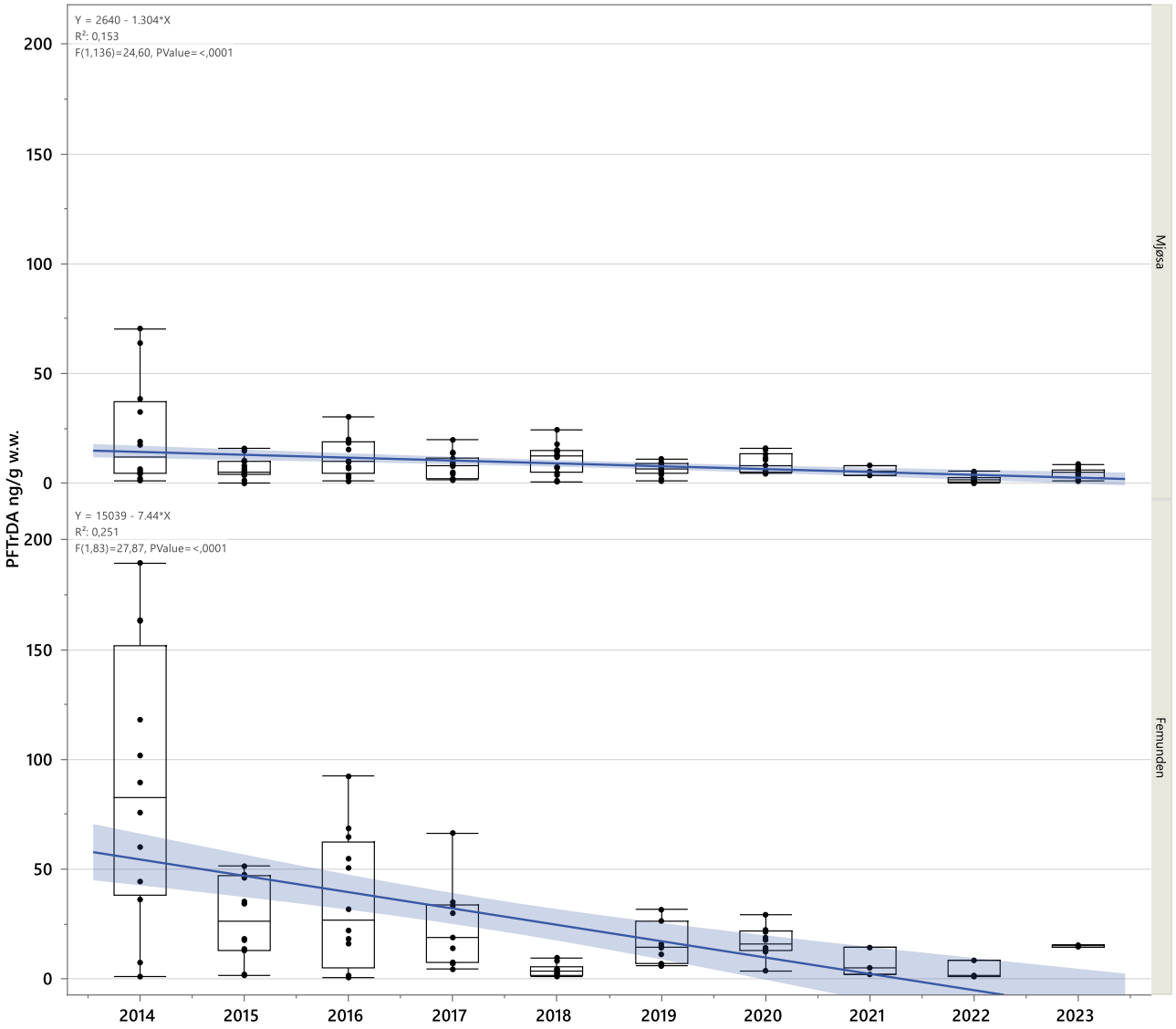


Figure 41 Time trend for PFTrDA in brown trout liver from Lake Mjøsa (top) and Lake Femunden, shown in ng/g w.w. For concentrations below LOQ, 0 is used.

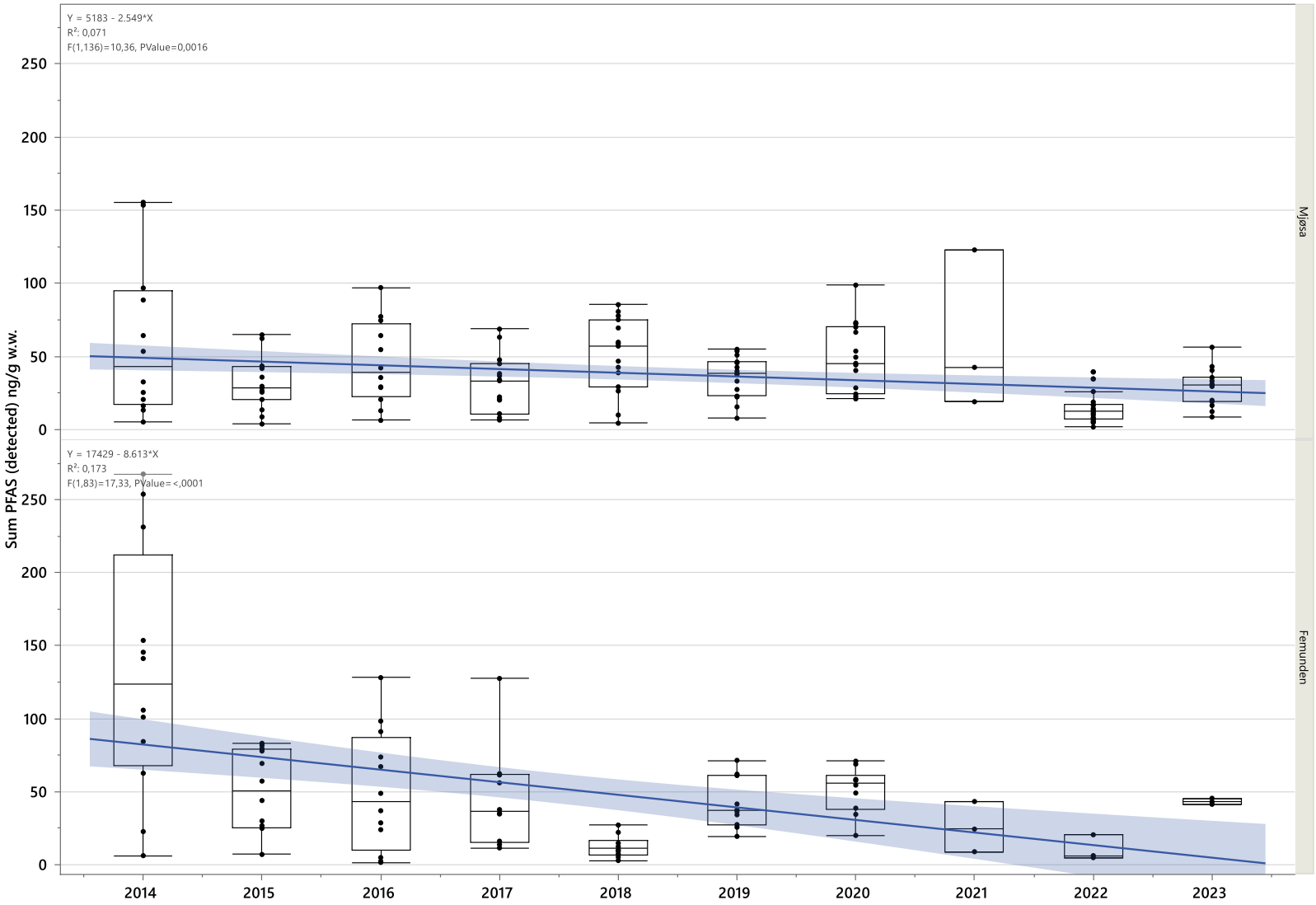


Figure 42 Time trend for sum detected PFAS ∑(PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTeDA, PFPeDA, PFOS, PFOSA) in brown trout liver from Lake Mjøsa (top) and Lake Femunden, shown in ng/g w.w. For concentrations below LOQ, 0 is used.

Time trend for Hg in Lakes Mjøsa and Femunden

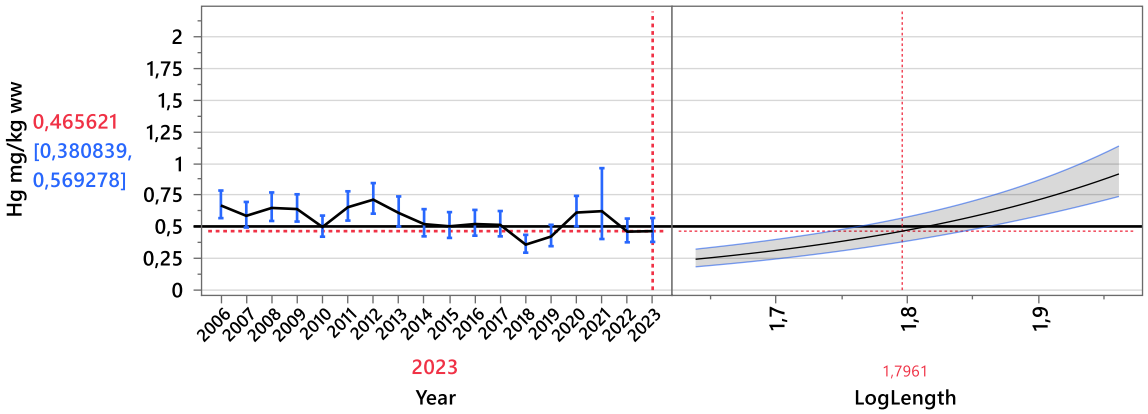


Figure 43 Length adjusted Hg (with 95 % confidence intervals) in trout from Lake Mjøsa 2006-2023. Brown trout are adjusted to the geometric average length (62.5 cm) in the dataset (~2.9 kg). Horizontal line at 0.5 mg/kg Hg (upper limit for placing fish products in the market) is shown. Length adjusted mean Hg concentration (with 95 % confidence limits) for 2023 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.

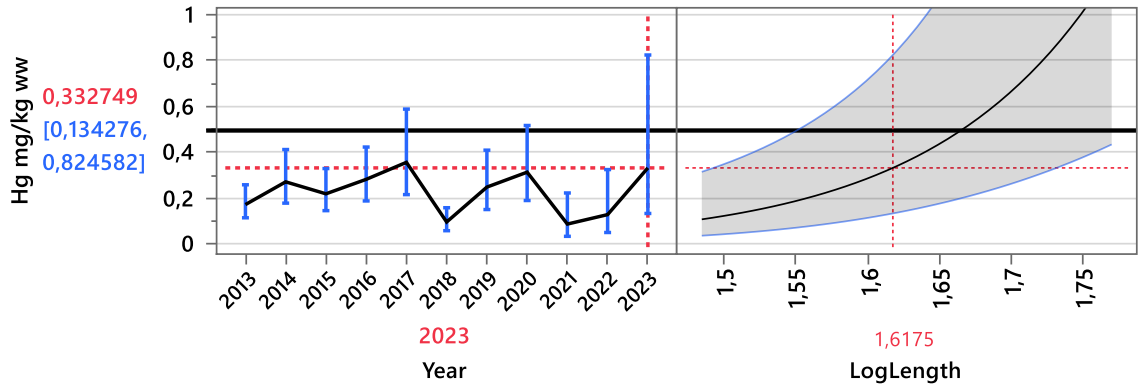


Figure 44 Length adjusted Hg (with 95 % confidence intervals) in trout from Lake Femunden 2013-2023. Brown trout are adjusted to the geometric average length (41.4 cm) in the dataset (~0.73 kg). Horizontal line at 0.5 mg/kg Hg (upper for placing fish products in the market) is shown. Length adjusted mean Hg concentration (with 95 % confidence limits) for 2023 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.

2.17 Comparison to EQS

Table 4 Concentrations of contaminants (µg/kg wet wt.) with Norwegian environmental quality standards (Direktoratsgruppen vanndirektivet 2018) in samples of brown trout (muscle and liver) from Lakes Mjøsa and Femunden. Red numbers indicate concentrations exceeding the quality standard.

	Biota (Brown trout) in Lake Mjøsa and Lake Femunden 2022			
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	394 – 1198	15/15
		Femunden	292 – 595	3/3
PBDEs (ΣBDE_6)*	0.0085	Mjøsa	3 – 13	3/3
		Femunden	0.27 – 0.72	3/3
PFOS (in liver)	9.1	Mjøsa	1.35 – 11	2/15
		Femunden	2.5-2.8	0/3
SCCPs	6000	Mjøsa	< 15.1-20.5	0/15
		Femunden	<15.1	0/3
River basin-specific pollutants				
MCCPs	170	Mjøsa	12.1-39.3	0/15
		Femunden	<3.3	0/15
D5	15000	Mjøsa	12.1 – 81.3	0/15
		Femunden	<1.1	0/3
PFOA (in liver)	91	Mjøsa	<0.5- 0.68	0/15
		Femunden	<0.5-0.65	0/3

3 Appendix - Material and Methods

3.1 Sampling methods

Sampling procedures follows the strict regulations for the Norwegian Environmental Specimen Bank, including avoiding commercial personal care products 24 hours upon sampling. All containers are pre-burned and rinsed with RO-water upon sampling. Field blanks (homogenized eggs) issued from the laboratory were included in the analyses, reflecting reference air contamination at the time of dissection of fish.

3.1.1. Zooplankton and Mysis

Zooplankton and the planktonic opossum shrimp Mysis from Lake Mjøsa were sampled in September 2023 when the zooplankton population was fully developed. Sampling was performed using nets with 500 µm mesh. Zooplankton were sampled in the epilimnetic zone (0 - 15 m) whereas Mysis were sampled at depths of 80-110 m during daylight as they tend to vertically migrate. Sampling area was in the main basin of the lake east and south of Helgøya (see Figure 1). Sample equipment included a nylon mesh net equipped with a collecting cup and a sieve both in brass. Clogging of nets by diatoms (algae) that may form jelly-like aggregates on the net was partly lowering the efficiency of zooplankton sampling, challenging the sampling procedure to provide the desired amount of 200 g material in total for the chemical analyses. Bulk samples of zooplankton were sieved in field into glass jars. Subsamples of zooplankton were extracted from the bulk mass to verify the species composition in a magnifier. Both zooplankton and Mysis were kept frozen (-20 °C) upon analyses.

3.1.2. Vendace, E. smelt and brown trout

European smelt (E. smelt) were caught using bottom nets in the same areas as brown trout, in the Gjøvik area. Both vendace and European smelt tend to migrate vertically in the water column within a 24-hour period to avoid predation from brown trout. During the night both species will prey on zooplankton and Mysis in the epilimnion, whereas they both undergo shoaling during daylight on depths of 30 - 50 m. Brown trout were caught by local fishermen using bottom nets in an area north of Gjøvik (Figure 1). In Lake Femunden, brown trout were caught in connection with the annual brown trout trolling competition “Femunddraget 2023” in the central and northern part of Femunden.

3.2 Sample preparation

Sampling of zooplankton, Mysis and fish from Lake Mjøsa and Lake Femunden were carried out in August and September 2020. After collection, individual fish were wrapped in clean aluminum foil, packed in clean polyethylene bags and kept cold (≈ 4 °C) or frozen (-20 °C) until dissection. The fish were stored in boxes lined with rinsed aluminum foil. Traditional fish boxes in expanded polystyrene (EPS) were avoided because of the risk of contamination by flame retardants. Dissections of fish samples were performed out in the open air in a non-urban environment to prevent contamination of siloxanes (cVMS) from indoor sources. All surfaces that could come into contact with fish were covered by aluminum foil, rinsed with methanol and acetone (HPLC grade). Fish length and weight were recorded. All tools used for dissection were made of steel and cleaned according to the Environmental Specimen Bank procedures (dishwasher, rinsed in Milli-Q water, acetone, and methanol). For brown trout about 150 - 200 g of dorsal muscle filet was dissected out from each individual. Vendace and European smelt had an individual weight ranging from 4 – 37 g, and composite samples from an average of 2 - 5 individuals within a similar weight class had to be processed to provide enough sample for analysis (a total of 20 – 25 g). Liver samples were

dissected from brown trout for PFAS, UV-chemicals and phenol determination. From vendace, stomach content was collected from approx. 100 individuals, however the content was not taxonomically identified. Traces of the stomach and intestine tissue from the vendace have been included to some extent. All samples were stored in glass beakers sealed with an aluminum foil under the lid. Glass and the aluminum foil were cleansed by heating up to 500 °C. The samples were stored in sub-zero temperatures (-20 °C) until analysis.

3.3 Data treatment

Each sample group (e.g. vendace and brown trout from Lake Mjøsa) was analyzed in batches, with field blanks following each batch analyses. Some of the contaminants were found in relative high concentrations in the blind (blank) samples, such as for the phenolic compounds. For these specific compounds a high variation within both the blanks and the actual samples was observed. This was partially explained by the presence of unsaturated fatty acids causing difficult matrix effects, subsequently causing high LOQs.

For all the time series and bar charts non-detects (< LOQ) are assigned a value of zero. For consistency we have removed nondetects from biomagnification models. In addition, biomagnification models are performed only on datasets with > 50 % of data detected.

Statistical analyses, such as simple descriptive statistics (mean, median), linear regressions, and models, were performed using the JMP 17.0. software from SAS Institute Inc. Generally, a significance level of α=0.05 was used, and for some calculations data were log(ln-)transformed, to improve the fit. We have applied regressions according to the best fit, using R^2 as a measure of fit.

3.3.1. Calculating trophic magnification factors (TMF)

Correlations between contaminant concentrations and trophic position were performed on a lipid weight basis for BDEs, CPs, siloxanes, UV compounds, and musk's, and wet weight for PFAS compounds and Hg. Datasets used in biomagnification models comprises pelagic species from Lake Mjøsa covering the last decade (2013-2023). In addition, we have added data from the benthic food chain collected in 2022, to compare trophic magnification of one of the musk compounds, galaxolide, in the pelagic and benthic food chains. All models are shown in table 2.

Trophic magnification factor (TMF) is the factor of increase in concentration of a contaminant per integer trophic level (TL) in the food web. The trophic level is traditionally estimated from stable N-isotope ratios (δ 15N) using empirical data from analyses of 15N/14N in organisms.

Δ15N is the empirical N-enrichment factor of 3,4 ‰ (Vander Zanden et al., 1997; Vander Zanden and Rasmussen, 1999; Post, 2002).

The biomagnification of a contaminant (C) is then calculated with the following equation:

$$Log[C] = b \cdot \delta 15N + a$$

where b is the trophic magnification slope (TMS) and a is the intercept.

The trophic magnification factor (TMF) of the ecosystem is calculated as the antilog of the TMS per trophic level, with the following equation:

$$TMF = e^{(b \cdot 3.4‰)}$$

3.4 QA/QC – chemical analyses

In Table 6 (separate tables for each main 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 divided in three groups from 1-3.

Group 1 includes the compounds with the highest certainty. For the compounds in this group the method is vel establish, not only at NIVA/NILU, but also internationally. That means the quality of this analysis 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.

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 the analytical precision is not acceptable (results are highly scattered, and not to be considered in group 1 or 2). Results of these analyses are considered to be least reliable.

The uncertainty and corresponding LOD and/or LOQ values are revised each year.

Tables of blanks, LOQ and uncertainty Table 6. Tables for blanks, LOQ and uncertainty of the different contaminant groups.

Table 5 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.	0.2-4	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		0.05-0.3		2
	Ethylhexylmethoxycinnamate (EHMZ-E)	5466-77-3		0.05-0.3		2
	Octocrylene	6197-30-4		0.5-2		2
	UV-327	3864-99-1		0.1-1		2
	UV-328	25973-55-1		0.1-1		2
	UV-329	3147-75-9		0.2-5		2
	homosalate	118-56-9		1-25		3
	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 filters:
Tests of the extraction and analysis recovery of homosalate based on spiking experiments give results outside the range of 60-140%. A new deuterated internal standard will be tried out to improve the recovery in the future.

Table 6 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.	5	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		0.5		2
	PFBA	375-22-4		0.5	Internal standard is added and solid samples are extracted twice. Water samples are concentrated on an SPE column. LC-QTOF-MS detection	2
	PFPA	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

Parameter group	Name parameter	CAS Number	Blank subtraction and determination of LOQ	LOQ range, ng/g or ng/L	Method	Uncertainty category
	PFSA					
	PMeS	1493-13-6	One blank per batch. LOQ as validated and externally controlled in proficiency testing.	0.1	Same method as for TFA	2
	PFEtS	354-88-1		0.1		2
	PFPrS	423-41-6		0.1		2
	PFBS	375-73-5		0.2	Internal standard is added and solid samples are extracted twice. Water samples are concentrated on an SPE column. LC-QTOF-MS detection	1
	PFPS	2706-91-4		0.2		2
	PFHxS	355-46-4		0.1		1
	PFHpS	375-92-8		0.1		1
	PFOS	2795-39-3		0.05		1
	brPFOS	1763-23-1		0.05		2
	PFNS	17202-41-4		0.1		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		0.3		2
	PFTeS	n/a		0.3		3
	nPFAS					
	PFBSA	30334-69-1	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-MeFBSA	68298-12-4		0.3		2
	N-EtFBSA	40630-67-9		0.3		2
	PFOSA	754-91-6		0.1		1
	meFOSA	31506-32-8		0.3		2
	etFOSA	4151-50-2		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
	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		3

Comments to PFAS:
PFTeS and 12:2 FTS; Reference standard materials were unavailable for these compounds. Uncertainty category is therefore reported as 3. However, knowledge from similar compounds provides confidence and we judge the results to be reliable.
brPFOS: The reference standard for branched PFOS is provided as a technical mixture. It is therefore difficult to get reliable results on spiked samples. It is possible that additional branched PFOS have not been reported, but the results here present the most significant.

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

Table 7 QACs

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	2
	DADMAC-C10	2390-68-3		50		2
	DADMAC-C12	3282-73-3		5		2
	DADMAC-C14	68105-02-2		1		2
	DADMAC-C16	70755-47-4		5		2
	DADMAC-C18	3700-67-2		5		2
	BAC-C8	959-55-7		5		2
	BAC-C10	965-32-2		5		2
	BAC-C12	139-07-1		25		2
	BAC-C14	139-08-2		25		2
	BAC-C16	122-18-9		25		2
	BAC-C18	122-19-0		25		2
	ATAC-C8	2083-68-3		5		2
	ATAC-C10	2082-84-0		5		2
	ATAC-C12	1119-94-4		5		2
	ATAC-C14	1119-97-7		50		2
	ATAC-C16	57-09-0		50		2
	ATAC-C18	1120-02-1		50		2
	ATAC-C20	15809-05-9		25		2
	ATAC-C22	17301-53-0		5		2

Comments to QACs: The method has been significant improved since earlier years and the blank, and then also the LOQs has been reduced. The results are now considered have higher certainty than earlier years.

Table 8 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		0.5		2
	Benzothiazole	95-16-9		10.0		2
	2(3H)-Benzothiazolone (HBT)	934-34-9		1		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

Table 9 Metals

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

Parameter group	Compound	Cas no	Blank	LOD range (mg/kg)	LOQ range (mg/kg)	Method	Uncertainty category
	Ho	7440-60-0		0.00001-0.0001	0.0002-0.0005		2*
	Er	7440-52-0		0.00001-0.0001	0.0002-0.0005		2*
	Tm	7440-28-0		0.00001-0.0001	0.0002-0.0005		2*
	Yb	7440-64-0		0.00001-0.0001	0.0002-0.0005		2*
	Lu	7439-94-3		0.00001-0.0001	0.0002-0.0005		2*
	Pb	7439-92-1		0.0001-0.0003	0.0005-0.001		1
	Hg	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 10 PBDEs

Parameter group	Name parameter	Cas no	Blank	LOD range ng/g 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	0.002-0.01	0.004-0.03	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		0.001-0.01	0.003-0.03		2	N
	BDE-28	41318-75-6		0.002-0.01	0.01-0.03		1	Y
	BDE-47	5436-43-1		0.02-0.06	0.1-0.2		2	N
	BDE-49	123982-82-3		0.002-0.01	0.01-0.03		2	N
	BDE-66	189084-61-5		0.001-0.01	0.004-0.02		2	N
	BDE-71	189084-62-6		0.001-0.004	0.004-0.02		2	N
	BDE-77	93703-48-1		0.001-0.003	0.004-0.01		2	N
	BDE-85	446254-52-0		0.001-0.01	0.01-0.02		2	N
	BDE-99	60348-60-9		0.005-0.02	0.03-0.05		1	Y
	BDE-100	189084-64- 8		0.002-0.007	0.01-0.02		2	N
	BDE-119	189084-66-0		0.002-0.005	0.005-0.01		2	N
	BDE-126	366791-32-4		0.001-0.004	0.004-0.01		2	N
	BDE-138	182677-30-1		0.002-0.02	0.01-0.07		2	N
	BDE-153	68631-49-2		0.003-0.02	0.01-0.07		1	Y
	BDE-154	207122-15-4		0.003-0.02	0.01-0.05		2	N
	BDE-156	405237-85-6		0.007-0.03	0.02-0.1		2	N
	BDE-183	207122-16-5		0.002-0.01	0.01-0.03		1	Y
	BDE-184	117948-63-7		0.001-0.01	0.003-0.03		2	N
	BDE-191	446255-30-7		0.003-0.02	0.01-0.06		2	N
	BDE-196	32536-52-0		0.003-0.04	0.01-0.1		2	N
	BDE-197	117964-21-3		0.002-0.02	0.01-0.06		2	Y

	BDE-202	67797-09-5		0.003-0.02	0.02-0.1		2	N
	BDE-206	63387-28-0		0.01-0.1	0.02-0.2		2	Y
	BDE-207	437701-79-6		0.01-0.1	0.02-0.2		2	N
	BDE-209	1163-19-5		0.04-0.08	0.1-0.2		2	Y

Table 11 Other BFRs.

Parameter group	Name parameter	Cas no	Blank	LOD range ng/g 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	0.02-0.1	0.06-0.2	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		0.1-0.5	0.3-1.3		2	N
	b-TBECH	3322-93-8		0.08-0.3	0.2-0.9		2	N
	g/d-TBECH	3322-93-8		0.06-0.2	0.2-0.6		2	N
	BATE	99717-56-3		0.02-0.1	0.07-0.3		2	N
	PBT	87-83-2		0.03-0.1	0.1-0.5		2	N
	PBEB	85-22-3		0.02-0.09	0.06-0.2		2	N
	PBBZ	608-90- 2		0.2-0.7	0.6-2		2	y
	HBB	87-82-1		0.08-0.3	0.2-0.8		2	y
	DPTE	35109-60-5		0.02-0.07	0.05-0.2		2	N
	EHTBB	183658-27-7		0.02-0.08	0.05-0.2		2	y
	BTBPE	37853-59-1		0.04-0.2	0.1-0.4		2	y
	TBPH (BEH /TBP)	26040-51-7		0.08-0.3	0.2-0.9		2	N
	DBDPE	84852-53-9		1.7-7	4.8-19		2	y

Table 12 Chlorinated paraffins.

Parameter group	Name parameter	Cas no	Blank	LOD range ng/g (ng/L)	LOQ range ng/g (ng/L)	Method	Uncertainty category	Stable isotope labeled (SIL) analogue
CP	SCCP	85535-84-8	Method blanks following sample series. S, M and LCCP are corrected for blanks prior to deconvolution. Results are corrected for blanks. Blanks are subtracted on congener group level prior to deconvolution. LOD/LOQ based on calculation of 3 and 10 stddev respectively	2.6-20	8-60	In-house method. Internal standard addition, extraction, H2SO4 cleanup followed by adsorption chromatography. In some cases with high levels of sulfur and/or PCB an additional cleanup with florsil is needed. GC-qToF 7200 in ECNI	3	13C-hexachlorodecane
	MCCP	85535-85-9		1.6-3.3	4.8-10		3	
	LCCP	63449-39-8		3.4	10.00	In-house method. Internal standard addition, extraction, GPC and/or H2SO4 cleanup followed by adsorption chromatography. Agilent LC-qToF 6546	3	

Table 13 Phthalates.

Parameter group	Compound	Cas no	Blank	LOD range (ng/g)	LOQ range (ng/g)	Method	Uncertainty category	Stable isotope labeled (SIL) analogue
Phthalate sediment	DEP	84-66-2	Three blanks pr batch. Blank substraction for each batch based on the blank average. LOD and LOQ calculated from 3 x stdev and 10 x stdev. From blanks	10-20	20-60	2-5 g of soil was dried overnight and 2 g of dry material and deuterated internal standard was added and was extracted with acetone using vortex and sonication for 10 min (done three times). Samples was centrifuged and evaporated and transferred to analytical glass. Recovery standard added and analysis on LC-MSMS.	2	N
	DiBP	84-69-5		1-5	5-10		2	N
	DnBP	84-74-2		1-5	5-10		2	N
	DHxP	84-75-3		0.1-0.5	0.5-2		2	N
	BBP	85-68-7		0.1-0.5	0.5-2		2	N
	DEHP	117-81-7		5-20	10-50		2	Y
	DCHP	84-61-7		0.5-2	0.5-2		2	N
	DOP	117-84-0		0.1-1	0.5-2		2	N
	DNP	84-76-4		1-10	10-20		2	N
	DiNP	28553-12-0		10-30	20-50		2	N
	DiDP	26761-40-0		10-30	20-50		2	N
	DAIP	131-17-9		0.5-2	1-3		2	N
	DPP	131-16-8		0.5-2	1-3		2	N
	DCHA	849-99-0		0.2-1	1-3		2	N
	DHP	3648-21-3		0.2-1	1-3		2	N
	DEHT	6422-86-2		Coelutes with DEHP	Coelutes with DEHP		2	N
	DPHP	53306-54-0		0.2-1	1-3		2	N

Table 14 OPFRs

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	1-5	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 were centrifuged, evaporated and transferred to analytical glass. Recovery standard added and analysis on LC-MSMS.	2	Y
	TCEP	115-96-8		0.5-2	2-3		2	Y
	TPrP	513-08-6		0.2-1	1-2		2	N
	TCPP	13674-84-5		0.5-2	2-5		2	Y
	TiBP	126-71-6		0.5-2	2-3		2	N
	DBPhP	2528-36-1		0.2-1	1-2		2	N
	TPP	115-86-6		0.2-1	1-2		2	Y
	TnBP	126-73-8		0.5-2	2-3		2	Y
	BdPhP	2752-95-6		0.2-1	1-2		2	N
	TDCPP	13674-87-8		0.5-2	2-3		2	Y
	TBOEP	78-51-3		0.2-1	1-2		2	N
	2-IPPDPP	64532-94-1		0.2-1	1-2		2	N
	4-IPPDPP	55864-04-5		0.2-1	1-2		2	N
	TCP	1330-78-5		0.5-3	1-6		2	N
	EHDP	1241-94-7		0.2-1	1-2		2	N
	IDDPP	29761-21-5		0.2-1	1-2		2	N
	B4IPPPP	55864-07-8		0.5-3	1-6		2	N
	TXP	25155-23-1		0.5-3	1-6		2	N
	TIPPP	64532-95-2		0.5-3	1-6		2	Y
	TEHP	78-42-2		0.2-1	1-2		2	Y
	TTBPP	78-33-1		0.5-3	2-6		2	N

Table 15 Siloxanes.

Parameter group	Name parameter	Cas nr	Blank	LOQ range ng/g or ng/L	Method	Uncertainty category	Stable isotope labeled (SIL) analogue
Siloxanes, biota/sediment/ particles	D4 - octamethylcyclotetrasiloxane	556-67-2	Three blanks per batch. Blank subtraction for each batch based on the blank average. LOQ calculated from 10 x stdev. from blanks	0.255-0.6383	To 1-2 g of sample, ^{13}C D4, D5 and D6 were added as internal standard, followed by addition of acetonitrile and hexane. Ultrasonic bath and shaking before centrifugation. No further cleanup. Recovery standard added to a sub sample before analysis on GC/MSD. As described in previous MILFERSK/Urban fjord reports. No standard was available for L9-L10, and we used a crude product to estimate the retention time and transitions.	2	Y
	D5 - decamethylcyclopentasiloxane	541-02-6		0.174-0.910		2	y
	D6 - dodecamethylcyclohexasiloxane	540-97-6		0.316-1.20		2	y
	M3T (Ph)			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	2374-14-3		2-50		2	N
	D4F - tetrakis-(trifluoropropyl)tetramethylcyclotetrasiloxane	429-67-4		3-30		2	N
	L6	107-52-8				3	N
	L7					3	N
	L8					3	N
	L9	no standard available				3	N
	L10	no standard available				3	N

Table 16 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	One laboratory blank was prepared alongside each batch of ~6 samples. For all samples, LODs were calculated by 3xSD of the associated laboratory blanks. Where compounds were not present in the laboratory blanks, sample/calibration standard peaks with signal: noise ratios of ~3:1 were converted to a sample concentration using the average blank volume/mass.	0.132-1.24	1 g sample was mixed with Na2SO4, added d11-Tonalide as internal standard, and extracted with acetone/hexane (1:3). After up-concentration the extract was cleaned up with EZ-POP. The extracts were analysed on a GC/MSD with EI ionization. 5 µL of the extract were injected on a DB5 column with 5 m pre column.	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/Tonalide	21145-77-7		0.132-1.24		3	Y
	Celestolide	13171-00-1		0.021-0.18		3	N

Table 17 Phenolic compounds.

Parameter group	Name parameter	Cas nr	Blank	Method	LOD range (ng/g)	LOQ range (ng/g)	Uncertainty category	Stable isotope labelled (SIL) analogue
Bisphenols	4,4-bisphenol A	80-05-7	Method blanks following sample series. LOD/LOQ based on calculation of 3 and 10 stdev respectively (or instrument detection limit if this is higher)	In-house method. Internal standard addition, accelerated solvent extraction (ASE) or supramolecular solvent extraction (SUPRAS), solid phase extraction cleanup. LC/HRMS (Orbitrap)	2-10	10-30	3	Y
	2,4-bisphenol A	837-08-1			0.5-6	1.7-20	3	N
	bisphenol G	127-54-8			1-5.4	3-17	3	N
	4,4-Bisphenol S	80-09-1			0.2-1	0.7-3	3	Y
	2,4-bisphenol S	5397-34-2			1-8	3-26	3	Y
	4,4-bisphenol F	620-92-8			0.6-5	2-17	3	Y
	2,4-bisphenol F	2467-03-0			1-8	3-26	3	N
	bisphenol P	2167-51-3			0.8-4	3-13	3	Y
	Bisphenol Z	843-55-0			1-6	3-20	3	Y
	TBBPA	79-94-7			2-10	7-30	3	Y
	Bisphenol TMC	129188-99-4			1.2-6	4-20	3	Y
	Bisphenol FL	3236-71-3			0.7-7	2.3-23	3	N
	Bisphenol B	77-40-7			0.4-2	1.3-7	3	N
	Bisphenol M	13595-25-0			0.2-1	0.7-3	3	Y
	Bisphenol AF	1478-61-1			0.1-0.7	0.3-2.3	3	N
	Bisphenol AP	1571-75-1			0.4-2.4	1.3-8	3	N
	4,4-bisphenol A	80-05-7			0.6-6	2-20	3	Y
	2,4-bisphenol A	837-08-1			1.4-5	4.6-17	3	N
Alkylphenols	4-tert-octylphenol	140-66-9			0.7-5.2	2.3-18	3	Y
	Dodecylphenol (branched)	27193-86-8			20-76	66-250	3	N
	Dodecylphenol	104-43-8			1.5-2.2	5-7.3	3	N
	4-octylphenol	1806-26-4			2-10	10-30	3	N
	Nonylphenol (branched)	84852-15-3			0.5-6	1.7-20	3	N
	4-nonylphenol	104-40-5			1-5.4	3-17	3	Y
Etoxylater	4NPEO1	104-35-8		In-house method. Internal standard addition, solvent extraction, derivatization, LC/MS-MS	2	7	3	Y
	4NPEO2	20427-84-3			2	7	3	Y
	4NPEO3	51437-95-7			2	7	3	Y
	4TOPEO1	2315-67-5			1	4	3	Y
	4TOPEO2	2315-61-9			1	4	3	Y
	4TOPEO3	2315-62-0			1	4	3	Y
	OPEO2	51437-90-2			1	4	3	Y
Other phenolic compounds	MB1	118-82-1		In-house method. Internal standard addition, extraction. HRMS			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			0.39-0.58*	1.0-1.6*	3	N

*Based on the analysis of Bisphenol AF

Parameter group	Name parameter	Cas nr	Blank	Method	LOD range (ng/g)	LOQ range (ng/g)	Uncertainty category	Stable isotope labelled (SIL) analogue
BCPS	BCPS	80-07-9		The extract from the siloxane analysis was further cleaned up by back-extraction with ACN. 13C-D6 was used as the internal standard.	0.05		3	N

4 Tables

4.1 Data results – contaminant groups

Main results for each contaminant group, with:

- N, number of analyses
- Units (e.g. ng/g w.w.)
- Results with mean and range (min – max)

4.1.1. PFAS

PFAS		Vendace stomach Mjøsa n=3	Vendace Mjøsa n=3	Smelt Mjøsa n=3	Brown trout. Liver Mjøsa n=15	Brown trout. Liver Femunden n=3
PFCA		ng/g w.w.	ng/g w.w.	ng/g w.w.	ng/g w.w.	ng/g w.w.
	PFBA	<1	<1	<1	<1	<1
	PFPA	<0.5	<0.5	<0.5	<0.5	<0.5
	PFHxA	<0.5	<0.5	<0.5	<0.5	<0.5
	PFHpA	<0.5	<0.5	<0.5	<0.5	<0.5
	PFOA	<0.5	<0.5	<0.5	**0.12** (<0.5 – **0.68**)	**0.22** (<0.5 – **0.65**)
	PFNA	<0.5	<0.5	<0.5	**0.75** (<0.5 – **1.62**)	**0.60** (<0.5 – **1.2**)
	PFDA	**1.03 (0.90 – 1.1)**	**0.87 (0.68 – 0.97)**	**0.63 (0.53 – 0.77)**	**2.67 (0.73 – 5.6)**	**3.53 (1.8 – 6.6)**
	PFUnDA	**1.08 (1.01 – 1.14)**	**0.90 (0.76 – 1.09)**	**1.18 (1.08 – 1.35)**	**5.72 (1.4 – 12.3)**	**6.4 (4.4 – 8.5)**
	PFDoDA	**0.57 (0.57 – 0.59)**	**0.54 (0.48 – 0.59)**	**0.59 (0.53 – 0.67)**	**3.88 (0.54 – 7.9)**	**4.43 (3.8 – 4.8)**
	PFTrDA	**0.67 (0.61 – 0.73)**	**0.13 (<0.4 – 0.38)**	**0.61 (0.59 – 0.62)**	**4.78 (0.97 – 8.8)**	**15.2 (14.7 – 15.5)**
	PFTeDA	<0.4	<0.4	<0.4	**1.63 (0.41 – 3.3)**	**3.4 (3.1 – 3.6)**
	PFHxDA	<0.4	<0.4	<0.4	<0.4	<0.4
	PFBS	<0.2	<0.2	<0.2	<0.2	<0.2
	PFPS	<0.1	<0.1	<0.1	<0.1	<0.1
	PFHxS	<0.1	<0.1	<0.1	<0.1	<0.1
	PFHpS	<0.1	<0.1	<0.1	<0.1	<0.1
	PFOS	**9.06 (8.49 – 9.95)**	**7.11 (5.69 – 8.68)**	**0.94 (0.92 – 0.95)**	**5.51 (1.35 – 11.1)**	**2.63 (2.5 – 2.8)**
	brPFOS	<0.1	<0.1	<0.1	<0.1	<0.1
	PFNS	<0.1	<0.1	<0.1	<0.1	<0.1
	PFDS	<0.1	<0.1	<0.1	<0.1	<0.1
	PFUnDS	<0.1	<0.1	<0.1	<0.1	<0.1
	PFDoDS	<0.1	<0.1	<0.1	<0.1	<0.1
	PFTrDS	<0.1	<0.1	<0.1	<0.1	<0.1
	PFTeDS	<0.1	<0.1	<0.1	<0.1	<0.1
nPFAS	PFBSA	<0.3	<0.3	<0.3	**3.07 (1.4 – 4.7)**	**6.47 (4.6 – 7.7)**
	N-MeFBSA	<0.3	<0.3	<0.3	<0.3	<0.3
	N-EtFBSA	<0.3	<0.3	<0.3	<0.3	<0.3
	PFOSA	**0.16 (0.11 – 0.2)**	<0.1	**0.08** (<0.3 – **0.12**)	**0.80 (0.31 – 1.4)**	**0.35 (0.29 – 0.39)**
	N-MeFOSA	<0.3	<0.3	<0.3	<0.3	<0.3
	N-EtFOSA	<0.3	<0.3	<0.3	<0.3	<0.3
	N-MeFOSE	<0.3	<0.3	<0.3	<0.3	<0.3
	N-EtFOSE	<0.3	<0.3	<0.3	<0.3	<0.3
newPFAS	N-EtFOSAA	<0.3	<0.3	<0.3	<0.3	<0.3
	4:2 FTS	<0.3	<0.3	<0.3	<0.3	<0.3
	6:2 FTS	<0.3	<0.3	<0.3	**0.46** (<0.3 – **5.5**)	<0.3
	8:2 FTS	<0.3	<0.3	<0.3	<0.3	<0.3
	10:2 FTS	<0.3	<0.3	<0.3	<0.3	<0.3
	12:2 FTS	<0.3	<0.3	<0.3	<0.3	<0.3

	ADONA	<0.3	<0.3	<0.3	<0.3	<0.3
	PFECHS	<0.3	<0.3	<0.3	<0.3	<0.3
	HFPO-DA	<1	<1	<1	<1	<1
	PFODA	<0.4	<0.4	<0.4	<0.4	<0.4

4.1.2. UV-compounds

UV Compounds	Zooplankton Mjøasa n=3	Mysis Mjøsa n=3	Vendace stomach Mjøsa n=3	Vendace Mjøsa n=3	Smelt Mjøsa n=3	Brown trout. Liver Mjøsa n=15	Brown trout. Liver Femunden n=3
	ng/g w.w.	ng/g w.w.	ng/g w.w.	ng/g w.w.	ng/g w.w.	ng/g w.w.	ng/g w.w.
EHMC-Z	<0.5	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0
EHMC-E	<0.5	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0
UV-329	<0.5	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0
UV-328	**0.47 (0.37 – 0.62)**	**0.19** (<0.2 **– 0.58)**	**0.67 (0.66 – 0.68)**	**0.08** (<0.2 **– 0.24)**	**0.40)0.35 – 0.44)**	<0.3	**0.132** (<0.3 **– 0.296)**
UV-327	**0.11** (<0.1 **– 0.21)**	<0.1	**0.44 (0.36 – 0.57)**	<0.1	**0.04** (<0.1 **– 0.11)**	**0.048** (<0.1 **– 0.226)**	<0.1
M1-UV328	<0.5	<0.5					
OC	**36.2 (26.5 – 54.2)**	**14.03 (9.49 – 19.2)**	**9.07 (<6 – 17)**	<6	<6	<6	<6
BP3	<1	<1	<1	<1	<1	<2	<2
homosalate	<20	<20	<20	<20	<20	<50	<50

4.1.3. Mercury (Hg)

Metals	Zooplankton Mjøasa n=3	Mysis Mjøsa n=3	Vendace stomach Mjøsa n=3	Vendace Mjøsa n=3	Smelt Mjøsa n=3	Brown trout. Muscle Mjøsa n=15	Brown trout. Muscle Femunden n=3
	µg/g w.w.	µg/g w.w.	µg/g w.w.	µg/g w.w.	µg/g w.w.	µg/g w.w.	µg/g w.w.
Hg	**0.0021 (0.00195 – 0.0022)**	**0.010 (0.0084 – 0.0124)**	**0.103 (0.096 – 0.11)**	**0.061 (0.058 – 0.066)**	**0.087 (0.073 – 0.11)**	**0.63 (0.40 – 1.2)**	**0.425 (0.292 – 0.595)**

4.1.4. Metals

Metals	Zooplankton Mjøasa n=3			Mysis Mjøsa n=3		
	µg/g. w.w.			µg/g. w.w.		
	mean	min	max	mean	min	max
Ag	0,0026	0,0021	0,0030	0,01400	0,0085	0,0180
As	0,0989	0,0781	0,1210	0,22833	0,1750	0,2760
Cd	0,0474	0,0394	0,0543	0,02487	0,0169	0,0298
Cr	0,1980	0,1610	0,2230	0,31667	0,1670	0,4140
Cu	0,4780	0,4330	0,5070	2,29000	1,6600	2,9000
Hg	0,0021	0,0020	0,0022	0,01000	0,0084	0,0124
Ni	0,4140	0,3240	0,4830	0,32733	0,1890	0,4350
Pb	0,3053	0,1450	0,4660	2,34167	0,1100	6,5400
Zn	4,9233	3,7400	5,6000	8,16333	7,1700	8,8700

Metals	Zooplankton Mjøasa n=3			Mysis Mjøsa n=3		
	ng/g. w.w.			ng/g. w.w.		
Ce	59.9	32,00	74.70	89.27	78.20	102.00
Dy	2.88	1.61	3.88	4.44	3.70	5.60
Er	1.635	0.956	2.05	2.53	2.17	3.14
Eu	0.909	0.456	1.15	1.71	1.49	1.97
Fe	0.031	0.0183	0.0394	0.05	0.04	0.05
Gd	4.11	2.18	5.19	6.43	5.68	7.69
Ho	0.616	0.289	0.836	0.98	0.81	1.22
La	35.53	21.2	43.3	62.70	53.90	73.10
Lu	0.2156	0.0978	0.287	0.33	0.26	0.45
Nd	36.53	20.20	45.7	56.63	49.00	66.50
Pr	7.883	4.51	9.68	12.47	10.80	14.90
Sb	0.000010	0.00000885	0.0000108	0.0000420	0.0000070	0.0001060
Sc	7.293	3.30	9.40	11.477	9.430	14.400
Sm	4.947	2.69	6.16	7.727	6.640	8.850
Sn	14.093	6.75	26.3	17.603	9.210	30.900
Tb	0.564	0.338	0.707	0.829	0.660	1.060
Tm	0.250	0.135	0.318	0.361	0.300	0.442
Y	0.000015	0.00000839	0.0000192	0.000026	0.000022	0.000030
Yb	1.439	0.677	2.00	2.29	1.84	2.95
Se	75.133	63.9	84.1	212.7	198	238

4.1.5. Benzothiazoles

Benzothiazoles	Zooplankton Mjøasa n=3	Mysis Mjøsa n=3
	ng/g w.w.	ng/g w.w.
Benzotriazole (BTZ)	<0.5	<0.5
Benzothiazole (BT)	<5	<5
CBS	<0.5	<0.5
MBT	<0.5	<0.5
MeBTZ	**2.61** (<0.5 – **7.85)**	**5.43** (<0.5 – **16.3)**
OHBT	<0.5	<0.5

4.1.6. Musk

Musk	Zooplankton Mjøasa n=3	Mysis Mjøsa n=3	Vendace stomach Mjøsa n=3	Vendace Mjøsa n=3	Smelt Mjøsa n=3
	ng/g w.w.	ng/g w.w.	ng/g w.w.	ng/g w.w.	ng/g w.w.
Galaxolide	**0.568 (0.425 – 0.664)**	**0.392 (0.242 – 0.479)**	**28.4 (27.4 – 29.2)**	**9.94 (7.48 – 12.5)**	**4.48 (3.54 – 5.33)**
Tonalide	**0.182 (0.158 – 0.214)**	**0.082 (<0.1 – 0.124)**	**3.67 (3.56 – 3.79)**	**1.11 (0.81 – 1.49)**	**0.79 (0.685 – 0.88)**
Phantolide	<0.2	<0.2	<0.09	<0.09	<0.09
Celestolide	<0.02	<0.02	<0.08	<0.08	**0.046** (<0.08 **– 0.14)**
Iso-E-super	**0.102** (<0.3 **– 0.307)**	<0.3	**4.21 (2.64 – 5.25)**	**0.69** (<1 **– 2.08)**	<1
Acetyl cedrene	<0.5	<0.5	**1.43 (1.28 – 1.61)**	**0.23 (<0.4 – 0.70)**	<0.4
Traseolid	<0.07	<0.07	<0.06	<0.06	<0.06

4.1.7. oPFR

oPFR	Zooplankton Mjøasa n=3	Mysis Mjøsa n=3
	ng/g w.w.	ng/g w.w.
EHDP	<0.5	<0.5
TnBP	<1	<1
TDCPP	<0.5	<0.5
TBEP	<0.5	<0.5
TCPP	**1.95 (1.05 – 3.31)**	**0.48** (<0.5 **– 0.75)**
TPrP	<0.2	<0.2
BdPhP	0.65 (0.51 – 0.79)	**0.08** (<0.2 **– 0.24)**
DBPhP	2.15 (1.75 – 2.79)	**0.83** (<0.6 **– 1.33)**
TCEP	<0.5	<0.5
TCP	<0.5	<0.5
TEHP	<0.5	<0.5
TEP	<0.5	<0.5
TTBPP	<0.5	<0.5
TPPT	<0.5	<0.5
TDTBPP	<0.5	<0.5
TPhP	1.21 (0.92 - 1.7)	<0.5
TIBP	<1	**3.8** (<1 **– 11.4)**
TIPPP/T4IPP	**0.30** (<0.4 **– 0.5)**	<0.4

4.1.8. Phthalates

Phthalates	Zooplankton Mjøasa n=3	Mysis Mjøsa n=3
	ng/g w.w.	ng/g w.w.
BMEP	<0.4	<0.4
DEP	<3	<3
BEEP	<1	<1
DIBP	**4.5 (3.8 – 5.69)**	**0.9** (<2 – **2.7**)
DNBP	**4.87 (3.57 – 5.7)**	<2
BBP	<0.4	<0.4
BnBP	<0.4	<0.4
DCHP	<0.4	<0.4
DPP	<0.4	<0.4
DMPP	<0.4	<0.4
DHxP	<0.4	<0.4
DEHP	**786.3 (662 – 974)**	**324.3 (160 – 427)**
DOP	<4	<4
DINP	**314 (275 – 360)**	**114.2 (77.5 – 156)**
DIDP	**113.3 (78.8 – 156)**	**29.2 (18.0 – 35.2)**
DIUP	<20	<20

4.1.9. PBDEs

PBDE	Zooplankton Mjøasa n=3			Mysis Mjøsa n=3			Vendace stomach Mjøsa n=3			Vendace Mjøsa n=3			Smelt Mjøsa n=3			Brown trout. Muscle Mjøsa n=15			Brown trout. Muscle Femunden n=3		
	ng/g w.w.			ng/g w.w.			ng/g w.w.			ng/g w.w.			ng/g w.w.			ng/g w.w.			ng/g w.w.		
	mean	min	max	mean	min	max	mean	min	max	mean	min	max	mean	min	max	mean	min	max	mean	min	max
BDE47	**0.037**	<0.2	**0.0712**	**0.1590**	**0.147**	**0.1650**	**2.44**	**2.33**	**2.63**	**0.4997**	**0.41**	**0.553**	**1.183**	**0.9350**	**1.62**	**4.398**	**1.35**	**6.8**	**0.150**	**0.076**	**0.227**
BDE99	**0.018**	<0.5	**0.0399**	**0.0823**	**0.078**	**0.0898**	**0.0313**	**0.0294**	**0.0328**	**0.0044**	<0.5	**0.0067**	**0.1272**	**0.0986**	**0.1630**	**1.243**	**0.455**	**1.9**	**0.111**	**0.058**	**0.162**
BDE100	**0.009**	<0.2	**0.0216**	**0.0418**	**0.037**	**0.0465**	**0.9243**	**0.9080**	**0.9410**	**0.1547**	**0.129**	**0.171**	**0.2278**	**0.0824**	**0.3790**	**1.625**	**0.445**	**2.66**	**0.104**	**0.053**	**0.148**
BDE126	<0.1			**0.0024**	<0.1	**0.0073**	**0.0026**	<0.002	**0.0077**	**0.0017**	<0.2	**0.0028**	**0.0016**	<0.6	**0.0049**	**0.011**	**0.003**	**0.022**	**0.005**	**0.004**	**0.006**
BDE153	<0.3			**0.0128**	<0.3	**0.0383**	**0.1467**	**0.135**	**0.169**	**0.0254**	**0.0234**	**0.0286**	**0.0404**	**0.0319**	**0.0530**	**0.255**	**0.091**	**0.381**	**0.033**	**0.029**	**0.040**
BDE154	**0.0016**	<0.2	**0.0047**	**0.0152**	**0.0055**	**0.0302**	**0.2900**	**0.271**	**0.304**	**0.0604**	**0.0573**	**0.0666**	**0.1147**	**0.0892**	**0.1510**	**0.597**	**0.187**	**0.96**	**0.090**	**0.050**	**0.127**
BDE183	<0.2			**0.0158**	<0.2	**0.0473**	**0.0064**	<0.5	**0.0121**	**0.0026**	<0.2	**0.00417**	<0.2			**0.006**	<0.2	**0.026**	**0.017**	**0.013**	**0.020**
BDE190	<0.1			**0.0154**	<0.1	**0.0463**	<0.5			<0.2			<0.3			<0.2			**0.008**	<0.2	**0.024**
BDE196	**0.0025**	<0.1	**0.0074**	<0.009			<0.1			**0.0057**	**0.0038**	**0.0088**	**0.0042**	<0.3	**0.0068**	**0.003**	<0.005	**0.024**	**0.022**	<0.005	**0.045**
BDE202	**0.0022**	<0.2	**0.0067**	**0.0477**	<0.6	**0.1430**	**0.0284**	**0.0195**	**0.0406**	**0.0091**	**0.0086**	**0.0094**	**0.0035**	<0.3	**0.0106**	**0.016**	<0.3	**0.068**	**0.048**	**0.035**	**0.064**
BDE206	<0.1			**0.0366**	<0.1	**0.0981**	**0.0272**	<0.2	**0.0477**	<0.1			<0.3			**0.004**	<0.1	**0.041**	**0.050**	**0.047**	**0.052**
BDE207	**0.0085**	<0.1	**0.0254**	**0.0390**	<0.9	**0.1170**	**0.0503**	**0.0432**	**0.0615**	**0.0109**	<0.9	**0.0166**	**0.0061**	<0.1	**0.0183**	**0.016**	<0.9	**0.068**	**0.045**	**0.033**	**0.069**
BDE209	<0.4			**0.1913**	<0.4	**0.5740**	<0.8			<0.4			<0.4			**0.007**	<0.9	**0.060**	**0.030**	<0.9	**0.047**

BDE17	<0.1			**0.0007**	<0.1	**0.0020**	**0.0284**	<0.3	**0.0851**	<0.1			**0.0040**	**0.0026**	**0.0066**	**0.002**	<0.4	**0.006**	<0.4		
BDE28	<0.1			**0.0022**	<0.2	**0.0036**	**0.0761**	**0.0742**	**0.0779**	**0.0151**	**0.0129**	**0.0178**	**0.0098**	**0.0075**	**0.0135**	**0.026**	**0.010**	**0.037**	**0.007**	**0.003**	**0.014**
BDE49	**0.0025**	<0.2	**0.0047**	**0.0114**	**0.0098**	**0.0133**	**0.1540**	**0.146**	**0.165**	**0.0365**	**0.0308**	**0.0402**	**0.0639**	**0.0532**	**0.0825**	**0.229**	**0.086**	**0.357**	**0.019**	**0.011**	**0.027**
BDE66	**0.0014**	<0.2	**0.0024**	**0.0072**	**0.0040**	**0.0119**	<0.2			**0.0013**	<0.1	**0.0024**	**0.0214**	**0.0173**	**0.0289**	**0.111**	**0.038**	**0.164**	**0.011**	**0.006**	**0.016**
BDE71	<0.1			**0.0014**	<0.1	**0.0041**	<0.2			<0.1			<0.1			**0.011**	<0.1	**0.161**	<0.1		
BDE77	<0.9			**0.0026**	<0.7	**0.0079**	<0.2			<0.1			<0.1			**0.004**	<0.002	**0.009**	**0.002**	**0.002**	**0.003**
BDE85	<0.7			**0.0035**	<0.2	**0.0105**	<0.3			**0.0004**	<0.2	**0.0013**	<0.4			**0.001**	<0.002	**0.009**	**0.001**	<0.002	**0.003**
BDE119	**0.0111**	<0.1	**0.0332**	**0.0022**	<0.2	**0.0067**	**0.0244**	**0.0223**	**0.0274**	**0.0016**	<0.2	**0.0029**	**0.0038**	<0.8	**0.0115**	**0.060**	0.018	**0.098**	**0.014**	**0.008**	**0.021**
BDE138	<0.9			**0.0142**	<0.003	**0.0427**	<0.5			<0.2			<0.2			<0.2			**0.009**	<0.2	**0.016**
BDE156	<0.3			**0.0135**	<0.6	**0.0404**	<0.01			<0.4			<0.4			<0.1			**0.005**	<0.1	**0.016**
BDE184	**0.00072**	<0.01	**0.0022**	**0.0135**	<0.2	**0.0406**	<0.2			**0.0007**	<0.002	**0.0011**	**0.0004**	<0.3	**0.0012**	**0.010**	**0.002**	**0.028**	**0.014**	**0.013**	**0.015**
BDE191	<0.2			**0.0195**	<0.006	**0.0586**	<0.6			<0.3			**0.0010**	<0.6	**0.0030**	<0.1			**0.012**	<0.1	**0.021**
BDE197	<0.3			**0.0214**	<0.6	**0.0552**	<0.5			**0.0028**	<0.2	**0.0045**	**0.0037**	<0.2	**0.0055**	**0.004**	<0.2	**0.023**	**0.011**	<0.2	**0.019**
TBA	**0.0021**	<0.01	**0.0039**	**0.0050**	**0.0033**	**0.0085**	**0.2317**	**0.208**	**0.244**	**0.0468**	**0.0456**	**0.0490**	**0.0120**	**0.00755**	**0.0204**	**0.017**	<0.2	**0.035**	**0.013**	**0.008**	**0.018**

4.1.10. CP

CP	Zooplankton Mjøasa n=3	Mysis Mjøsa n=3	Vendace stomach Mjøsa n=3	Vendace Mjøsa n=3	Smelt Mjøsa n=3	Brown trout. Muscle Mjøsa n=15	Brown trout. Muscle Femunden n=3
	ng/g w.w.	ng/g w.w.	ng/g w.w.	ng/g w.w.	ng/g w.w.	ng/g w.w.	ng/g w.w.
MCCP	**23.47 (22.70 – 24.10)**	**20.93 (15.70 – 30.50)**	**29.5 (23.9 – 37.8)**	**5.89 (4.07 – 8.13)**	**3.99 (3.58 – 4.44)**	**19.29 (11.3 – 39.3)**	<3
SCCP	**8.57 (7.68 – 9.19)**	**7.26 (6.41 – 8.01)**	**3.7** (<9 **– 11.1)**	**1.81** (<4 **– 5.43)**	<4.0	**5.1** (<20 **– 20.5)**	<20
LCCP						**15.70 (<3 – 43.7)**	<3

4.1.11. Siloxanes

Siloxanes	Zooplankton Mjøasa n=3	Mysis Mjøsa n=3	Vendace stomach Mjøsa n=3	Vendace Mjøsa n=3	Smelt Mjøsa n=3	Brown trout. Liver Mjøsa n=15	Brown trout. Liver Femunden n=3
	ng/g w.w.	ng/g w.w.	ng/g w.w.	ng/g w.w.	ng/g w.w.	ng/g w.w.	ng/g w.w.
D4	<0.6	**1.00 (0.68 – 1.16)**	**13.07 (10.7 – 14.8)**	**2.64 (2.21 – 2.94)**	**0.66** (<0.9 **– 1.03)**	**1.01 (0.24 – 2.98)**	<0.9
D5	**5.27 (2.85 – 7.75**)	**10.13 (5.99 – 14.1)**	**94.8 (87.4 – 99.6)**	**24.63 (17.8 – 37.5)**	**56.9 (42.1 – 80.0)**	**38.61 (8.12 – 81.3)**	<1
D6	**0.50** (<0.6 **– 0.76)**	**5.91 (1.09 – 15.2)**	**0.92** (<2 **– 2.77)**	<2	**3.7 (3.4 – 4.0)**	**4.53 (1.01 – 11.5)**	<2
L3	<0.3	<0.2	<0.4	<0.2	<0.2	**<0.1**	<0.1
L4	<0.7	<0.6	**1.75** (<4 **– 3.24)**	**0.23** (<0.**5 – 0.69)**	<0.5	**<0.4**	<0.4
L5	<1	<3	**0.45 (**<1 **– 1.34)**	<0.7	**0.94 (**<1 – **1.41**)	**1.42** (<0.8 **– 3.44)**	<0.8
M3T(Ph)	<0.8	<2	**0.188** (<0.6 **– 0.56)**	<0.4	**0.91 (0.79 – 1.11)**	**2.57 (0.55 – 5.61)**	<0.4

4.2 Biota metadata

ID	Individ /bland	Lake	Norw name	English	Latin	Date	Weight g	Length cm	d13C	d15N	Comment
ZM-H-01	Bland	Mjøsa	Zooplankton	Zooplankton		01.09.2023			-31.28	11.23	
ZM-H-02	Bland	Mjøsa	Zooplankton	Zooplankton		01.09.2023			-31.61	10.69	
ZM-H-03	Bland	Mjøsa	Zooplankton	Zooplankton		01.09.2023			-32.87	11.63	
MM-H-01	Bland	Mjøsa	Mysis	Mysis	Mysis relicta	01.09.2023			-30.95	10.48	
MM-H-02	Bland	Mjøsa	Mysis	Mysis	Mysis relicta	01.09.2023			-30.74	10.87	
MM-H-03	Bland	Mjøsa	Mysis	Mysis	Mysis relicta	01.09.2023			-31.64	11.12	
LM-H-1	Bland	Mjøsa	Lågåsild	Vendace	Coregonus albula	01.07.2023	28	15	-31.77	12.49	10 individer per prøve
LM-H-2	Bland	Mjøsa	Lågåsild	Vendace	Coregonus albula	01.07.2023	24	14	-33.70	12.83	10 individer per prøve
LM-H-3	Bland	Mjøsa	Lågåsild	Vendace	Coregonus albula	01.07.2023	27	15	-31.84	12.23	10 individer per prøve
KM-H-1	Bland	Mjøsa	Krøkle	European smelt	Osmeranus eperlanus	01.06.2023	3	9	-28.82	13.01	40 individer per prøve
KM-H-2	Bland	Mjøsa	Krøkle	European smelt	Osmeranus eperlanus	01.06.2023	4	10	-28.79	13.09	40 individer per prøve
KM-H-3	Bland	Mjøsa	Krøkle	European smelt	Osmeranus eperlanus	01.06.2023	27	16	-29.60	14.51	10 individer per prøve
LMAG-H-1	Bland	Mjøsa	Mage, lågåsild	Stomach content		01.07.2023			-34.96	10.61	
LMAG-H-2	Bland	Mjøsa	Mage, lågåsild	Stomach content		01.07.2023			-35.33	10.35	
LMAG-H-3	Bland	Mjøsa	Mage, lågåsild	Stomach content		01.07.2023			-34.60	10.87	
ØM-M-1	Individ	Mjøsa	Ørret	Brown trout	Salmo trutta	06.08.2023	4400	74	-27.14	15.30	
ØM-M-2	Individ	Mjøsa	Ørret	Brown trout	Salmo trutta	06.08.2023	5200	70	-30.14	14.75	
ØM-M-3	Individ	Mjøsa	Ørret	Brown trout	Salmo trutta	04.08.2023	7100	73	-29.16	14.30	
ØM-M-4	Individ	Mjøsa	Ørret	Brown trout	Salmo trutta	11.07.2023	6300	75	-25.86	14.21	
ØM-M-5	Individ	Mjøsa	Ørret	Brown trout	Salmo trutta	10.07.2023	4000	72	-29.47	15.19	
ØM-M-6	Individ	Mjøsa	Ørret	Brown trout	Salmo trutta	19.07.2023	5200	73	-27.53	14.43	
ØM-M-7	Individ	Mjøsa	Ørret	Brown trout	Salmo trutta	20.06.2023	4400	73	-31.88	15.00	
ØM-M-8	Individ	Mjøsa	Ørret	Brown trout	Salmo trutta	18.06.2023	5000	75	-26.21	14.78	
ØM-M-9	Individ	Mjøsa	Ørret	Brown trout	Salmo trutta	19.06.2023	3900	73	-25.97	15.03	
ØM-M-10	Individ	Mjøsa	Ørret	Brown trout	Salmo trutta	14.06.2023	6100	78	-25.97	14.70	
ØM-M-11	Individ	Mjøsa	Ørret	Brown trout	Salmo trutta	15.06.2023	5700	73	-29.05	15.31	
ØM-M-12	Individ	Mjøsa	Ørret	Brown trout	Salmo trutta	15.06.2023	4000	70	-26.76	15.63	

ID	Individ /bland	Lake	Norw name	English	Latin	Date	Weight g	Length cm	d13C	d15N	Comment
ØM-M-13	Individ	Mjøsa	Ørret	Brown trout	Salmo trutta	11.06.2023	3200	69	-26.46	15.27	
ØM-M-14	Individ	Mjøsa	Ørret	Brown trout	Salmo trutta	07.06.2023	3100	63	-26.45	14.32	
ØM-M-15	Individ	Mjøsa	Ørret	Brown trout	Salmo trutta	06.06.2023	3600	72	-26.17	14.65	
ØF-M-1	Bland 1	Femunden	Ørret	Brown trout	Salmo trutta	01.07.2023	370	35	-20.61	8.20	Analyse ØF-1
ØF-M-2	Bland 1	Femunden	Ørret	Brown trout	Salmo trutta	01.07.2023	420	36	-23.62	9.99	
ØF-M-3	Bland 1	Femunden	Ørret	Brown trout	Salmo trutta	01.07.2023	430	37	-23.64	10.15	
ØF-M-4	Bland 1	Femunden	Ørret	Brown trout	Salmo trutta	01.07.2023	530	40	-23.31	8.90	
ØF-M-5	Bland 1	Femunden	Ørret	Brown trout	Salmo trutta	01.07.2023	530	40	-24.08	9.97	
ØF-M-6	Bland 2	Femunden	Ørret	Brown trout	Salmo trutta	01.07.2023	610	41	-23.11	10.29	Analyse ØF-2
ØF-M-7	Bland 2	Femunden	Ørret	Brown trout	Salmo trutta	01.07.2023	680	42	-23.90	10.17	
ØF-M-8	Bland 2	Femunden	Ørret	Brown trout	Salmo trutta	01.07.2023	610	41	-22.65	10.50	
ØF-M-9	Bland 2	Femunden	Ørret	Brown trout	Salmo trutta	01.07.2023	810	43	-22.45	10.35	
ØF-M-10	Bland 2	Femunden	Ørret	Brown trout	Salmo trutta	01.07.2023	770	45	-23.10	10.35	
ØF-M-11	Bland 3	Femunden	Ørret	Brown trout	Salmo trutta	01.07.2023	680	42	-22.54	10.18	Analyse ØF-3
ØF-M-12	Bland 3	Femunden	Ørret	Brown trout	Salmo trutta	01.07.2023	1080	49	-24.32	9.92	
ØF-M-13	Bland 3	Femunden	Ørret	Brown trout	Salmo trutta	01.07.2023	1430	55	-24.37	9.36	
ØF-M-14	Bland 3	Femunden	Ørret	Brown trout	Salmo trutta	01.07.2023	1700	54	-25.62	10.16	
ØF-M-15	Bland 3	Femunden	Ørret	Brown trout	Salmo trutta	01.07.2023	2700	64	-25.07	9.04	

5 References

Baldwin, A. K., Corsi, S. R., De Cicco, L. A., Lenaker, P. L., Lutz, M. A., Sullivan, D. J., & Richards, K. D. (2016). Organic contaminants in Great Lakes tributaries: Prevalence and potential aquatic toxicity. Science of the Total Environment, 554–555, 42–52. https://doi.org/10.1016/j.scitotenv.2016.02.137

Barber, L.B., Loyo-Rosales, J.E., Rice, C.P., Minarik, T.A., Oskouie, A.K., 2015. Endocrine disrupting alkylphenolic chemicals and other contaminants in wastewater treatment plant effluents, urban streams, and fish in the Great Lakes and Upper Mississippi River Regions. Sci. Total Environ. 517, 195–206. http://dx.doi.org/10.1016/j.scitotenv.2015.02.035

Bau, M., Schmidt, K., Pack, A., Bendel, V. and Kraemer, D., 2018. The European Shale: An improved data set for normalisation of rare earth element and yttrium concentrations in environmental and biological samples from Europe. Applied Geochemistry, V 90, 142-149.

Borgå, K., Kidd, K.A., Muir, D.C., Berglund, O., Conder, J.M., Gobas, F.A., Kucklick, J., Malm,O., Powell, D.E., 2011. Trophic magnification factors: considerations of ecology, eco-systems, and study design. Integr. Environ. Assess. Manag. 8, 64–84. http://dx.doi.org/10.1002/ieam.244

Chen, C., He, W., Ni, Z., Zhang, X., Cui, T., Song, X., Feng, J., 2024. Bioaccumulation, trophic transfer and risk assessment of polycyclic musk in marine food webs of the Bohai Sea. Marine Pollution Bulletin Volume 202, May 2024, 116353. https://doi.org/10.1016/j.marpolbul.2024.116353

Fjeld, E., Bæk, K., Rundberget, J.T., Schlabach, M. and Warner, N.A., 2017. Miljøgifter i store norske innsjøer, 2016. Miljødirektoratet M-807/2017, 88

Jartun, M., Økelsrud, A., Kildahl, H., Øxnevad, S., Rundberget, T., Bæk, K., Enge, E.K., Halse, A.K., Hanssen, L., Harju, M., Johansen, I., 2021. Monitoring of environmental contaminants in freshwater ecosystems 2020 – Occurrence and biomagnification. NIVA-report 7653-2021.

Jartun, M., Økelsrud, A., Bæk, K., Ruus, A., Rundberget, T., Vogelsang, C., Jenssen, T.S., Lund, E., Grung, M., Øxnevad, S., Enge, E.K., Schlabach, M., Hanssen, L., Johansen, I., 2021. Environmental contaminants in freshwater food webs, 2021. NIVA-report 7794-2022.

Jartun, M., Økelsrud, A., Rundberget, T., Bæk, K., Rundberget, T., Øxnevad, S., Ruus, A., Grung, M., Enge, E.K., Hanssen, L., Harju, M., Johansen, I., 2023. Monitoring of environmental contaminants in freshwater food webs (MILFERSK) 2022. NIVA-report 7875-2023.

JRC (2008). Bis(2-ethylhexyl) phthalate (DEHP) Summary Risk Assessment Report. http://echa.europa.eu/documents/10162/060d4981-4dfb-4e40-8c69-6320c9debb01

Kandyliari A, Mallouchos A, Papandroulakis N, Golla JP, Lam TT, Sakellari A, Karavoltsos S, Vasiliou V, Kapsokefalou M. Nutrient Composition and Fatty Acid and Protein Profiles of Selected Fish By-Products. Foods. 2020 Feb 14;9(2):190. doi: https://doi.org/10.3390%2Ffoods9020190

Kim, D., Cho, H.-E., Won, E.-J., Kim, H.-J., Lee, S., An, K.-G., Moon, H.-B., Shin, K.-H., 2022. Environmental fate and trophic transfer of synthetic musk compounds and siloxanes in Geum River, Korea: compound-specific nitrogen isotope analysis of amino acids for accurate trophic position estimation. Environ. Int. 161, 107123 https://doi.org/10.1016/j.envint.2022.107123.

Kolpin, D.W., Furlong, E.T., Meyer, M.T., Thurman, E.M., Zaugg, S.D., Barber, L.B., Buxton, H.T., 2002. Pharmaceuticals, hormones, and other organic wastewater contaminants in U.S. Streams, 1999–2000: a national reconnaissance. Environ. Sci. Technol. 36, 1202–1211. http://dx.doi.org/10.1021/es011055j.

Lyu, Y., Ren, S., Zhong, F., Han, X., He, Y., Tang, Z., 2021. Occurrence and trophic transfer of synthetic musks in the freshwater food web of a large subtropical lake. Ecotox. Environmen. Safe. 213, 112074 https://doi.org/10.1016/j. ecoenv.2021.112074.

Næsje, T.F., Forseth, T., Saksgård, R. Hårsaker K. and Sandlund, O.T., 1996. Production and management of piscivorous brown trout in Lake Femund. Annual report 1995. - NINA 436: 1-37.

Parolini, M., Magni, S., Traversi, I., Villa, S., Finizio, A., Binelli, A., 2015. Environmentally relevant concentrations of galaxolide (HHCB) and tonalide (AHTN) induced oxidative and genetic damage in Dreissena polymorpha. J. Hazard. Mater. 285, 1–10. https://doi.org/10.1016/j.jhazmat.2014.11.037

Post, D.M., 2002. Using stable isotopes to estimate trophic position: models, methods, and assumptions. Ecology 83, 703-718.

Reiner, J.L., Kannan, K. Polycyclic Musks in Water, Sediment, and Fishes from the Upper Hudson River, New York, USA. Water Air Soil Pollut 214, 335–342 (2011). https://doi.org/10.1007/s11270-010-0427-8

Sandlund, O.T., Museth, J., Næsje, T.F., Qvenild, T., Saksgård, R. and Ugedal, O. 2012. Storauren i Femund og Isteren. Utvikling i bestandene over de siste 30 år (Brown trout in Femund and Isteren. Developments in stocks over the past 30 years). - NINA Rapport 853.

Sandlund, O.D., Grøndahl, F.A., Kjellberg, G. and Næsje, T.F., 2017. Variabel livshistorie hos krøkle (Osmerus eperlanus) i Mjøsa og Randsfjorden. VANN 01-2017, 81-92.
Spikkeland, I., Kinsten, B., Kjellberg, G., Nilssen, J.P. and Väinölä, R., 2016. The aquatic glacial relict fauna of Norway – an update of distribution and conservation status. Fauna norvegica, Vol.36, 51-65.

Taylor, S.R. and McLennan, S.M., 1985. The continental crust: its composition and evolution. Blackwell Scientific Publications, Oxford, UK. 312 pp.

USEPA (United States Environmental Protection Agency), 2018. ChemView. https://chemview.epa.gov/chemview. (Accessed 27 October 2020).

Vander Zanden, M.J., Cabana, G. and Rasmussen, J.B., 1997. Comparing the trophic position of littoral fish estimated using stable nitrogen isotopes (d15N) and dietary data. Can. J. Fish. Aquat. Sci., 54, 1142-1158.

Vander Zanden, M.J. and Rasmussen, J.B., 1999. Primary consumer δ 13C and δ 15N and the trophic position of aquatic consumers. Ecology 80(4), 1395–1404

Zhang, X., Xu, Q., Man, S., Zeng, X., Yu, Y., Pang, Y., Sheng, G., Fu, J., 2013. Tissue concentrations, bioaccumulation, and biomagnification of synthetic musks in freshwater fish from Taihu Lake, China. Environ. Sci. Pollut. Res. Int. 20 (1), 311–322. https://doi.org/10.1007/s11356-012-1095-

The Norwegian Institute for Water Research

We are Norway's premier research institute in the fields of water and the environment. We are experts on ecosystems in both freshwater and marine environments, from mountains, lakes and rivers, to fjords, coasts and oceans. We develop science-based knowledge and solutions to challenges related to the interaction between water and climate, the environment, nature, people, resources and society.