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Monitoring of environmental contaminants in freshwater ecosystems 2019

- Occurrence and biomagnification

The diving tower in Hamar. Photo: Morten Jartun

Norwegian Institute for Water Research

REPORT

Main Office
Gaustadalléen 21
NO-0349 Oslo, Norway
Phone (47) 22 18 51 00

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

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

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

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

Internet: www.niva.no

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Author(s) Morten Jartun, Asle Økelsrud, Thomas Rundberget, Kine Bæk (NIVA), Ellen Katrin Enge, Anne Karine Halse, Arntraut Götsch, Mikael Harju (NILU) and Ingar Johansen (IFE).	Topic group Environmental monitoring	Distribution Open
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Summary

This program, «Monitoring of environmental contaminants in freshwater ecosystems and single species in large Norwegian lakes", has covered sampling and determination of environmental contaminants by analyses of organisms in an aquatic, pelagic food web of Lake Mjøsa, and in the top predator in Lake Femunden. Samples of different trophic levels, from epipelagic zooplankton to the top predator brown trout, were collected during the late stages of the growth season in 2019. In this report, the status of contamination in the food web, trends and biomagnification potential of various environmental contaminants is discussed.

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Morten Jartun — Project Manager

Marianne Olsen — Research Manager

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Monitoring of environmental contaminants in freshwater ecosystems, 2019

Occurrence and biomagnification

Preface

The Norwegian Institute for Water Research (NIVA) is on behalf of the Norwegian Environment Agency (Miljødirektoratet) carrying out a monitoring program of contaminants in freshwater ecosystems (MILFERSK 2017-2021). This report presents the main results of the environmental monitoring on samples of biota collected from Lakes Mjøsa and Femunden in 2019.

Samples of zooplankton, the crustacean *Mysis relicta*, vendace (*Coregonus albula*), European (E.) smelt (*Osmerus eperlanus*) and brown trout (*Salmo trutta*) were collected from Lake Mjøsa. Brown trout was sampled from the pristine reference lake Femunden.

Sampling of zooplankton, Mysis, and E. smelt was carried out by Morten Jartun and Asle Økelsrud from NIVA. Brown trout from Lake Mjøsa was caught by Harald Jøranli, vendace from Lake Mjøsa was caught by Jon Museth at the Norwegian Institute for Nature Research (NINA), and brown trout from Lake Femunden was caught by Bjørn Arvid Foss. Sample processing and dissection of target matrices for chemical analyses were performed by Morten Jartun.

Chemical analyses:

- Stable isotopes of nitrogen ($\delta^{15}N$) and carbon ($\delta^{13}C$): Institute for Energy Technology (IFE, Ingar Johansen)
- Mercury (Hg): Eurofins Environment Testing Norway AS
- Brominated flame retardants (BFR), organic phosphorus flame retardants (oPFR), cyclic volatile methylated siloxanes (cVMS), new brominated flame retardants (nBFR), alkyl- and bisphenols and dechloranes: Norwegian Institute for Air Research (NILU)
- PFAS and UV-chemicals: Norwegian Institute for Water Research (NIVA)

Coordination of sampling equipment and chemical data was carried out by Kine Bæk and Katharina B. Løken (NIVA). Data analyses and reporting by Morten Jartun and Asle Økelsrud. Quality assurance was performed by Marianne Olsen and Sissel B. Ranneklev. Coordinator at the Norwegian Environment Agency (Miljødirektoratet) has been Eivind Farmen, and the project manager at NIVA has been Morten Jartun.

Oslo, 02.11.2020

Morten Jartun
Project manager
NIVA

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Summary

This program, «Monitoring of environmental contaminants in freshwater ecosystems and single species in large Norwegian lakes", has covered sampling and determination of environmental contaminants by analyses of organisms in an aquatic, pelagic food web of Lake Mjøsa, and in the top predator in Lake Femunden. Samples of different trophic levels, from epipelagic zooplankton to the top predator brown trout, were collected during the late stages of the growth season in 2019. In this report, the status of contamination in the food web, trends and biomagnification potential of various environmental contaminants is discussed.

Main objectives of the program are:

- Study the occurrence of contaminants in various trophic levels
- Estimation of biomagnification potential of legacy and new contaminants in an aquatic food web

Data from this program can be used as input to international chemical regulations (e.g. REACH and Stockholm convention), and in reporting according to the national requirements of the Water Framework Directive (Vannforskriften). 2019 was the seventh year of contamination monitoring of the two lakes following the same approach, although the time series are much longer for specific contaminants, such as brominated flame retardants (PBDEs) and mercury (Hg). The contaminants studied include mercury (Hg), cyclic volatile methylated siloxanes (cVMS), PBDEs, per- and polyfluorinated substances (PFAS), organic phosphorus flame retardants (oPFRs), alkylphenols, bisphenols, new brominated flame retardants (nBFRs), UV-chemicals and dechloranes.

Statistical models on significant ecological and morphometric predictors for Hg variation in brown trout from Lakes Mjøsa and Femunden show that a major part of the variation is explained by trophic level ($\delta^{15}N$) and size in Lake Mjøsa, whereas trophic level, carbon source ($\delta^{13}C$) and size explained most of the variation in Lake Femunden. Based on the entire dataset for Lake Mjøsa from 2006-2019, in average the trout will reach the EU's and the Norwegian recommended upper consumption limit of 0.5 mg/kg w.w. in fish muscle at around 57 cm, which corresponds to ~ 2.1 kg. For Lake Femunden the trout based on data from 2013 to 2019 will reach the 0.5 mg/kg w.w. limit at around 52 cm, and ~ 1.25 kg.

The cyclic volatile methylated siloxane (cVMS) D5 show biomagnifying potential in Lake Mjøsa. Studying the data from 2013-2019 we see a slight downwards trend for the concentrations in top predators.

Levels of PBDEs peaked in early 2000 in biota from Lake Mjøsa after an industrial discharge of these compounds in the late 1990s. From 2000 to 2019 there is a decline of 90 % in the top predator concentrations, but still all fish samples have concentrations exceeding the EQS for ΣBDE_6.

PFAS is detected in both lakes, with long-chained carboxylic acids (C9 to C14) dominating the PFAS distribution in both lakes. In addition, PFOS was found in higher concentrations in Lake Mjøsa compared to Lake Femunden, with 3 out of 15 samples exceeding the EQS for PFOS.

Besides dechlorane 602 and the oPFRs TCPP and TP, only sporadic detections above limit of quantification (LOQ) were observed for other contaminant groups such as other organic phosphorus flame retardants (oPFRs), alkylphenols, bisphenols, new brominated flame retardants (nBFRs), UV-chemicals and other dechloranes.

Sammendrag

Tittel: Miljøgifter i ferskvann (Milfersk) – forekomst og biomagnifisering i 2019.
År: 2020
Forfatter(e): Morten Jartun, Asle Økelsrud, Thomas Rundberget (NIVA), Ellen Katrin Enge, Anne Karine Halse, Arntraut Götsch, Mikael Harju (NILU) and Ingar Johansen (IFE).
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Dette programmet, «Overvåking av miljøgifter i ferskvann – Miljøgifter i næringsnett og enkeltarter i store norske innsjøer», har gjennomført prøvetaking og analyser av organismer i et akvatisk, pelagisk næringsnett i Mjøsa, og i toppredatoren ørret fra Femunden. Prøver fra forskjellige trofiske nivåer, fra epipelagisk dyreplankton til toppredatoren ørret, ble samlet i løpet av siste del av vekstsesongen i 2019. I denne rapporten diskuteres biomagnifiseringspotensialet til forskjellige miljøgifter.

Hovedmålene for programmet er:

- å studere forekomsten av forurensninger i forskjellige trofiske nivåer
- å estimere potensialet for biomagnifisering av enkelte gamle og nye miljøgifter i et næringsnett i ferskvann

Data fra dette programmet kan brukes som bidrag og bakgrunnsmateriale til internasjonale kjemiske forskrifter (f.eks. REACH og Stockholmkonvensjonen), og de nasjonale kravene i vannrammedirektivet (Vannforskriften). 2019 var det syvende året med overvåking av miljøgifter på denne spesifikke måten i de to innsjøene, selv om tidsseriene er mye lenger for enkelte av miljøgiftene, som bromerte flammehemmere (PBDE) og kvikksølv (Hg). De andre miljøgiftene i denne studien omfatter siloksaner (cVMS), per- og polyfluorinerte alkylstoffer (PFAS), organiske fosforflammehemmere (oPFR), alkylfenoler, bisfenoler, nye bromerte flammehemmere (nBFR), UV-kjemikalier og dekloraner.

Statistiske modeller for signifikante økologiske og morfometriske prediktorer for Hg-variasjon i ørret fra Mjøsa og Femunden viser at en stor del av variasjonen forklares med trofisk nivå ($\delta^{15}N$) og fiskelengde i Mjøsa, mens trofisk nivå, karbonkilde ($\delta^{13}C$) og lengde forklarte det meste av variasjonen i Femunden. Basert på hele datasettet for Mjøsa fra 2006-2019 vil ørreten i gjennomsnitt nå EUs og den norske anbefalte øvre konsumgrensen på 0,5 mg/kg våtvekt i fiskemuskel på rundt 57 cm, noe som tilsvarer ~ 2,1 kg. For Femunden vil ørreten basert på data fra 2013 til 2019 oppnå en konsentrasjon på 0,5 mg/kg våt vekt på rundt 52 cm, og ~ 1,25 kg.

Siloksanforbindelsen (cVMS) D5 viser biomagnifiserende potensial i Mjøsa. Når vi studerer dataene fra 2013-2019, ser vi en svak nedadgående trend for konsentrasjonene i toppredatoren ørret.

Nivåene av PBDE toppet seg tidlig på 2000-tallet i biota fra Mjøsa etter industrielt utslipp av disse forbindelsene på slutten av 1990-tallet. Fra 2000 til 2019 er det en nedgang på 90% av PBDE i fisk, men likevel har samtlige prøver av fiskemuskel fortsatt konsentrasjoner som overskrider EQS for ΣBDE_6.

PFAS påvises i begge innsjøene, med langkjedede karboksylsyrer (C9 til C14) som dominerer PFAS-fordelingen i begge innsjøene. I tillegg ble PFOS funnet i høyere konsentrasjoner i Mjøsa sammenlignet med Femunden, med 3 av 15 prøver som oversteg EQS for PFOS.

Med unntak av dekloran 602 og de organiske fosfororganiske flammehemmerne TCPP og TP, var det bare sporadiske påvisninger over kvantifiseringsgrensen (LOQ) for gruppene av miljøgifter som andre organiske fosforflammehemmere (oPFR), alkylfenoler, bisfenoler, nye bromerte flammehemmere (nBFRer), UV-kjemikalier og andre dekloraner.

1 Introduction

1.1 Background

"Contaminants in freshwater ecosystems" (Miljøgifter i ferskvann – MILFERSK) is a monitoring program designed to monitor the occurrence and biomagnification of selected new and legacy contaminants in large freshwater ecosystems in Norway. The aquatic, pelagic food web in Lake Mjøsa is studied in detail succeeding the sampling strategy from "Contaminants in great Norwegian lakes" established in the period 2013-2016. Lake Mjøsa is the largest lake in Norway, receiving anthropogenic input by means of road runoff, urban runoff, discharges from wastewater treatment plants and other minor sources making this lake especially interesting for studying impact of emerging contaminants. In our study, Lake Femunden, the third largest lake in Norway acts as a reference lake, as it resides in a pristine mountain and forest area with limited impact from human activities.

The Norwegian Institute for Water Research (NIVA) is carrying out the studies on the behalf of the Norwegian Environment Agency (Miljødirektoratet).

A wide range of environmental, emerging contaminants have been determined in samples of zooplankton, the planktonic opossum shrimp *Mysis relicta*, vendace (*Coregonus albula*), E. smelt (*Osmerus eperlanus*), and brown trout (*Salmo trutta*) in Lake Mjøsa, and the top predator brown trout from Lake Femunden. Mjøsa and Femunden were selected in order to continue the data series from previous annual monitoring campaigns.

Main objectives for the monitoring program are:

- Report the concentrations of selected contaminants in multiple trophic levels within a pelagic food web
- Estimate the bioaccumulation of contaminants in selected species
- Estimate the biomagnification factors for selected contaminants in the pelagic food web
- Evaluate the potential for harmful effects on different trophic levels in the food web
- Evaluate the historic trends and discuss potential sources for selected contaminants

In this report, levels of **stable isotopes** ($\delta^{15}N$, $\delta^{13}C$), **mercury** (Hg), **cyclic volatile methylated siloxanes** (cVMS), **brominated flame retardants** (BFR, i.e. polybrominated diphenyl ethers, PBDEs), **organic phosphorus flame retardants** (oPFR), **per- and polyfluorinated substances** (PFAS), **alkylphenols and bisphenols**, **UV-chemicals** and **dechloranes** in biota are presented. Several of these substances tend to accumulate in specific tissues (bioaccumulation) within the organisms, exhibiting higher concentrations relative to their surroundings such as the water or sediment. In addition to the direct ecological importance of studying these contaminants in biota, impact on potential human health is also an important consideration, e.g. by discussing the contaminant levels in respect to environmental quality standards (EQS).

Contamination is discussed based on concentrations in biota tissues in the specific trophic levels and the time trends for the individual contaminant or contaminant group. The monitoring program for large lakes in Norway has been revised several times, but for some of the contaminants the concentrations in specific species have been studied for several years, such as for mercury (Hg) and PBDEs. Still, the program has been changed regularly according to knowledge on emerging contaminants, such as siloxanes, PFAS, organic phosphorus flame retardants (oPFR) and phenols. This means that the time series for some of the contaminants are longer and more detailed than for others. Revisions, such as the choice of target tissue, will promote early detections of possible new contaminants in a large aquatic ecosystem.

1.2 Studied lakes – a short description

Studies of the concentration of environmental contaminants in pelagic food webs have previously been carried out in large Norwegian lakes such as Mjøsa, Randsfjorden, Tyrifjorden, and Femunden (Fjeld et al., 2017) with some additional lakes studied in specific years. In 2019 the main sampling program consisted of biota samples from five trophic levels in Lake Mjøsa and the top predator, brown trout, collected from Lake Femunden, see picture in Figure 1. Table 1 lists some of the main properties of the two lakes studied in 2019. The main sampling sites are indicated in Figure 2. Table 2 lists the main sampling stations.

Table 1. Lake information. PE: population equivalents (number of persons connected to a wastewater treatment plant).

Info	Lake Mjøsa	Lake Femunden
Location (UTM33 EUREF89)	N: 6746114 E: 282000	N: 6898700 E: 338500
Volume (km^3)	65	6
Surface area (km^2)	369	203
Max depth (m)	453	153
Catchment area (km^2)	17 251	1 790
PE	206000	~200
Potential impacts	5 urban areas, major roads, (old) industry, 3 major WWTP, agriculture	Mountain and forest areas

1.2.1 Lake Mjøsa

Lake Mjøsa and Lake Femunden are both large, deep fjord lakes (down to 450 and 150 m, respectively) situated in the southeastern part of Norway, see Figure 2. They do, however, differ in the potential environmental impact from local, anthropogenic sources of contamination. Lake Mjøsa is located in the east-central part of Norway with several possible environmental impacts, such as runoff from major roads, industries, urban areas (five cities located at the lake), and discharge from waste water treatment plants (WWTP), including three large ones and several of minor sizes, with a total of 200 000

population equivalents (PE). Agricultural runoff and input from major rivers are other fluxes to the lake. In addition, several large and minor tributaries flow into Mjøsa from a large catchment area of 17 000 km^2. Theoretical mean residence time is 4.9 years.

1.2.2 Lake Femunden

Lake Femunden is the third largest lake in Norway. Contrary to Lake Mjøsa, it is situated in a forest and mountain catchment area. The area of the lake is 1 700 km^2. It is characterized as a low productive oligotrophic lake with no artificial regulation and with limited anthropogenic impacts, mostly from backpacking hikers and some minor roads. 62 % of the catchment area consist of bare mountain, whereas 26 % is forests, 12 % water bodies and only 0.2 % agriculture. To our knowledge, the main environmental impact must come from long-range transport. There is a small wastewater facility close to the lake (PE: ~200), but it has infiltration to the ground and no direct discharges to the lake.

The climate in this area is dry (annual precipitation in southern end of the lake is 570 mm), but with large differences in temperature between seasons. Femunden as a lake is stretched, approx. 60 km long and 10 km wide (widest area). The lake is 90 m deep in the northern part and 150 m deep in the southern end. Riverine inputs peak in the snow melting season in May/June with a mean discharge of 12-16 $Ls^{-1}km^{-2}$. Theoretical mean residence time is 7.6 years.

Figure 1. Lake Femunden resides in pristine areas dominated by mountains and forests (Photo: Morten Jartun)

1.2.3 Food webs of Lakes Mjøsa and Femunden

The (pelagic) food webs established within the lakes are 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. In Lake Mjøsa (Figure 3) the pelagic food web has been well defined and studied over several years (e.g. Spikkeland et al., 2016; Sandlund et al., 2017; Fjeld et al., 2017). 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 crustacean *Mysis relicta* is an important part of the pelagic food web, as it feeds on zooplankton, and is an important prey for 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 size. 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 E. smelt to be at a higher trophic level in this lake compared to similar lakes in Norway.

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*). E. 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 trouts 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.

Table 2. Sampling stations with coordinates in UTM33N. Sample sizes (in g for zooplankton and Mysis; individuals for fish) are given in brackets.

Lake	Parameters	N samples	Stations	UTM33 (EUREF89)		Depth
				N	E	m
Mjøsa	Zooplankton Mysis	3 (50 g) 3 (100 g)	South/east of Helgøya	6735833	283365	Zoop.: 0-10 Mysis: 70-100
	E. smelt	10 (100 ind.)	East of Helgøya	6738520	285438	30-50
				6737040	280445	
	Brown trout Vendace	15 10 (25 ind.)	North of Gjøvik	6749473	265847	10-50
Femunden	Brown trout	10	Area of Elgå	6898700	338500	-

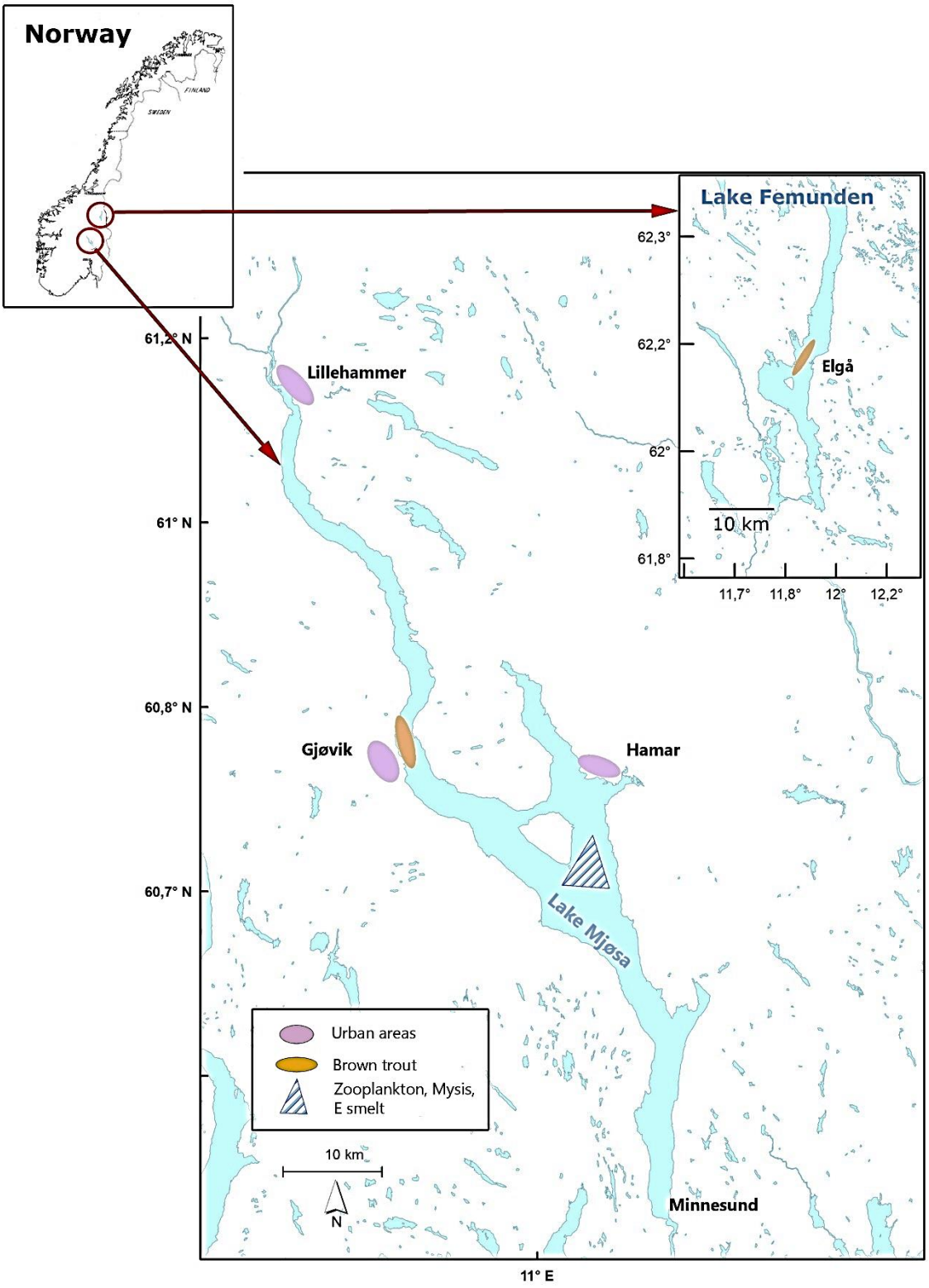

Figure 2. Map of Lakes Mjøsa and Femunden with the main sampling areas for zooplankton, Mysis and fish in Lake Mjøsa, and for fish in Lake Femunden.

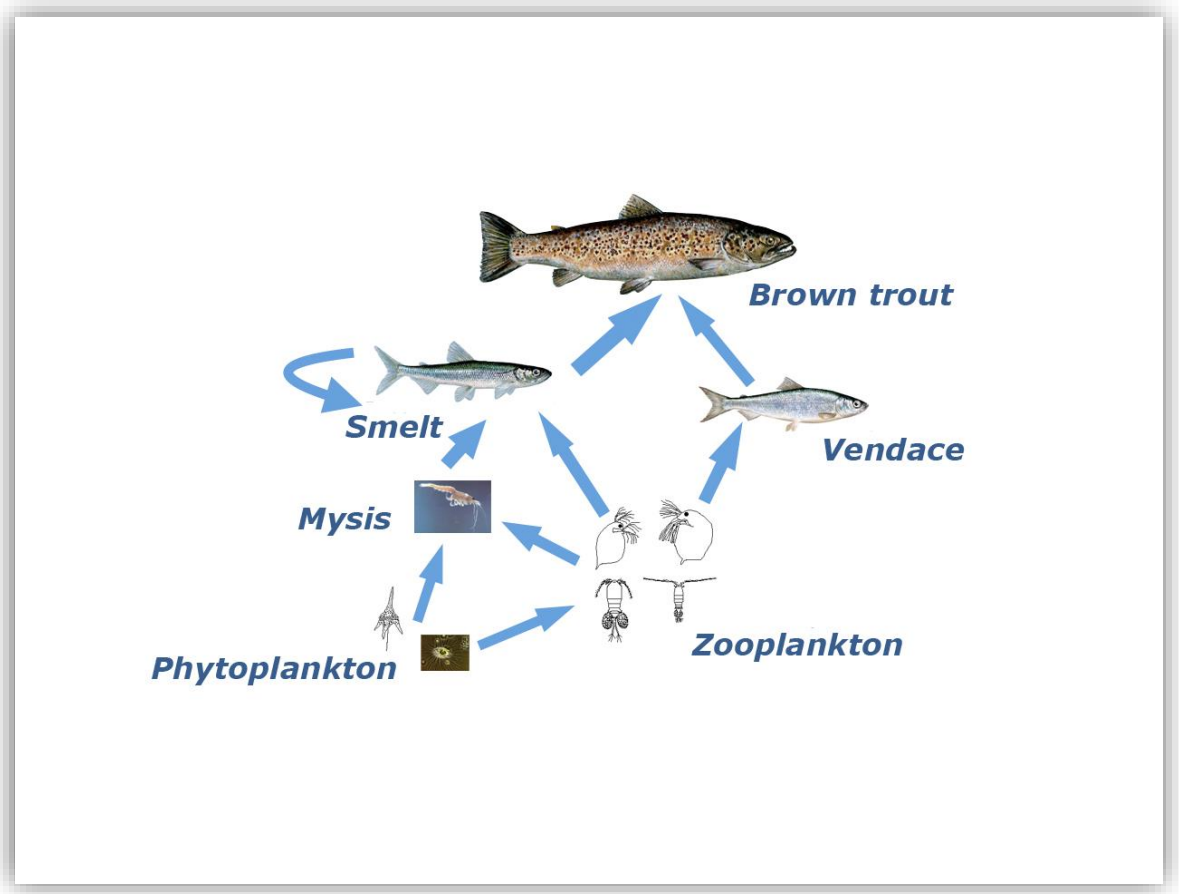

Figure 3. The pelagic food web studied in Lake Mjøsa.

1.3 Introduction to the contaminants

1.3.1 Mercury, Hg

Hg in fish is mostly present as the toxic compound Methyl-Hg, which is a neurotoxin also for humans. Historically, the two main sources of elemental Hg are point source discharges and atmospheric deposition (Driscoll et al., 2013; Donadt et al., 2021). Local sources such as the pulp industry have been known to cause severe contamination of Lake Mjøsa in the past (Underdal, 1970; Sandlund et al., 1981). Because of this, Hg has been monitored in Lake Mjøsa for several years. Strict restrictions on the use of Hg exists in Norway. There is a general ban on the use of Hg in products such as older thermometers and barometers, industrial catalysts and dental amalgam. Regulation of Hg applies to several activities such as the restrictions on manufacture, import, export, sale and use of chemicals and other products hazardous to health and the environment (Product regulation), the industrial directives and waste regulation.

1.3.2 Cyclic volatile methylated siloxanes (cVMS)

Cyclic volatile methyl siloxanes (cVMS), such as octamethylcyclotetrasiloxane (D4), decamethylcyclopentasiloxane (D5), and dodecamethylcyclohexasiloxane (D6), are used as ingredients in personal care products and are emitted to aquatic environments first through wastewater discharge (e.g. Lu et al., 2011; Huse and Aas-Aune, 2009). The European chemical agency (ECHA) categorizes D4 as persistent, bioaccumulative, and toxic (PBT) and very persistent very bioaccumulative (vPvB). D5 is categorized as vPvB (ECHA, 2015). Both D4 and D5 are on the REACH candidate list, and restrictions will apply to wash-off cosmetic products in a concentration above 0.1 % in 2020. These siloxanes exhibit unusual physical-chemical properties in the environment being both hydrophobic and volatile. Biomagnifying properties have been demonstrated by e.g. Borgå et al. (2012a and b).

1.3.3 Brominated flame retardants (BFR); polybrominated diphenyl ethers (PBDEs)

Polybrominated diphenyl ethers (PBDE) are anthropogenic contaminants used as flame retardants in a range of products such as textiles and EE-products. These compounds are generally very stable and hydrophobic, and some exhibit hormone disrupting and neurotoxic properties (Stockholm convention, 2013). In Norway there is a ban against all use, import and production of PBDEs. The Stockholm convention included in 2009 several PBDEs, such as BDE-47, BDE-99, BDE-153 and BDE-154, in its Annex A, and BDE-209 was listed in 2017. In 2000, fish with extreme concentrations of PBDEs were found in Lake Mjøsa (Fjeld et al., 2001), caused by a local industrial discharge. Levels of PBDEs are now coming down and are reduced to 1/5 of the initial concentrations 15-20 years ago (Fjeld et al., 2017).

1.3.4 Organic phosphorus flame retardants (oPFR)

Organic phosphorus flame retardants (oPFRs) are a class of substances with a wide range of physiochemical properties, some being polar and others highly hydrophobic. Some oPFRs exhibit bioaccumulative potential, and several are susceptible to long-range atmospheric transport (Möller et al., 2012; Gustavsson et al., 2018). oPFRs are often considered a substitute for PBDEs after being banned (Pantelaki and Voutsa, 2019). Major uses include additives as flame retardants, plasticizers and anti-foaming agents (Meeker et al., 2013; Andresen, 2006; Van der Veen and de Boer, 2012; Wei et al., 2015). Knowledge of the biological effects of oPFRs is still limited, but Tris (2-chloroethyl) phosphate (TCEP) is on the REACH candidate list as a substance of very high concern (SVHC) and is considered reprotoxic and toxic to aquatic life. There are still limited evidence on the toxicology of specific oPFRs, but there are some studies suggesting endocrine disrupting effects and neurodevelopment abnormalitites caused by oPFRs (Yang et al., 2019; van der Veen and de Boer, 2012).

oPFRs have a wide range of chemical properties determining their mobility, persistence and toxicity in the environment (Yang et al., 2019; van der Veen and de Boer, 2012). Levels of oPFRs in environmental compartments have been reported in e.g. Evenset et al. (2009) and Regnery et al. (2011).

1.3.5 Per- and polyfluorinated alkyl substances (PFASs)

Per- and polyfluoroalkyl substances are a large group of anthropogenic chemicals with exceptional physical-chemical properties. Exhibiting both hydrophilic and hydrophobic properties, these compounds are widely used in products mainly for their abilities to reduce surface tension in addition to both water and oil repellant properties. Products include fire-fighting foam (AFFF), food packaging, ski wax and textiles. Emissions worldwide are, and have been, substantial given the range of products for industrial and personal purposes. Several PFASs are very persistent, bioaccumulative and are reported very mobile in the environment (e.g. ECHA, 2019).

Some of the substances are carcinogenic, have reproductive effects, and may alter the lipid metabolism in organisms. Two specific compounds, perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS), have so far driven the regulation of fluorinated substances because of their ubiquitous presence in environmental compartments, in addition to their bioaccumulative and toxic potential for aquatic and mammal species (e.g. Lau et al., 2007). Several PFASs have been included on the REACH candidate list, such as PFBS, PFHxS, PFOA, C9–C14 PFCAs and HFPO-DA). In 2020, the European Food Safety Authority (EFSA) announced a new safety threshold for tolerable weekly intake (TWI) of 4.4 ng/kg body weight for a group of main PFASs (PFOA, PFNA, PFHxS and PFOS), see EFSA Contam Panel (2020).

PFASs are often divided into subgroups such as the PFCAs (perfluoroalkyl carboxylic acids, e.g. PFOA), PFSAs (perfluoroalkyl sulfonic acids, e.g. PFOS), perfluorooctane sulfonamide substances (PFOS precursors, e.g. PFOSA, FOSAA), and fluorotelomer sulfonic acids (n:2 FTSA, linear chained compounds not fully fluorinated, e.g. 6:2 FTS).

1.3.6 Alkylphenols and bisphenols

Bisphenol-A (BPA) is considered an environmental and human endocrine disruptor (EDC) and is included on the REACH candidate list (ECHA, 2018a). Due to the potential impact on human health, the use of BPA in e.g. baby bottles and in thermal paper is prohibited according to EU-legislation and the use in food-packaging is restricted (EU regulation, 2018). However, the substitutes such as bisphenol-B, -S, and -F have been reported to exhibit similar biological effects (Chen et al., 2016). The analogues are not yet regulated. Alkylphenols (APs) are a class of EDCs and are the degradation products of the non-ionic surfactants alkylphenol polyethoxylates (APEs), used as plasticizers in high density polyethylene (HDPE), polyethyleneterephthalate (PET) and polyvinylchloride (PVC) and in the manufacture of textiles, paper and agricultural chemical products (Salgueiro-González et al., 2015).

1.3.7 UV-chemicals

Organic UV-filters such as octocrylene (CAS: 6197-30-4), benzophenone-3 (CAS: 131-57-7), and ethylhexylmethoxycinnamate (CAS: 5466-77-3) are aromatic compounds adsorbing UV-radiation and

are thus used in sunscreen and other personal care products. Other uses include additives as stabilizers in e.g. clothes, plastics, and paints, e.g. benzotriazole UV-stabilizers (e.g. UV-327, UV-328, and UV-329). UV-filters are ubiquitous in the environment, posing a potential for endocrine disruption and developmental toxicity (Vidal-Linan et al., 2018). They are most likely to enter aquatic environments through wastewater effluents and sludge (Langford et al., 2015). In the EU, there are regulations limiting the concentrations of these compounds in care products to 4-10 % depending on substance (EC, 2009).

1.4 Introduction to Environmental quality standards (EQS)

According to the Water Framework Directive, chemical status of a water body is assessed from compliance with environmental quality standards (EQS) for chemicals that are defined as priority substances and/or priority hazardous substances. Chemical status is recorded as 'good' or 'fail'. The EQS is determined based on PNEC (Predicted no-effect concentrations) values and standard toxicity tests. Depending on the amount and character of the data, the derivation of EQS is performed according to three approaches: i) the assessment factor (AF), ii) the species sensitivity distribution (SSD) and iii) the multispecies test. In Norway, EQS values are implemented through the Water Regulation (*Vannforskriften*), and for monitoring surveys biota samples are preferred over abiotic samples to better understand the environmental impact caused by contaminants over time. As an example, mercury (Hg) is a contaminant which tends to biomagnify (as me-Hg) upwards in food chains, and a low EQS_{biota}-value for Hg indicate a high toxicity for this contaminant and a high bioaccumulation and biomagnifying factor (Direktoratsgruppen vanndirektivet, 2018). The EQS-value is set to protect the most sensitive species within the ecosystem from adverse effects.

In freshwater, brown trout is one of the species that meet most of the criteria for EQS classification such as:

- reflecting changes of contaminant concentrations in the environment,
- ability of biomagnification in the entire study area,
- representative for the study area,
- large population
- large enough individual size for target tissue sampling

Several legacy POPs (persistent organic pollutants), such as PBDEs binds to sulfhydryl groups in proteins. The same is relevant for mercury (Hg). Fish muscle is thus the preferred sample tissue for these contaminants, in addition to the siloxane D5. Due to limited detections in muscle in previous years, bisphenol A, TBBPA (tetrabromobisphenol A) and octyl- and nonylphenol were determined in bile for the 2019 samples. PFOS and PFOA are determined in liver, which is the preferred matrix for freshwater fish when comparing concentrations to EQS (Direktoratsgruppen, 2018).

2 Methods

2.1 Sampling of fish and zooplankton

All biological materials in the project were collected and processed according to the strict procedures of the Norwegian Environmental Specimen Bank for freshwater fish (Miljøprøvebanken, 2015). In this procedure several actions are mandatory to implement for the field personnel in order to avoid potential cross-contamination of the samples. One example is that all personnel must avoid using personal care products, or only use approved products one day prior to sampling. During capture, later handling and sampling it is vital that the fish must not come into contact with potentially contaminating surfaces or substances.

2.1.1 Zooplankton and Mysis

Zooplankton and the planktonic opossum shrimp *Mysis* from Lake Mjøsa were sampled in August 2019 when the zooplankton population was fully developed. Sampling was performed using nets with 200µm mesh in the epilimnetic zone (0-10 m). Sampling area was located in the main basin of the lake east and south of Helgøya (see Figure 2). Sample equipment included a nylon mesh net (mesh size 200 and 500 µm) equipped with a collecting cup with 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. Bulk samples of zooplankton were sieved in field into glass jars. Subsamples of zooplankton were extracted from the bulk mass to check the species composition in a magnifier.

Sampling of Mysis was carried out using net tows at a depth of 70 to 100 meters. Mysis tend to migrate vertically in the water column to avoid predation. After sampling, Mysis were transferred to the same type of test glasses and tubes as the zooplankton samples and stored frozen until analysis at -20 °C. All tools supposed to be in direct contact with the samples were cleaned with methanol and acetone (HPLC grade). At all times during field work, approved disposable gloves (nitrile rubber) were used.

2.1.2 Vendace, European smelt and Brown trout.

2019 was a challenging year for the vendace population in Lake Mjøsa and the river Gudbrandsdalslågen. Fishing for vendace has been going on in Lake Mjøsa for several hundred years, although with a declining interest among local fishermen. The amount of caught vendace has varied between 150 tonnes in peak years down to a few tonnes annually up until 2018. In 2019 a total of 10 kg vendace was caught in Gudbrandsdalslågen, the main spawning river. In normal years, the vendace population remain in deep, cold waters within Lake Mjøsa until the temperature in Gudbrandsdalslågen reaches the optimum temperature of approx. 7°C in October. Then they start the journey upriver to spawn. In 2019 almost no vendace was caught in Lake Mjøsa or Gudbrandsdalslågen (Linløkken and Rukan, 2020). We were able to get 16 individuals from our colleagues in the Norwegian

Institutes for Nature Research (NINA) in Lillehammer for our contaminant analyses. Because of limited size of these individuals, a total of 5 composite samples were analyzed. Catch area was not entirely the same as previous years, though even so we have included these samples in our study to uphold the time series.

European smelt (E. smelt) were caught using bottom nets in the same areas as brown trout, in the Gjøvik area. Both vendace and E. smelt tend to migrate vertically in the water column within a 24-hour period to avoid predation. 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. In Lake Mjøsa, E. smelt and brown trout were caught by local fishermen using bottom nets in an area north of Gjøvik (Figure 2). In Lake Femunden, brown trout were caught during the annual fishing for European whitefish and char in the main basin outside Elgå.

2.1.3 Sample preparation

Sampling of fish in Lake Mjøsa and Lake Femunden were carried out in August and September 2019. 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 of samples. 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 vendace and brown trout about 20 – 100 g of dorsal muscle filet was dissected out from each individual. E. smelt had an individual weight ranging from 15 – 25 g. Composite samples from an average of 4-5 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 out of E. smelt, vendace, and brown trout for PFAS-analysis and UV-chemicals (a selection of samples). In 2019 we also sampled bile from brown trout and a composite sample of E. smelt for the determination of alkylphenols.

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.

2.2 Analytical methods

2.2.1 Stable isotopes of N ($\delta^{15}N$), C ($\delta^{13}C$), and S ($\delta^{34}S$)

Sample matrices for isotopes were whole body for zooplankton and *Mysis*, and muscle tissue for the fish samples. Approx. 0.5 g material was dissected and transferred to Eppendorf tubes upon analyses.

The ratio between the stable nitrogen isotopes ^{14}N and ^{15}N ($\delta^{15}N$), the carbon isotopes ^{12}C and ^{13}C ($\delta^{13}C$), and the sulfur isotopes ^{32}S and ^{34}S were determined by IFE (Institute for Energy Technology), based on Vander Zanden and Rasmussen (2001). Analyses were performed according to standard protocols without removing lipids nor carbonates prior to analysis. Important steps of the method include combustion in an element analyzer, reduction of NO_x in a Cu-oven, separation of N_2 and CO_2 on a GC-column followed by determination of ^{15}N, ^{13}C, and ^{34}S on an Isotope Ratio Mass Spectrometer (IRMS).

2.2.2 Mercury, Hg

Sample matrices for Hg were whole body for zooplankton and *Mysis*, and muscle tissues for all fish samples.

Mercury, Hg, was determined in all samples by Eurofins, according to NS-EN ISO 12846 (Norsk standard, 2012). For zooplankton and Mysis, whole body samples were analyzed, whereas muscle was the sample matrix for all fish. After homogenization, 1 g of sample is weighed in a test tube, followed by extraction with nitric acid (HNO_3). Blinds and control samples are treated the same way. Quantification was performed by a M-7500 Mercury analyzer (HydridGenerating-AtomicAbsorptionSpectrophotometry, HG-AAS). This is a cold-vapor technique.

2.2.3 Cyclic volatile methyl siloxanes (cVMS)

Sample matrices for siloxanes were whole body for zooplankton and *Mysis*, and muscle tissues for all fish samples.

The samples were analyzed by NILU according to methods published by Krogseth et al. (2017). Field blanks for sampling of siloxanes were prepared using 2 – 3 grams of XAD-2 sorbent packed into a polypropylene/cellulose filter bag. Before use in the field, XAD-2 sorbent was cleaned by ultra-sonication in hexane for 30 minutes. Hexane was removed and replaced with dichloromethane and XAD-2 sorbent was sonicated again for 30 minutes. After sonification, XAD-2 sorbent was dried overnight in a clean cabinet equipped with a HEPA (high efficiency particulate air) and carbon filter to prevent contamination of the XAD-2 sorbent from indoor air. XAD-2 sorbent was then packed into the previously described filter bags and placed in polypropylene tubes and sent to field personnel for sampling purposes.

Several prepared field blanks were kept at NILU's laboratories and analyzed to determine reference concentrations present in the field blanks prior to exposure within the field. Comparison of concentrations between reference levels and field blank levels was done to determine potential contamination during sampling. Extraction of all sample material was done in a clean cabinet equipped with both HEPA- and carbon filters to prevent contamination from indoor air and dust. All laboratory

personnel involved in sample extraction avoid use of personal care products such as lotion or deodorant.

Samples were extracted using a mixture of 3:1 hexane:acetonitrile with ultrasonification for 15 min. Samples were subsequently shaken for 1 hour followed by centrifugation at 2500 rpm. A small aliquot of hexane supernatant was transferred to a GC vial followed by addition of tris(trimethylsiloxy)silane as a recovery standard.

Samples were analyzed by GC-MS equipped with DB-5MS column using large volume injection (5 µL). Instrumental conditions have been described by Krogseth et al. (2017). Method detection limits (MDLs) have been shown acceptable for the analysis of siloxanes in environmental samples as they account for the variation introduced to the analytical signal from the extracted matrix (Warner et al. 2013). However, due to the different matrices investigated in this study, it was not possible logistically to determine MDL for all matrices. Therefore, limit of quantification (LOQ) was described as the average plus 10 × standard deviation of the procedural blank signal. This LOQ was used as a conservative detection limit for reporting concentrations. Limits of detection (LOD) described as 3 × standard deviation of the procedural blank signal was also reported for comparison with LOQ. Three blanks are prepared per sample batch for extraction, and LOD/LOQ is reported per batch. LOD/LOQ may therefore vary within matrices.

Siloxanes (D4, D5 and D6) were determined in a clean-room facility using GC-MS.

2.2.4 Brominated flame retardants (BFR); polybrominated diphenyl ethers (PBDEs)

Sample matrices for PBDEs were whole body for zooplankton and *Mysis*, and muscle tissues for all fish samples.

PDBEs were determined by NILU, based on the methods by Bengtson Nash (2008). In brief, 2-5 g of biological material is weighed and homogenized with about 50 g of dry sodium sulphate to fine grained powder. This fine-grained powder was transferred to an elution column with several isotope labelled BFR components and eluted with cyclohexane/acetone (1:1). The extract was concentrated and cleaned using a silica column, conc. H_2SO_4 was added followed by another clean-up on silica column down to 100 µL with addition of a recovery standard. BFR components were determined and quantified in 2 separate GC/HRMS-analyses. Proper identification and quantification were confirmed based on correct retention time, correct isotope ratio, a signal/noise ratio > 3:1, and a correct recovery of internal standard, in addition to accepted blind for the method.

If the concentration of a PBDE was below 3 x blank average (i.e. below LOQ), the result was reported as “not detected”, indicated with negative numbers in the raw data.

2.2.5 Alkylphenols and bisphenols

Sample matrices for alkyl- and bisphenols were whole body for zooplankton and *Mysis*, whole fish/muscle for E.smelt (due to fish size) and muscle tissue for vendace. For brown trout in Lake Mjøsa bile was chosen as the preferred matrix. Bile might be a suitable matrix as the analytical method does not distinguish between original compounds and their metabolites. Jonsson et al. (2008) found the concentration of bile metabolites relatively persistent during starving condition (<45% decrease in 12 days). We therefore suggested that analysis of de-conjugated metabolites in fish bile could be used as a sensitive parameter to monitor alkylphenol and bisphenol exposure in fish. For Lake Mjøsa, muscle tissue has been the target matrix also for phenols since 2017 but with limited detections, so in 2019 we decided to test bile in brown trout from Lake Mjøsa and both bile and muscle for brown trout in Lake Femunden.

Alkylphenols and bisphenols (octylphenol, nonylfenol, bisphenol A, S, F, AF, AP, B, E, FL, M and Z, TBBPA) were determined by NILU. Prior to extraction, isotope labelled phenols were added to the samples, following both extraction and preconcentration. Extraction was carried out using distilled methanol, ethyl acetate, and MTBE (methyl tert-butyl ether) securing good recovery, and preconcentration under nitrogen followed by clean-up with SPE-column to remove lipids and other interferences. All samples were analyzed using Thermo LC-QExactive Plus OrbiTrap. Limits of detection (LOD) and quantification (LOQ) were calculated for each sample using an accepted standard method which included an average of blank concentrations plus 3- and 10-times standard deviation for the blanks for LOD and LOQ respectively.

2.2.6 Organic phosphorus flame retardants (oPFR)

Sample matrices for oPFRs were whole body for zooplankton and *Mysis*, and muscle tissue for the fish samples in accordance with previous years. Liver, bile or blood are not suitable matrices for the original oPFR compounds, as only a range of metabolites might be found here. With available analytical standards for these metabolites, analyses can be performed on e.g. liver or bile in coming years.

oPFRs were determined by NILU. Prior to extraction, a mixture of isotope labelled PFR-standards were added to the sample for quantification. All samples, including biota, water, and sediment, were extracted using acetonitrile. The extracts were reduced under a stream of nitrogen followed by a clean-up using silica column to ensure good recovery. PFR-compounds were quantified using a Thermo TSQ Vantage UPLC/MS-MS, methods described in Evenset et al. (2018). LOD and LOQ were calculated for each sample by averaging batch blanks plus 3x and 10x the standard deviation for LOD and LOQ, respectively.

2.2.7 Per- and polyfluorinated substances (PFAS)

Sample matrices for PFAS were whole body for zooplankton and *Mysis*, and liver tissue from fish. As of 2014 liver has been the preferred matrix for PFAS as a wider range of substances are detected in this

blood rich organ. In 2013, the monitoring program “Contaminants in great Norwegian lakes” analyzed samples of both muscle and liver on the same individuals showing that the concentrations were significantly higher in liver (Fjeld et al., 2014). Similar analyses were performed in the project “PFAS in Tyrifjorden”, where NIVA and the Norwegian geotechnical institute (NGI) studied the PFAS fingerprint in samples of both liver and muscle in 7 different fish species (Slinde et al., 2019). Figure 4 shows higher detected concentrations and a higher number of detected target-PFAS in liver compared to fish muscle.

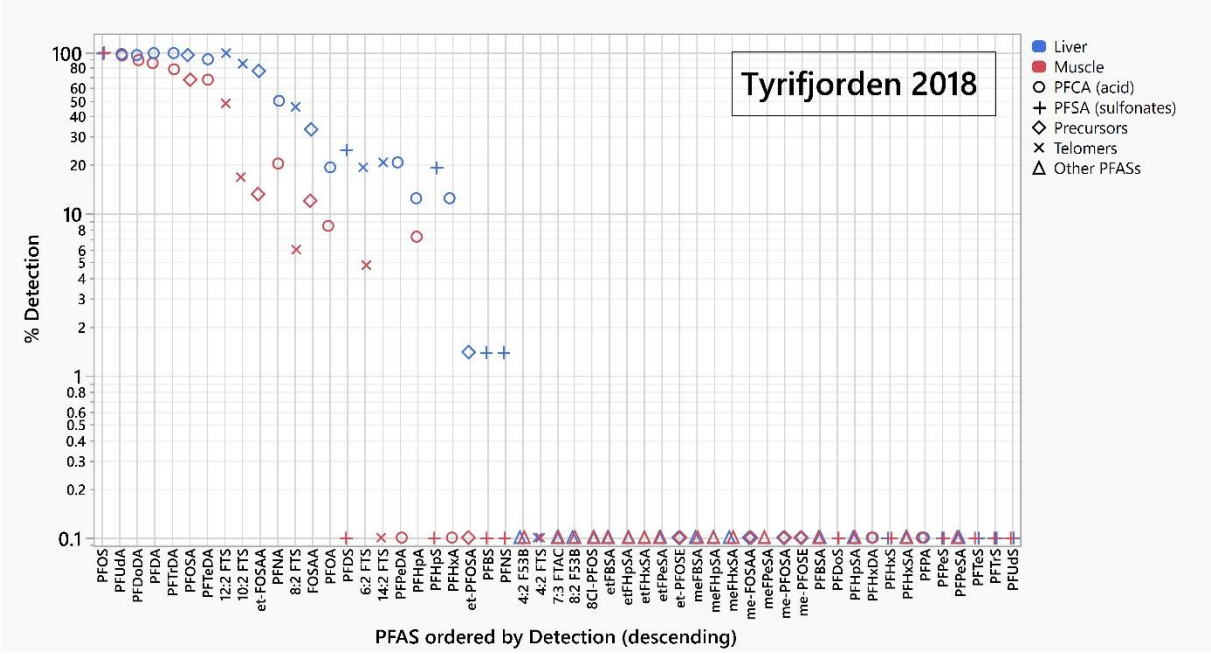

Figure 4. Overview of PFAS detections in liver (blue) and muscle (red) for target PFAS in samples of perch and trout from Lake Tyrifjorden (data from Slinde et al., 2019).

PFAS were determined by NIVA. Prior to extraction, a mixture of isotope labelled PFAS were added to the sample (~2 g), following the sequence of both extraction and preconcentration with acetonitrile. The analytical method is based on e.g. Verrault (2007) with some adaptions. Samples were extracted using acetonitrile and buffers for pH-control. Extracts were cleaned using solid phase extraction (SPE) and active carbon. PFAS were determined using a LC-qToF-MS. LOD and LOQ were calculated for each sample using 3x the signal to noise ratio (z/n) and 9x for LOD and LOQ, respectively.

2.2.8 UV-chemicals

Sample matrices for UV-chemicals were whole body for zooplankton and *Mysis*, muscle tissue in vendace and E. smelt in Lake Mjøsa, and brown trout in Lake Femunden. For brown trout in Lake Mjøsa 8/15 samples were muscle and 7/15 samples were liver. In previous years, muscle has been the preferred sample matrix but with low detection frequencies (Jartun et al., 2019).

UV-chemicals (octocrylene (OC), benzophenone (BP3) and ethylhexylmethoxycinnamate (EHMC)) were determined by NIVA. The analytical methods are based on published works by e.g. Langford et

al. (2015). A mixture of isotope labelled internal standards were added to homogenized biota samples, following both the extraction and preconcentration steps. Samples were extracted with organic solvents (isopropanol and cyclohexane), and the extracts were reduced to approximately 1 ml under a stream of nitrogen (35 °C) before further clean-up via Gel Permeation Chromatography (GPC). UV-chemicals were quantified using GC-MSD (Agilent) or APGC-Vion (Waters). LOD and LOQ were calculated for each sample using an accepted standard method of 3 x signal/noise ratio (z/n) and 9 times z/n respectively.

2.2.9 Dechloranes

Dechloranes were determined in whole body samples of zooplankton and Mysis, and in fish muscle, analyzed by NILU. The extraction of dechloranes follows the same routine as for PBDEs, followed by a quantification on GC-HRMS or a BG-QToF instrument. LOD and LOQ were calculated for each sample using the average of blanks plus 3 and 10 times standard deviation for blanks, respectively.

2.3 Data treatment

Statistical analyses, such as simple descriptive statistics (mean, median), linear regressions, and models, were performed using the JMP 15.0.0 software from SAS Institute Inc. Generally, a significance level of α=0.05 was used, and for some calculations data were $\log_e$(ln-)transformed.

For reported results below LOQ, half the value was chosen in statistical evaluations when approx. 50 % or more of the total N were above LOQ for that specific compound. When a majority of results for a given compound and species are below LOQ, the value of information is reduced or limited, subsequently causing challenges when performing statistical analysis.

2.4 Calculating trophic magnification factors

Correlations between contaminant concentrations and trophic position were performed on a lipid weight basis for siloxanes, Hg, BDEs and PFAS.

Trophic magnification factor (TMF) is the factor of increase in concentration of a contaminant per integer trophic level (TL) in the food web (see chapter 3.4). The trophic level is traditionally estimated from stable N-isotope ratios ($\delta^{15}N$) using empirical data from analyses of $^{15}N/^{14}N$ in organisms.

Calculating TL from $\delta^{15}N$-ratios preferably involves a baseline adjustment, which means that the $\delta^{15}N$-ratio for primary consumers (pc) are subtracted from the $\delta^{15}N$ in consumers (c) of a higher trophic level:

$$TL=[(\delta^{15}N_C - \delta^{15}N_{pc})/\Delta^{15}N] + 2$$

Where TL is the trophic level of consumers, $\delta^{15}N_c$ *and* $\delta^{15}N_{pc}$ are the N-isotope ratio for consumers and primary consumers, respectively. $\Delta^{15}N$ is the enrichment factor of 3.4 ‰ per trophic level (Vander Zanden et al., 1997; Vander Zanden and Rasmussen, 1999).

When the natural logarithm of the concentration is plotted against the trophic level of the organisms, the relationship between the concentration of a contaminant (C_{LW}) and trophic level might be expressed with the following function:

$$ln\ C_{LW} = a + b \cdot TL$$

This is the natural exponential function, in which *b* is the gradient (slope) to the regression between the *ln*-transformed concentration (lipid weight) of a contaminant (C_{LW}) and the trophic level (TL) of this contaminant. If a baseline adjustment for primary consumers is not possible, a relative trophic level (TL_{rel}) for the different organisms may be calculated by dividing $\delta^{15}N_c$ with the N-enrichment factor $\Delta^{15}N$:

$$TL_{rel} = \frac{\delta 15Nc}{\Delta 15N}$$

where TL_{rel} is the relative trophic level, $\delta^{15}N_c$ is the measured ratio between stable N-isotopes and $\Delta^{15}N$ is the empirical N-enrichment factor of 3,4 ‰ (Vander Zanden et al., 1997; Vander Zanden and Rasmussen, 1999; Post, 2002). In this respect, a baseline adjustment for each lake and year to account for the difference in $\delta^{15}N$ between consumers and primary consumers will not be necessary. TL_{rel} may then be used to calculate the trophic distance between different organisms within a lake but will not be accurate for determining their absolute level or to compare trophic levels between lakes with a different $\delta^{15}N$.

When

$$ln\ C_{LW} = a + b \cdot TL_{rel}$$

TMF is now defined as:

$$TMF = e^b$$

A trophic magnification is determined when the regression coefficient *b* is significantly > 0. The corresponding trophic magnification factor (TMF), defined as e^b, will then consequently be > 1.

3 Results

3.1 Detection frequency for contaminants

Table 3 provides an overview of the entire data set, highlighting the detection frequency for each contaminant within the major groups of substances. Detection frequency is the percentage of samples for each matrix above LOQ.

Table 3. Detection frequency (%) for the contaminants sorted in compound groups. Presented as percentage of detected results. Shading refers to 5 subclasses: white: 0-20 %, light pink: 21-40 %, pink: 41-60 %, light red: 61-80 % and red: 81-100 %. Data for mercury (Hg), cyclic volatile methylated siloxanes (cVMS), brominated flame retardants (PBDEs), organic phosphorus flame retardants (oPFR), per- and polyfluorinated alkyl substances (PFAS), alkyl- and bisphenols, new brominated flame retardants (nBFR) and UV-chemicals.

Compound class	Compound	CAS-no.	Zooplankton N=3	Mysis N=3	E. smelt N=10	Vendace N=5	Brown trout, L.Mjøsa N=15	Brown trout, L.Femunden N=10	Total dataset N=46
Mercury	Hg	7439-97-6	33	100	100	100	100	100	96
cVMS	D4	556-67-2	0	0	0	0	47	0	15
	D5	541-02-6	100	100	100	100	100	0	78
	D6	540-97-6	0	0	70	100	100	80	76
PBDEs	17	147217-75-2	0	0	20	0	80	0	80
	28	41318-75-6	0	0	100	100	100	80	30
	47	5436-43-1	0	100	100	100	100	100	83
	49	243982-82-3	0	100	100	100	100	100	93
	66	189084-61-5	0	100	80	100	100	100	93
	71	189084-62-6	0	0	0	0	7	0	89
	77	93703-48-1-	0	0	0	0	40	0	2
	85	182346-21-0	0	0	0	0	7	0	13
	99	60348-60-9	33	100	100	100	100	100	2
	100	189084-64-8	0	100	100	100	100	100	96
	119	189084-66-0	0	0	10	60	67	60	93
	126	366791-32-4	0	0	0	0	13	0	43
	138	182677-30-1	0	0	0	0	0	0	4
	153	68631-49-2	0	33	90	100	100	90	0
	154	207122-15-4	0	100	100	100	100	100	85
	156	N/A	0	0	0	0	0	0	93
	183	207122-16-5	0	0	0	20	27	40	0
	184	117948-63-7	0	0	0	0	73	90	20

Compound class	Compound	CAS-no.	Zooplankton N=3	Mysis N=3	E. smelt N=10	Vendace N=5	Brown trout, L.Mjøsa N=15	Brown trout, L.Femunden N=10	Total dataset N=46
PBDEs	191	189084-68-2	0	0	0	0	0	0	43
	196	446255-38-5	0	0	0	0	0	0	0
	197	117964-21-3	0	0	0	20	7	20	0
	202	67797-09-5	0	0	10	0	27	10	9
	206	63387-28-0	0	0	10	0	0	10	13
	207	437701-79-6	0	0	10	0	0	10	4
	209	1163-19-5	33	0	40	0	20	10	4
nBFR	TBA	607-99-8	33	100	50	100	87	100	20
	ATE (TBP-AE)	3278-89-5	0	0	40	80	33	0	28
	a-TBECH	3322-93-8	0	0	20	80	27	0	22
	b-TBECH	3322-93-8	0	0	30	100	47	0	33
	g/d-TBECH	3322-93-8	0	0	20	100	47	0	30
	BATE	99717-56-3	0	0	50	100	60	0	41
	PBT	87-83-2	0	0	20	100	40	0	28
	PBEB	85-22-3	0	0	20	100	40	0	28
	PBBZ	608-90-2	0	0	0	0	0	0	0
	HBB	87-82-1	33	0	40	100	93	20	57
	DPTE	35109-60-5	0	0	40	100	60	0	39
	EHTBB	183658-27-7	0	0	30	100	7	0	20
	BTBPE	37853-59-1	0	0	20	80	13	0	17
	TBPH (BEH /TBP)	26040-51-7	0	0	10	0	0	0	2
	DBDPE	84852-53-9	0	0	10	0	7	20	9
oPFR	TEP	78-40-0	0	0	0	0	0	0	0
	TCEP	115-96-8	0	0	0	0	0	0	0
	TPrP	513-08-6	0	0	0	0	0	0	0
	TCPP	13674-84-5	100	100	100	100	7	60	61
	TiBP	126-71-6	0	0	0	0	0	0	0
	BdPhP	2752-95-6	0	0	0	0	0	0	0
	TPP	115-86-6	100	100	80	100	27	0	50
	DBPhP	2528-36-1	0	0	0	0	0	0	0
	TnBP	126-73-8	100	33	20	20	0	0	15
	TDCPP	13674-87-8	0	0	10	0	0	0	2
	TBEP	78-51-3	0	0	0	20	0	10	4
	TCP	1330-78-5	0	0	0	20	0	0	2
	EHDP	1241-94-7	0	0	0	100	0	10	13
	TXP	25155-23-1	0	0	0	0	0	0	0
	TEHP	78-42-2	100	100	20	0	0	0	17
Phenols	4,4-bis-A	80-05-7	0	0	10	0	33	20	17
	2,4-bis-A	80-05-7	0	0	0	0	0	0	0
	bis-G	127-54-8	0	0	0	0	0	0	0
	4,4-bis-S	80-09-1	0	0	0	0	0	0	0

Compound class	Compound	CAS-no.	Zooplankton N=3	Mysis N=3	E. smelt N=10	Vendace N=5	Brown trout, L.Mjøsa N=15	Brown trout, L.Femunden N=10	Total dataset N=46
	2,4-bis-S	80-09-1	0	0	0	0	0	0	0
	4,4-bis-F	620-92-8	0	0	40	20	0	20	15
	2,4-bis-F	620-92-8	0	0	30	20	13	20	17
	2,2-bis-F	620-92-8	0	0	0	0	33	10	13
	bis-P	2167-51-3	0	0	0	0	0	0	0
	bis-Z	843-55-0	0	0	0	0	0	0	0
	TBBPA	79-94-7	0	0	0	0	0	0	0
	4-tert-octylphenol	140-66-9	0	0	0	0	7	0	2
	4-octylphenol	1806-26-4	0	0	0	0	0	0	0
	4-nonylphenol	84852-15-3	0	0	0	0	0	0	0
PFAS	PFPA	2706-90-3	0	0	0	0	0	0	0
	PFHxA	307-24-4	0	0	0	0	0	0	0
	PFHpA	375-85-9	0	0	0	0	0	0	0
	PFOA	335-67-1	0	0	0	0	0	0	0
	PFNA	375-95-1	0	0	100	20	80	80	67
	PFDA	335-76-2	0	0	100	100	100	100	87
	PFUnDA	2058-94-8	0	0	100	100	100	100	87
	PFDoDA	307-55-1	0	0	100	100	93	100	85
	PFTrDA	72629-94-8	0	0	100	100	100	100	87
	PFTeDA	376-06-7	0	0	100	100	93	100	85
	PFPeDA	18024-09-4	0	0	30	0	67	90	48
	PFHxDA	67905-19-5	0	0	0	0	0	0	0
	PFBS	375-73-5	0	0	0	0	0	0	0
	PFPS	2706-91-4	0	0	0	0	0	0	0
	PFHxS	355-46-4	0	0	0	0	0	0	0
	PFHpS	375-92-8	0	0	0	0	0	0	0
	PFOS	1763-23-1	0	100	100	100	100	100	93
	8Cl-PFOS	N/A	0	0	0	0	0	0	0
	PFNS	474511-07-4	0	0	0	0	0	0	0
	PFDS	335-77-3	0	0	0	0	0	0	0
	PFDoS	7978-39-5	0	0	0	0	0	0	0
	PFOSA	754-91-6	0	0	100	80	100	100	85
	N-MeFOSA	31506-32-8	0	0	0	0	0	0	0
	N-EtFOSA	4151-50-2	0	0	0	0	0	0	0
	N-MeFOSE	24448-09-7	0	0	0	0	0	0	0
	N-EtFOSE	1691-99-2	0	0	0	0	0	0	0
	4:2 FTS	757124-72-4	0	0	0	0	0	0	0
	6:2 FTS	27619-97-2	0	0	0	0	0	0	0
	8:2 FTS	39108-34-4	0	0	0	0	0	0	0
	10:2 FTS	120226-60-0	0	0	0	0	0	0	0

Compound class	Compound	CAS-no.	Zooplankton N=3	Mysis N=3	E. smelt N=10	Vendace N=5	Brown trout, L.Mjøsa N=15	Brown trout, L.Femunden N=10	Total dataset N=46
	4:2 F53B	N/A	0	0	0	0	0	0	0
	6:2 F53B	73606-19-6	0	0	0	0	0	0	0
	N-MeFOSAA	2355-31-9	0	0	0	0	0	0	0
	N-EtFOSAA	2991-50-6	0	0	0	0	0	0	0
	F53	754925-54-7	0	0	0	0	0	0	0
	7:3 FTCA	812-70-4	0	0	0	0	0	0	0
	PFBSA	30334-69-1	0	0	80	0	100	100	72
	N-MeFBSA	68298-12-4	0	0	0	0	0	0	0
	N-EtFBSA	40630-67-9	0	0	0	0	0	0	0
UV-chemicals	BP3	131-57-7	67	0	0	0	0	0	4
	EHMC-Z	5466-77-3	0	0	30	0	0	0	7
	EHMC-E	5466-77-3	0	0	20	0	0	0	4
	Sum-EHMC		0	0	20	0	0	0	4
	OC	6197-30-4	67	33	0	0	0	0	7
Dechloranes	Dibromoaldrin	20389-65-5	0	0	0	0	0	0	0
	Dechlorane 602	31107-44-5	0	0	90	100	100	90	83
	Dechlorane 603	13560-92-4	0	0	0	0	0	0	0
	Dechlorane 604	34571-16-9	0	0	0	0	0	0	0
	Dechlorane 601	13560-90-2	0	0	0	0	0	0	0
	Dechlorane plus syn	135821-03-3	0	0	10	0	7	0	4
	Dechlorane plus anti	135821-74-8	0	33	10	0	13	0	9
	1,3-DPMA	N/A	0	0	0	0	0	0	0
	1,5-DPMA	13821-04-4	0	0	0	0	0	0	0

3.2 Fish morphometry, lipid-levels and food web structure

Besides the apparent magnitude of input of contaminants to the ecosystem, contaminant concentrations in aquatic biota are to large degree driven by variations in individual size, age, trophic level in the food web (reflected in the $\delta^{15}N$ and calculated TL), as well as lipid content (Bjerregaard, 2005). Although often co-occurring, accumulation related to variation in individual size and age are inherently different than mechanisms related to biomagnification. Biomagnification is the increase of a contaminant up the food chain due to transfer of contaminants from one trophic level to the next, also referred to as trophic transfer. In addition, habitat use, i.e. where in the ecosystem an organism feed and which carbon sources they rely upon, reflected by the $\delta^{13}C$, may also impact on organism contaminant concentrations (Power et al., 2002). We have added data related to individual size (in fish

only), lipid content, trophic level ($\delta^{15}N$) and preferred feeding habitat ($\delta^{13}C$) in sampled biota for 2019 (Table 4) and for 2013-2019 and (Table 5) in order to explore the relationships between these predictors and measured contaminant concentrations in the biota.

Table 4. Length (cm), weight (g), lipid content (%), and stable N- and C- isotopes ($\delta^{15}N$, $\delta^{13}C$) for samples of fish (muscle), Mysis and zooplankton from 2019 in Lake Mjøsa. The mean ($\bar{x}$), and number(n) of samples are shown.

2019			Length, cm	Weigth, g	$\delta^{15}N$, ‰	$\delta^{13}C$, ‰	Lipid, %
Species		n	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$
Mjøsa	Zooplankton epi.	3			**6.6**	**-27.4**	**0.3**
	Mysis	3			**9.8**	**-29.5**	**1.7**
	Vendace	5	**18.3**	**34.3**	**13.4**	**-27.9**	**1.5**
	E. smelt	10	**10.9**	**21.5**	**15.0**	**-27.2**	**1.5**
	Brown trout	15	**70.6**	**4280**	**15.5**	**-27.4**	**3.0**
Femunden	Brown trout	10	**40.1**	**712.2**	**9.8**	**-22.8**	**1.1**

Table 5. Length (cm), weight (g), lipid content (%), and stable N and C isotopes ($\delta^{15}N$, $\delta^{13}C$) for samples of fish (muscle), Mysis and zooplankton from 2013-2019 in Lake Mjøsa. The mean ($\bar{x}$), and number(n) of samples are shown.

2013-2019			Length, cm	Weigth, g	$\delta^{15}N$, ‰	$\delta^{13}C$, ‰	Lipid, %
Species		n	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$
Mjøsa	Zooplankton epi.	**15**			**6.9**	**-28.5**	**0.3**
	Zooplankton hypo.	**6**			**12.2**	**-32.5**	**4.7**
	Mysis	**17**			**10.5**	**-30.5**	**3.0**
	Vendace	**37**	**19.4**	**58.9**	**13.3**	**-29.4**	3.4
	E. smelt	**78**	**15.5**	**33.8**	**14.9**	**-28.0**	**1.3**
	Brown trout	**104**	**67.0**	**3805**	**15.6**	**-28.1**	**2.9**
Femunden	Brown trout	**90**	**41.7**	**783.6**	**9.7**	**-22.8**	**1.0**

Mean length in brown trout from Lake Mjøsa sampled from 2013 to 2019 was 70.6 cm and mean weight 4.3 kg, while for brown trout sampled from Lake Femunden the mean length and weight was 40.1 and 0.7 kg, respectively. This probably reflects that Lake Mjøsa has a denser population of large trout than Lake Femunden (Kraabøl et al., 2009; Sandlund et al., 2012). As is evident from the scatterplot (Figure 5), lipid concentration increases with length in trout in Lake Mjøsa. The mean lipid concentration is also higher in Lake Mjøsa compared to trout from Lake Femunden (Table 4 and Table 5). Mean % lipid content in Vendace caught in 2019 was around half of what has been recorded in previous years (Table 4 and Table 5). This is likely explained by this year's batch consisting of fish caught during spawning migration, i.e. with lowered condition factor and depleted lipid-levels.

Values for $\delta^{15}N$ will tend to increase upwards in the food web with an average of 3.4 ‰ for each trophic level (Minagawa and Wada, 1984; Vander Zanden and Rasmussen, 1999). In Lake Mjøsa, the mean $\delta^{15}N$ -values range from 6.9 in epipelagic zooplankton to 15.6 ‰ in brown trout in the sampled material from 2013 to 2019 (Table 5). This translates into~ 2.6 trophic levels given the 3.4 ‰ increase per trophic level. A typical pelagic foodchain in Lake Mjøsa, leading up to brown trout as the top predator, consist of epipelagic zooplankton as primary consumers of phytoplankton, via either predatory cladocerans and/or Mysis relicta (Mysis), which are again eaten by smaller fish species such as Vendace and or E.smelt (Figure 6). This is a simplified food chain as there likely is a large degree of omnivory

along the foodchain. For example, some of the pelagic copepod species are opportunistic omnivores, such as the large-bodied copepod *Limnocalanus macrurus*, which may also periodically display predacious behavior (Warren, 1985). The sample of hypolimnetic zooplankton in 2018, which consisted of mainly *L. macrurus* (~δ^{15}N of 13.15 ‰) suggested a high degree of predatory (Jartun et al., 2019). There may also be some enrichment to the δ^{15}N of the potential food sources (i.e. increased baseline δ^{15}N) for hypolimnetic zooplankton, such as in decaying and settling phytoplankton and/or particulate organic matter (POM) from allochthonous origins mediated via microbial links (Grey et al., 2001), as well as the infusion of δ^{15}N -enriched pool of inorganic N available for uptake by primary producers during mixing periods (Vander Zanden and Rasmussen, 1999; Post, 2002).

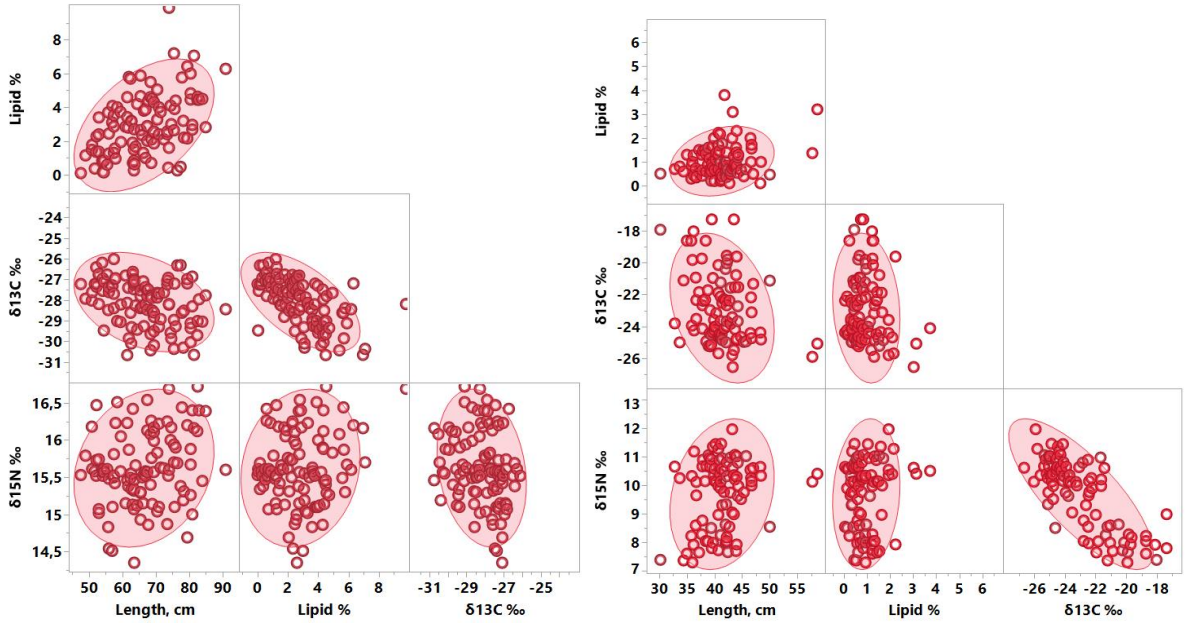

Figure 5. Correlation matrices between stable N- and C-isotopes (δ^{15}N, δ^{13}C), length and lipid content in brown trout from Lake Mjøsa (left) and Lake Femunden (right) sampled from 2013 to 2019. 90 % confidence elipses are shown for each pair of correlations.

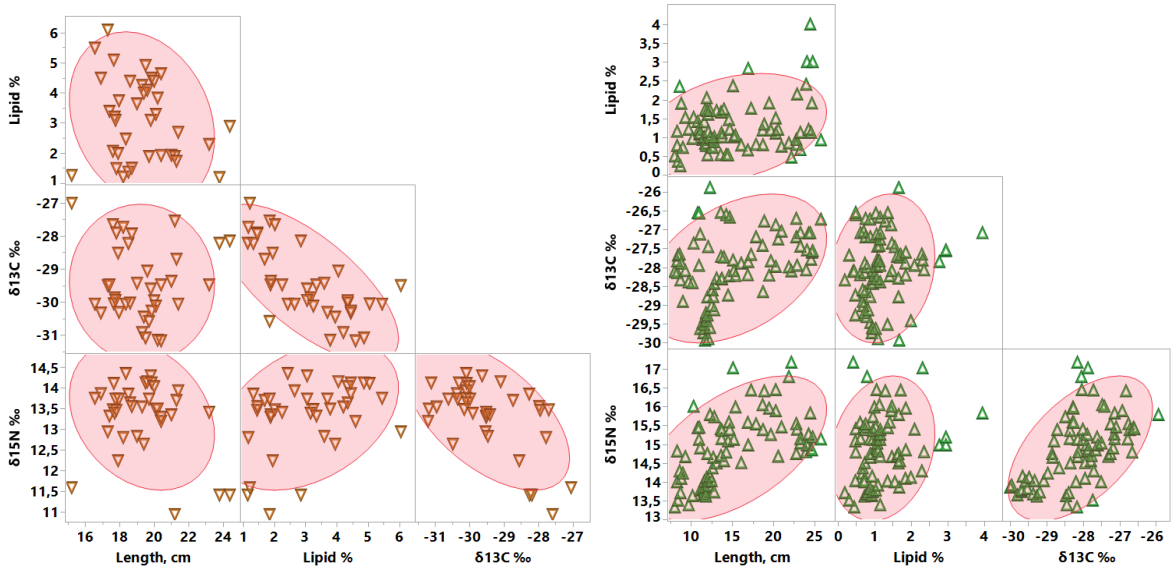

Figure 6. Correlation matrices between stable N- and C-isotopes ($\delta^{15}N$, $\delta^{13}C$), length and lipid content in vendace (left) and E. smelt (right) from Lake Mjøsa sampled from 2013 to 2019. 90 % confidence elipses are shown for each pair of correlations.

True planktonic primary consumers of Lake Mjøsa, on the other hand, is expected to have a $\delta^{15}N$ ~6 ‰ (Fjeld et al., 2017), however, as observed by Fjeld et al. (2016), primary consumer epipelagic zooplankton in Mjøsa vary between $\delta^{15}N$ 4.63 and 8.43 ‰. Annual variations may occur due to differences in nitrogen sources and accordingly baseline $\delta^{15}N$ (Vander Zanden and Rasmussen, 1999). Increasing C:N ratio, i.e. decreasing nitrogen content relative to carbon, in phytoplankton has also been found to increase the $\delta^{15}N$ in grazing primary consumer zooplankton Daphnia magna (Adams and Sterner, 2000). This also corresponds with a significant positive relationship between C:N ratios and $\delta^{15}N$ in epipelagic zooplankton ($\delta^{15}N$ ‰ = 3.14 + 0.93*C:N, R^2 = 0.45, p = 0.02), with significant variations in $\delta^{15}N$ ‰ among some years (Tukey-Kramer HSD, $p < 0.05$). Seasonal variations in $\delta^{15}N$ in phytoplankton was reported to vary less in phytoplankton, main food source to epipelagic zooplankton during summer (June-August), than POM in Lake Loch Ness, Scotland (Grey et al., 2001). This suggests that $\delta^{15}N$ in epipelagic zooplankton in Lake Mjøsa may potentially vary less within years than among years. Although there are significant variations in $\delta^{15}N$ ‰ among some years in other biota groups (Tukey-Kramer HSD, $p < 0.05$), the variations are less pronounced and year to year variations decreases up the food-chain (Figure 8).

Mysis, an important food source for several species of fish, appears from its isotopic composition (Figure 7 and Figure 8, see also below regarding $\delta^{13}C$) to rely mainly on a diet of epipelagic planktonic primary consumers, i.e. Daphnia spp. and Bosmina spp. (Kjellberg et al., 1991), but also to some degree on deep water omnivorous plankton species (copepods). Difference in trophic level between brown trout and E. smelt in Lake Mjøsa was quite low (0.9 ‰), which may be explained by the inclusion of some large, cannibalistic individuals up to 113 g in the sample batch of E. smelt. $\delta^{15}N$ for E. smelt increases with length, also indicating that large E. smelt become cannibals (Figure 6, right). For the trout there is less variation in trophic level ($\delta^{15}N$ -values) within the sampled length range, reflecting lesser variation in diet in the sampled trout (i.e. all are piscivores). In Lake Mjøsa there are plenty of

pelagic prey fish, including smaller sized species (e.g. E. smelt and vendace), meaning that a greater portion of trout can become piscivore at an early age compared to lakes with less smallsized pelagic prey fish, such as in Lake Femunden (Museth et al., 2018). In addition, Lake Mjøsa is more productive and has a more complex ecosystem structure than Lake Femunden, and thus longer food chains, which is reflected in a higher measured mean $\delta^{15}N$ for the Lake Mjøsa trout (15.6 ‰) compared to the trout from Lake Femunden (9.7 ‰).

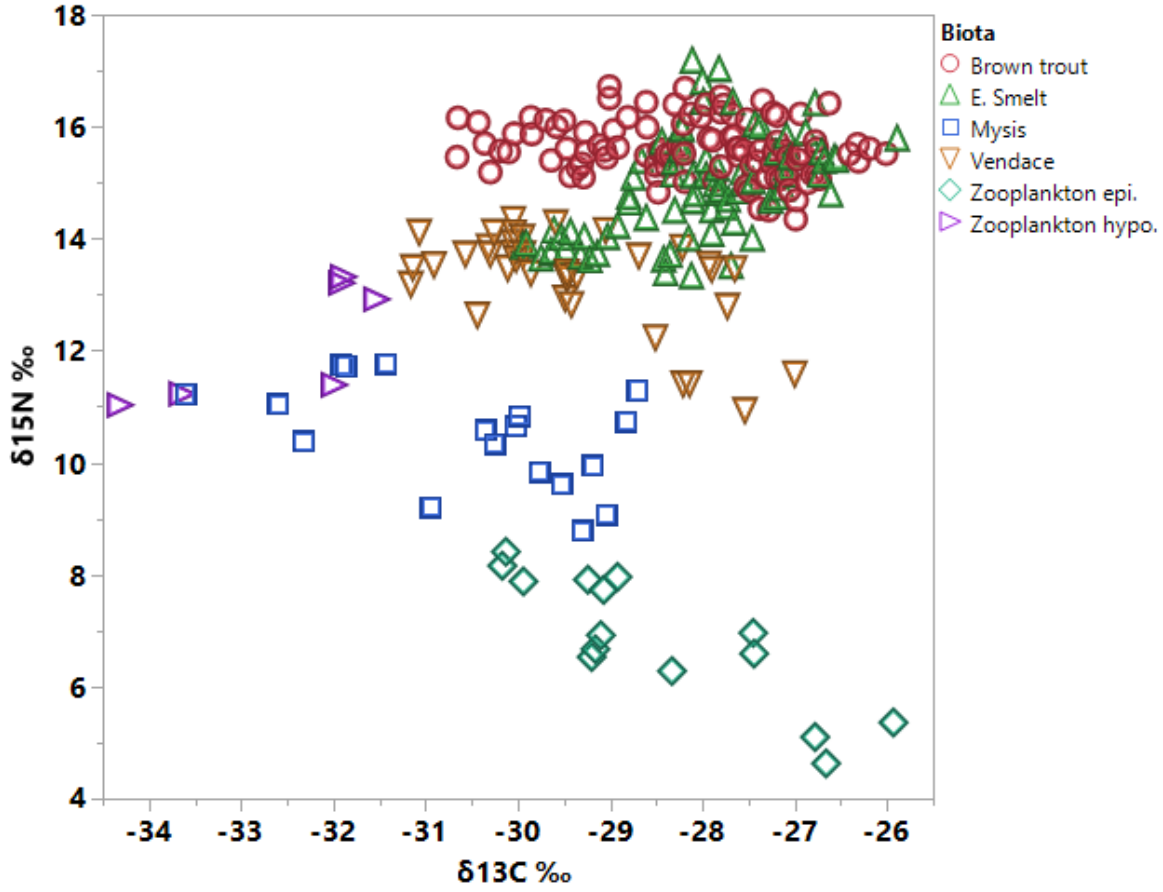

Figure 7. Relationships between measured $\delta^{15}N$ and $\delta^{13}C$ ‰ in biota sampled in Lake Mjøsa from 2013 to 2019. Zooplankton sampled from the upper strata (down to ~ 10 m) of the lake are defined as epilimnetic zooplankton (Zooplankton epi.), while zooplankton sampled from the deeper parts of the lake (50-80 m) are defined as hypolimnetic zooplankton (Zooplankton hypo.).

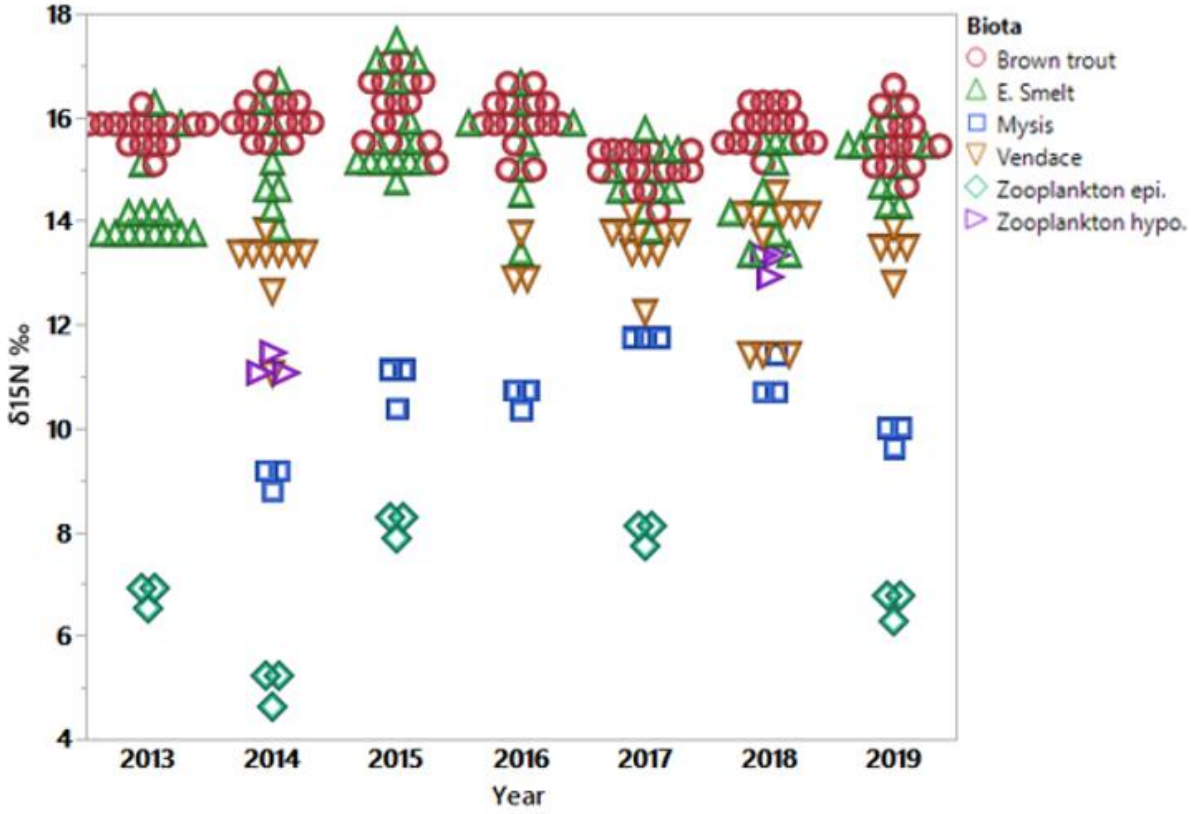

Figure 8. Year to year variations in measured $\delta^{15}N$ in sampled biota groups in Lake Mjøsa from 2013 to 2019. Zooplankton sampled from the upper strata (down to ~ 10 m) of the lake are defined as epilimnetic zooplankton (Zooplankton epi.), while zooplankton sampled from the deeper parts of the lake (50-80 m) are defined as hypolimnetic zooplankton (Zooplankton hypo.).

$\delta^{13}C$ values varies with different carbon sources, typically with around -27 ‰ for terrestrial, -20 ‰ for littoral, - 28 ‰ for pelagial and -30 ‰ for profundal carbon sources (Figure 7). As Lake Mjøsa is a large lake, and pelagic food webs are predominantly dependent on the primary production in phytoplankton, and likely to a lesser degree on allocthonous material (Post, 2002), and this is reflected in an overall pelagic signature in sampled biota. As zooplankton reflects the isotopic signature of their food, e.g. in phytoplankton, mechanisms governing isotopic ratios of ^{13}C to ^{12}C in dissolved inorganic carbon (DIC) affects $\delta^{13}C$ signature in phytoplankton. Indeed, observed fluctuations in the $\delta^{13}C$ of phytoplankton have been found to correspond with $\delta^{13}C$ in DIC (Jones et al. in prep in Grey et al., 2001). In general, increased productivity results in increased $\delta^{13}C$ in DIC (Herczeg 1987; Hollander and McKenzie 1991; Wang and Veizer 2000), whereas respiration has been considered to be the reason for declining $\delta^{13}C$ (more depleted), particularly in hypolimnetic waters during stratification (Quay et al. 1986; Miyajima et al. 1997). Significant differences in mean $\delta^{13}C$ (from- 26.5 to - 30.8 ‰) among years in sampled epipelagic zooplankton in Lake Mjøsa (Tukey-Kramer HSD, $p < 0.05$), may therefore be explained by variations in DIC $\delta^{13}C$, available for assimilation by phytoplankton, related to variations in production rates, and/or upwelling of water from hypolimnion with depleted $\delta^{13}C$ as a result of respiration. Lake Mjøsa is a well-mixed lake, especially in the main basin south-east of the Helgøya island (where annual samples are made), with a relatively deep and weakly developed thermocline

during the summer, and therefore prone to mixing with colder underlying water during periods of strong winds (Lyche-Solheim et al., 2018). Likely $\delta^{13}C$ in epipelagic zooplankton may vary between periods of wind induced mixing of epilimnion with deeper water and periods with more stagnant water and a more pronounced and stable epilimnion. Given that the isotopic turnover, or half-life of the isotopic signature of epipelagic zooplankton such as adult daphnids is ~15 days (Vander Zanden et al., 2015), a shift to either a more enriched or a more depleted $\delta^{13}C$ may follow after longer periods of strong winds or stagnation. In 2019 more than 95 % of each of the three samples of epipelagic zooplankton consisted of D.cristata, which is reflected in a rather low $\delta^{15}N$, i.e. trophic level, as well as an enriched mean $\delta^{13}C$ (mean $\delta^{13}C$ = -27.4) , indicating assimilation of DIC with increased $\delta^{13}C$. This coincided with a relatively long period (~ 3 weeks) of warm and calm weather, suggesting little mixing of surface water with deeper DIC $\delta^{13}C$ depleted water from the hypolimnion.

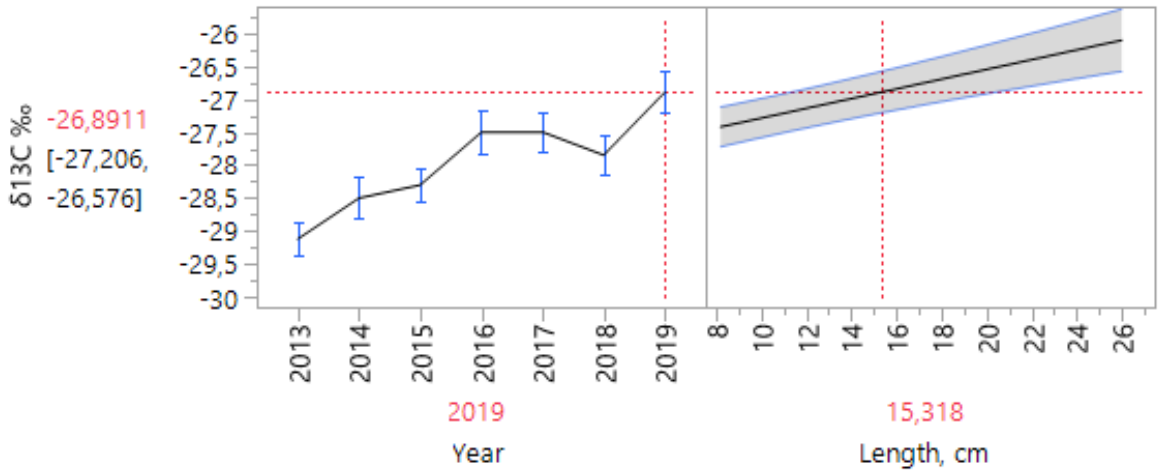

Figure 9. Length adjusted $\delta^{13}C$ ‰ (with 95 % confidence intervals) in E. smelt from Lake Mjøsa 2013-2019. E. smelt are adjusted to the geometric average length (15.3 cm) in the dataset. The figure to the right shows the variation in $\delta^{13}C$ ‰ with length for the last year in the analysis, 2019. Note that the figure to the right has the same y-axis unit as the figure to the left.

Allochthonous matter may incorporate a considerable part of the diet in some zooplankton species in Lake Mjøsa such as in the abundant copepod *Eudiaptomus gracilis*, as were reported in Loch Ness (Grey et al., 2001). During the winter months and early spring, before the growth season, copepods are more dependent on POM originating from allochthonous sources, which again should affect the isotopic signature in planktivorous fish during this period. However, epipelagic zooplankton such as daphnids are present in samples 0-50 meters, mainly in the period June-September (Lyche-Solheim et al., 2019), and are likely a significant food source at the base of the pelagic food chain during summer months. It is therefore expected that this would have contributed significantly to the $\delta^{13}C$ in the sampled fish in our study, in particular in the smaller fish such as E.smelt and Vendace caught in the autumn. Isotopic turnover (half-life) in smaller fish (20-30 g) may be about 2 months (Weidel et al., 2011), i.e. a change in diet (isotopic signature in dietary items) will influence the signature of the predator after more than two months upon shift of the diet. In large fish such as the trout in this study, may have an isotopic

half-life of over 1 year, or even longer in slow growing fish (Hesslein et al. 1993), although many estimates on larger fishes are poorly constrained (Weidel et al., 2011). This means that the isotopic signature in large trout reflects a diet integrated over a longer period and therefore to a lesser degree vary among years due to variations at lower trophic levels, as also discussed above regarding annual variations in $\delta^{15}N$.

Data on trout from lake Mjøsa indicate that size increases with a more pelagic diet, as shown by the positive correlation between length and $\delta^{13}C$ (Figure 5). This reflects an overall pelagic piscivore diet in large trout. The annual mean $\delta^{13}C$ values for E. smelt from 2013 to 2019, adjusted for year to year variations in length, appears to be increasingly influenced by more enriched carbon sources. This may be explained by either variations in the baseline $\delta^{13}C$ in phytoplankton, following changes in DIC $\delta^{13}C$, or possibly increased reliance on terrestrial and or littoral derived carbon sources (Figure 9). However, in order to establish a more reliable hypothesis, more research on both isotopic signatures in both phytoplankton and catchment derived allochthonous matter, as well as analysis stomach sample and isotopic signatures of E.smelt food items, would be pertinent. The relatively strong significant correlation between ($\delta^{15}N$) and carbon source ($\delta^{13}C$) in Lake Femunden trout ($r = 0.77$, $p<0.05$), suggest that trophic level increases with a more pelagic diet (Figure 5, right). This may reflect variations in feeding strategies in the population, or also an ontogenetic niche shift from a predominantly littoral to more pelagic feeding at a certain size (Klemetsen et al., 2003). Since trout in Lake Mjøsa to a greater degree rely on more pelagic food sources than trout in Lake Femunden (Sandlund et al., 1992; Museth et al., 2018), the trout in Lake Mjøsa, tend to display lower, more negative, $\delta^{13}C$ -values.

3.3 Contaminant levels compared to EQS

Table 6 lists the contaminants with EQS values in the monitoring program for Lake Mjøsa and Lake Femunden and the concentrations detected in fish (biota) samples. QS_{biota} was considered for samples of brown trout muscle, except for PFOS and PFOA where the sample media was liver. The results for each contaminant are discussed in more detail in their respective chapter. Notice that the concentrations are given as *µg/kg* in the EQS table (Direktoratsgruppen vanndirektivet, 2018) and in Table 6, which corresponds to *ng/g* used throughout the rest of the report.

Comparing the concentrations of compounds found in the top predator brown trout in both lakes with their specified EQS, we see that the EQSs for PBDEs (ΣBDE_6=0.0085 µg/kg) and Hg (20 µg/kg) are exceeded for all samples. This is in compliance with previous years, see discussions in chapters 3.6 and 3.4, respectively. For PFOS, 3 out of 15 samples of brown trout in Lake Mjøsa exceeds the EQS (9.1 µg/kg), but the mean concentration of PFOS in brown trout from Lake Mjøsa (6.8 µg/kg) is below the EQS, see discussion in more detail under PFAS results in chapter 3.10.

The rest of the brown trout samples have concentrations of the specific compounds listed in the Water framework directive (Direktoratsgruppen vanndirektivet, 2018) below their respective EQS.

Table 6. EQS values from Norwegian water framework directive (WFD) (Direktoratsgruppen vanndirektivet, 2018) compared to results from Lakes Mjøsa and Femunden for the contaminants that fall under the WFD. Last column lists the number of samples (n) in total and above the EQS value. Results (Lake, concentration ranges and N) above EQS are all marked in **red** and the difference between Lake Mjøsa (M) and Femunden (F) is shown. Concentrations in µg/kg w.w. (ng/g w.w.).

	Biota (brown trout)			
Contaminant	**QS_{biota}**	**Concentration range (min- max) for Brown trout**		**n > QS_{biota}**
	µg/kg w.w.	*µg/kg w.w.*		*n*
PBDEs (ΣBDE_6)*	0.0085	**Mjøsa**	**1.6 – 14**	**15/15**
		Femunden	**0.11 – 0.90**	**10/10**
PFOS	9.1	**Mjøsa**	1.7 – **11**	**3/15**
		Femunden	1.7 – 4.3	0/10
PFOA	91.3	< LOQ		0/25
Nonylphenol**	3000	< LOQ		0/25
Octylphenol**	0.004	< LOQ		0/25
cVMS (D5)	15217	Mjøsa	2.6 – 99	0/15
		Femunden	< LOQ	0/10
Hg	20	**Mjøsa:**	**190 - 1500**	**15/15**
		Femunden:	**67 - 510**	**10/10**

* (ΣBDE_6): BDE-28, BDE-47, BDE-99, BDE-100, BDE-153, BDE-154.
** In 2019 phenols were determined in *bile* (Brown trout), and not fish muscle (suggested as preferred matrix for EQS evaluation).

3.4 Mercury (Hg)

3.4.1 Predictors for variations in mercury (Hg)

Mercury (Hg) is known to increase in fish by increasing size (Cidzdziel et al., 2002) and age (Stafford et al., 2004; Trudel and Rasmussen, 2006). Hg also has a high potential for biomagnification (i.e. mercury increase with trophic level), this is particularly the case for methylated Hg, MeHg. Several studies show that Hg increase with relative trophic level (TL) in fish (McIntyre and Beauchamp, 2007; Garcia and Carignan, 2005; Cabana and Rasmussen., 1994; Vander Zanden and Rasmussen, 1996). This means that in fish in the top of the food chain, MeHg comprise 90-95 % of the total Hg (Bloom, 1992; Bjerregaard, 2005). There are also variations in Hg accumulation between littoral and pelagic food webs, with reported increased bioaccumulation of Hg in pelagic food webs (Chételat et al., 2011) and higher Hg concentrations in pelagic fish compared to littoral fish at similar trophic levels (Power et al., 2002;

Gorski et al., 2003; Stewart et al., 2008). Hg also in general increases in biota with depth (Eagles-Smith et al., 2008; Stafford et al., 2004).

In Lake Mjøsa, the best predictors for variations in Hg in brown trout is length and trophic level, with significant positive relationships, i.e. Hg increases with length and trophic position in the trout from 2013 to 2019 (Figure 10). As we discussed in last year's report, we wanted to include age as a predictor for Hg from 2019 onwards, as we hypothesized that variations in Hg among years at a certain length may be influenced by large variations in age. As expected, age was positively correlated with length (r = 0.6, p<0,05) in our 2019 data, but not with Hg (r= 0.32, p > 0.05). This may be explained by increased somatic growth dilution (SGD) in some large individuals, while the condition factor (weight by length) increases with age (r = 0.51, p < 0.05) in the data. However, this dataset is small (N=15) so firm conclusions on this relationship cannot not be made at this stage.

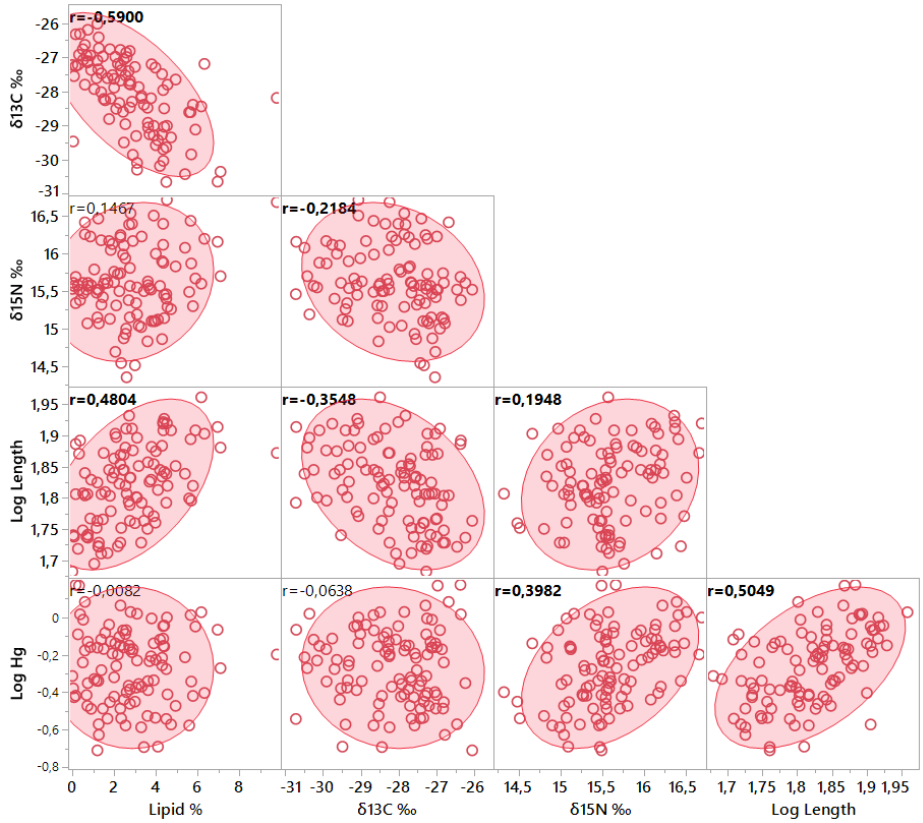

Figure 10. Correlation matrices between stable N- and C-isotopes ($\delta^{15}N$, $\delta^{13}C$), Loglength, lipid content and LogHg in brown trout from Lake Mjøsa sampled from 2013 to 2019. 90 % confidence ellipses are shown for each pair of correlations, and correlations (Pearson's r). All correlations in bold are significant (p<0.05).

In E.smelt the strongest predictors for variations in Hg are size (as length) and trophic level, with significant increase in Hg with both predictors (Figure 11). Variations in $\delta^{13}C$ also influence upon variations in Hg, with increased Hg with a more enriched $\delta^{13}C$ signature. This suggests an increased accumulation of Hg with increased reliance on terrestrial and or littoral derived carbon sources, as suggested in chapter 3.2. However, to strenghten this as a hypothesis, more in-depth analysis of diet and isotopic signature of allocthonous derived POM would be needed. As Hg transport into lake Mjøsa

largely originate from catchment runoff this could be a relevant pathway of increased Hg in allocthonous derived foodchains versus foodchains based on autocthonous production. However, signatures in $\delta^{13}C$ phytoplankton, and subsequently in epipelagic zooplankton, also varies substantially. There are also strong indications that accumulation of Hg is increased in pelagic versus littoral foodchains (Chetelat et al., 2011; Stewart et al., 2008; Økelsrud et al., 2016). Lake Mjøsa is a large and well mixed lake, and likely the transport and fate of Hg in the lake is complex with mixing across both vertical and horizontal axes. The significant correlation between $\delta^{15}N$ and $\delta^{13}C$, as well as both with length and Hg, may also indicate that large predatory E.smelt may integrate its diet across both pelagic and littoral foodchains, and that these individuals strongly influence on the adressed relationships.

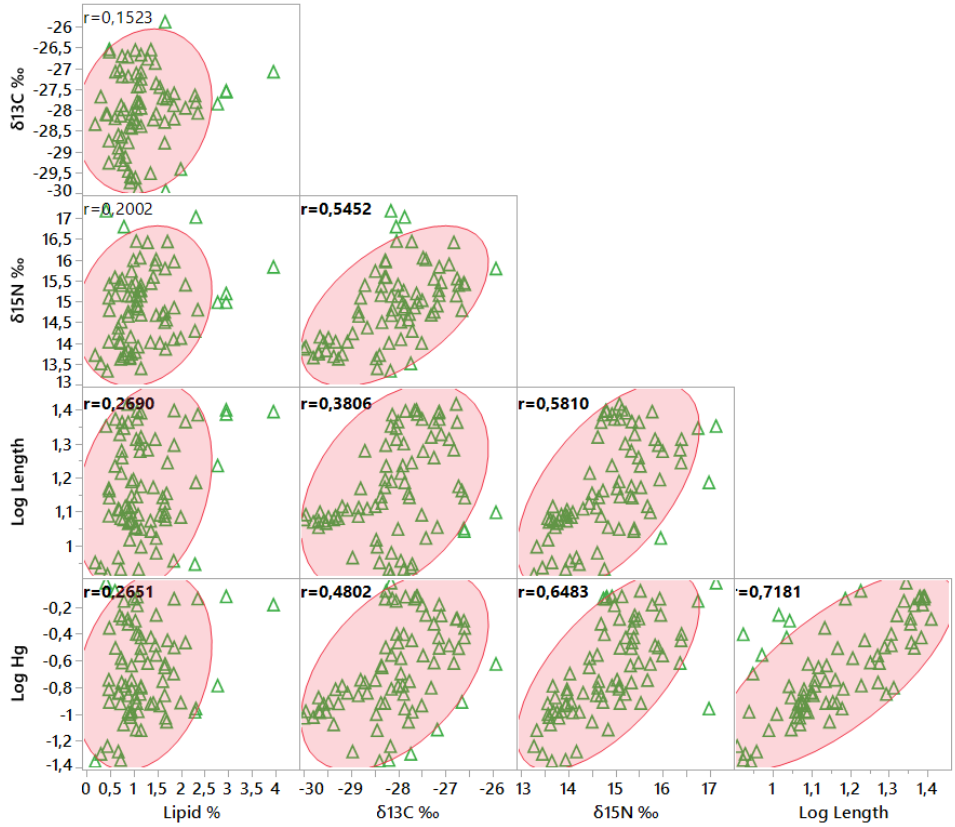

Figure 11. Correlation matrices between stable N- and C-isotopes ($\delta^{15}N$, $\delta^{13}C$), Loglength, lipid content and LogHg in E.smelt from Lake Mjøsa sampled from 2013 to 2019. 90 % confidence elipses are shown for each pair of correlations, and correlations (Pearson's r). All correlations in bold are significant ($p<0.05$).

Vendace differs from both brown trout and E.smelt in dietary sources, as vendace is mainly a pelagic zooplankton specialist whereas both brown trout and E.smelt have diets varying from zooplankton, litoral benthos and fish. This is evidient from both an overall pelagic signature as well as being at a lower trophic level, compared to brown trout and E.smelt. Length is the only significant predictor for variation in Hg, with increased Hg with length. It should be noted that age, which is a potential predictor for Hg variations in fish, was not included in the above correlation analysis. Age was determined for the sampled trout from 2019. As little variance is explained by trophic level, most likely age is a strong contributer to Hg accumulation in the sampled size-range of vendace. As can be seen

by the strong correlation between lipid % and $\delta^{13}C$, fat increases with a more pelagic signature (diet), however lipid % is not a strong predictor for Hg in vendace (Figure 12), nor in the other two sampled fish species (Figure 10 and Figure 11). This relates to the strong capacity of Hg (mono-methyl-Hg) to bind to sulfhydryl (SH) groups in cysteine residues of proteins and enzymes in muscle and therefore to a stronger degree accumulate in muscle rather than in fatty tissues (Pelletier, 1995; Bjerregaard 2005; Kuwabara et al., 2007), in contrast to several lipophilic organic pollutants (Bjerregaard, 2005).

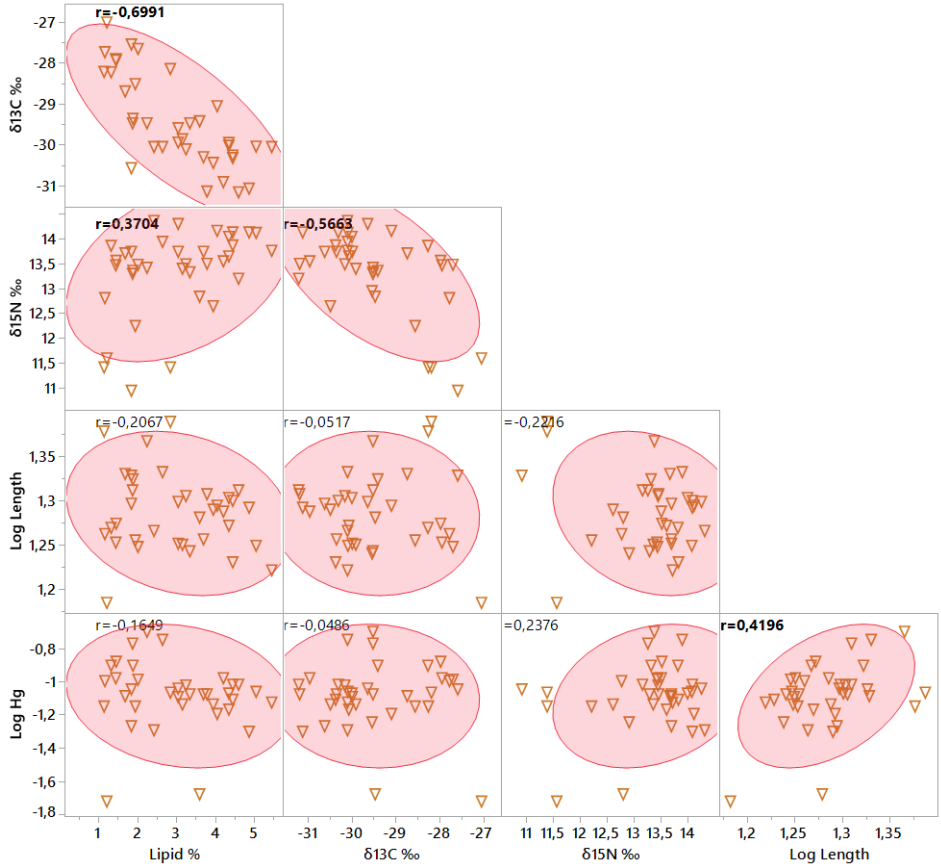

Figure 12. Correlation matrices between stable N- and C-isotopes ($\delta^{15}N$, $\delta^{13}C$), Loglength, lipid content and LogHg in vendace from Lake Mjøsa sampled from 2013 to 2019. 90 % confidence ellipses are shown for each pair of correlations, and correlations (Pearson's r). All correlations in bold are significant ($p<0.05$).

Whereas $\delta^{13}C$ is not a strong predictor for Hg in Lake Mjøsa trout, the opposite is the situation for Lake Femunden trout. Whereas most trout in Lake Mjøsa are pelagic piscivore, the fish sampled from Lake Femunden have a larger spread in $\delta^{13}C$, which suggests more variation in feeding habitat, from littoral area to open waters. There is a strong correlation between $\delta^{15}N$ and $\delta^{13}C$ in Femunden trout, and indeed the data clusters into two groups, indicating an ontogenetic shift from mainly littoral to mainly pelagic feeding (becoming predominately piscivores) which leads to an increase in trophic level (increased $\delta^{15}N$) , as well a more pelagic signature (more depleted $\delta^{13}C$). This again increases the bioaccumulation through the increased pelagic diet (Chételat et al., 2011). As discussed previously this shift is not seen in the Lake Mjøsa trout while all sampled fish likely are pelagic piscivores. Although there is a significant positive correlation between Hg and length, the correlation is weaker than that for $\delta^{15}N$ and $\delta^{13}C$ with Hg. Suggesting that the change of feeding habitat and diet has a stronger effect

on variation in Hg, than size in Lake Femunden. As with the sampled fish in Lake Mjøsa, % lipid is not a significant predictor for variation in Hg in brown trout in Lake Femunden (Figure 13), likely related to mechanisms discussed above.

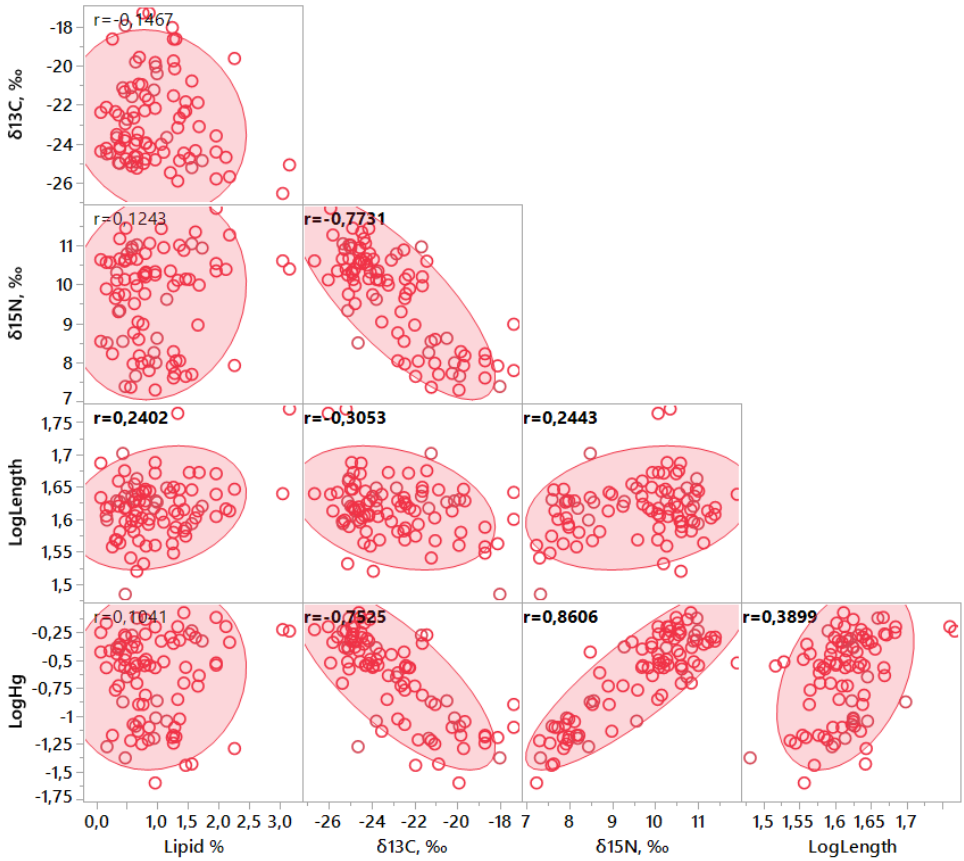

Figure 13. Correlation matrices between stable N- and C-isotopes ($\delta^{15}N$, $\delta^{13}C$), Loglength, lipid content and LogHg in brown trout from Lake Femunden sampled from 2013 to 2019. 90 % confidence elipses are shown for each pair of correlations, and correlations (Pearson's r). All correlations in bold are significant ($p<0.05$).

Statistical models (covariance analyses) on significant ecological and morphometric predictors for Hg variations in trout from Lake Mjøsa and Lake Femunden, equation 1 and 2 respectively, indicate that more of the variation may be explained by such factors in the Lake Femunden trout than in Lake Mjøsa trout (Table 7 and Table 8). In Lake Mjøsa trout differences in trophic level ($\delta^{15}N$) and size (length) explained 37 % of the Hg variation, while in Lake Femunden trophic level, carbon source ($\delta^{13}C$) and size explained 79 % of the variation in the Hg in the trout. This suggest that more of the Hg in the Lake Mjøsa trout is explained by non-ecological factors, i.e. more dependant on variations in bioavaialable Hg than in Lake Femunden trout. This is also a probable scenario, while there are likely both more legacy-Hg in both the catchment of Lake Mjøsa as well as in lake sediments, compared to in Lake Femunden. The lower model-intercept for Lake Femunden compared to for Lake Mjøsa, also suggest lower mercury levels at the bottom of the food chain compared to in Lake Mjøsa. However, for firm conclusions on this, sampling of prey items for the Lake Femunden trout would be pertinent.

Equation 1: $LogHg_{Lake\ Mjøsa\ trout} = a + b_1 (\delta^{15}N) + b_2 (log\ length)$

Equation 2: : $LogHg_{Lake\ Femunden\ trout} = a + b_1 (\delta^{15}N) + b_2 (log\ length) + b_3 (\delta^{13}C)$

Table 7. Statistical model (ANCOVA) explaining total Hg concentrations (mg/kg ww) in brown trout in Lake Mjøsa from 2013-2019. The term estimate refer to the parameters given in equation 1 above.

Term		Response: log Hg		
		$R^2 = 0.37$	n = 105	
		d.f. = 2, 102	p < 0.0001	
		Estimate	tRatio	Prob > |t|
a	Intercept	-4.8773	-7.97	<.0001
b_1	$\delta^{15}N$	0.1300	3.99	0.0001
b_2	log length	1.4149	5.53	<.0001

Table 8. Statistical model (ANCOVA) explaining total Hg concentrations (mg/kg w.w.) in brown trout in Lake Femunden from 2013-2019. The term estimate refer to the parameters given in equation 2 above.

Term		Response: log Hg		
		$R^2 = 0.79$	n = 90	
		d.f. = 3. 86	p < 0.0001	
		Estimate	tRatio	Prob > |t|
a	Intercept	-13.4373	-8.29	<.0001
b_1	$\delta^{15}N$	0.5008	8.76	<.0001
b_2	log length	3.4174	3.25	0.0016
b_3	$\delta^{13}C$	-0.0682	-2.09	0.0396

3.4.2 Mercury levels in 2019

Mean Hg in trout muscle from both Lake Mjøsa (0.60 mg/kg) and Lake Femunden (0.26 mg/kg) was higher in 2019 (Table 9) compared to 2018, which had lower mean Hg concentrations than all previous years sampled (in Lake Mjøsa from 2006 and in Lake Femunden from 2013). The mean concentrations in brown trout in Lake Mjøsa in 2019 equals the mean for all sampled previous years. In Lake Femunden the mean concentration of Hg for 2019 was lower than the average for the years 2013-2018 (0.32 mg/kg w.w). As reported for the 2018 data (Jartun et al., 2019) we could not find any obvious reason for the unusually low mean concentration in the predictors tested for Lake Mjøsa, as both size trophic level and carbon sources were close to average for previous years. While the mean Hg concentration in 2019 was around the same as for the previous years in Lake Mjøsa, the average for strong predictors such as trophic level and length was above that for previous years, with mean $\delta^{15}N$ (16.5 ‰) and mean length (70.6 cm) for 2019, compared to the mean $\delta^{15}N$ (15.3 ‰) and the mean length (62.8 cm) for the years 2006 to 2018. Length is proven to be a significant positive predictor for variations in Hg. As there are variations in size in sampled trout from year to year, adjustment to a common size in the data is pertinent in order to reflect the true variations in Hg concentrations among years. This is further

discussed below. Variations in year to year biomagnification of Hg is also discussed below. E. smelt in Lake Mjøsa naturally varies in Hg because of the inclusion of a few large cannibalistic individuals up to 26 cm (in the 2018 sample), that are also higher up in the food chain. For most years though sizes of individuals in the samples are relatively homogenous and mainly consist of individuals around 14 cm (± SD = x cm). Hg concentrations in vendace are low, and reflects a diet mainly consisting of zooplankton. Mysis which is an important dietary source for pelagic fish in Lake Mjøsa is at level with the EQS for mercury at 0.02 mg/kg Hg. Hg concentrations in zooplankton are all below this EQS threshold.

Table 9. Hg concentrations (mean, min, max) in mg/kg w.w. in zooplankton, Mysis, and fish from Lake Mjøsa, and brown trout from Lake Femunden. Values for mean length (cm) and weight (g) are included for fish. Data are from 2019.

2019	Sample	n	x̄	Min	Max	Length, cm (x̄)	Weight, g (x̄)
Mjøsa	Brown trout	15	0.60	0.20	1.49	70.6	4280
	E. smelt	10	0.31	0.09	0.55	10.9	21.5
	Vendace	5	0.11	0.10	0.13	18.3	34.3
	Mysis	3	0.011	0.001	0.012		
	Zooplankton	3	0.003	0.002	0.005		
Femunden	Brown trout	10	0.26	0.07	0.51	40.1	712

3.4.3 Biomagnification of Hg, Hg accumulation by size and time trends in Hg concentrations

Annual trophic magnification factors (TMFs) for mercury (Hg) was calculated, including all sampled biota (zooplankton, *Mysis* and fish), for each year from 2013 to 2019, Figure 14. In order to calculate a common TMF for a longer period (2013 – 2018) we checked for differences in annual trophic magnification slopes (TMS, i.e. slope (b) of the relationship between ln-transformed Hg concentrations and the measured biota $\delta^{15}N$), by formulating an ANCOVA, allowing for interactions between year and TMS. We also checked the model for any significant differences in intercepts between years. Measured $\delta^{15}N$ in the combined data from 2013 to 2019 ranged from 4.63 to 17.17 ‰, thus above the recommended minimum $\delta^{15}N$ range (at least three trophic levels) in biota for proper TMF calculations (Borgå et al., 2011).

The ANCOVA model testing interactions between year and trophic magnification slope (TMS) indicated that the TMS differed significantly among years (test for different slopes, $F_{(6,257)} = 5.13$, $p<0.0001$) as did the annual intercepts ($F_{(6,257)} = 5.0$, $p=0.0001$). The trophic magnification factor (TMF) is a measure of average increase of a contaminant (e.g. Hg) per trophic level, thus a decrease in the $\delta^{15}N$ range in measured biota, will naturally increase the calculated TMF, given that contaminant concentrations in biota at the minimum and maximum of the measured range are equal, or close to equal. The measured Hg range among years differed less than the range of measured $\delta^{15}N$, which in part explains the great variations in TMF among years. The shorter measured $\delta^{15}N$ range for some years is a result of the lack of true primary consumers. As mentioned in 1.1, annual fluctuations from 2013 to 2019 occur in sampled primary consumer $\delta^{15}N$ signatures (range: 4.63-8.43), likely as a result of variations in nitrogen sources influencing the isotopic signature in phytoplankton. Nevertheless, the calculated TMF for all

years included is not influenced by these annual variations, and probably reflects the best estimate for TMF of Hg in the lake.

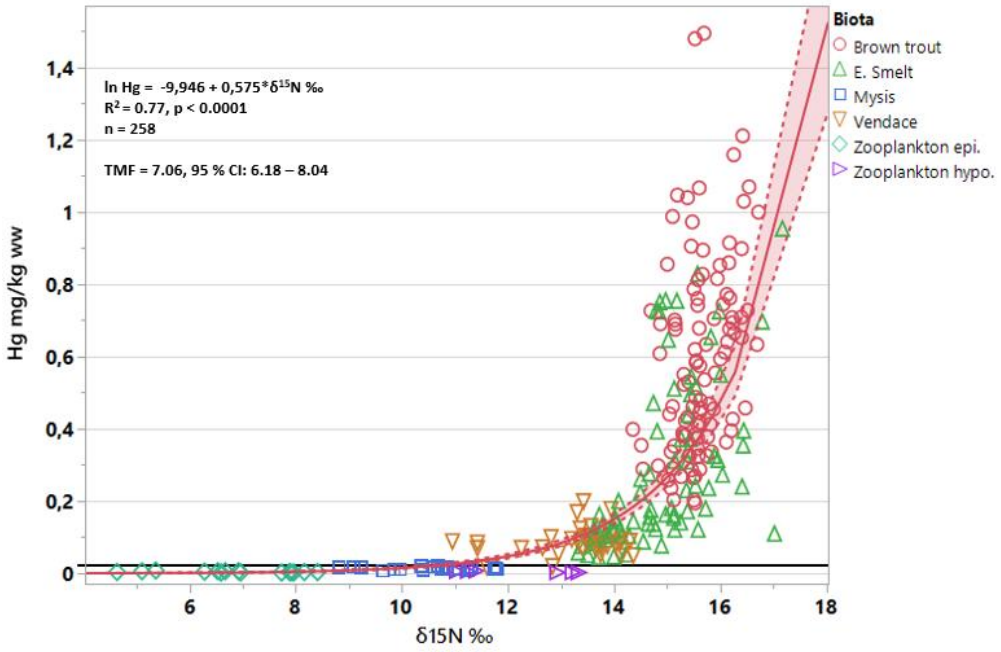

Figure 14. Exponential regression, with 95 % confidence level, of Hg concentrations in Lake Mjøsa biota from 2013 to 2019 as a function of measured $\delta^{15}N$. Prediction formula and estimated TMF with 95 % confidence level are shown above the regression curve. The horizontal line (bold) indicate the EQS for mercury at 0.02 mg/kg Hg.

Table 10. Minimum (min) and maximum (max) concentrations of Hg mg/kg, min and max values of stable N isotopes ($\delta^{15}N$, ‰), approximate numbers of trophic levels (TL), and calculated TMFs for sampled biota in Lake Mjøsa for each individual year from 2013 to 2019 and number (n) of samples are shown.

Year (n)	2013 (33)	2014 (41)	2015 (36)	2016 (30)	2017 (41)	2018 (41)	2019 (36)
Hg mg/kg, min-max	0.006-0.83	0.004-0.91	0.004-1.2	0.020-1.2	0.003-1.5	0.003-0.91	0.001-1.49
$\delta^{15}N$, min-max	6.5-16.2	4.6-16.5	7.9-17.2	10.3-16.5	7.7-15.5	10.7-16.2	6.3-16.5
~ TL	2.8	3.5	2.7	1.8	2.3	1.6	3.0
TMF	5.8	4.9	8.6	8.5	13.2	13.1	7.2

Length is a well-known predictor for Hg concentrations in fish, in general with increasing Hg with length (Økelsrud et al., 2016; Olk et al., 2016; Olsen et al., 2019). We have added data from previous years to investigate the correlation between length and Hg in a larger dataset for Lake Mjøsa (Figure 15) and Lake Femunden (Figure 16). We also present the length adjusted (to geometric mean length) Hg concentrations for each of the years sampled in Lake Mjøsa (Figure 17). Based on the entire dataset for Lake Mjøsa from 2006-2019, in average the trout will reach the EU's and the Norwegian recommended upper consumption limit of 0.5 mg/kg w.w. in fish muscle at around 57 cm, which corresponds to ~ 2.1 kg. For Lake Femunden the trout based on data from 2013 to 2019 will reach the 0.5 mg/kg w.w. limit at around 52 cm, and ~ 1.25 kg. While this is an estimate of the average length at the consumption limit, there are certainly individual fish with both above and below 0.5 mg/kg w.w.

at this length. In addition, there are greater uncertainties in this estimate for Lake Femunden due to the large span between lower and upper 95 % confidence limits (Figure 16).

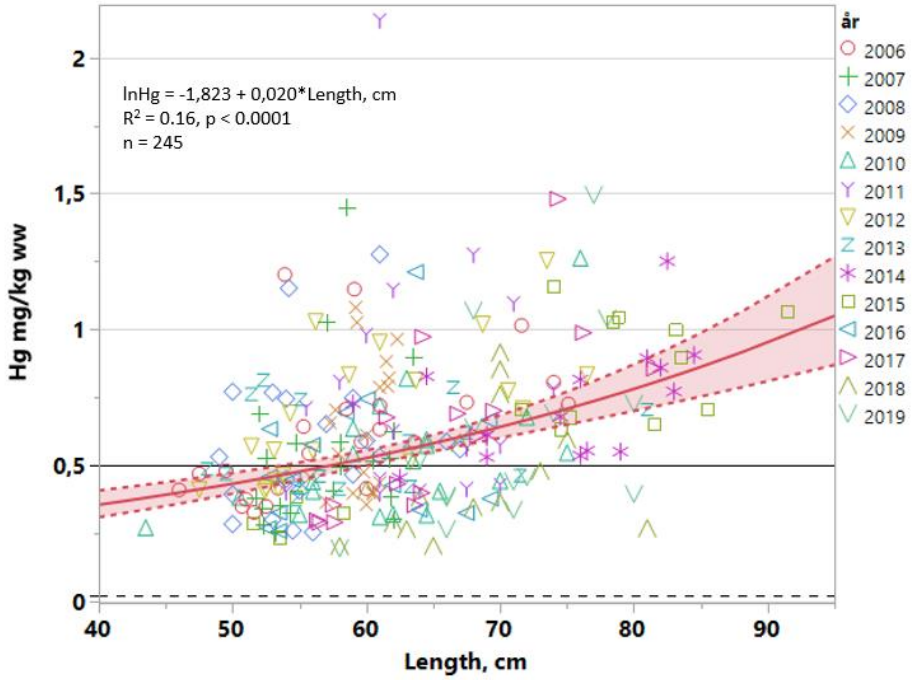

Figure 15. Regression analysis of length and Hg (with 95 % confidence level) in trout from Lake Mjøsa sampled from 2013 to 2019. Horizontal lines at 0.5 mg/kg Hg (solid line, upper consumption limit) and the EQS for mercury at 0.02 mg/kg Hg (dashed line).

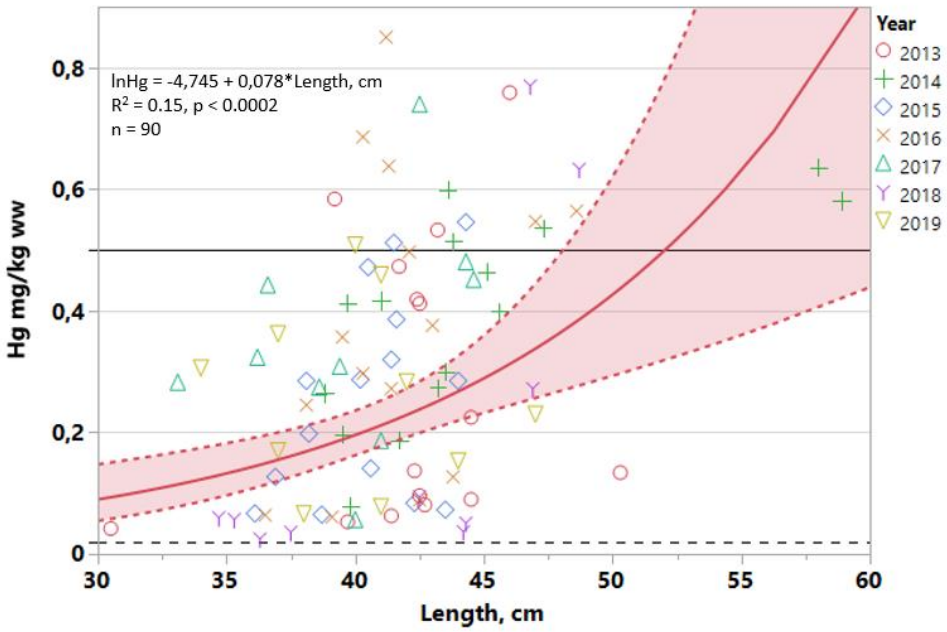

Figure 16. Regression analysis of length and Hg (with 95 % confidence bands) in trout from Lake Femunden sampled from 2013 to 2019. Horizontal lines at 0.5 mg/kg Hg (solid line, upper consumption limit) and the EQS for mercury at 0.02 mg/kg Hg (dashed line).

Length adjusted mean Hg in trout in Lake Mjøsa has decreased in the years after 2012, and the length adjusted mean Hg concentrations in the seven years between 2006 and 2012, except for 2010, are all higher than the length adjusted mean Hg concentrations in the following seven years from 2013 to 2019 (Figure 17). It's worth remarking that if we look at a longer timeframe, mean length adjusted Hg in trout in Lake Mjøsa also varied in the years prior to 2006. In 1979-80 length adjusted Hg was 1.4 mg/kg (adjusted to 58 cm), which after it dropped down to around 0.5 mg/kg in 1982-84, and from 1998 to 2005 it was stable around 0.4 mg/kg, where it increased to about 0.6 mg/kg (Fjeld et al., 2016). The very high Hg concentrations in 1979/80 was attributed to emissions from the local pulp and paper industry (Fjeld et al., 2016). Fluctuations in Hg in trout that follow in the years after, are more difficult to find any apparent reasons for, while the emissions in Norway has dropped with 80 % since 1995 (https://miljostatus.miljodirektoratet.no/kvikksolv) and deposited long range transported transboundary elemental Hg (Hg^0) from 1990 to 2013 has decreased by 1-2 % per year in North-America and Europe (Zhang et al., 2019). Yearly emissions in the years 2013-2015 from the three largest local water treatment plants, situated in the north, west and east, ranged from 0.1 to 0.5 kg (Garmo et al., 2017). Likely these relatively low concentrations mirror the general ban on mercury in products in Norway from 2008. Results from studies on sediment profiles in Lake Mjøsa also reflects a decrease in Hg depositions from 1960s to around 2003, and furthermore that Hg from local sources have declined relatively more than long-range transported Hg in this period (Rognerud, 1985; Fjeld et al., 2004).

Both the reduction in local emissions and deposits from long-range transported Hg has led to consistent declines in measured Hg in fish in boreal and subarctic Fennoscandia (Braaten et al., 2019). However, local variations in catchment properties and mechanisms related to release and transport of Hg stored in catchments soils (legacy-Hg), may lead to both temporal and geographical variations in fluxes of Hg into lakes (Braaten et al., 2018), with variations in Hg uptake in the food web and subsequently concentrations in fish (Stewart et al., 2008; Braaten et al., 2018). In addition, legacy-Hg from lake sediments may be remobilized as a result of sediment resuspension through strong currents (Rognerud, 1985) and/or disturbance of sediments through urban development, within the lake or adjacent to the lake shoreline. Hence, variations in Hg in fish populations may fluctuate despite the decreased reductions in emissions.

In our last report (Jartun et al. 2019) we suggested that the relatively low length adjusted Hg in brown trout in 2018 could be related to algal bloom dilution, ABD (Pickhardt et al., 2002, 2005) which may dilute Hg up the food chain (Allen et al., 2005), and/or increased growth, also known as somatic growth dilution, SGD (Verta, 1990; Ward et al., 2010; Lepak et al., 2012). As we do not have data variations in growth (length by age) from earlier years this is only an assumption at this stage. However, annual fluctuations in biomass at lower trophic levels (zooplankton) may indicate some degree of correlation between increased biomass and lowered Hg. As reported in our last report (Jartun et al. 2019) Biomass concentrations of zooplankton in Lake Mjøsa were high in 2018, i.e. comparable to concentrations recorded in the 1980s (Solheim et al., 2019). Unpublished data from the monitoring program in Lake Mjøsa in 2019 (Solheim et al., 2020 in preparation) also indicate that the biomass concentrations of zooplankton in Lake Mjøsa were almost as high in 2019 as in 2018, with also a relatively low length adjusted Hg compared to previous years (up to 2018). Although the mechanisms contributing to Hg

concentrations in fish at the top of the food chains in Lake Mjøsa are many and complex, this may still be a contributing factor to the observed annual fluctuations.

We also include the timeseries for Femunden as a comparison (Figure 18). As the results show the length adjusted Hg in Lake Femunden is lower, due to the lower geometric average (41.4 cm) in the dataset. All annual averages at this length are below the recommended upper consumption limit of 0.5 mg/kg w.w. As length is not the strongest predictor for variations in Hg in Lake Femunden, likely fluctuations may partly be explained by variations in other strong predictors trophic level and dietary carbon source (as shown in the ANCOVA model). For example, the highest annual length adjusted Hg co-occurs with the highest annual mean $\delta^{15}N$ (2017: mean $\delta^{15}N$ = 10.2 ‰), while the lowest annual length adjusted Hg cooccurs with lowest annual mean $\delta^{15}N$ (2018: mean $\delta^{15}N$ = 8.5 ‰).

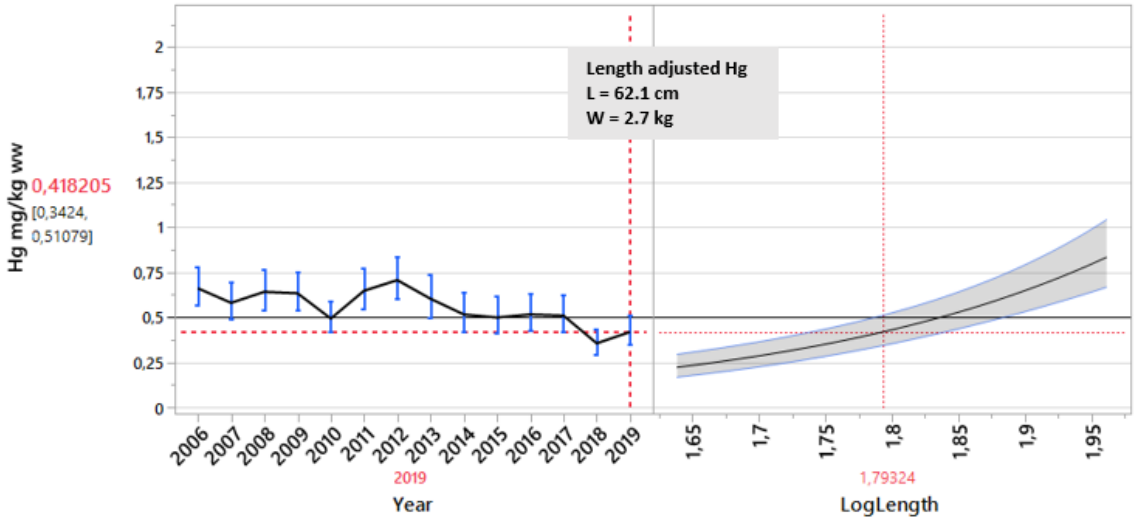

Figure 17. Length adjusted Hg (with 95 % confidence intervals) in trout from Lake Mjøsa 2006-2019. Trout are adjusted to the geometric average length (62.1 cm) in the dataset (~2.7 kg). Horizontal line at 0.5 mg/kg Hg (upper consumption limit) are added. Length adjusted mean Hg concentration (with 95 % confidence limits) for 2019 is marked with a red dashed line and numbers. Length adjusted Hg (with 95 % confidence intervals) for each individual year, together with mean metrics are added in Table 11 below.

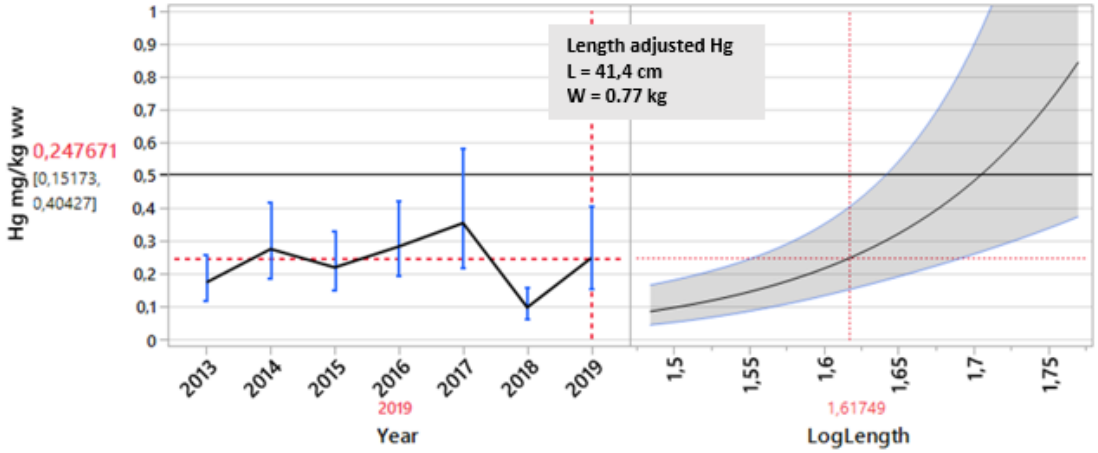

Figure 18. Length adjusted Hg (with 95 % confidence intervals) in trout from Lake Femunden (2013-2019). Trout are adjusted to the geometric average length (41.4 cm) in the dataset (0.77 kg). Horizontal line at 0.5 mg/kg Hg (upper consumption limit) are added. Length adjusted mean Hg concentration (with 95 % confidence limits) for 2019 is marked in red and with a red dashed line. Length adjusted Hg (with 95 % confidence intervals) for each individual year, together with mean metrics are added in Table 12 below.

Table 11. Length adjusted mean Hg (mg/kg w.w.) with 95 % confidence limits in brown trout from Lake Mjøsa from each individual year as shown in Figure 17. Corresponding Hg concentrations (mean (x̄), min, max) in mg/kg w.w. and values for mean length (cm) and weight (g) are included for fish from 2006-2019.

Year	n	Length adjusted mean Hg (mg/kg ww)	Lower 95 % CI	Upper 95 % CI	x̄	Min	Max	Length, cm (x̄)	Weight, g (x̄)
2006	22	0.66	0.56	0.78	0.61	0.33	1.20	58.1	2459
2007	20	0.58	0.49	0.69	0.55	0.25	1.45	56.8	2074
2008	20	0.64	0.54	0.76	0.59	0.25	1.28	56.1	2054
2009	20	0.63	0.53	0.75	0.63	0.36	1.08	59.7	2321
2010	20	0.49	0.42	0.58	0.52	0.27	1.26	62.1	2675
2011	18	0.65	0.54	0.77	0.77	0.40	2.14	64.2	2814
2012	20	0.71	0.59	0.83	0.68	0.41	1.26	59.6	2493
2013	15	0.60	0.50	0.73	0.57	0.38	0.81	59.6	2587
2014	15	0.52	0.41	0.63	0.73	0.45	1.25	74.6	5180
2015	15	0.50	0.41	0.61	0.72	0.24	1.16	73.0	5395
2016	15	0.52	0.42	0.63	0.52	0.26	1.21	59.3	2515
2017	15	0.51	0.42	0.62	0.63	0.29	1.48	65.3	3391
2018	15	0.36	0.29	0.43	0.46	0.20	0.92	67.7	3416
2019	15	0.42	0.34	0.51	0.60	0.20	1.50	70.6	4280

Table 12. Length adjusted mean Hg (mg/kg w.w.) with 95 % confidence limits in brown trout from Lake Femunden from each individual year as shown in Figure 18. Corresponding Hg concentrations (mean (x̄), min, max) in mg/kg w.w. and values for mean length (cm) and weight (g) are included for fish from 2013-2019.

Year	n	Length adjusted mean Hg (mg/kg ww)	Lower 95 % CI	Upper 95 % CI	x̄	Min	Max	Length, cm (x̄)	Weight, g (x̄)
2013	15	0.17	0.12	0.26	0.27	0.04	0.76	42.2	830
2014	15	0.27	0.18	0.42	0.39	0.08	0.64	44.6	891
2015	15	0.22	0.15	0.33	0.26	0.06	0.55	40.5	760
2016	15	0.28	0.19	0.42	0.38	0.06	0.85	41.6	767
2017	10	0.35	0.22	0.58	0.35	0.06	0.74	39.6	712
2018	10	0.10	0.06	0.43	0.20	0.02	0.77	41.7	756
2019	10	0.25	0.15	0.40	0.26	0.07	0.51	40.1	712

3.5 Cyclic volatile methylated siloxanes (cVMS)

3.5.1 Levels of cVMS in 2019

Concentrations of cyclic volatile methylated siloxanes (cVMS) were determined in zooplankton, *Mysis*, and in fish muscle of vendace, E. smelt and brown trout from Lake Mjøsa, and in brown trout from Lake Femunden.

Detection frequency for the individual cVMS (D4, D5 and D6) in the specific sample matrices is shown in Table 3. This is also shown in Table 13, where detections > LOQ are indicated with orange cells. D4 was only detected in brown trout from Lake Mjøsa (47 % of N), equivalent to 15 % of the total dataset (N=46), whereas D5 was detected above LOQ in all samples from Lake Mjøsa. Neither D4 nor D5 were detected > LOQ in Lake Femunden. D6 was detected in 90 % of the samples of higher trophic levels (vendace, E.smelt and brown trout) in Lake Mjøsa and in 80 % of the samples of brown trout in the reference Lake Femunden (8 out of 10 samples), but neither in zooplankton nor *Mysis* in Mjøsa.

Highest concentrations of cVMS were found in the top predator brown trout from Lake Mjøsa with D5 being the dominant compound in all matrices (Table 13, Figure 19). On a wet weight basis, the mean D5 concentration in brown trout muscle tissue from Lake Mjøsa was 38 ± 25 ng/g w.w. (1300 ± 690 ng/g lipid), only slightly higher than E. smelt and vendace with mean D5 concentrations 34±20 ng/g w.w. and 26 ± 10 ng/g w.w., respectively. On a lipid basis the mean D5 concentrations are higher in E.smelt (3100 ± 3500 ng/g lipid) and vendace (1800 ± 900 ng/g lipid) than in brown trout from Lake Mjøsa, but this a result of high variance in the lipid content in E. smelt and vendace in 2019, see chapter 3.2.

Siloxanes are used in a variety of products such as personal care products (PCP), detergents, paint and insulation, following that discharges from wastewater treatment plants (WWTP) might be a substantial source of siloxanes to freshwater recipients (Montemayor et al., 2013; Wang et al., 2009). The total amount of siloxanes imported to Norway in products was estimated to 475 tonnes in 2015 with D5 being the dominant chemical (Blytt and Stang, 2018). In a study of contaminants in sludge from Norwegian WWTPs, the total concentration of Σ(D4,D5,D6) has doubled between 2013 and 2018. All three cVMS have increased in sludge: D4 (10x), D5 (1.5 x) and D6 (30x), indicating a shift from D5 being the dominant cVMS (Blytt and Stang, 2018). This may indicate that the major sources of cVMS in Lake Mjøsa, but it does not account for the increase in D6 in brown trout from Lake Femunden with no discharges to the lake. Atmospheric deposition of cVMS is discussed in e.g. Xu and Wania (2013) and Bohlin-Nizzetto et al. (2019), but we do not know to which extent atmospheric deposition may be a significant source for cVMS in Lakes Mjøsa and Femunden.

The EQS value for D5 in biota is 15217 ng/g w.w. (Direktoratsgruppen vanndirektivet, 2018). No samples in either lake exceeded this value. The mean concentrations of D5 in vendace, E.smelt and

brown trout from Lake Mjøsa (1800, 3100 and 1300 ng/g, respectively) are all lower than those found in cod liver in the Oslofjord (3356 ng/g ± 1600 SD; Ruus et al., 2019). Fish muscle has so far been the preferred matrix for studying cVMS in Lake Mjøsa and Lake Femunden.

Table 13. Concentration range (min-max), mean ($\bar{x}$) and number (N) of detections for siloxanes (cVMS: D4, D5 and D6) in samples of zooplankton, Mysis, vendace, E. smelt and brown trout from Lake Mjøsa and brown trout from Lake Femunden in 2019. Left part of the table is ng/g on wet weight (w.w.) basis and the right part is ng/g on lipid basis. Concentrations below LOQ (w.w.) have been replaced by half the limit when calculating $\bar{x}$. "N>LOQ" is the number of samples above LOQ. Orange cells indicate that more than 50 % of the samples are above LOQ.

2019				Concentrations ng/g, wet weight, w.w.			Concentrations ng/g, lipid		
Lake	Matrix	N	Statistics	D4	D5	D6	D4	D5	D6
Mjøsa	Zoopl.	3	Range	<0.69	1.5 - 1.9	<1.08 - <1.89	93 - 150	510 - 780	150 - 330
			Mean, $\bar{x}$	0.35	1.7	0.68	120	600	240
			N>LOQ	0/3	3/3	0/3	0/3	3/3	0/3
	Mysis	3	Range	<0.69 - <1.76	4.8 - 5.5	<1.89	20 - 54	270 – 340	54 – 58
			Mean, $\bar{x}$	0.54	5.1	0.95	32	300	55
			N>LOQ	0/3	3/3	0/3	0/3	3/3	0/3
	Vendace	5	Range	<2.16 - <5.8	17 – 38	6.2 - 8.9	52 - 240	820 – 3000	300 – 590
			Mean, $\bar{x}$	1.4	26	6.9	100	1800	470
			N>LOQ	0/5	5/5	5/5	0/5	5/5	5/5
	E. smelt	10	Range	<0.93	12 – 74	<2.94 - 6.2	20 - 88	820 – 12000	84 – 920
			Mean, $\bar{x}$	0.47	34	3.6	36	3100	310
			N>LOQ	0/10	10/10	7/10	0/10	10/10	7/10
	B. trout	15	Range	<0.34 - 1.75	2.6 – 99	1.7 - 7.7	5.8 - 140	460 – 2800	61 – 650
			Mean, $\bar{x}$	0.72	38	4.9	33	1300	230
			N>LOQ	7/15	15/15	15/15	7/15	15/15	15/15
Femunden	B. trout	10	Range	<2.16	<2.0	<2.4 – 5.8	49 - 310	45 - 290	145 - 1600
			Mean, $\bar{x}$	1.08	1.0	4.75	130	120	610
			N>LOQ	0/10	0/10	8/10	0/10	0/10	8/10

Figure 19 shows the concentrations of D4, D5 and D6 on lipid weight basis in all matrices in Lake Mjøsa and Lake Femunden in 2019. Limit of detection and quantification (LOD/Q) for the individual cVMS varied between sample matrices, but also within each matrix, indicated with red triangles. It is observed that the mean D5 concentration are higher in E.smelt and Vendace compared to brown trout in Lake Mjøsa, however the difference is not significant.

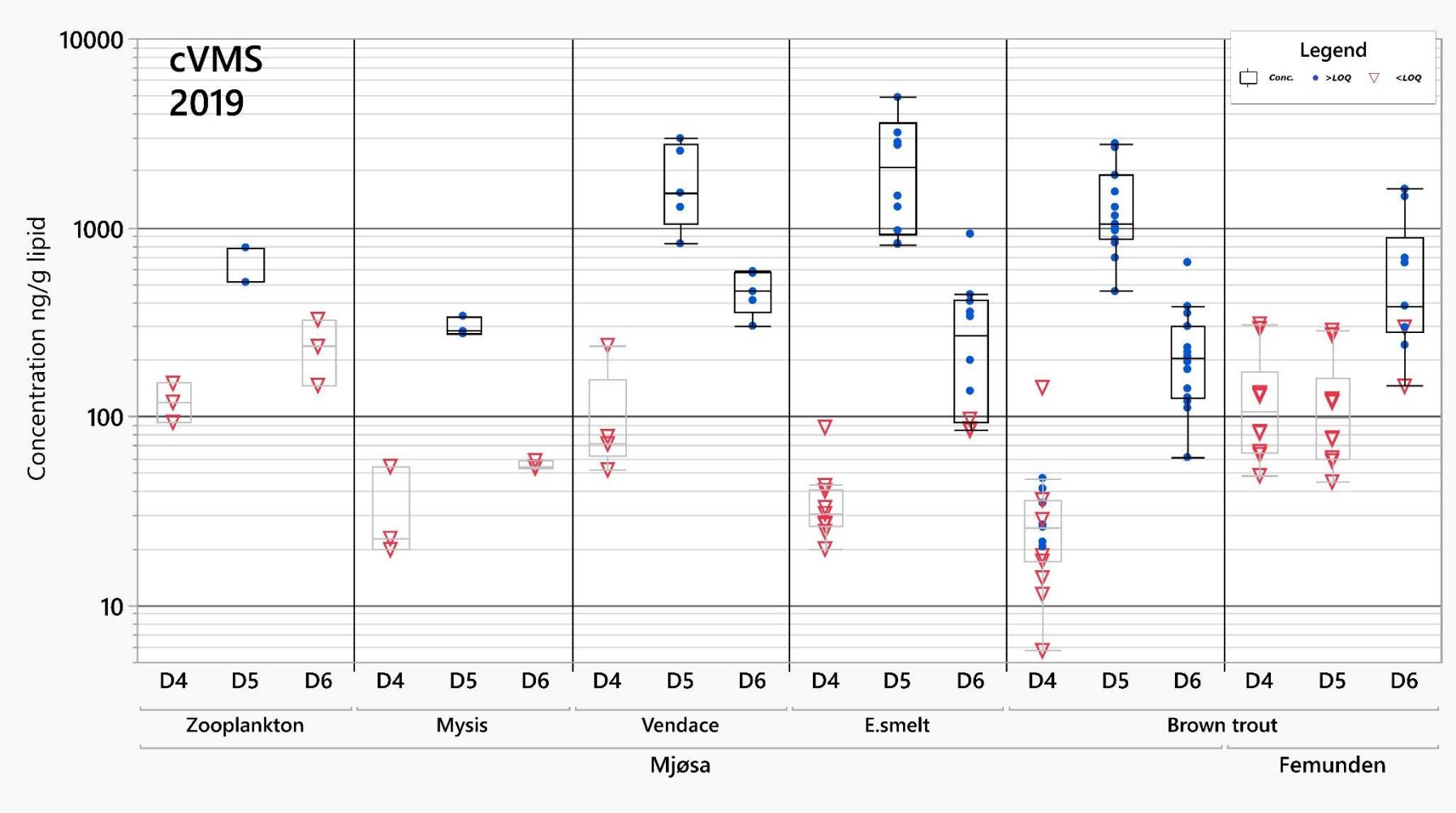

Figure 19. Boxplot of cVMS-concentrations in zooplankton, Mysis, vendace, E. smelt and brown trout from Lake Mjøsa and brown trout from Lake Femunden 2019. Concentrations in ng/g lipid. Boxes show the median and 50 % of the total data. Concentrations below LOQ have been replaced by half the limit and visualized by red triangles and grey boxes, whereas concentrations above LOQ are visualized by blue dots. Note that LOQ for D4, D5 and D6 may vary within each matrix.

3.5.2 Annual variation of cVMS in Lake Mjøsa and Lake Femunden

Although some of the cVMS data collected between 2010 and 2019 in biota from Lake Mjøsa and Lake Femunden are below the LOQ, comparable concentrations for D5 and D6 in brown trout from Lake Mjøsa are shown in Figure 20. Annual variation of cVMS-concentrations between Lake Femunden and Lake Mjøsa is given in Figure 21. D5 is the dominant compound throughout the entire period with some detections of D6 each year. Concentrations of D4 has been almost exclusively below LOQ.

We tested for differences in mean concentrations of D5 between sites and/or years by analysis of variances (ANOVA) or Welch F test (unequal group variances). When significant differences within group of sites or years were found we used post hoc Tukey-Kramer tests or unequal variance two sample t-tests to test for differences between pair of sites. The first model studies time series of D5 concentrations in brown trout from Lake Mjøsa between 2010-2019. There is a significant linear regression between years and D5 concentrations (r^2=0.1, p=0.0006) indicating a weak correlation, however significant decrease from 2010-2019. For the wet weight concentrations there is a decrease in D5 concentrations in 2015. We tested the two groups of years (Group 1: 2010-2015 and Group 2: 2016-2019) separately using a Welch test and there is a significant variance between mean concentrations within the two groups. Group 1 has significantly higher concentrations than Group 2 (p<0.0001).

A second model studies the difference in D5 concentrations between Lake Mjøsa and Lake Femunden. Figure 21 illustrates the model with significant higher concentrations of D5 in Lake Mjøsa compared to Lake Femunden (p<0.0001). Concentrations in Lake Femunden are mostly below LOQ in recent years, and we observe a significant decrease for D5 concentrations (lipid) in brown trout from Lake Mjøsa (p<.0001) from 2010 to 2019.

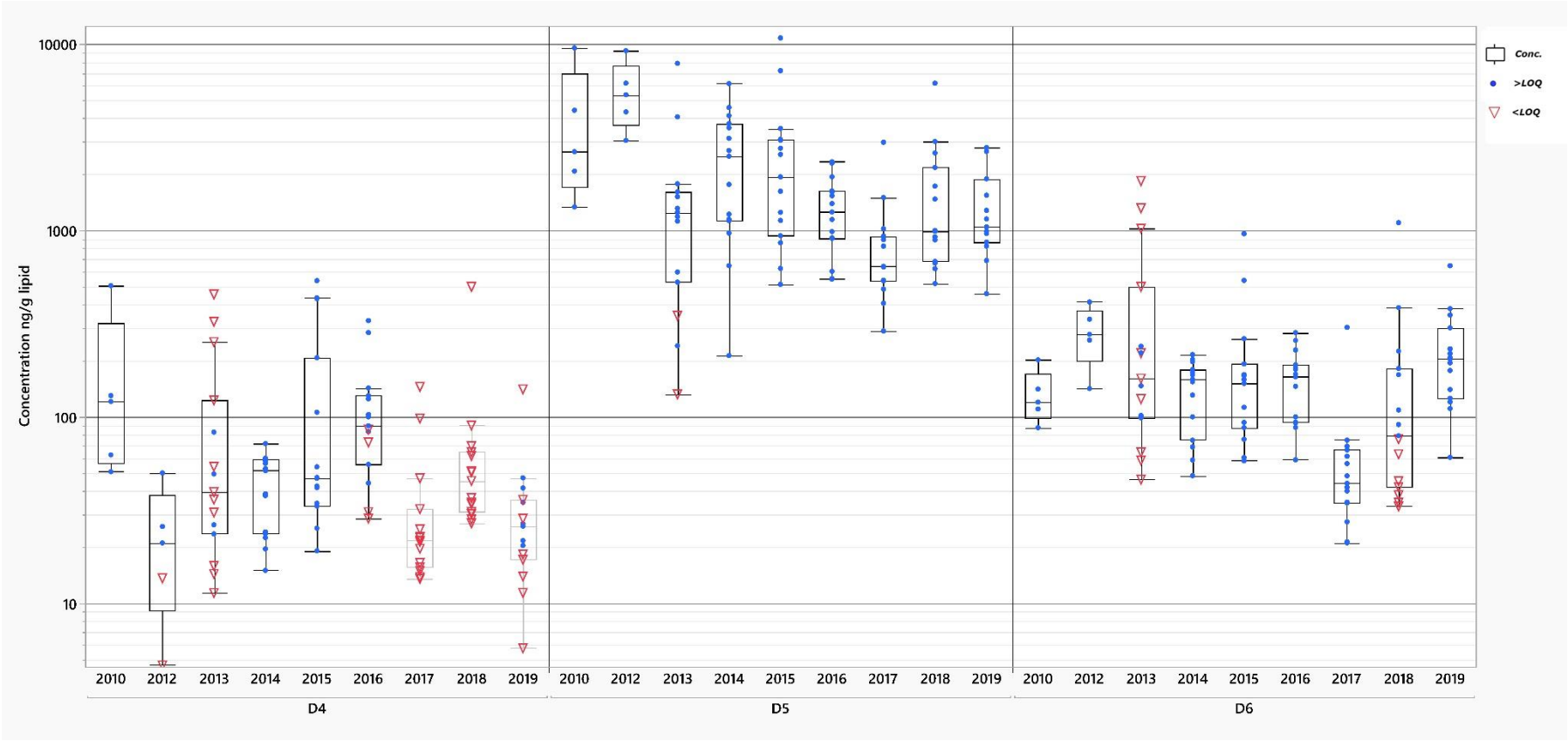

Figure 20. Boxplot indicating the concentrations of cVMS D4, D5 and D6 in samples of brown trout from Lake Mjøsa from 2010 to 2019 (total N=115). Note the logarithmic scale on the y-axis, and that LOQ may vary within each matrix. Boxes in years where more than 50 % of the samples were below LOQ is greyed out.

Interpretation on the inter-annual variability of cVMS data should be done with caution. Variation may arise from e.g. the substitution of data < LOD/LOQ, especially for D4 and D6 for which a large part of the data is below LOD/Q (Table 3) and where these LOD/Q-values differ within the sampled matrixes.

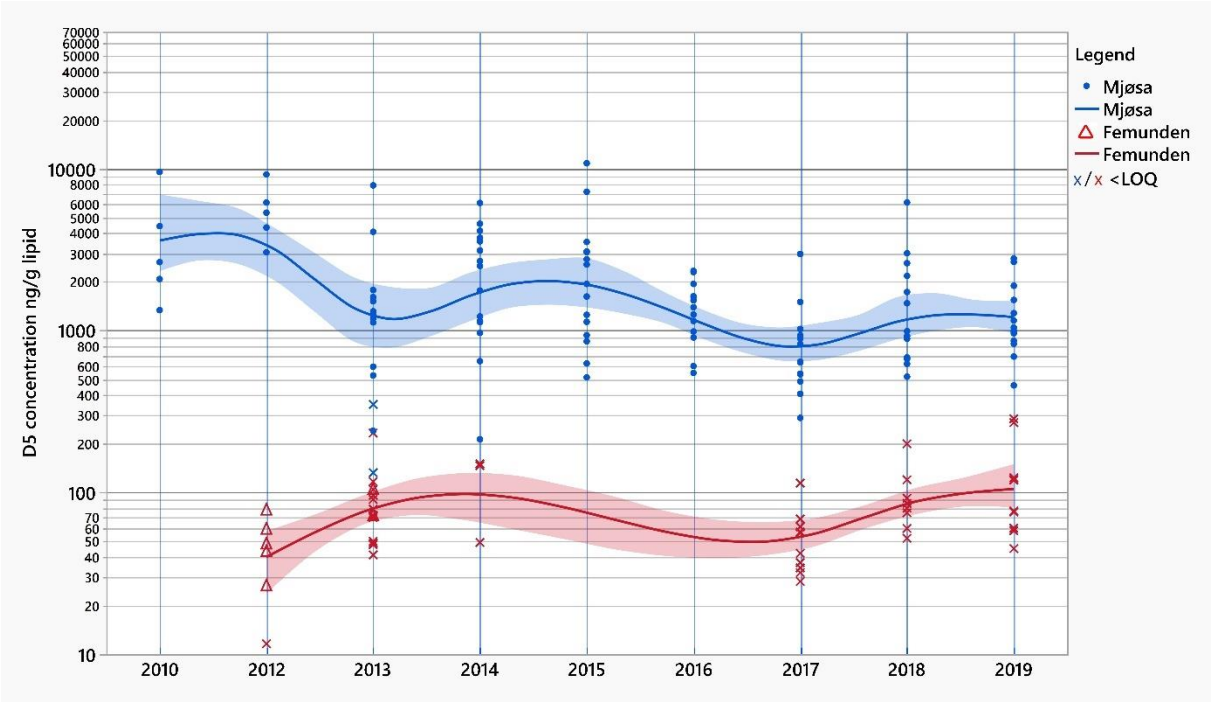

Figure 21. Time series for D5 concentrations (lipid weight) in samples of brown trout (muscle) from Lake Mjøsa (blue) and Lake Femunden (red) 2010-2019. Annual mean concentrations shown with a line with 95 % confidence interval of the calculated mean. Concentrations below LOQ are marked with "x" and are replaced by half the limit.

Discharges from wastewater treatment plants are considered major sources for cVMS to the aquatic environment (Sparham et al., 2008) depending on the treatment method (Wang et al., 2015). In addition, much focus has been on the coming regulation of D4 and D5 in consumer products from 2020, maybe resulting in more consumers choosing products without these compounds.

3.5.3 Trophic magnification of D5 and D6 in Lake Mjøsa

cVMS levels and their potential bioaccumulation behavior have been studied by Krogseth et al. (2017) in a subarctic lake, detecting concentrations of D5 in the range of 9.9 – 131 ng/g w.w. This food web included a benthic link, differing from Lake Mjøsa where we are studying a pure pelagic food web. Krogseth et al. (2017) found no trophic magnification for D5, with lower cVMS concentrations in the higher trophic levels such as brown trout and Arctic char (*Salvelinus alpinus*). Concentrations of cVMS in freshwater fish from Lake Mjøsa are higher than comparable studies in Sweden (Kierkegaard et al., 2013) and North America (McGoldrick et al., 2014). Studies from the Baltic sea found a ratio between

D4, D5 and D6 in fish to be 1:20:4, respectively (Kierkegaard et al., 2013). Studies from Mjøsa, including the 2019 data in this report, support these findings (Jartun et al., 2018 and 2019; Fjeld et al., 2017).

Trophic magnification of D5 and D6 in the pelagic food web of Lake Mjøsa has previously been demonstrated by e.g. Borgå et al. (2012b), Borgå et al. (2013a) and Fjeld et al. (2017). Calculations of trophic level (TL) are partly dependent on the $\delta^{15}N$ in zooplankton samples. It is shown that $\delta^{15}N$ for zooplankton varies significantly between years (Fjeld et al., 2017). We see that for some years (e.g. Jartun et al., 2018) large omnivorous zooplankton species tend to dominate the sampled material, which alters the $\delta^{15}N$ and subsequently the calculation of TL. In 2019, however, true primary consumers dominated the zooplankton samples, with 95 % of the samples consisting of *Daphnia cristata* on a lower TL. Calculation of the trophic magnification factor (TMF) is explained in chapter 2.4. Annual variation of TL in higher trophic levels, such as for brown trout, is then avoided. Estimated TMF will not change by using TL_{rel}.

When calculating the TMF for D5, all data from 2010-2019 in Lake Mjøsa have been analyzed. For some sampling years the sampling material is scarce for some trophic levels in the food web, such as the explained challenging sampling of zooplankton. Figure 22 shows the linear regression of ln-transformed D5 concentrations vs. TL_{rel} in zooplankton, *Mysis*, vendace, E. smelt and brown trout from Lake Mjøsa for the years 2010-2019. There is a significant positive regression (r^2=0.20, p<0.0001) between TL_{rel} and ln D5 (ng/g lip) resulting in a calculated TMF of 2.06 (95 % CI: 1.75 – 2.43).

For the analysis of D6 against TL_{rel} there are larger uncertainties to the interpretations as a larger proportion of the analytical results were below LOQ. The model for all years between 2010 and 2019 is shown in Figure 23, which indicates a calculated TMF for D6 in Lake Mjøsa of 1.27 (r^2 =0.03, p<0.0025, 95 % CI: 1.09 – 1.47), a weak positive correlation but significant.

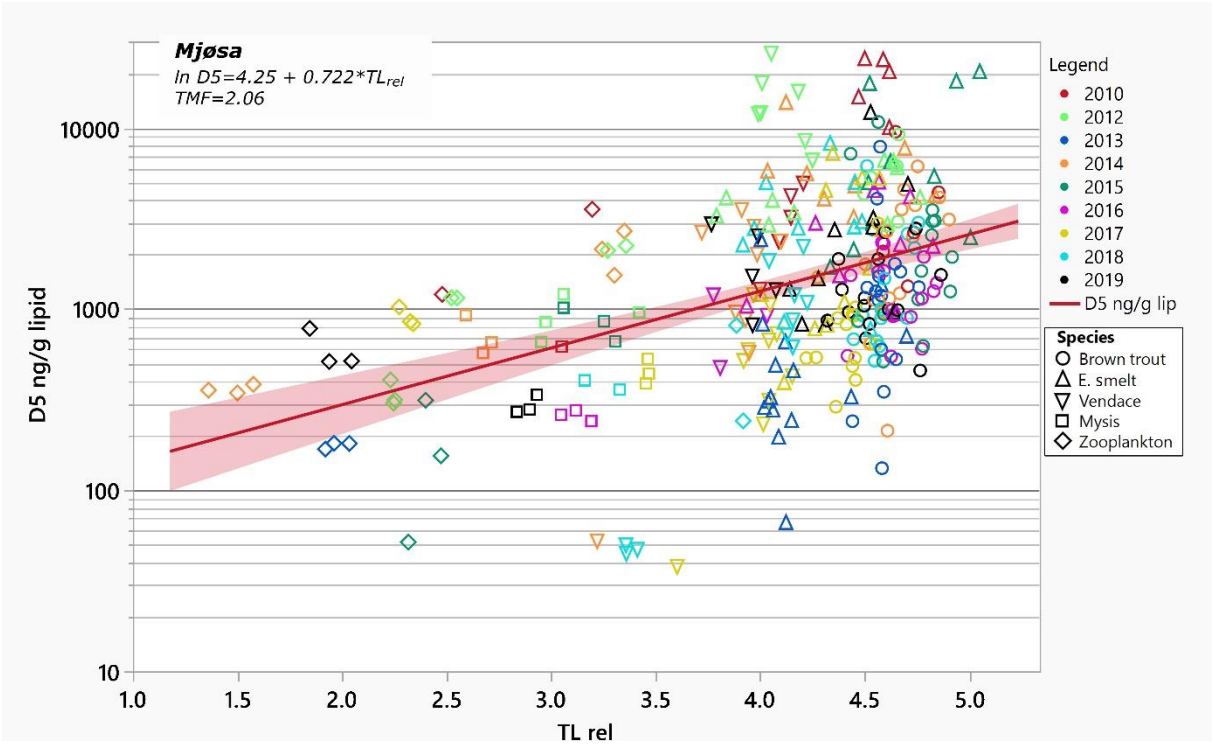

Figure 22. Relations between D5 (lipid normalized) and relative trophic level (TL_{re}) in zooplankton, Mysis and fish muscle from Lake Mjøsa between 2010-2019. Regressions of ln-D5 on TL_{rel} with 95 % confidence levels are shown. Results from 2019 are shown in black. Concentrations below LOQ have been replaced by half the limit.

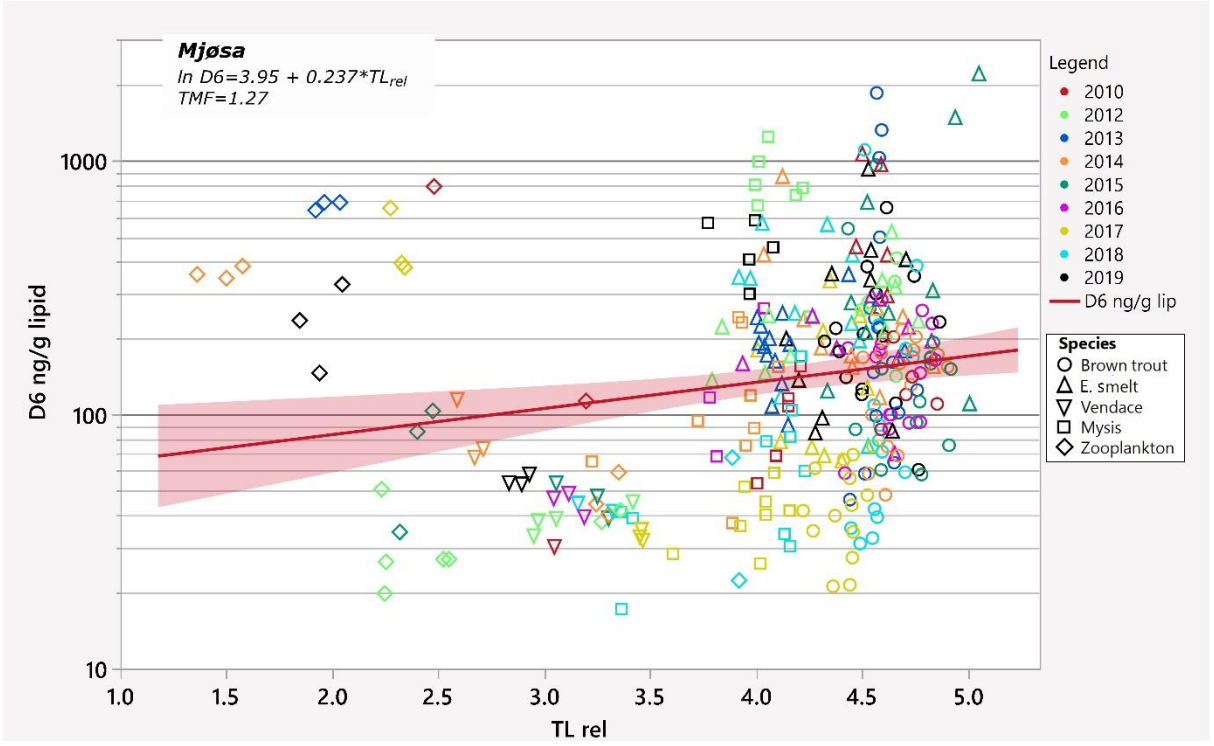

Figure 23. Relations between D6 (lipid normalized) and relative trophic level (TL_{re}) in zooplankton, Mysis and fish muscle from Lake Mjøsa between 2010-2019. Regressions of ln-D6 on TL_{rel}

with 95 % confidence levels are shown. Results from 2019 are shown in black. Concentrations below LOQ have been replaced by half the limit.

Trophic magnification of cVMS up the pelagic food web of Lake Mjøsa have been reported by Borgå et al. (2012, 2013) in Fjeld et al. (2014,2015,2016,2017) and in Jartun et al. (2019). Some other studies support the trophic magnification of cyclic siloxanes in aquatic food webs, although the methods and models studied vary in sensitivity as for Lake Erie (McGoldrick et al., 2014). Differences in exposure and lipid partitioning between cVMS and legacy POPs such as specific PCBs may contribute to the results. Trophic magnification of D5 was also shown in a study from China with BDE-99 as a reference contaminant (Jia et al., 2015). However, no evidence was found to support biomagnification of any cVMS in an urban fjord (Ruus et al., 2019) or in a marine food web of the Oslofjord, rather a trophic dilution up the food web (Powell et al., 2018).

3.6 Brominated flame retardants (BFR)

3.6.1 Concentrations of PBDEs in 2019

PBDEs were determined in samples of zooplankton, Mysis and fish muscle (vendace, E. smelt and brown trout) from Lake Mjøsa and in muscle of brown trout from Lake Femunden. Detection frequency for the individual BDEs is shown in Table 3. Results are mainly focused on the most common BDEs, specified by the Water Framework Directive ΣBDE_6: BDE-28, BDE-47, BDE-99, BDE-100, BDE-153 and BDE-154 (Direktoratsgruppen, 2018). All these compounds are commonly found in natural compartments as reviewed by Eljarrat and Barceló (2018). Detection frequencies for BDEs (ΣBDE_6) were 80-100 % in the *Mysis* and fish samples, and no detections in the zooplankton samples at the lower trophic level.

Concentrations of ΣBDE_6 and individual BDEs 28, 47, 99, 100, 153 and 154 in 2019 are presented for both wet weight concentrations and lipid normalized concentrations in Table 14 and Figure 24. Highest concentrations were found in brown trout from Lake Mjøsa with a mean concentration of ΣBDE_6 7.4 ng/g w.w. (560 ng/g lipid). Mean concentrations of ΣBDE_6 in E. smelt and vendace were 1.9 and 2.6 ng/g w.w., respectively (150 and 170 ng/g lipid, respectively). Corresponding concentrations in *Mysis* and zooplankton in Lake Mjøsa were 0.25 and 0.023 (all <LOQ) ng/g w.w., respectively. Brown trout in Lake Femunden had mean ΣBDE_6 concentrations of 0.42 ng/g w.w. (43 ng/g lipid).

EQS for ΣBDE_6 in biota is 0.0085 ng/g w.w. All biota samples exceeded this value. The European food safety authority (EFSA) presented a risk assessment on PBDEs in 2011. There are 209 theoretical congeners of PBDEs, but sufficient toxicity data only for four (BDE-47, -99, -153 and -209), with the highest dietary exposure to BDE-47 and -209 (EFSA CONTAM, 2011). PBDEs may cause DNA damage (Gao et al., 2009), and effects on neurodevelopment has also been identified as a critical effect (Eriksson et al., 2001). Based on uncertainties and limited data for some food groups, a tolerable weekly intake (TWI) could not be established. However, studies of exposure and subsequent concentrations in human tissue have found that with current dietary exposure there's a potential health concern for BDE-99, but not for the other three BDEs studied (EFSA CONTAM, 2011). This study is a general study covering several European countries. In early 2000 an industrial discharge of PBDEs into Lake Mjøsa caused substantial contamination of organisms living in the lake (Mariussen et al., 2008). Elevated concentrations of PBDEs were subsequently found in samples of serum in local consumers of fish from Lake Mjøsa compared to a reference group, and that approx. 98 % of the measured PBDE concentration in serum derived from fish consumption (Thomsen et al., 2008). Since early 2000, the levels of PBDEs in fish from Lake Mjøsa has declined (see Figure 25) but there are no specific studies on potential effects on fish or humans caused by these substances.

The fully brominated congener BDE-209 was detected in 9 out of 46 samples, 7 of these detections were in brown trout and E. smelt from Lake Mjøsa. A result of this is a limited estimate of the mean concentrations by substituting LOQ values with half the limit for BDE-209. Studies have shown that deca-BDE (209) is absorbed through the dietary intake, but it is rapidly debrominated to lower

brominated congeners, especially BDE-154 (Kierkegaard et al., 1999; Stapleton et al., 2006; Noyes et al., 2013).

A full overview of all the BDEs in the analytical program is given in Figure 24 together with the ΣBDE_6 concentrations. ΣBDE_6 constitutes 75-97 % of total PBDEs in most samples. BDEs 47, 99, 100, 153 and 154 are dominating the results, as is also shown in previous years in Lake Mjøsa and Femunden (Jartun et al., 2019; Fjeld et al., 2017). Concentrations in brown trout from Lake Femunden are significantly lower than in brown trout from Lake Mjøsa, caused mainly by a large, local discharges to Lake Mjøsa in the early 2000s. Still, for Lake Femunden, with limited local sources, the levels are all higher than the EQS-concentration of 0.0085 ng/g w.w.

Table 14. Mean, minimum (min) and maximum (max) concentrations of the six BDEs referenced in the Water Framework Directive; BDEs 28, 47, 99, 100, 153 and 154 (Direktoratsgruppen, 2018) in samples of zooplankton, Mysis, vendace, E. smelt and brown trout from Lake Mjøsa and in brown trout from Lake Femunden in 2019. Concentrations (ng/g w.w.) below LOQ have been replaced by half the limit. Results above LOQ are shaded in orange. Upper table shows conc. in wet weight (w.w.), lower table on lipid weight (lipid).

				Concentration of PBDEs and ΣBDE$_6$ in ng/g wet weight (w.w.)						
Lake	**Matrix**	**N**	**Statistics**	**BDE-28**	**BDE-47**	**BDE-99**	**BDE-100**	**BDE-153**	**BDE-154**	**ΣBDE$_6$**
Mjøsa	Zoopl.	3	*Range*	0.002	0.011	0.0040-0.0080	0.002	0.001-0.002	0.001	0.021-0.026
			Mean, x̄	0.002	0.011	0.005	0.002	0.002	0.001	0.023
			N>LOQ	0/3	0/3	1/3	0/3	0/3	0/3	
	Mysis	3	*Range*	0.002	0.14-0.15	0.059-0.067	0.022-0.028	0.002-0.006	0.011-0.013	0.24-0.27
			Mean, x̄	0.002	0.14	0.062	0.025	0.003	0.012	0.25
			N>LOQ	0/3	3/3	3/3	3/3	1/3	3/3	
	Vendace	5	*Range*	0.0070-0.0080	1.0-1.7	0.61-1.1	0.27-0.53	0.057-0.092	0.098-0.20	2.1-3.6
			Mean, x̄	0.0080	1.2	0.76	0.36	0.067	0.13	2.6
			N>LOQ	5/5	5/5	5/5	5/5	5/5	5/5	
	E. smelt	10	*Range*	0.0050-0.013	0.63-2.2	0.033-0.11	0.16-0.44	0.018-0.064	0.075-0.19	0.95-2.9
			Mean, x̄	0.0090	1.4	0.060	0.28	0.043	0.13	1.9
			N>LOQ	10/10	10/10	10/10	10/10	9/10	10/10	
	B. trout	15	*Range*	0.0040-0.025	0.93-6.8	0.18-2.7	0.25-2.6	0.046-0.48	0.11-1.0	1.6-14
			Mean, x̄	0.015	4.2	1.2	1.3	0.22	0.49	7.4
			N>LOQ	15/15	15/15	15/15	15/15	15/15	15/15	
Femunden	B. trout	10	*Range*	0.0010-0.0090	0.052-0.30	0.021-0.21	0.016-0.18	0.0030-0.048	0.014-0.16	0.11-0.90
			Mean, x̄	0.0030	0.15	0.10	0.076	0.018	0.068	0.42
			N>LOQ	8/10	10/10	10/10	10/10	9/10	10/10	

2019				Concentration of PBDEs and ΣBDE$_6$ in ng/g lipid						
Lake	**Matrix**	**N**	**Statistics**	**BDE-28**	**BDE-47**	**BDE-99**	**BDE-100**	**BDE-153**	**BDE-154**	**ΣBDE$_6$**
Mjøsa	Zoopl.	3	*Range*	0.55-0.88	3.0-4.8	0.96-2.8	0.46-0.74	0.51-0.65	0.35-0.45	5.8-9.0
			Mean, x̄	0.71	3.9	1.8	0.60	0.60	0.40	7.9
	Mysis	3	*Range*	0.11-0.13	7.9-8.7	3.3-3.8	1.4-1.6	0.090-0.37	0.68-0.74	13-15
			Mean, x̄	0.12	8.4	3.6	1.4	0.19	0.72	14
	Vendace	5	*Range*	0.38-0.57	56-120	34-79	14-38	2.8-6.6	5.0-14	110-260
			Mean, x̄	0.50	83	51	24	4.5	8.9	170
	E. smelt	10	*Range*	0.34-2.3	42-360	3.0-8.1	10-72	1.6-9.0	4.9-27	63-480
			Mean, x̄	0.75	110	4.2	23	3.3	10	150
	B. trout	15	*Range*	0.23-3.3	48-2000	6.9-410	10-820	1.7-110	4.2-260	72-3600
			Mean, x̄	0.75	310	77	120	18	41	560
Femunden	B. trout	10	*Range*	0.047-0.70	4.0-36	1.6-24	1.2-19	0.21-5.5	1.1-18	8.5-100
			Mean, x̄	0.28	15	10	7.7	2.0	7.0	43

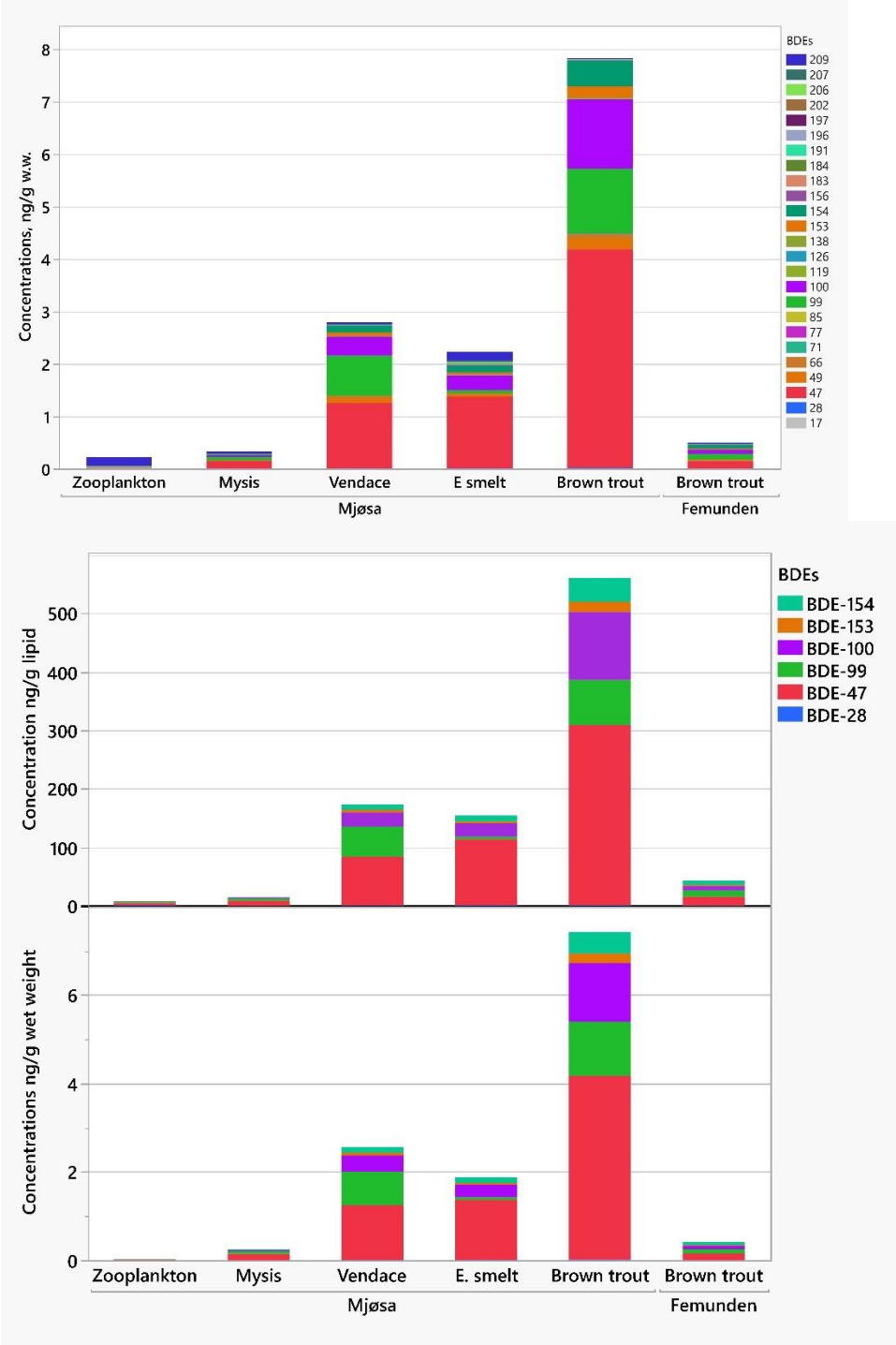

Figure 24. Stacked graph of all BDEs (top) and ΣBDE$_6$ (middle: lipid weight; bottom: wet weight) included in the 2019 study in samples of zooplankton, *Mysis*, vendace, E. smelt and brown trout in Lake Mjøsa and brown trout in Lake Femunden. Concentrations are given in ng/g and results below LOQ have been replaced by half the limit.

3.6.2 Time trends for PBDEs

PBDEs have been studied in Lake Mjøsa in several fish species such as vendace, E. smelt and brown trout since the early 1990s. The number of samples, and the choice of matrices throughout the years have changed, which limits the value of comparing newer data with the oldest concentrations. But for brown trout and vendace, consistent data for PBDEs in muscle is available from around year 2000.

Mean concentrations of BDE_6 in samples of brown trout from Lake Mjøsa between 2000-2019 are shown in Figure 25. Concentrations have decreased since the extreme values in the early 2000, an approximate decrease of 95 %, at which point large discharges from an industry company close to Lillehammer affected the entire lake. Highest reported concentrations of ΣBDE_6 was 5400 ng/g lipid in brown trout in the year 2000 (Mariussen et al., 2008; Fjeld et al., 2016). Discharges to Lake Mjøsa was stopped in 2003. In 2019 the concentration was 560 ng/g lipid in brown trout (Table 14, Figure 24), however the mean BDE_6 lipid concentrations are calculated differently when looking at a single year (Figure 24) compared to the entire time series (Figure 25). We only have mean concentrations for the congeners in BDE_6 from 2000-2012, and no individual fish data. When calculating the mean concentration in the entire **time series** from year 2000, we have to use the mean for each BDE-congener and the **mean lipid content** before calculating ΣBDE_6 lipid. For fish caught in 2013-2019 we use individual fish data (Figure 26).

Levels of ΣBDE_6 in brown trout from Lake Mjøsa seem to have stabilized the latest years around concentrations of 8 ng/g w.w. (approx. 350-500 ng/g lipid).

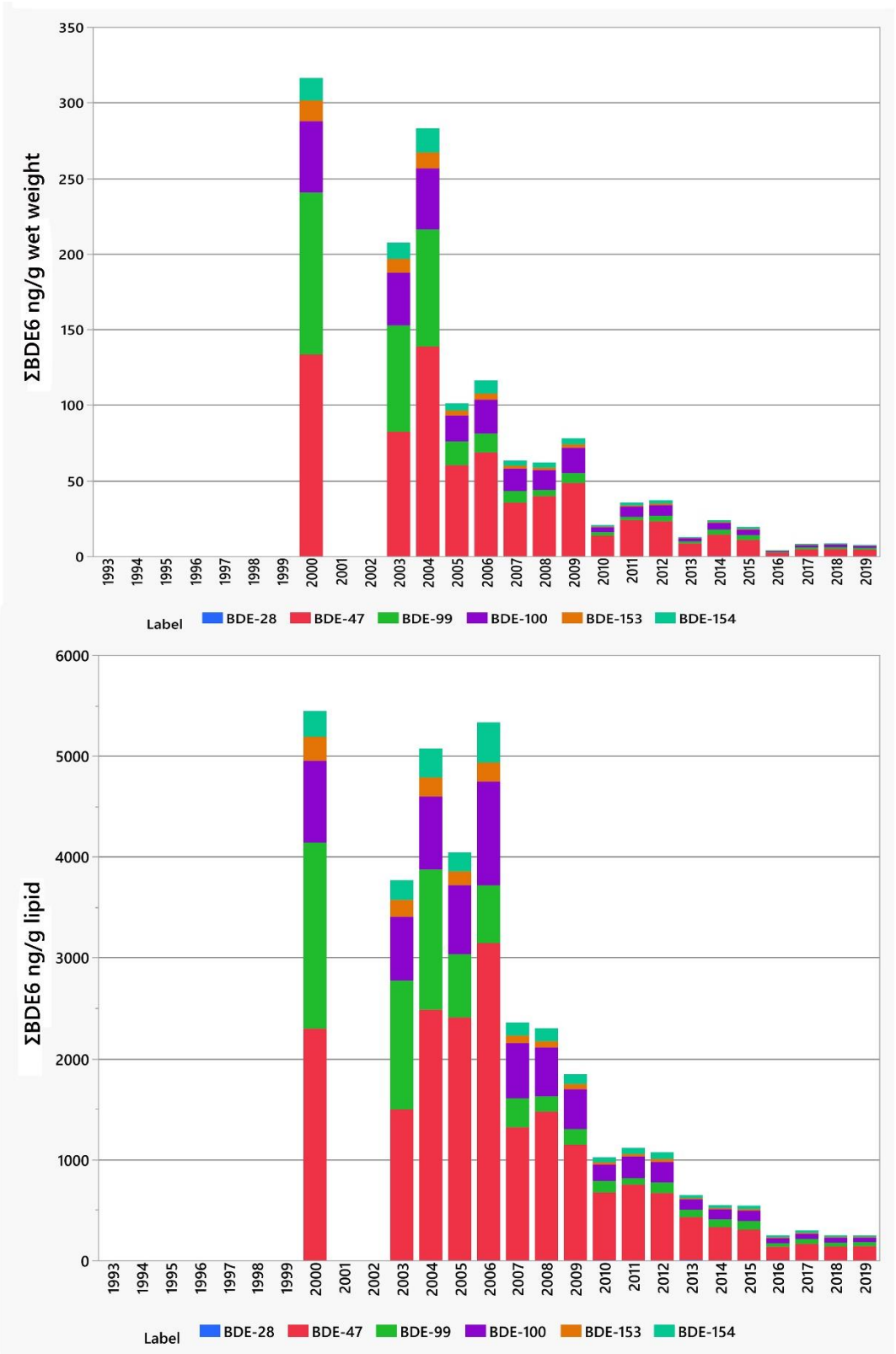

Figure 25. Mean concentrations of BDE_6 in samples of brown trout from Lake Mjøsa between 2000-2019. Concentrations are given in ng/g wet weight (top) and ng/g lipid (bottom). Concentrations below LOQ have been replaced by half the limit.

In Figure 26 the ΣBDE_6 levels in brown trout from Lake Mjøsa on lipid weight basis from 2013-2019 are given. In this figure we have calculated ΣBDE_6 using individual data for both BDE congeners and lipid content. The congener distribution pattern seems similar in 2017 – 2019 and diverging lipid content may explain the small differences. The decrease in ΣBDE_6 concentrations from 2013 to 2019 was not statistically significant (p=0.13).

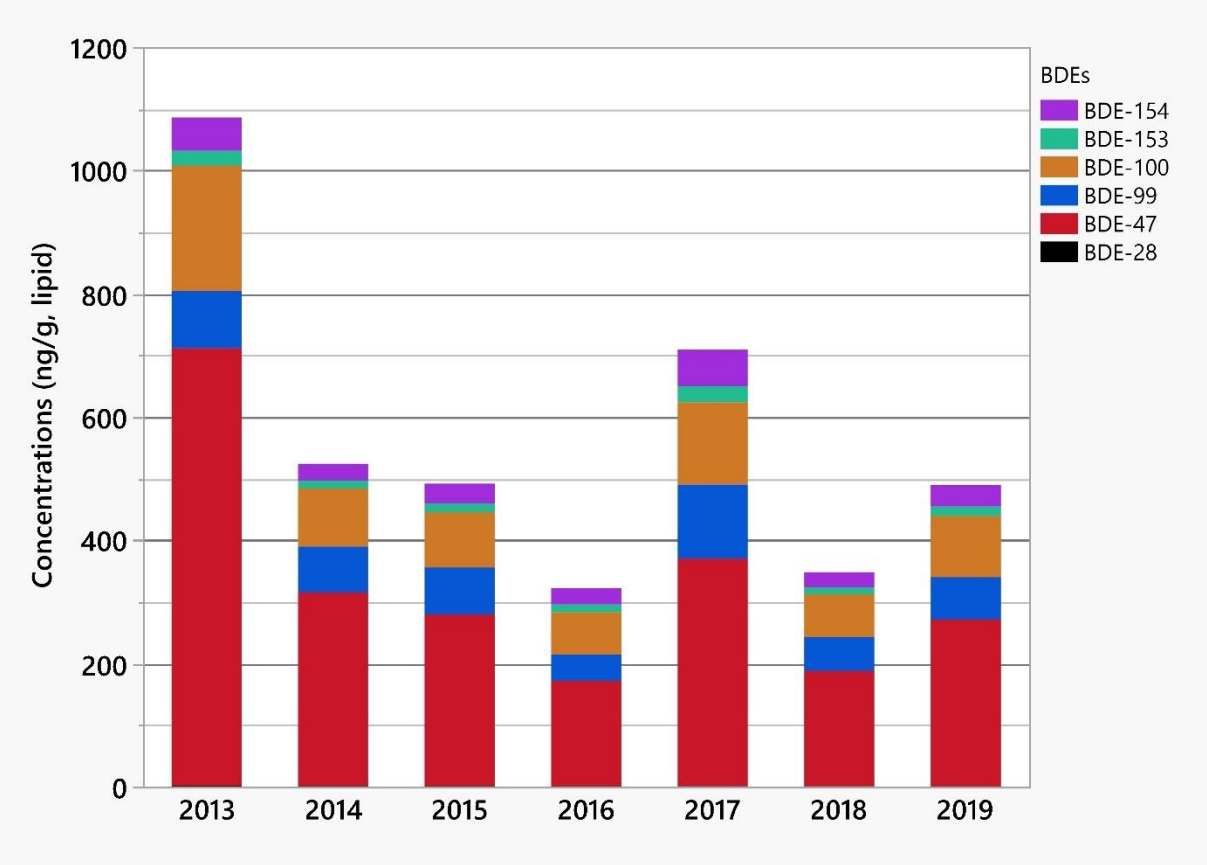

Figure 26. Mean concentrations for ΣBDE_6 in samples of brown trout from Lake Mjøsa, 2013-2019. Concentrations are given in ng/g lipid. Concentrations below LOQ have been replaced by half the limit.

The differences in mean concentrations (ng/g, w.w.) between brown trout in Lake Mjøsa and in Lake Femunden are illustrated in Figure 27. Individual concentrations for ΣBDE_6 (w.w.) are shown with dots, and the mean concentration is smoothed over the years from 2013-2019. We have included the EQS-value of 0.0085 ng/g w.w. in this figure, showing that all samples of brown trout in this period exceed the EQS value.

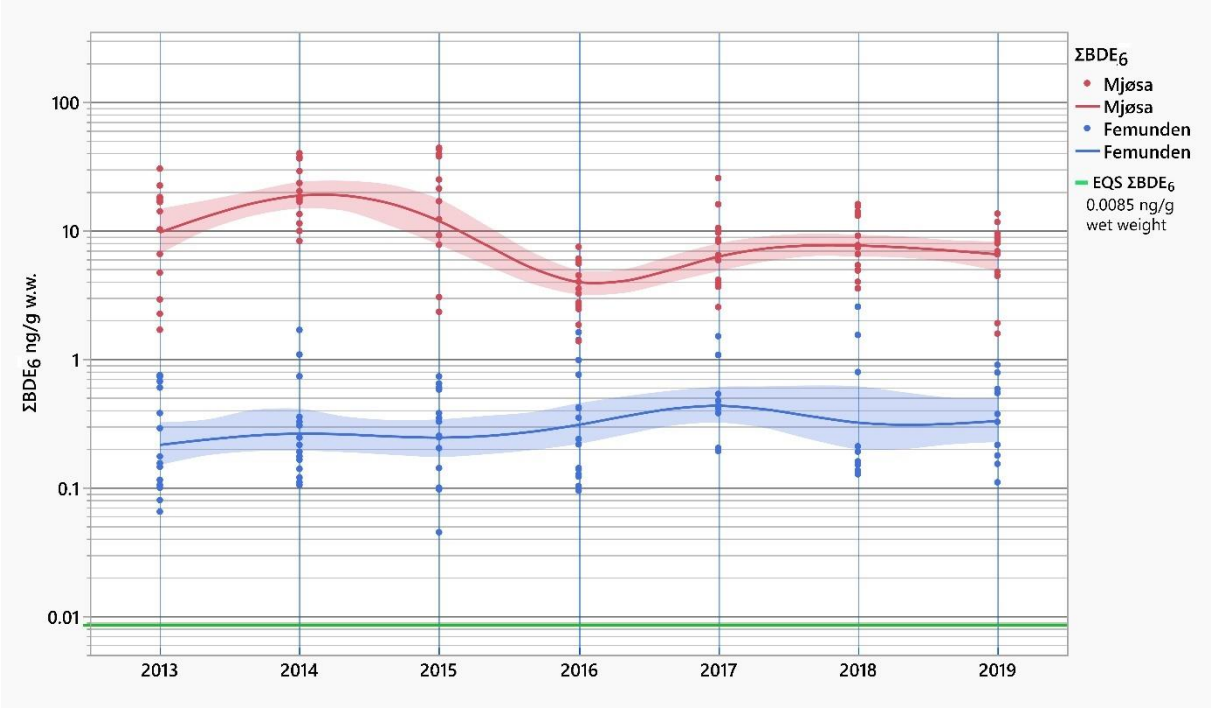

Figure 27. Mean concentrations for ΣBDE_6 in samples of brown trout from Lakes Mjøsa and Femunden, 2013-2019. Concentrations are given in ng/g w.w. A fitted line indicates the mean value smoothed over the years with a 95 % confidence interval shading. Concentrations below LOQ have been replaced by half the limit.

3.7 Correlation and trophic magnification of Hg, D5, D6, BDE-47 and PFOS

Contaminants with similar physical-chemical properties such as volatile siloxanes, mercury, and some brominated flame retardants (e.g. BDE-47) can express comparable accumulation pattern in food webs. Lipophilicity and bioaccumulative tendency are important properties for these compounds. Previously in Lake Mjøsa, the correlation between D5 and D6, PCB-153, BDE-47, Hg, and relative trophic level (TL_{rel}, calculated from $\delta^{15}N$) have been studied based on ln-transformed lipid-normalized concentrations in samples from the pelagic food web. Lipid content and lipophilic contaminant concentrations are often correlated across organisms, with concentrations typically normalized to lipid content before regression analysis (Borgå et al., 2012a). Trophic magnification factors (TMF) are calculated and reported on the basis of lipid equivalent concentrations. Fjeld et al. (2017) and Jartun et al. (2019) have shown good correlation with relative trophic level (TL_{rel}) for D5 and D6 concentrations indicating biomagnification for these compounds. Same patterns are shown for Hg and BDE-47. In 2019 we have included perfluoroctanesulfonate (PFOS) in this correlation matrix instead of the siloxane D6 because of low detection frequency for D6 across the sample categories.

PFOS preferably interacts with serum proteins in blood rich tissue such as blood and liver (Jones et al., 2003), whereas Hg (me-Hg), siloxanes and PBDEs are highly lipophilic (McIntyre and Beauchamp, 2007; Borgå et al., 2013b; Eljarrat and Barceló, 2018). Trophic magnification factors (TMFs) describes the compound flux through multiple organisms on multiple trophic levels along a defined food chain or web (Franklin, 2015). The TMF thus increases with efficient and rapid uptake of a given compound by a consumer (or predator) organism through their diet and subsequent slow elimination rate of the compound (Goss et al., 2013). Ideally, calculations of TMFs (see chapter 2.4) should be performed on a whole-organism normalization or an organ specific basis (e.g. liver, muscle) normalized to respective lipid or protein concentrations. In our study we have not corrected the organ specific concentrations to whole-body, and thus introduced an uncertainty when interpreting the biomagnification potential. This is, however, not unusual when studying different organisms in a food web (Kelly et al., 2009) ranging from small copepods (zooplankton) to large predators such as brown trout. For Hg, cVMS and PBDEs concentrations have been evaluated on a lipid normalization, however for PFOS we do not have data on protein concentrations, and therefore the TMF calculation for PFOS was performed on a wet weight basis.

Figure 28 displays the $\log_e$-normalized concentration data for D5, Hg and BDE-47 against TL_{rel} as well as the correlation between the individual contaminants in 2019. For PFOS, wet weight concentrations were used. All compounds have a significant positive correlation with TL_{rel} ($p<0.0001$). In this figure, data from 2013-2019 are included, limiting the influence of deviations in the trophic level of zooplankton in specific years (such as in 2018). TMF calculated from a larger dataset (2013/2014-2019) is discussed for each contaminant in its respective chapter. TMFs for D5, Hg, PFOS and BDE-47 in the total dataset from 2013-2019 were 2.08, 6.98, 5.77 and 3.24, respectively.

PFOS seem to have a strong positive correlation with Hg, and a moderate correlation with BDE-47 across the dataset for 2013-2019 ($r^2=0.57$ and $r^2=0.47$, respectively). TMF values confirm the

biomagnifying properties for all these four contaminants in Lake Mjøsa, as is also previously reported by Fjeld et al. (2016, 2017) and Jartun et al. (2019). D5 has a weak correlation with BDE-47 and Hg (r^2=0.27 and r^2=0.15, respectively).

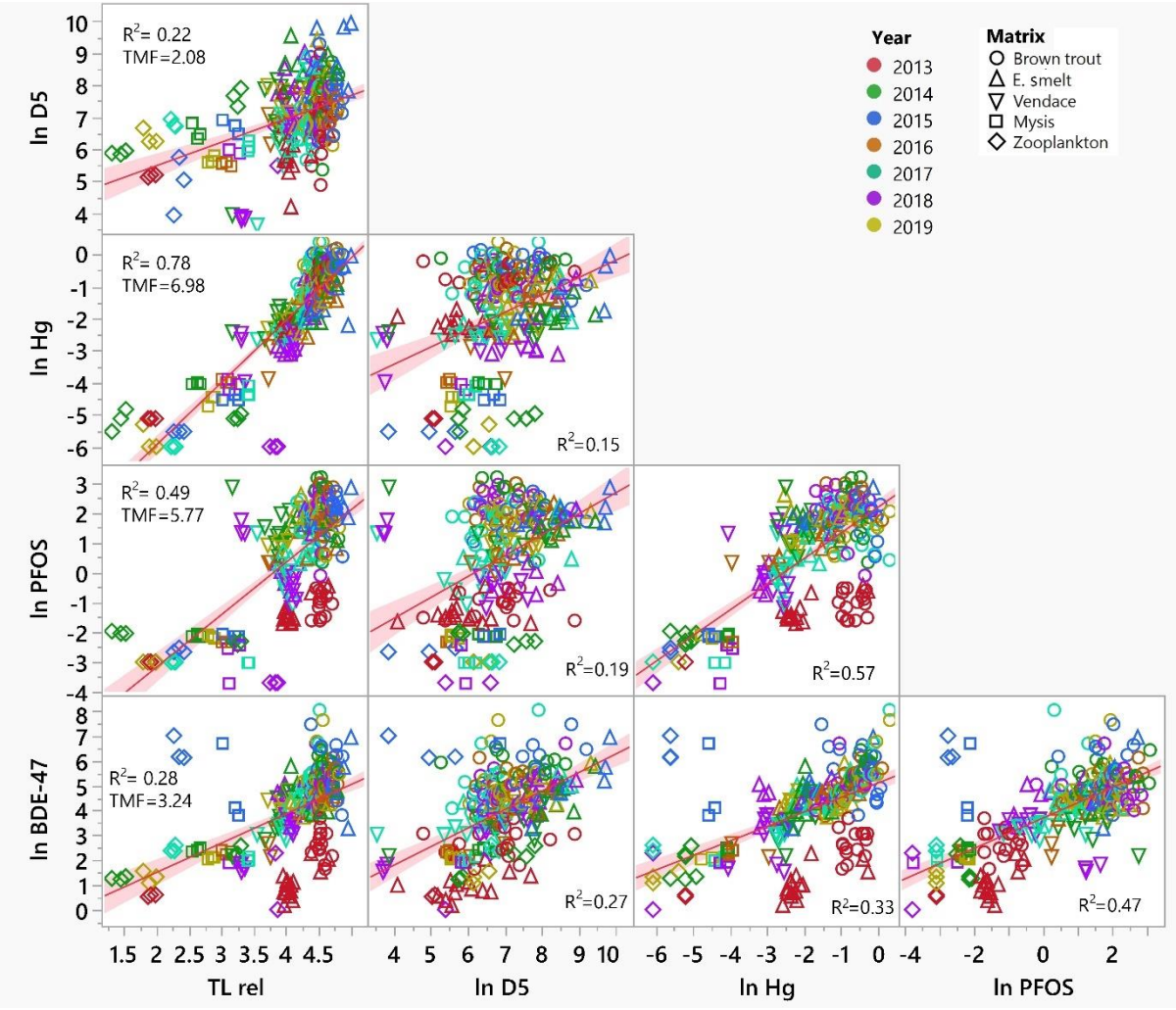

Figure 28. Scatter plots and regression lines between Hg, D5, PFOS, BDE-47 and relative trophic level (TL_{rel}) in fish (Hg, D5 and BDE-47: muscle; PFOS:liver), Mysis, and zooplankton from Lake Mjøsa, sampled in 2019. Concentrations are log_e(ln)-transformed on a lipid weight basis, ng/g lip, except for PFOS (wet weight). Conc. below LOQ are replaced by half the limit. r^2: correlation coefficient, TMF: trophic magnification factor.

3.8 Alkylphenols and bisphenols

Sample matrices for alkyl- and bisphenols were whole body for zooplankton and *Mysis*, fish muscle for E. smelt and vendace. For brown trout in Lake Mjøsa bile was chosen as the preferred matrix. For brown trout in Lake Femunden we analyzed fish muscle in 4 out of 10 samples, and bile in 6 out of 10 samples. Almost all samples were below LOQ, as is shown in the overview of detection frequency in Table 3 and in Figure 29, except some minor detections of bisphenol-A and bisphenol-F in samples of E. smelt and brown trout.

Up until 2018, fish muscle was the acceptable target matrix for phenols in this study. However, bile has been reported to contain higher concentrations of alkylphenols than other tissues within the same individual (Jonsson et al., 2008; Wu et al., 2016). In 2019 we decided to test for phenols in bile, given that enough sample was retrieved.

Although generally low concentrations were found (only some above LOQ), the highest concentrations were found in muscle tissue of E. smelt (4,4-bis-A: 45 ng/g w.w., LOQ in E.smelt was 11 ng/g w.w.). 4,4-bis-F and 2,4-bis-F (33 and 29 ng/g w.w., respectively) was found in one sample of vendace, also in muscle tissue. Some detections slightly >LOQ were found in brown trout bile, but there are no significant indications within the dataset from 2019 that bile was a more efficient matrix for the detection of alkyl- and bisphenols in freshwater biota than muscle (preferred sample matrix in 2017 and 2018 (Jartun et al., 2018, 2019). Nonylphenol and octylphenol are listed on the EQS directive list of priority hazardous substances with EQS_{biota} concentrations of 3000 and 0.004 µg/kg w.w., respectively. All samples were below EQS for these two compounds.

In Lake Femunden, there were mostly concentrations below LOQ. One individual brown trout contained concentrations of 4,4-bis-F and 2,4-bis-F (48 and 59 ng/g w.w., respectively) in bile with an LOQ of 3 and 12 ng/g, respectively. The rest of the samples from Lake Femunden had concentrations below LOQ. Table 15 shows the main statistics, i.e. the LOQ for the phenolic compounds in biota from 2019. Figure 29 provides an overview of all the phenolic compounds for this year with detection limits shown as a triangle for each sample matrix and the few detections marked with a dot (·). The specific matrices (whole body, muscle and bile) are marked in colors. Most of the samples are below LOQ.

The few detections of phenolic compounds in 2019 match the results from previous years 2017 and 2018 (Jartun et al., 2018, 2019). A few low concentrations of bis-F compounds in fish from both Lake Mjøsa and Femunden were found in all years, the only difference was that in 2019 a few samples of E. smelt and vendace were above LOQ. Bisphenol A was detected in a few samples of brown trout and E. smelt in both lakes, but only slightly above LOQ.

Concentrations of nonyl- and octylphenol have been reported in cod liver and blue mussels along the Norwegian coast with median values of 5-36.9 ng/g w.w. for nonylphenol in cod liver (Green et al., 2019). Ruus et al. (2019) reported very few detections of phenolic compounds in biota, but concentrations above EQS for bisphenol-A in stormwater runoff around a Norwegian urban fjord.

Table 15. Concentration range (min-max), mean ($\bar{x}$) and number (N) of detections for alkylphenols and bisphenols in samples of zooplankton, Mysis, vendace, E. smelt and brown trout from Lake Mjøsa and brown trout from Lake Femunden in 2019. Concentrations are given in ng/g on wet weight (w.w.) basis. Concentrations below LOQ (w.w.) have been replaced by half the limit when calculating $\bar{x}$. "N>LOQ" is the number of samples above LOQ.

Lake	Matrix	N	Statistics	4,4-bis-A	2,4-bis-A	Bis-G	4,4-bis-S	2,4-bis S	4,4-bis-F	2,4-bis-F	2,2-bis-F	Bis-P	Bis-Z	TBBPA	4-tert-octylphenol	4-octyl-phenol	4-nonyl-phenol
Mjøsa	Zoopl.	3	Range	<12	<1	<2	<5.5	<0.5	<2.6	<4	<0.5	<1.5	<3	<3	<6	<3.5	<5
			Mean, $\bar{x}$	<12	<1	<2	<5.5	<0.5	<2.6	<4	<0.5	<1.5	<3	<3	<6	<3.5	<5
			N>LOQ	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mysis	3	Range	<12	<1	<2	<5	<0.5	<2.5	<4	<0.5	<1	<3	<3	<6	<3.5	<5
			Mean, $\bar{x}$	<12	<1	<2	<5	<0.5	<2.5	<4	<0.5	<1	<3	<3	<6	<3.5	<5
			N>LOQ	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Vendace	5	Range	<7.5	<2	<3	<5	<1	<9-33	<9-29	<1.5	<2	<3.5	<4.5	<5	<5	<7.5
			Mean, $\bar{x}$	<7.5	<2	<3	<5	<1	10	9.4	<1.5	<2	<3.5	<4.5	<5	<5	<7.5
			N>LOQ	0	0	0	0	0	1	1	0	0	0	0	0	0	0
	E. smelt	10	Range	<11-45	<1	<2	<5	<0.5	<2.5-5.9	<3.5-7.1	<0.5	<1	<3	<3	<5.5	<3	<5
			Mean, $\bar{x}$	<11	<1	<2	<5	<0.5	<2.5	<3.5	<0.5	<1	<3	<3	<5.5	<3	<5
			N>LOQ	1	0	0	0	0	4	3	0	0	0	0	0	0	0
	B. trout	15	Range	<9.5-19	<1.5	<2	<0.5	<0.5	<3	<11-27	<0.5-1.8	<2	<3	<3.5	<4.5-5.1	<3	<4
			Mean, $\bar{x}$	<9.5	<1.5	<2	<0.5	<0.5	<3	<11	<0.5	<2	<3	<3.5	<4.5	<3	<4
			N>LOQ	5	0	0	0	0	0	2	5	0	0	0	1	9	0
Femunden	B. trout	10	Range	<9.5-11	<1.5	<2	<1.5	<1	<3-48	<12-59	<0.5-1.6	<2	<3	<4	<5	<3.5	<4.5
			Mean, $\bar{x}$	<9.5	<1.5	<2	<1.5	<1	6,4	12	<0.5	<2	<3	<4	<5	<3.5	<4.5
			N>LOQ	2	0	0	0	0	2	2	1	0	0	0	0	0	0

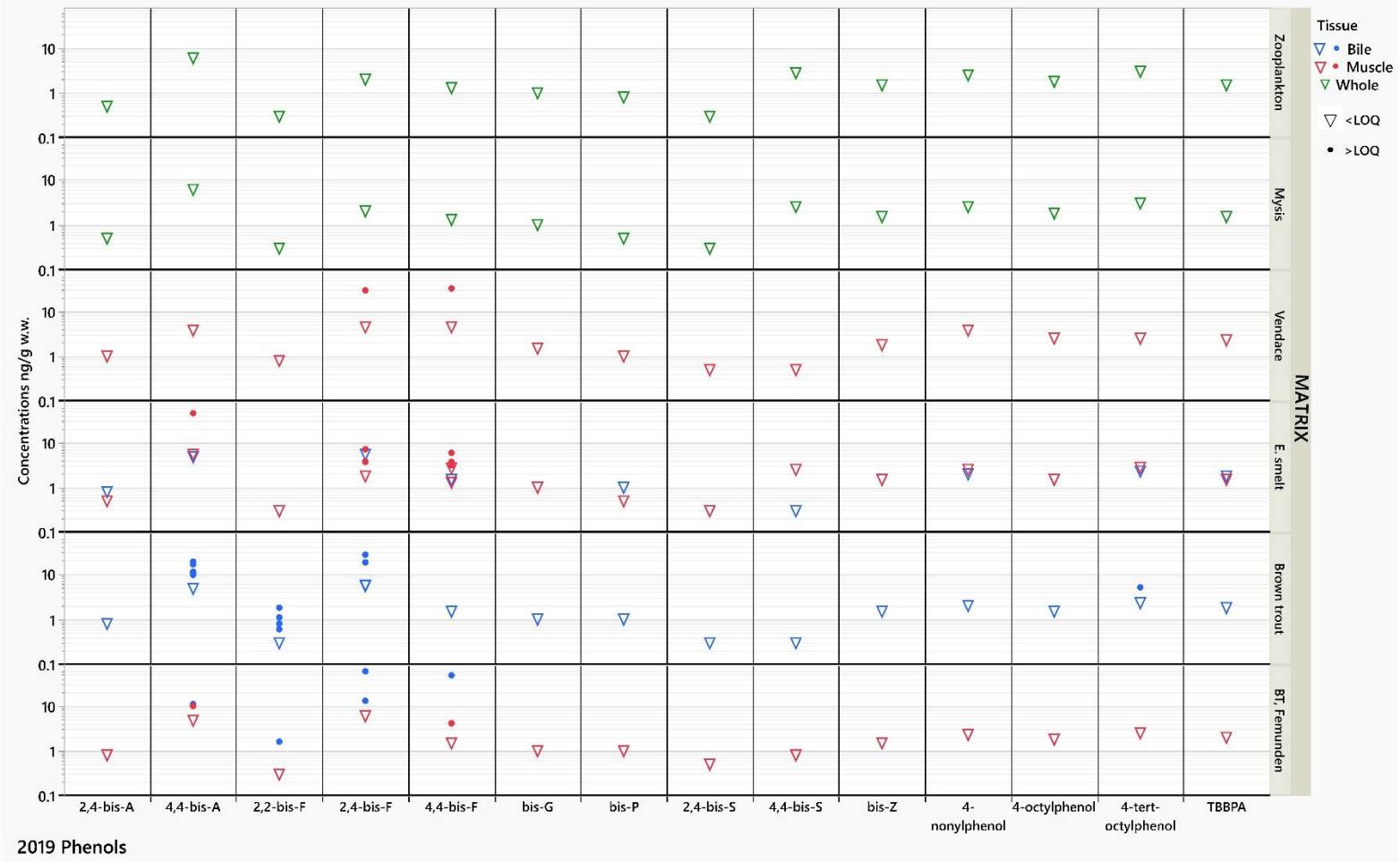

Figure 29. Overview of alkylphenols and bisphenols in biota from Lake Mjøsa and Femunden sampled in 2019. Concentrations (y-axis) in ng/g w.w. Sample tissues were whole body (whole in green) for zooplankton and Mysis, muscle (marked in red) for vendace, E.smelt and 4/10 samples of brown trout in Lake Femunden, and bile (marked in blue) for all brown trout in Lake Mjøsa and 6/10 samples of brown trout in Lake Femunden. Concentrations below LOQ are visualized with a triangle (▽), whereas concentrations above LOQ are visualized by dots.

3.9 Organic phosphorus flame retardants (oPFR)

Organic phosphorus flame retardants were determined in whole body of zooplankton and *Mysis* and in fish muscle from Lake Mjøsa and brown trout from Lake Femunden. Detection frequencies for all oPFRs are listed in Table 3, indicating that tris-chloropropyl phosphate (TCPP) and triphenyl phosphate (TPP) were found in most samples of zooplankton, Mysis and the fish at lower trophic levels in Lake Mjøsa. TCPP was also detected in 60 % of the samples of brown trout in Lake Femunden, but not in the brown trout from Lake Mjøsa. Tri-n-butylphosphate (TnBP) and tris(2-ethylhexyl)phosphate (TEHP) were detected in almost all samples of zooplankton and Mysis. As for the rest of the oPFRs in the analytical program, there were only sporadic detections, such as 2-ethylhexyldiphenyl phosphate (EHDP) in all samples of vendace and TEHP in E. smelt.

Table 16 shows the main results of oPFRs found in zooplankton, Mysis, vendace, E.smelt and brown trout from Lake Mjøsa and brown trout from Lake Femunden in 2019. Highest concentrations of TCPP were found in vendace from Lake Mjøsa (0.32 – 1.1 ng/g w.w., mean 0.64 ng/g w.w.), and for TPP in samples of zooplankton (0.50-0.67 ng/g w.w., mean 0.58 ng/g w.w.). No oPFRs were detected in samples of the top predator brown trout from Lake Mjøsa, and only TCPP was detected in 6 out of 10 samples of brown trout from Lake Femunden. Similar results i.e. mostly concentrations below LOQ were found in a study of predator fish (Lake trout) in Canadian great lakes where only two oPFRs (TCEP and tris(2-butoxyethyl) phosphate (TBOEP)) were frequently detected in concentrations below 10 ng/g w.w. (McGoldrick et al., 2014). Another study by Zhao et al. (2018) were able to detect 9 out of 14 oPFRs but could not determine a trophic magnification of oPFRs in a food web in China.

The presence of a few specific oPFRs only in the lower trophic levels in Lake Mjøsa suggest that these compounds are readily metabolized in the top predators, and that future studies of oPFRs should be focused on potential degradation products. Some of the oPFRs are readily metabolized to diester equivalents, e.g. triphenyl phosphate (TPP, also determined TPHP in some literature) metabolizes to diphenyl phosphate (DPP/DPHP), and TCPP (also determined TClPP) degrades to *bis*(1-chloro-2-propyl) phosphate (BCPP/BClPP) (Butt et al., 2014; Wang et al., 2017).

Ruus et al. (2019) found detectable levels of oPFRs in samples of effluent water and sludge from a Norwegian wastewater treatment plant (WWTP) close to the Oslofjord. TCPP and triethyl phosphate (TEP) were the dominate oPFRs in effluent water whereas TCPP and tris(2-butoxyethyl) phosphate (TBEP) had the highest concentrations in sludge. This indicates that discharges from WWTPs might be a relevant source for these compounds to the environment.

Table 16. Concentration range (min-max), mean (x̄) and number (N) of detections for organic phosphorus flame retardants (oPFRs) in samples of zooplankton, Mysis, vendace, E. smelt and brown trout from Lake Mjøsa and brown trout from Lake Femunden in 2019. Concentrations are given in ng/g on wet weight (w.w.) basis. Concentrations below LOQ (w.w.) have been replaced by half the limit when calculating x̄. "N>LOQ" is the number of samples above LOQ. Sample groups with more than 50 % of the samples above LOQ are marked in orange.

Lake	Matrix	N	Statistics	TEP	TCEP	TPrP	TCPP	TiBP	BdPhP	TPP	DBPhP	TnBP	TDCPP	TBEP	TCP	EHDP	TXP	TEHP
Mjøsa	Zoopl.	3	Range	<1	<0.4	<0.01	0.39-0.88	<0.15	<0.01	0.50-0.67	<0.01	0.09-0.12	<0.2	<0.1	<0.05	<0.1	<0.05	0.97-1.5
			Mean, x̄	<1	<0.4	<0.01	0.59	<0.15	<0.01	0.58	<0.01	0.11	<0.2	<0.1	<0.05	<0.1	<0.05	1.2
			N>LOQ	0	0	0	3	0	0	3	0	3	0	0	0	0	0	3
	Mysis	3	Range	<1	<0.4	<0.01	0.21-0.51	<0.15	<0.01	0.15-0.41	<0.01	<0.1-0.09	<0.2	<0.1	<0.05	<0.1	<0.05	2.7-4.1
			Mean, x̄	<1	<0.4	<0.01	0.35	<0.15	<0.01	0.29	<0.01	<0.1	<0.2	<0.1	<0.05	<0.1	<0.05	3.6
			N>LOQ	0	0	0	3	0	0	3	0	1	0	0	0	0	0	3
	Vendace	5	Range	<1	<0.6	<0.05	0.32-1.1	<0.20	<0.05	0.10-0.33	<0.05	<0.1-0.17	<0.2	<0.1-0.11	<0.1-4.4	0.16-0.77	<0.1	<0.1
			Mean, x̄	<1	<0.6	<0.05	0.64	<0.20	<0.05	0.22	<0.05	<0.1	<0.2	<0.1	0.9	0.31	<0.1	<0.1
			N>LOQ	0	0	0	5	0	0	5	0	1	0	1	1	5	0	0
	E. smelt	10	Range	<1	<0.4	<0.01	0.19-0.42	<0.15	<0.01	<0.03-0.25	<0.01	<0.1-0.27	<0.2-0.31	<0.1	<0.05	<0.1	<0.05	<0.2-2.6
			Mean, x̄	<1	<0.4	<0.01	0.31	<0.15	<0.01	0.10	<0.01	<0.1	<0.2	<0.1	<0.05	<0.1	<0.05	0.57
			N>LOQ	0	0	0	10	0	0	8	0	2	1	0	0	0	0	2
	B. trout	15	Range	<0.3	<0.4	<0.01	<0.05-0.24	<0.15	<0.01	<0.03-0.08	<0.01	<0.01	<0.2	<0.1	<0.05	<0.1	<0.05	<0.2
			Mean, x̄	<0.3	<0.4	<0.01	<0.05	<0.15	<0.01	<0.03	<0.01	<0.01	<0.2	<0.1	<0.05	<0.1	<0.05	<0.2
			N>LOQ	0	0	0	1	0	0	4	0	0	0	0	0	0	0	0
Femunden	B. trout	10	Range	<0.3	<0.6	<0.05	<0.10-0.27	<0.20	<0.05	<0.05	<0.05	<0.01	<0.2	<0.05-0.31	<0.1	<0.1-0.52	<0.1	<0.1
			Mean, x̄	<0.3	<0.6	<0.05	0.13	<0.20	<0.05	<0.05	<0.05	<0.01	<0.2	<0.05	<0.1	<0.1	<0.1	<0.1
			N>LOQ	0	0	0	6	0	0	0	0	0	0	1	0	1	0	0

3.10 Per- and polyfluorinated substances (PFAS)

3.10.1 Levels of PFAS in 2019

Per- and polyfluorinated alkyl substances (PFAS) were determined in samples of whole-body zooplankton and *Mysis*, and in fish liver (vendace, E. smelt and brown trout) from Lake Mjøsa, and in brown trout liver from Lake Femunden. PFASs tend to accumulate in blood rich organs, so liver has been the preferred sample matrix for fish in the monitoring program since 2013, as discussed in chapter 2.2.7.

Detection frequencies for PFASs are shown in Table 3. The long-chained carboxylic acids (PFCAs) with C > 9 are detected in almost all fish samples. No PFASs were detected in any samples of zooplankton nor *Mysis*, except for PFOS that was detected in *Mysis*. Other than the long-chained PFCAs, only the perfluorooctanesulfonate (PFOS) and the precursors perfluorooctanesulfonamide (PFOSA) and perfluoro-1-butansulfonamide (PFBSA) were detected. The major results for PFASs above LOQ are given in Table 17.

Table 17. Concentrations of dominating PFAS (ng/g w.w.) presented as mean, minimum and maximum in zooplankton, *Mysis*, vendace, E. smelt and brown trout from Lake Mjøsa and in brown trout from Lake Femunden. Concentrations below LOQ have been replaced by half the limit. Results **above** LOD are marked in orange.

Lake	Matrix	N	Stats.	PFDA	PFUnDA	PFDoDA	PFTrDA	PFTeDA	PFOS	PFOSA	PFBSA
Mjøsa	Zoopl.	3	Range	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.3
			Mean, x̄	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.3
			N>LOQ	0	0	0	0	0	0	0	0
	Mysis	3	Range	<0.004	<0.004	<0.004	<0.004	<0.004	0.11-0.12	<0.004	<0.3
			Mean, x̄	<0.004	<0.004	<0.004	<0.004	<0.004	0.12	<0.004	<0.3
			N>LOQ	0	0	0	0	0	3	0	0
	Vendace	5	Range	1.1-1.4	2.2-2.9	1.9-2.3	1.4-2.1	0.72-0.97	2.3-2.9	<0.004-0.12	<0.3
			Mean, x̄	1.2	2.7	2.1	1.8	0.88	2.6	0.09	<0.3
			N>LOQ	5	5	5	5	5	5	4	0
	E. smelt	10	Range	2.3-7.7	4.7-18	2.0-10	3.3-16	0.89-3.9	4.5-13.2	0.55-1.4	<0.3-0.52
			Mean, x̄	4.9	11	6.3	7.7	2.1	7.9	1.0	0.34
			N>LOQ	10	10	10	10	10	10	10	8
	B. trout	15	Range	0.74-4.8	1.3-12	<0.004-7.2	1.0-11	<0.004-0.83	1.7-11	0.47-1.5	1.9-6.6
			Mean, x̄	3.0	7.5	4.4	6.7	0.41	6.8	0.88	3.8
			N>LOQ	15	15	14	15	14	15	15	15
Fem.	B. trout	10	Range	1.1-3.1	4.5-14	2.2-8.0	5.9-32	0.98-5.2	1.7-4.3	0.19-0.63	0.4-7.8
			Mean, x̄	1.9	8.7	4.6	16	2.6	2.9	0.42	2.8
			N>LOQ	10	10	10	10	10	10	10	10

Generally, the individual PFAS with concentrations above LOQ are mostly found in fish, and not in the lower trophic levels (zooplankton and *Mysis*), except for PFOS also found in *Mysis*. Highest concentration of the carboxylic acids (PFCA) was found in samples of brown trout from Lake Femunden (PFTrDA, range 5.9-32 ng/g w.w., mean 16 ng/g w.w.). For the other long-chained PFCAs, the highest concentrations are found in samples of E. smelt in Lake Mjøsa. Shorter chained PFCAs, i.e. $5 \leq C \geq 8$, was not found above LOQ in any of the samples in either lake.

Dominating PFAS in both lakes are long-chained perfluorinated carboxylic acids (PFCAs): PFNA (C-9), PFDA (C-10), PFUnDA (C-11), PFDoDA (C-12), PFTrDA (C-13), PFTeDA (C-14), perfluoroctanesulfonate (PFOS) and the precursor substances perfluorooctanesulfonamide (PFOSA) and perfluoro-1-butansulfonamide (PFBSA). PFPeDA (C-15) was detected in brown trout (both lakes). All other PFAS were below LOQ. The percentage of detected PFAS in all samples from 2019 are shown in Figure 30.

In Figure 30 we see that the long-chained PFCAs are dominating the PFAS pattern, representing 70-80 % of the detected PFAS in fish liver samples from Lake Mjøsa and Lake Femunden. The three fish species from Lake Mjøsa have the same pattern with PFCAs and PFOS (15-20 %) as main constituents, whereas in Lake Femunden the PFOS fraction is only 7 %. Precursor substances detected (PFOSA and PFBSA) constitute a larger percentage in the top predator (brown trout) than in vendace and E.smelt.

This PFAS distribution is also shown in samples from 2013-2019 (Figure 35), indicating that the sources for PFAS are different in the two lakes.

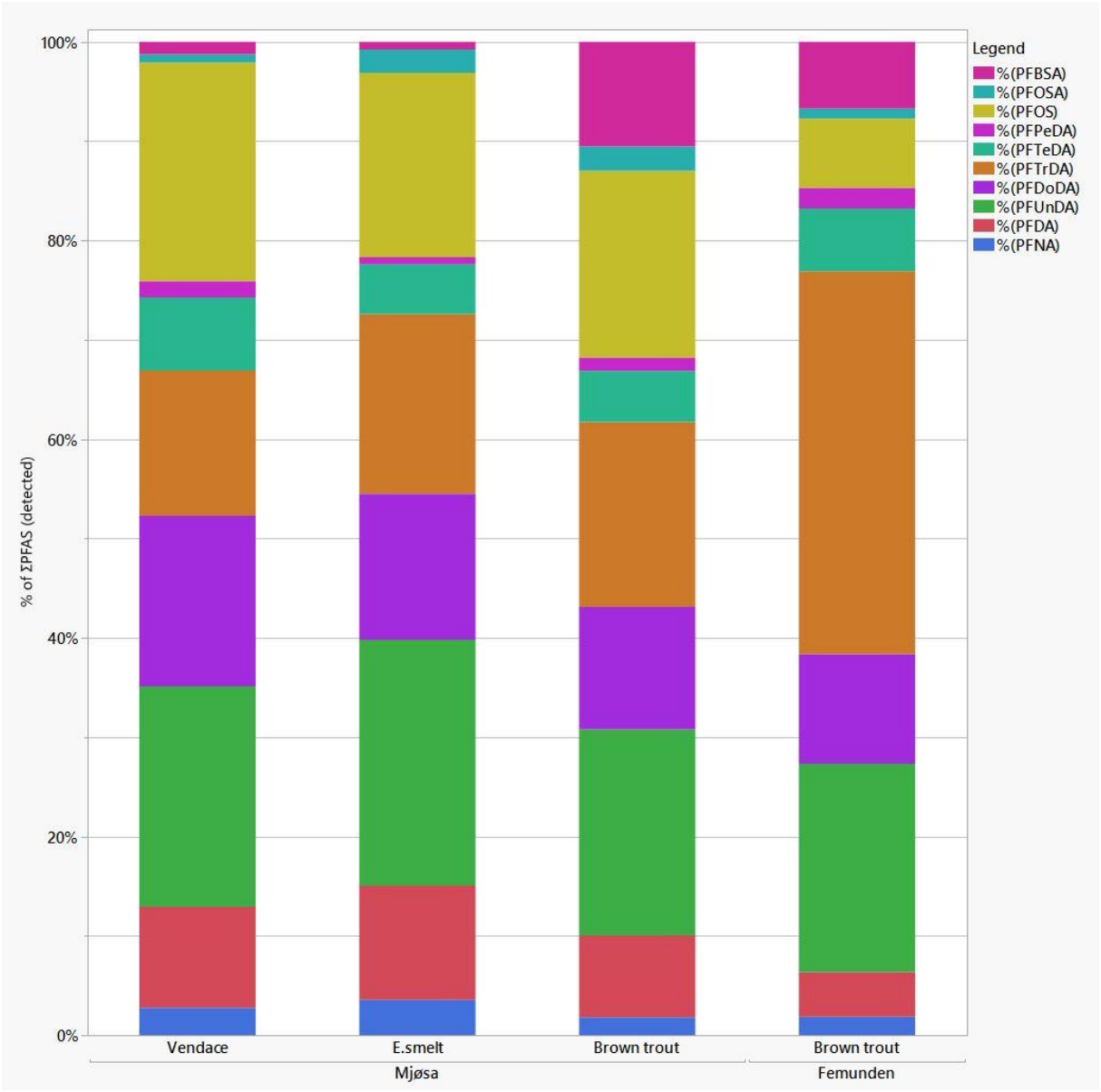

Figure 30. Percentage distribution of dominant and detected PFAS in samples of fish liver in Lake Mjøsa and Lake Femunden in 2019.

In Figure 31 boxplots of the PFCA concentrations in all matrices from 2019 are shown, indicating similar levels in brown trout from Lake Mjøsa and Lake Femunden. PFTrDA is significantly higher in brown trout from Lake Femunden compared to brown trout in Lake Mjøsa (mean concentrations 16 and 6.7 ng/g w.w., respectively, p=0.0012).

Concentrations of PFOS and PFOSA in 2019 are shown in Figure 32. Highest mean PFOS concentrations were found in E. smelt in Lake Mjøsa (mean 7.9 ng/g w.w.), slightly but not significantly higher than in brown trout (mean 6.8 ng/g w.w.). In 2019 three samples of E. smelt and three samples of brown trout from Lake Mjøsa exceeded the EQS_{biota} concentration for PFOS (9.1 ng/g w.w.).

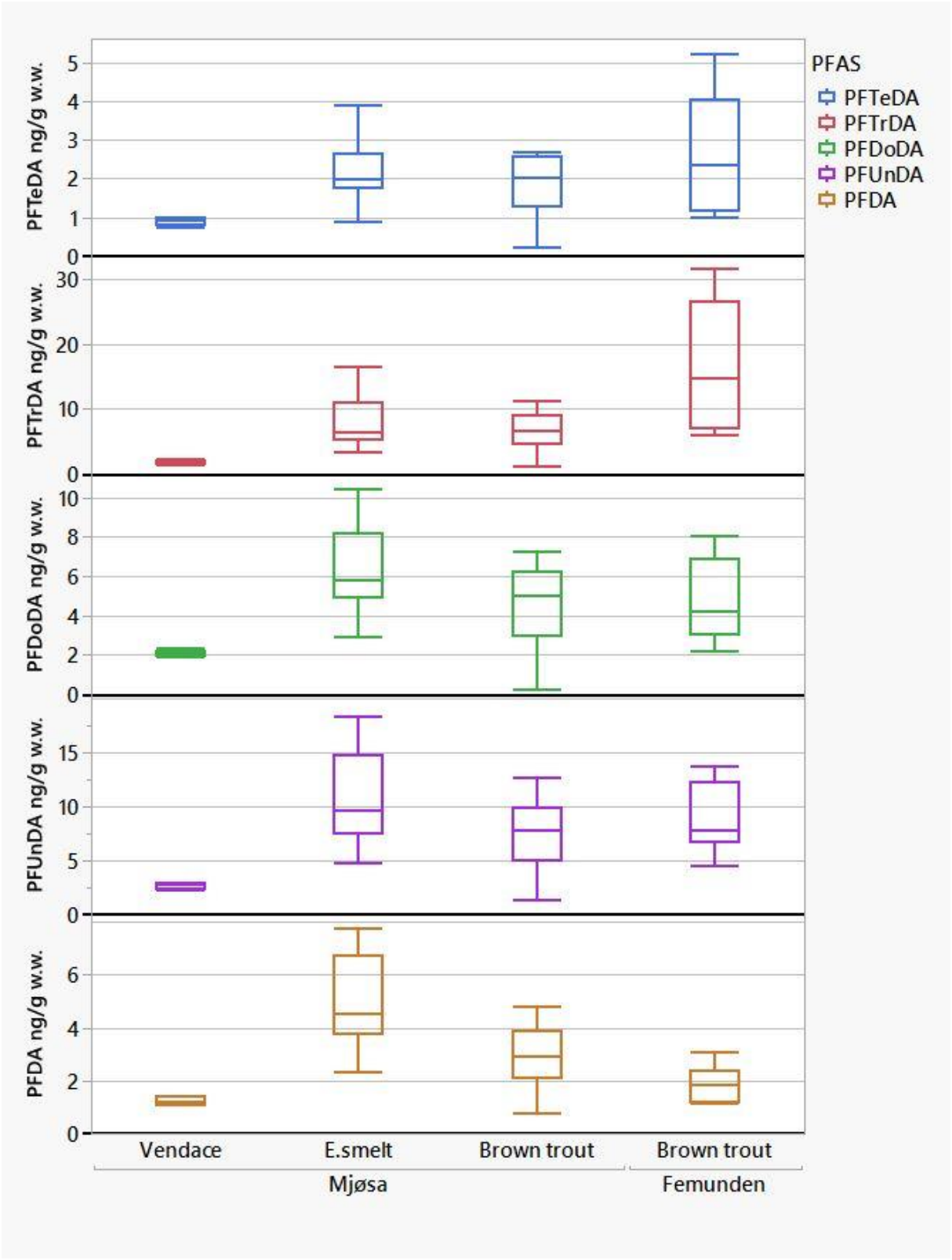

Figure 31. Boxplot of long-chained PFCAs (C10-14) showing the concentrations (ng/g w.w.) in samples of fish liver in Lake Mjøsa and Lake Femunden in 2019. Concentrations <LOQ have been replaced by half the limit.

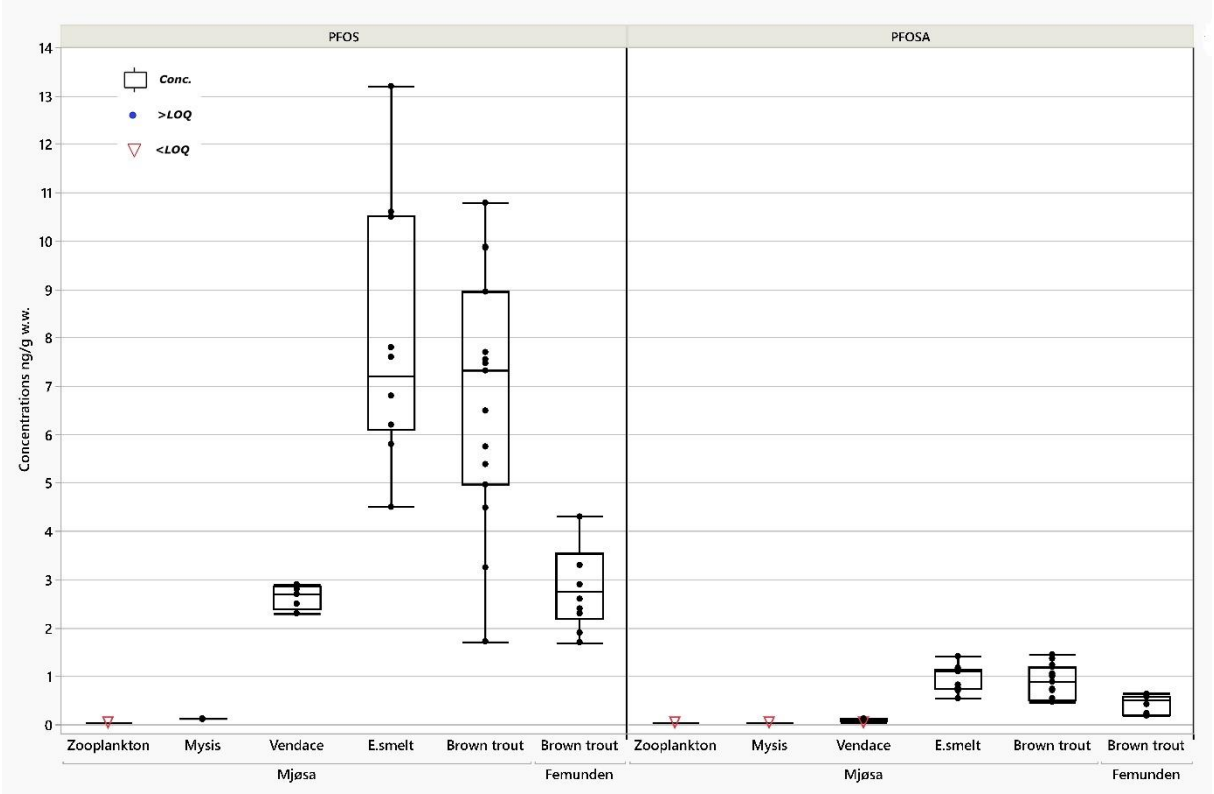

Figure 32. Boxplot of PFOS and PFOSA showing the concentrations (ng/g w.w.) in samples of zooplankton, *Mysis* (whole body), and fish liver in Lake Mjøsa and Lake Femunden in 2019. Concentrations <LOQ have been replaced by half the limit and indicated with a triangle.

In previous studies (Fjeld et al., 2017; Jartun et al., 2018) concentrations of PFTrDA have been higher in Lake Femunden, with suggested explanation in the differences in diet between brown trout in Lake Femunden and Lake Mjøsa. Large brown trout in Mjøsa are almost solely pelagic, whereas the brown trout in Lake Femunden are more closely linked to the terrestrial food web, e.g. insects. Studies have shown that the respiratory elimination of ionic and thus more water soluble PFAS, such as the carboxylic acids, are less efficient in terrestrial organisms (e.g. insects) than in aquatic organisms (Kelly et al., 2009).

To assess the actual contamination of PFOS and PFOA in biota, concentrations in fish from Lake Mjøsa and Lake Femunden (ng/g w.w., liver) were compared to the EQS values for the two substances given in Table 6. EQS_{biota} values are 9.1 and 91.3 ng/g w.w. for PFOS and PFOA, respectively. PFOA was not detected in any fish sample from either lake. PFOA is reported to be efficiently excreted via the renal route (kidneys, urine) with whole-body half-life of ~12 days (Consoer et al., 2014). PFOS was found above EQS of 9.1 ng/g w.w. in 3 out of 15 samples of brown trout in Lake Mjøsa, with concentrations ranging from 1.7 – 11 ng/g w.w. Mean concentration of PFOS in brown trout from Lake Mjøsa in 2019 was 6.8 ng/g w.w., whereas mean concentrations for the same species in Lake Femunden was 2.9 ng/g w.w. EFSA (European Food Safety Authority) presented in September 2020 a new safety threshold for a group of selected PFAS of 4.4 ng per kg. body weight per week (EFSA Contam Panel, 2020). Based on

the old limits (2018) for tolerable weekly intake (TWI) for single PFASs, e.g. 13 ng PFOS per kg. body weight, the Norwegian Food Safety Authority has advised against consumption of fish from Lakes Vansjø, Leirin and Tyrifjorden based on the levels of PFAS found in freshwater fish (Matportalen, 2020). Concentrations of PFAS found in these lakes are higher than in Lake Mjøsa, and they all represent areas with specific local point sources for PFAS. There are no guidelines or advice against the consumption of fish from Lake Mjøsa specifically regarding the PFAS concentrations, but there are general advices based on historical data for Hg and PBDEs.

Levels of PFAS in brown trout from Lake Mjøsa have generally been lower than other lakes more closely related to known, local sources of PFAS such as Lake Vansjø close to a fire-fighting training facility (Fjeld et al., 2015) and Lake Tyrifjorden with historical discharges of a range of PFAS from paper industry upstream in the catchment area (Slinde et al., 2019). In Tyrifjorden, concentrations of PFOS in perch liver were 322-1110 ng/g w.w., up to 500 times the concentrations found in brown trout from Lake Mjøsa.

3.10.2 Trophic magnification of PFAS

Biomagnification of PFOS was slightly discussed in chapter 3.7 with the correlation of other dominant contaminants (Hg, D5 and BDE-47). Substantial data for all PFAS in samples of the food web in Lake Mjøsa from 2014 – 2019 are available, and Figure 33 shows the linear regressions for PFCAs. For all dominant PFCAs (C10-C14) there is a significant positive regression ($p<0.0001$) between ln (C) and TL_{rel} indicating that all these compounds biomagnify in Lake Mjøsa. TMFs for PFDA, PFUnDA, PFDoDA, PFTrDA and PFTeDA are 2.62, 4.36, 3.56, 4.38 and 2.21, respectively.

Biomagnifying properties of PFOS and PFOSA are demonstrated in Figure 34 with data from zooplankton, *Mysis*, vendace, E. smelt and brown trout from 2014-2019. Both contaminants show a positive significant ($p<0.0001$) regression between the ln-transformed concentrations and TL_{rel}, with TMFs of 5.77 and 3.32, respectively.

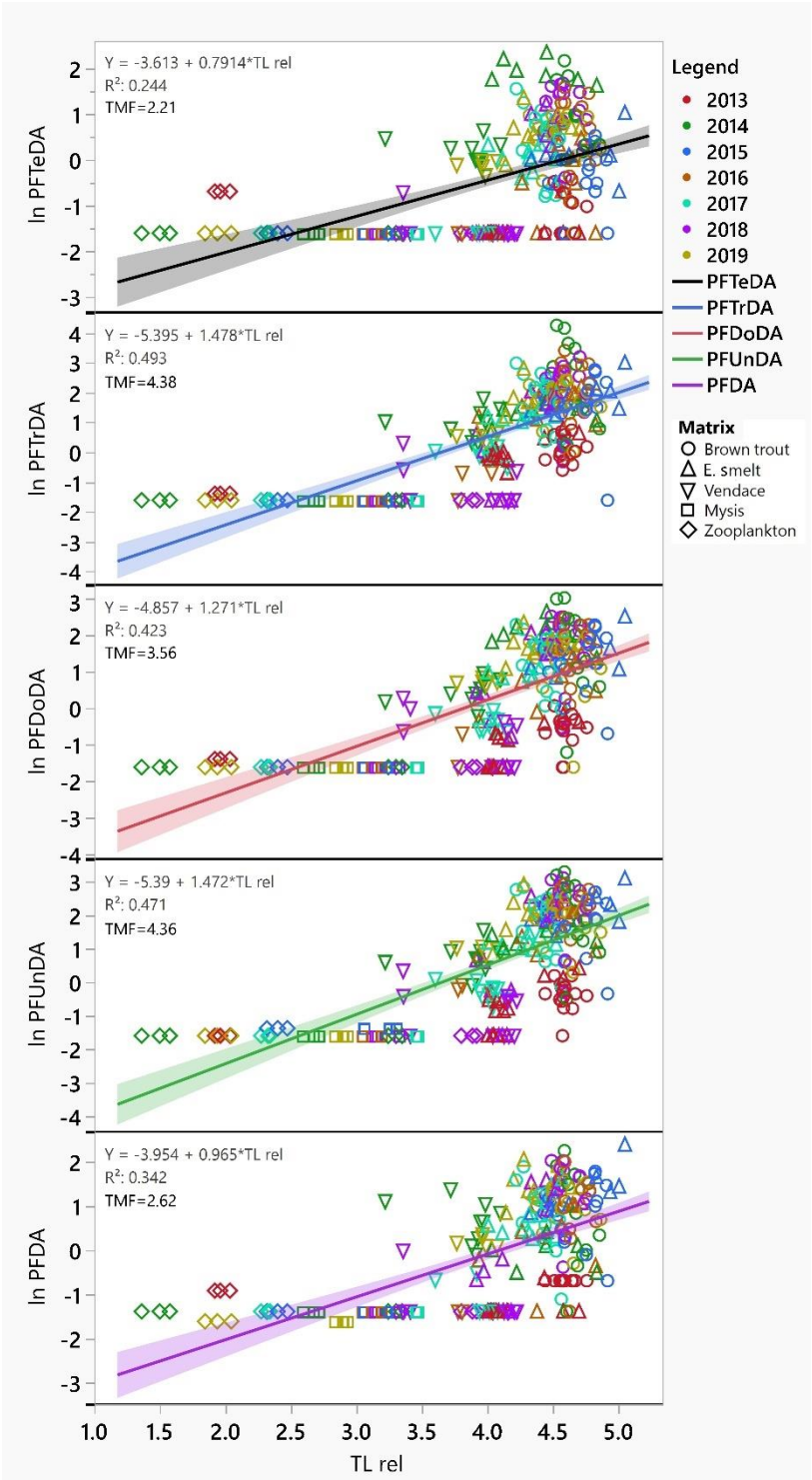

Figure 33. Log_e-transformations of PFCA concentrations in zooplankton, *Mysis*, vendace, E. smelt and brown trout (fish liver) in Lake Mjøsa from 2014-2019 plotted against relative trophic level (TL_{rel}). Regression lines are inserted with a 95 % confident interval, and details from the model including calculation of trophic magnification factors (TMF) are shown. Concentrations below LOQ have been replaced by half the limit.

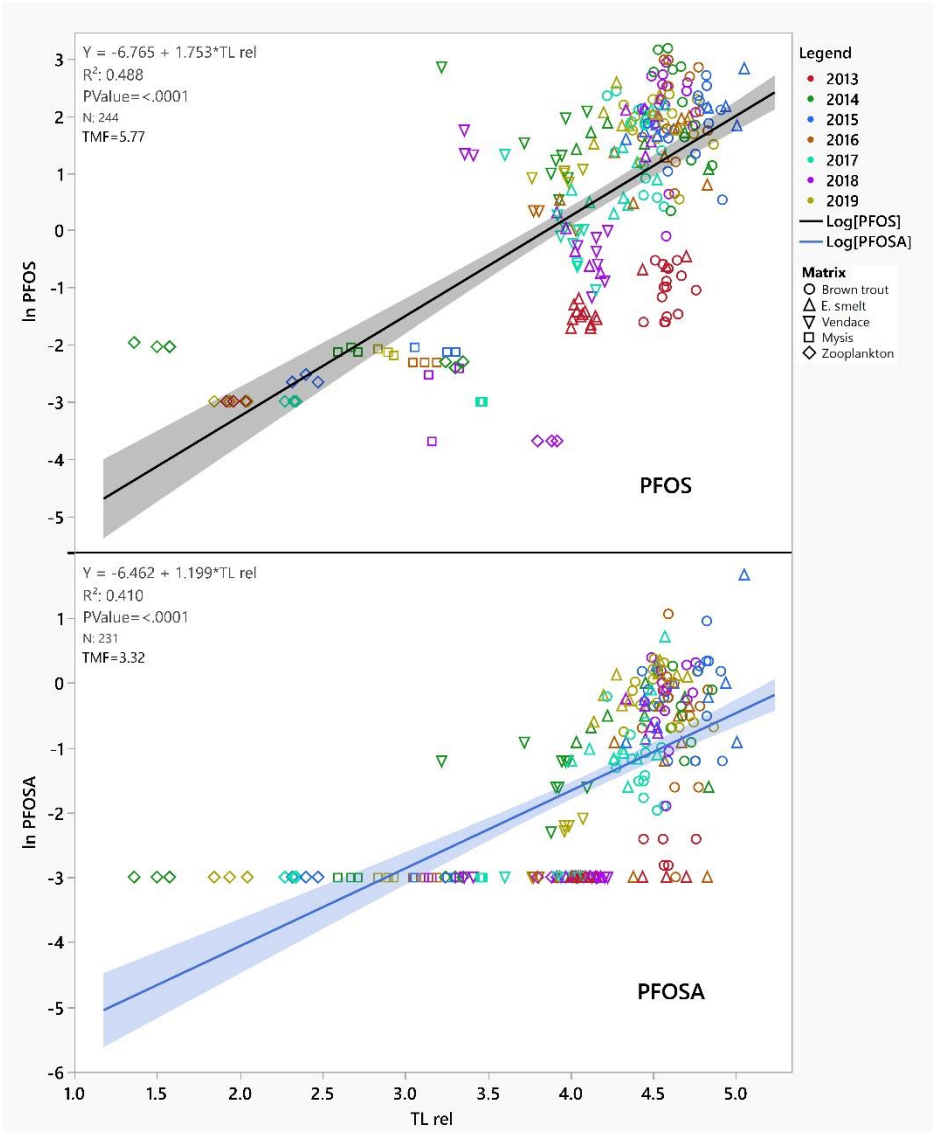

Figure 34. Log_e-transformations of PFOS and PFOSA concentrations in zooplankton, *Mysis*, vendace, E. smelt and brown trout (fish liver) in Lake Mjøsa from 2014-2019 plotted against relative trophic level (TL_{rel}). Regression lines are inserted with a 95 % confident interval, and details from the model including calculation of trophic magnification factors (TMF) are shown. Concentrations below LOQ have been replaced by half the limit.

3.10.3 PFAS – trends from 2014-2019 for Lake Mjøsa and Lake Femunden

Studies of PFAS in Lake Mjøsa have been carried out since 2006 (Fjeld et al., 2013), but for several years the matrix was muscle with large parts of the data below LOQ, or at least in low concentrations. As of 2014 the target tissue for PFAS determination in fish has been liver.

Time trends for the dominating PFASs in brown trout liver from Lake Mjøsa and Lake Femunden between 2014 to 2019 are shown in Figure 35 (stacked) and Figure 36 (independently). Looking at brown trout only, similar levels are found for all detected PFCAs in the two lakes within this period,

except for PFOS. This is an indication that the sources for PFCAs to these lakes are the same and is most likely a result of long-range atmospheric transport and/or breakdown of more volatile precursors as there are no local, anthropogenic sources within the catchment of Lake Femunden. There is a significantly higher concentration of PFOS in Lake Mjøsa compared to Lake Femunden ($p<0.0001$), which may be a result of more urban runoff and effluents from WWTP (e.g. Ruus et al., 2019) to Lake Mjøsa compared to the rural Lake Femunden.

For PFOS, the concentrations in fish liver are significantly higher in Lake Mjøsa compared to Lake Femunden, indicating more local sources of PFOS or precursors to PFOS within the catchment. However, levels of PFOS in fish liver in Lake Mjøsa are lower than in other great Norwegian lakes with known local sources, such as Tyrifjorden (Slinde et al., 2019) and Vansjø (Fjeld et al., 2017). PFOS was the dominating PFAS in fire-fighting foam until banned in 2007. There are no large-scale fire training areas within the catchment of Lake Mjøsa, but some minor and local areas used by municipalities and local fire crews (Norwegian Civil Defence) with potential runoff to the lake.

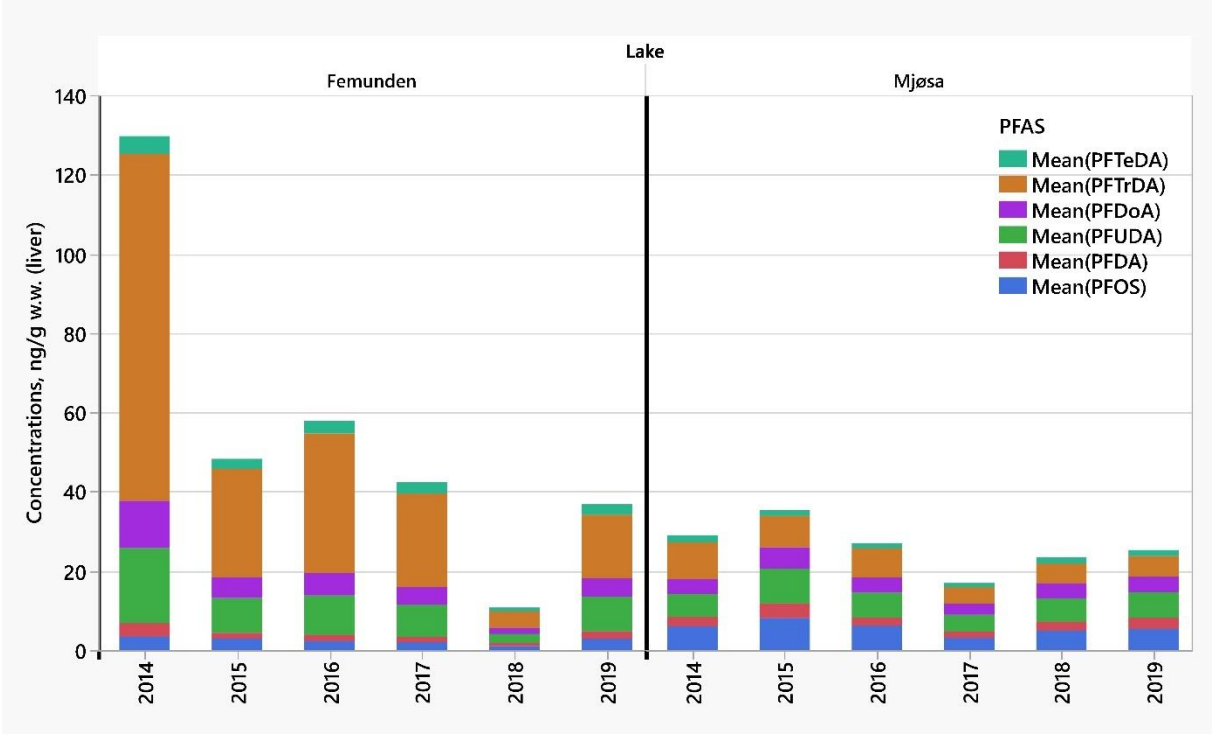

Figure 35. Time trend for dominating PFAS in brown trout from Lake Femunden (left) and Lake Mjøsa (right) indicated by mean concentrations (ng/g w.w.). Concentrations below LOQ have been replaced by half the limit.

In Lake Femunden PFTrDA has dominated the liver samples since 2014, whereas PFOS is a more dominating PFAS in Lake Mjøsa.

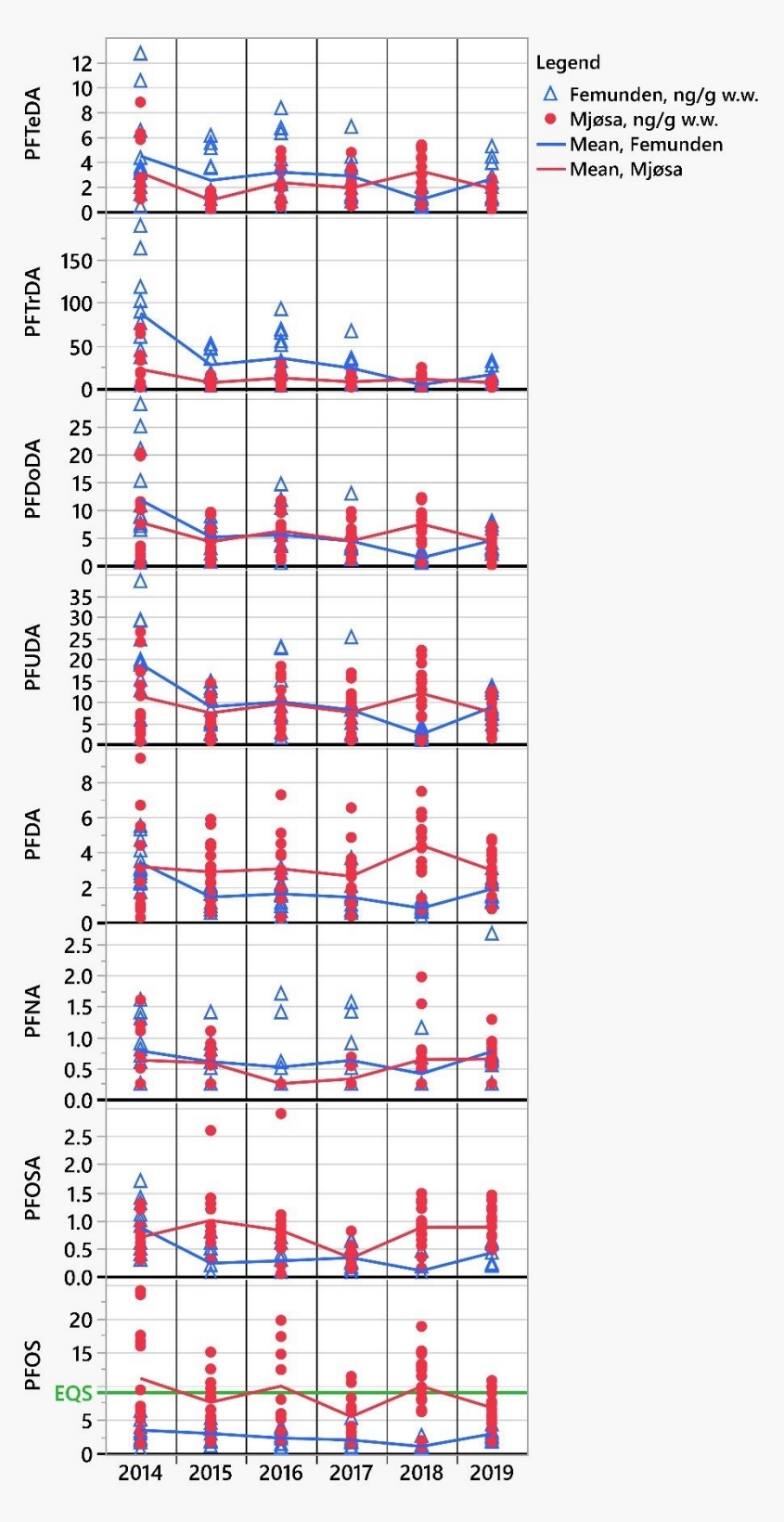

Figure 36. Concentrations of dominating PFASs (ng/g w.w.) in samples of brown trout (liver) in Lake Mjøsa and Lake Femunden 2014-2019 indicated with a red dot and a blue triangle for the two lakes respectively. The mean is shown with a line. Concentrations below LOQ have been replaced by half the limit.

3.11 UV-chemicals

Synthetic ultraviolet light filtering (UV-filter) compounds are contaminants of emerging concern and have regulatory limitations for their concentrations in cosmetic products (EC, 2009). In the main analytical program for Lake Mjøsa and Femunden, three UV-chemicals have been determined in zooplankton, *Mysis* and fish muscle and liver by NIVA; octocrylene (OC, CAS: 6197-30-4), benzophenone-3 (BP-3, CAS: 131-57-7), and ethylhexylmethoxycinnamate (EHMC, CAS: 5466-77-3).

Table 3 indicate the detection frequencies of UV-chemicals in our study. BP3 and OC was detected in zooplankton and E.smelt. Table 18 lists the detections and LOQs for UV-chemicals. EHMC-isomers were only detected in a few samples of E. smelt in Lake Mjøsa.

In previous years, muscle was the preferred target tissue for UV-chemicals (Jartun et al., 2018, 2019). In 2019 we analyzed liver in half of the brown trout samples from Lake Mjøsa to find out if the detection frequency was higher in liver compared to muscle. We could not detect any UV-chemicals in neither muscle nor liver for the brown trout samples, see results in Table 18.

EHMC is a very lipophilic compound known to accumulate in the aquatic food chain (Christen et al., 2011). EHMC-E and EHMC-Z are *trans* and *cis* isomers of 2-ethylhexyl-4-methoxycinnamate (EHMC) with somewhat different properties. The Z (*cis*) isomer has a lower absorption coefficient than E (*trans*), and often co-exist in a ratio of *trans*:*cis* 99:1 (Pangnakorn et al., 2007; Sharma et al., 2016). The Z (*cis*) isomer may cause more damaging effect than the *trans* isomer. When these chemicals are exposed to sunlight, the *trans*-isomer is transformed to the *cis*-isomer. Although levels of these contaminants are currently low in Lake Mjøsa, future monitoring should continue the search for these chemicals in the aquatic environment.

UV-filters benzophenone-3 (BP3), ethylhexylmethoxycinnamate (EHMC), octocrylene (OC), and 2-(2Hbenzotriazol-2-yl)-4,6-bis(2-phenyl-2-propanyl)phenol (UV-234) have been studied in Norwegian environment by Thomas et al. (2014). These compounds were detected in treated wastewater and leachate, indicating that effluents from wastewater treatment plants (WWTPs) might be relevant sources to the aquatic environment. BP3, EHMC, OC, 2-(5-chloro-2H-benzotriazol-2-yl)- 4,6-bis(2-methyl-2-propanyl)phenol (UV- 327) and 2-(2H-benzotriazol-2-yl)-4-(2,4,4-trimethyl-2-pentanyl)phenol (UV-329) were detected in sludge. UV-chemicals such as EHMC and OC have also been reported in fish samples from Spain (Gago-Ferrero et al., 2015), but no indication of biomagnification was found in this study mainly because of a limited food web with few trophic levels.

Table 18. Concentrations of UV-chemicals (ng/g w.w.) presented as range (min-max), mean, in samples of zooplankton, *Mysis* (whole body), vendace, E. smelt (muscle) and brown trout (muscle and liver) from Lake Mjøsa and in brown trout (muscle) from Lake Femunden. Results where more than 50 % of the samples were **above** LOQ are marked in orange.

Lake	Matrix	N	Stats.	BP3	EHMC-Z	EHMZ-E	ΣEHMZ	OC
Mjøsa	Zoopl.	3	Range	<0.05-0.067	<0.05	<0.5	<0.5	<1.4-2.5
			Mean, x̄	<0.05	<0.05	<0.5	<0.5	1.7
			N>LOQ	2	0	0	0	2
	Mysis	3	Range	<0.1	<0.02	<0.1	<0.12	<1.2-1.2
			Mean, x̄	<0.1	<0.02	<0.1	<0.12	<1.2
			N>LOQ	0	0	0	0	1
	Vendace	5	Range	<0.06	<0.03	<0.2	<0.23	<0.8
			Mean, x̄	<0.06	<0.03	<0.2	<0.23	<0.8
			N>LOQ	0	0	0	0	0
	E. smelt	10	Range	<0.08-<0.1	<0.02-0.25	<0.1-0.92	<0.12-1.2	<1.2-<1.9
			Mean, x̄	<0.1	0.04	<0.1	<0.12	<1.2
			N>LOQ	0	3	2	2	0
	B. trout Muscle	8	Range	<0.1	<0.05	<0.7	<0.75	<2
			Mean, x̄	<0.1	<0.05	<0.7	<0.75	<2
			N>LOQ	0	0	0	0	0
	B. trout Liver	7	Range	<0.06	<0.02	<0.4	<0.75	<1.2
			Mean, x̄	<0.06	<0.02	<0.4	<0.75	<1.2
			N>LOQ	0	0	0	0	0
Fem.	B. trout	10	Range	<0.05	<0.05	<0.12 – <0.5	<0.15 – <0.5	<1.4 - <1.9
			Mean, x̄	<0.05	<0.05	<0.5	<0.5	<1.4
			N>LOQ	0	0	0	0	0

3.12 New brominated flame retardants - nBFR

Table 19 and Table 20 list the detections and LOQs of new brominated flame retardants in zooplankton, *Mysis* and fish muscle from Lake Mjøsa and Lake Femunden. Only 1,2-Bis(2,4,6-tribromophenoxy)ethane (BTBPE), Decabromodiphenylethane (DBDPE) and pentabromobenzene (PBBZ) were detected above LOQ in the samples, as shown in Table 3.

Detections for zooplankton should be addressed carefully because of large uncertainties due to small sample amounts and matrix effects. Results for the nBFR is considered semi-quantitative, which is also reflected in the fluctuating LOQs within each sample matrix, see Table 19 and Table 20.

After regulation of some PBDEs as major contaminants in products such as textiles, alternative compounds (nBFR) have been introduced to the market to replace some of the older BFRs. The list of nBFR is expanding, but our analyses include 2,3-dibromopropyl-2,3,4-tribromophenyl-ether (DPTE) found in the Barents Sea and DBDPE which is found in the Arctic (de Wit et al., 2010; Harju et al., 2013). Little is so far known about the concentrations and environmental fate and impact these substances may have. In a recent study from the Arctic, nBFRs with low molecular weights such as hexabromobenzene (HBB), pentabromoethylbenzene (PBEB) and pentabromotoluene (PBT) were detected in amphipods (Carlsson et al., 2018). Several of the nBFRs may undergo long-range transport.

Table 19. (..part 1) Concentrations of new brominated flame retardants (nBFR) (ng/g w.w.) presented as range (min-max), mean, in samples of zooplankton, *Mysis* (whole body), vendace, E. smelt and brown trout (muscle) from Lake Mjøsa and in brown trout (muscle) from Lake Femunden. Results where more than 50 % of the samples were **above** LOQ are marked in orange.

Lake	Matrix	N	Stats.	TBA	ATE(TBP-AE)	a-TBEC	b-TBECH	g/d-TBECH	BATE	PBT	PBEB	PBBZ	HBB	DPTE
Mjøsa	Zoopl.	3	Range	<0.003-0.004	<0.009	<0.025-<0.039	<0.017-<0.027	<0.011-<0.018	<0.006-<0.007	<0.01	<0.007	<0.086	<0.035-0.04	<0.003
			Mean, x̄	<0.003	<0.009	<0.031	<0.022	<0.014	<0.006	<0.01	<0.007	<0.086	<0.035	<0.003
			N>LOQ	1	0	0	0	0	0	0	0	0	1	0
	Mysis	3	Range	0.004	<0.009	<0.01	<0.008	<0.005	<0.006	<0.01	<0.007	<0.086	<0.035	<0.003
			Mean, x̄	0.004	<0.009	<0.01	<0.008	<0.005	<0.006	<0.01	<0.007	<0.086	<0.035	<0.003
			N>LOQ	3	0	0	0	0	0	0	0	0	0	0
	Vendace	5	Range	0.012-0.021	<0.009-0.043	<0.019-0.04	0.018-0.042	0.022-0.047	0.02-0.048	0.024-0.052	0.023-0.047	<0.086	0.061-0.082	0.026-0.039
			Mean, x̄	0.015	0.015	0.02	0.028	0.032	0.029	0.034	0.030	<0.086	0.070	0.031
			N>LOQ	5	4	4	5	5	5	5	5	0	5	5
	E. smelt	10	Range	<0.003-0.005	<0.006-0.041	<0.007-0.047	<0.005-0.04	<0.003-0.019	<0.004-0.022	<0.007-0.025	<0.004-0.021	<0.057	<0.023-0.042	<0.002-0.015
			Mean, x̄	0.004	0.009	<0.01	<0.007	<0.003	0.007	<0.007	<0.004	<0.057	<0.023	<0.002
			N>LOQ	5	4	2	3	2	5	2	2	0	4	4
	B. trout	15	Range	<0.001-0.035	<0.004-0.016	<0.004-0.016	<0.003-0.014	<0.002-0.01	<0.002-0.011	<0.004-0.010	<0.003-0.009	<0.034	<0.014-0.029	<0.001-0.009
			Mean, x̄	0.011	<0.004	<0.009	<0.007	<0.003	0.004	<0.004	<0.003	<0.034	0.020	0.003
			N>LOQ	13	5	4	7	7	8	6	6	0	14	9
Fem.	B. trout	10	Range	0.005-0.048	<0.004	<0.004-<0.016	<0.003-<0.016	<0.002-<0.01	<0.002-<0.004	<0.004	<0.003	<0.034	<0.014-0.020	<0.001-<0.002
			Mean, x̄	0.014	<0.004	<0.004	<0.006	<0.006	<0.002	<0.004	<0.003	<0.034	<0.014	<0.001
			N>LOQ	10	0	0	0	0	0	0	0	0	2	0

Table 20. (..part 2) Concentrations of new brominated flame retardants (nBFR) (ng/g w.w.) presented as range (min-max), mean, in samples of zooplankton, *Mysis* (whole body), vendace, E. smelt and brown trout (muscle) from Lake Mjøsa and in brown trout (muscle) from Lake Femunden. Results where more than 50 % of the samples were **above** LOQ are marked in orange.

Lake	Matrix	N	Stats.	EHTBB	BTBPE	TBPH (BEH/TBP)	DBDPE	Dibromo-aldrin
Mjøsa	Zoopl.	3	Range	<0.007	<0.022	<0.027	<4.5	<0.034
			Mean, x̄	<0.007	<0.022	<0.027	<4.5	<0.034
			N>LOQ	0	0	0	0	0
	Mysis	3	Range	<0.010-<0.015	<0.022	<0.027	<4.5	<0.034
			Mean, x̄	<0.012	<0.022	<0.027	<4.5	<0.034
			N>LOQ	0	0	0	0	0
	Vendace	5	Range	0.026-0.051	<0.022-0.036	<0.027	<4.5	<0.034
			Mean, x̄	0.035	0.028	<0.027	<4.5	<0.034
			N>LOQ	5	4	0	0	0
	E. smelt	10	Range	<0.015-0.113	<0.015-0.028	<0.018-0.078	<3.0-9.0	<0.0229-<0.0368
			Mean, x̄	0.036	<0.015	<0.018	<3.0	<0.0229
			N>LOQ	3	2	1	1	0
	B. trout	15	Range	<0.005-0.006	<0.009-0.011	<0.011	<1.8-8.0	<0.014
			Mean, x̄	<0.005	<0.009	<0.011	<1.8	<0.014
			N>LOQ	1	2	0	1	0
Fem.	B. trout	10	Range	<0.004-<0.012	<0.009	<0.011-<0.015	<1.8-3.1	<0.014-<0.092
			Mean, x̄	<0.004	<0.009	<0.011	<1.8	<0.014
			N>LOQ	0	0	0	2	0

3.13 Dechloranes

Dechlorane 602 were detected in almost all samples of fish lever from both Lake Mjøsa and Lake Femunden. Mean concentration for vendace, E.smelt and brown trout in Lake Mjøsa were 0.010, 0.005 and 0.019 ng/g w.w., respectively. Mean dechlorane 602 concentration in brown trout from Lake Femunden was 0.0090 ng/g w.w. Dechlorane plus *anti* and plus *syn* were detected sporadically in a few samples of Mysis, E. smelt and brown trout from Lake Mjøsa, but 95 % of samples were <LOQ for the dechloranes besides 602. Detections ranged from 0.02-0.09 ng/g w.w. for dechlorane plus *anti* and *syn*, sum of dechlorane plus (sum *syn* and *anti*) ranged from 0.05-0.10 ng/g w.w.

Dechlorane plus, including its *anti* and *syn* isomers has been identified as a Substance of Very High Concern (SVHC) and incorporated in the EU Candidate List based on its persistent and bioaccumulative properties (ECHA, 2018b). There is a call for evidence on dechlorane plus to submit these compounds to the Stockholm convention on persistent organic pollutants, to gather information on global manufacture, use, emissions, potential alternatives and the presence of dechlorane plus in plastic products, e.g. recycled materials. Thus far, dechlorane plus with its isomers has not been detected in a large number of samples of freshwater fish in Norway, but they have been reported in benthic food chains in the Arctic (Carlsson et al., 2018).

Table 21 provides an overview of the results, i.e. a summary of the LOQ for these compounds.

Table 21. Concentrations of dechloranes (ng/g w.w.) presented as range (min-max), mean, in samples of zooplankton, *Mysis* (whole body), vendace, E. smelt and brown trout (muscle) from Lake Mjøsa and in brown trout (muscle) from Lake Femunden. Results where more than 50 % of the samples were **above** LOQ are marked in orange.

Lake	Matrix	N	Stats.	Dechlorane 601	Dechlorane 602	Dechlorane 603	Dechlorane 604	Dechlorane plus syn	Dechlorane plus anti	1,3-DPMA	1,5-DPMA
Mjøsa	Zoopl.	3	Range	<0.015	<0.003	<0.003	<0.094	<0.041	<0.054	<0.031	<0.064
			Mean, x̄	<0.015	<0.003	<0.003	<0.094	<0.041	<0.054	<0.031	<0.064
			N>LOQ	0	0	0	0	0	0	0	0
	Mysis	3	Range	<0.015	<0.003	<0.003	<0.094	<0.041	<0.054-0.086	<0.031	<0.064
			Mean, x̄	<0.015	<0.003	<0.003	<0.094	<0.041	<0.054	<0.031	<0.064
			N>LOQ	0	0	0	0	0	1	0	0
	Vendace	5	Range	<0.025-<0.03	0.008-0.011	<0.0048-<0.0056	<0.097-<0.11	<0.041	<0.054	<0.031	<0.064
			Mean, x̄	<0.025	0.01	<0.0049	<0.1	<0.041	<0.054	<0.031	<0.064
			N>LOQ	0	5	0	0	0	0	0	0
	E. smelt	10	Range	<0.01-<0.05	<0.009-0.0076	<0.002-<0.01	<0.06-<0.17	<0.027-0.05	<0.036-0.078	<0.021	<0.043
			Mean, x̄	<0.01	0.005	<0.002	<0.06	<0.027	<0.036	<0.021	<0.043
			N>LOQ	0	9	0	0	1	1	0	0
	B. trout	15	Range	<0.0060-<0.0076	0.007-0.023	<0.0013	<0.038	<0.016-0.027	<0.022-0.038	<0.013	<0.026
			Mean, x̄	<0.0060	0.019	<0.0013	<0.038	<0.016	<0.022	<0.013	<0.026
			N>LOQ	0	15	0	0	1	2	0	0
Fem.	B. trout	10	Range	<0.011-<0.13	<0.019-0.020	<0.0021-<0.0057	<0.038-<0.50	<0.016-<0.045	<0.022-<0.067	<0.013-<0.099	<0.026-<0.2
			Mean, x̄	<0.013	0.009	<0.0029	<0.050	<0.016	<0.022	<0.013	<0.026
			N>LOQ	0	9	0	0	0	0	0	0

4 Conclusions

The main conclusions from the results in 2019 include:

- Statistical models on significant ecological and morphometric predictors for mercury (Hg) variation in brown trout from Lakes Mjøsa and Femunden show that a major part of the variation is explained by trophic level ($\delta^{15}N$) and fish size in Lake Mjøsa, whereas trophic level, carbon source ($\delta^{13}C$) and fish size explained most of the variation in Lake Femunden. Based on the entire dataset for Lake Mjøsa from 2006-2019, in average the trout will reach the EU's and the Norwegian recommended upper consumption limit of 0.5 mg/kg w.w. in fish muscle at around 57 cm, which corresponds to ~ 2.1 kg. For Lake Femunden the trout based on data from 2013 to 2019 will reach the 0.5 mg/kg w.w. limit at around 52 cm, and ~ 1.25 kg.

- Cyclic volatile methylated siloxanes (cVMS; D5 and D6), Hg, BDE-47 and several of the PFAS, including PFOS, are biomagnifying in the food web of Lake Mjøsa with the highest concentrations found in top predators of brown trout and European smelt.

- There is a slight decline in D5 concentration in brown trout in the time frame of 2013-2019. There have been no samples exceeding the EQS of 15217 ng/g w.w. for D5.

- For PBDEs (ΣBDE_6) there is a downwards trend since the early 2000s, but still all fish samples from both Lake Mjøsa and Lake Femunden are above the EQS concentration for ΣBDE_6 of 0.0085 ng/g w.w.

- Long-chained carboxylic acids (PFCAs), PFOS and the precursors PFOSA and PFBSA are the dominating PFAS in freshwater fish from both lakes. 3 out of 15 samples of brown trout in Lake Mjøsa exceeded the EQS value of 9.1 ng/g w.w. for PFOS. The time series for PFAS is on a downwards trend for the PFCAs and PFOS for all fish in Lake Mjøsa compared to levels in 2013/2014 but seem to have stabilized the last four years.

- Only very few detections were observed in biota samples (fish muscle, liver or bile) for organic phosphorus flame retardants (oPFR), alkylphenols and bisphenols, new brominated flame retardants (nBFR), UV-chemicals and dechloranes. Other target tissues than muscle in 2019 (liver and bile) did not seem to increase number of detections in the sample material.

The monitoring program addresses contaminants of high concern, and even though some contaminants are observed below the limit of quantification it is important to keep searching for these compounds to provide an early warning if they were to enter Norwegian freshwater ecosystems. Well known contaminants such as Hg, PBDEs and PFOS are determined in concentrations well above the EQS. Even though several of these compounds are regulated in products and downwards trends are

indicated for e.g. BDEs and Hg, the distribution and fate of these well-known contaminants should be studied in the same detail also in the years to come.

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6 Appendices

6.1 List of all compounds in the Milfersk program.

Compound class	Compound	Name	CAS-no.
Mercury	Hg	Mercury	7439-97-6
cVMS	D4	2,2,4,4,6,6,8,8-Octamethyl-1,3,5,7,2,4,6,8-tetroxatetrasilocane	556-67-2
	D5	2,2,4,4,6,6,8,8,10,10-Decamethyl-1,3,5,7,9,2,4,6,8,10-pentoxapentasilecane	541-02-6
	D6	Dodecamethylcyclohexasiloxane	540-97-6
PBDEs	17	2,2',4-Tribromodiphenyl ether	147217-75-2
	28	2,4,4'-Tribromodiphenyl ether	41318-75-6
	47	2,2',4,4'-Tetrabromodiphenyl ether	5436-43-1
	49	2,2',4,5'-Tetrabromodiphenyl ether	243982-82-3
	66	2,3',4,4'-Tetrabromodiphenyl ether	189084-61-5
	71	2,3',4',6-Tetrabromodiphenyl ether	189084-62-6
	77	3,3',4,4'-Tetrabromodiphenyl ether	93703-48-1-
	85	2,2',3,4,4'-Pentabromodiphenyl ether	182346-21-0
	99	2,2',4,4',5-Pentabromodiphenyl ether	60348-60-9
	100	2,2',4,4',6-Pentabromodiphenyl ether	189084-64-8
	119	2,3',4,4',6-Pentabromodiphenyl ether	189084-66-0
	126	3,3',4,4',5-Pentabromodiphenyl ether	366791-32-4
	138	2,2',3,4,4',5'-Hexabromodiphenyl ether	182677-30-1
	153	2,2',4,4',5,5'-Hexabromodiphenyl ether	68631-49-2
	154	2,2',4,4',5,6'-Hexabromodiphenyl ether	207122-15-4
	156	2,3,3',4,4',5-Hexabromodiphenyl ether	N/A
	183	2,2',3,4,4',5',6-Heptabromodiphenyl ether	207122-16-5
	184	2,2',3,4,4',6,6'-Heptabromodiphenyl ether	117948-63-7
	191	2,3,3',4,4',5',6-Heptabromodiphenyl ether	189084-68-2
	196	2,2',3,3',4,4',5',6-Octabromodiphenyl ether	446255-38-5
	197	2,2',3,3',4,4',6,6'-Octabromodiphenyl ether	117964-21-3
	202	2,2',3,3',5,5',6,6'-Octabromodiphenyl ether	67797-09-5

Compound class	Compound	Name	CAS-no.
	206	2,2',3,3',4,4',5,5',6-Nonabromodiphenyl ether	63387-28-0
	207	2,2',3,3',4,4',5,6,6'-Nonabromodiphenyl ether	437701-79-6
	209	Decabromodiphenyl ether	1163-19-5
nBFR	TBA	Tribromoanisole	607-99-8
	ATE (TBP-AE)	Allyl-2,4,6-tribromophenyl ether	3278-89-5
	a-TBECH	Tetrabromoethylcyclohexane	3322-93-8
	b-TBECH	Tetrabromoethylcyclohexane	3322-93-8
	g/d-TBECH	Tetrabromoethylcyclohexane	3322-93-8
	BATE	2-bromoallyl 2,3,6-tribromophenylether	99717-56-3
	PBT	Pentabromotoluene	87-83-2
	PBEB	Pentabromoethylbenzene	85-22-3
	PBBZ		608-90-2
	HBB	Hexabromobenzene	87-82-1
	DPTE	2,3-dibromopropyl-2,4,6-tribromophenyl ether	35109-60-5
	EHTBB	2-ethyl-hexyl tetrabromobenzoate	183658-27-7
	BTBPE	1,1'-[1,2-Ethanediylbis(oxy)]bis(2,4,6-tribromobenzene)	37853-59-1
	TBPH (BEH /TBP)	bis(2-ethylhexyl) tetrabromophthalate	26040-51-7
	DBDPE	Decabromodiphenyl ethane	84852-53-9
oPFR	TEP	Tetraethyl diphosphate	78-40-0
	TCEP	Tris(2-chloroethyl) phosphate	115-96-8
	TPrP	Tripropyl phosphate	513-08-6
	TCPP	Tris(1-chloropropyl) phosphate	13674-84-5
	TiBP	Triisobutyl phosphate	126-71-6
	BdPhP	Butyl diphenyl phosphate	2752-95-6
	TPP	Triphenyl phosphate	115-86-6
	DBPhP	Dibutyl phenyl phosphate	2528-36-1
	TnBP	Tri-n-butyl phosphate	126-73-8
	TDCPP	Tris(1,3-dichloro-2-propyl)phosphate	13674-87-8
	TBEP	Tris(2-butoxyethyl) phosphate	78-51-3
	TCP	Tricresyl phosphate	1330-78-5
	EHDP	2-Ethylhexyl diphenyl phosphate	1241-94-7
	TXP		25155-23-1
	TEHP	Tris(2-ethylhexyl) phosphate	78-42-2
Phenols	4,4-bis-A	4,4'-(Propanediyl)diphenol	80-05-7
	2,4-bis-A	2,4'-(Propanediyl)diphenol	80-05-7
	bis-G	4,4’-(1-Methylethylidene)bis[2-(1-methylethyl)phenol]	127-54-8
	4,4-bis-S	4,4'-Sulfonyldiphenol	80-09-1
	2,4-bis-S	2,4'-Sulfonyldiphenol	80-09-1

Compound class	Compound	Name	CAS-no.
	4,4-bis-F	4,4'-Methylenediphenol	620-92-8
	2,4-bis-F	2,4'-Methylenediphenol	620-92-8
	2,2-bis-F	2,2'-Methylenediphenol	620-92-8
	bis-P	4,4’-(1,4-Phenylenediisopropylidene)bisphenol	2167-51-3
	bis-Z	4,4'-(1,1-Cyclohexanediyl)diphenol	843-55-0
	TBBPA	Tetrabromobisphenol A	79-94-7
	4-tert-octylphenol	4-tert-octylphenol	140-66-9
	4-octylphenol	4-octylphenol	1806-26-4
	4-nonylphenol	4-Nonylphenol	84852-15-3
PFAS	PFPA	Perfluoropentanoic acid	2706-90-3
	PFHxA	Perfluorohexanoic acid	307-24-4
	PFHpA	Perfluoroheptanoic acid	375-85-9
	PFOA	Perfluorooctanoic acid	335-67-1
	PFNA	Perfluorononanoic acid	375-95-1
	PFDA	Perfluorodecanoic acid	335-76-2
	PFUnDA	Perfluoroundecanoic acid	2058-94-8
	PFDoDA	Perfluorododecanoic acid	307-55-1
	PFTrDA	Perfluorotridecanoic acid	72629-94-8
	PFTeDA	Perfluorotetradecanoic acid	376-06-7
	PFPeDA	Perfluoropentadecanoic acid	18024-09-4
	PFHxDA	Perfluorohexadecanoic acid	67905-19-5
	PFBS	Perfluorobutanesulfonic acid	375-73-5
	PFPS	Perfluoropentane-1-sulfonic acid	2706-91-4
	PFHxS	Perfluorohexanesulfonic acid	355-46-4
	PFHpS	Perfluoroheptanesulfonic acid	375-92-8
	PFOS	Perfluorooctanesulfonic acid	1763-23-1
	8Cl-PFOS	8-chloroperfluoro-1-octanesulfonate	N/A
	PFNS	Perfluorononanesulfonic acid	474511-07-4
	PFDS	Perfluorodecane sulfonic acid	335-77-3
	PFDoS	Perfluoro-1-dodecansulfonate	7978-39-5
	PFOSA	Perfluorooctanesulfonamide	754-91-6
	N-MeFOSA	N-methylperfluoro-1-octanesulfonamide	31506-32-8
	N-EtFOSA	N-Ethylperfluoroctansulfonamid	4151-50-2
	N-MeFOSE	2-(N-methylperfluoro-1-octanesulfonamido)-ethanol	24448-09-7
	N-EtFOSE	2-(N-ethylperfluoro-1-octanesulfonamido)-ethanol	1691-99-2
	4:2 FTS	1H,2H-perfluorohexane sulfonate (4:2) (Fluortelomer sulfonic acid)	757124-72-4
	6:2 FTS	1H,2H-perfluorooctane sulfonate (6:2) (Fluortelomer sulfonic acid)	27619-97-2

Compound class	Compound	Name	CAS-no.
	8:2 FTS	1H,2H-perfluorodecane sulfonate (8:2) (Fluortelomer sulfonic acid)	39108-34-4
	10:2 FTS	1H,2H-perfluorododecane sulfonate (10:2) (Fluortelomer sulfonic acid)	120226-60-0
	4:2 F53B	Chlorinated polyfluorinated ether sulfonate	N/A
	6:2 F53B	Potassium 2-(6-chloro-1,1,2,2,3,3,4,4,5,5,6,6-dodecafluorohexyloxy)-1,1,2,2-tetrafluoroethane sulfonate	73606-19-6
	N-MeFOSAA	2-(N-methylperfluoro-1-octanesulfonamido)acetic acid	2355-31-9
	N-EtFOSAA	2-(N-ethylperfluoro-1-octanesulfonamido)acetic acid	2991-50-6
	F53	Potassium 1,1,2,2-tetrafluoro-2-(perfluorohexyloxy)ethane sulfonate	754925-54-7
	7:3 FTCA	7:3 Fluorotelomer carboxylic acid	812-70-4
	PFBSA	Perfluoro-1-butansulfonamide	30334-69-1
	N-MeFBSA	N-Methyl perfluorobutanesulfonamide	68298-12-4
	N-EtFBSA	N-ethyl perfluorobutanesulfonamide	40630-67-9
UV-chemicals	BP3	Benzophenone 3	131-57-7
	EHMC-Z	2-ethylhexyl-4-methoxycinnamate ester	5466-77-3
	EHMC-E	2-ethylhexyl-4-methoxycinnamate ester	5466-77-3
	Sum-EHMC		
	OC	Octocrylene	6197-30-4
Dechloranes	Dibromoaldrin	Dibromoaldrin	20389-65-5
	Dechlorane 602		31107-44-5
	Dechlorane 603		13560-92-4
	Dechlorane 604		34571-16-9
	Dechlorane 601		13560-90-2
	Dechlorane plus syn	Bis(hexachlorocyclopentadieno)cyclooctane	135821-03-3
	Dechlorane plus anti	Bis(hexachlorocyclopentadieno)cyclooctane	135821-74-8
	1,3-DPMA	1,3-Dechlorane Plus monoadduct	N/A
	1,5-DPMA	1,5-Dechlorane Plus monoadduct	13821-04-4

6.2 Raw data, all compounds.

ID	Matrix	Lake	Gender	Age	Length	Weight	Pooled sample?	Lipid	Isotopes		Hg		UV-chem		
									$d^{13}C_{VPDB}$	$d^{15}N_{AIR}$	Hg		BP3	EHMC-Z	EHMC-E
				y	cm	g	Y/N (no.)	%			µg/g	*Tissue*	ng/g	ng/g	ng/g
ZM-1	Zooplankton	Mjøsa						0.37	-27.44	6.59	<0.005	*Muscle*	<0.05	<0.05	<0.5
ZM-2	Zooplankton	Mjøsa						0.29	-27.45	6.96	<0.005	*Muscle*	0.056	<0.05	<0.5
ZM-3	Zooplankton	Mjøsa						0.23	-28.33	6.28	0.005	*Muscle*	0.067	<0.05	<0.5
MM-1	Mysis	Mjøsa						1.77	-29.77	9.84	0.012	*Muscle*	<0.1	<0.02	<0.1
MM-2	Mysis	Mjøsa						1.75	-29.53	9.63	0.009	*Muscle*	<0.1	<0.02	<0.1
MM-3	Mysis	Mjøsa						1.62	-29.20	9.96	0.012	*Muscle*	<0.1	<0.02	<0.1
KM-M-1	E.smelt	Mjøsa			4.1	8.5	Y (10)	1.15	-27.84	14.81	0.392	*Muscle*	<0.1	<0.02	<0.1
KM-M-2	E.smelt	Mjøsa			3.9	8.6	Y (10)	1.74	-27.74	14.55	0.087	*Muscle*	<0.1	0.044	0.182
KM-M-3	E.smelt	Mjøsa			4.1	8.2	Y (10)	1.89	-27.90	14.08	0.199	*Muscle*	<0.08	0.250	0.920
KM-M-4	E.smelt	Mjøsa			4.3	8.9	Y (10)	2.34	-27.66	14.28	0.103	*Muscle*	<0.1	<0.02	<0.1
KM-M-5	E.smelt	Mjøsa			4.5	9.2	Y (10)	1.52	-28.10	14.66	0.275	*Muscle*	<0.1	<0.02	<0.1
KM-M-6	E.smelt	Mjøsa			11	22	Y (3)	1.41	-26.56	15.43	0.371	*Muscle*	<0.1	<0.02	<0.1
KM-M-7	E.smelt	Mjøsa			10.5	23	Y (3)	1.52	-27.37	16.00	0.548	*Muscle*	<0.1	0.028	<0.1
KM-M-8	E.smelt	Mjøsa			11.2	22	Y (3)	1.08	-26.57	15.44	0.495	*Muscle*	<0.1	<0.02	<0.1
KM-M-9	E.smelt	Mjøsa			12.5	24	Y (3)	1.71	-25.89	15.78	0.235	*Muscle*	<0.1	<0.02	<0.1
KM-M-10	E.smelt	Mjøsa			13.8	25	Y (3)	0.53	-26.55	15.40	0.438	*Muscle*	<0.1	<0.02	<0.1
LM-M-1	Vendace	Mjøsa			17.9	31.6	Y (3)	1.50	-27.90	13.47	0.105	*Muscle*	<0.06	<0.03	<0.2
LM-M-2	Vendace	Mjøsa			18.8	39.3	Y (3)	1.51	-27.93	13.56	0.132	*Muscle*	<0.06	<0.03	<0.2
LM-M-3	Vendace	Mjøsa			18.6	34.2	Y (3)	1.38	-28.22	13.86	0.125	*Muscle*	<0.06	<0.03	<0.2
LM-M-4	Vendace	Mjøsa			18.3	34.8	Y (3)	1.22	-27.73	12.81	0.101	*Muscle*	<0.06	<0.03	<0.2
LM-M-5	Vendace	Mjøsa			17.7	31.5	Y (4)	2.07	-27.65	13.48	0.103	*Muscle*	<0.06	<0.03	<0.2
ØM-M-1	Brown trout	Mjøsa	F	10	74	5500	N	2.56	-27.06	14.87	0.691	*Muscle*	<0.1	<0.05	<0.7
ØM-M-2	Brown trout	Mjøsa	F	9	71	4700	N	3.28	-27.87	15.04	0.441	*Muscle*	<0.1	<0.05	<0.7
ØM-M-3	Brown trout	Mjøsa	M	8	78	7300	N	0.73	-26.31	15.38	1.04	*Muscle*	<0.1	<0.05	<0.7
ØM-M-4	Brown trout	Mjøsa	F	7	68	4300	N	2.89	-27.80	16.54	1.07	*Muscle*	<0.1	<0.05	<0.7
ØM-M-5	Brown trout	Mjøsa	F	7	68	2700	N	2.02	-27.52	16.13	0.641	*Muscle*	<0.1	<0.05	<0.7

ID	Matrix	Lake	Gender	Age	Length	Weight	Pooled sample?	Lipid	Isotopes		Hg		UV-chem		
									$d^{13}C_{VPDB}$	$d^{15}N_{AIR}$	Hg		BP3	EHMC-Z	EHMC-E
				y	cm	g	Y/N (no.)	%			µg/g	*Tissue*	ng/g	ng/g	ng/g
ØM-M-6	Brown trout	Mjøsa	M	7	80	5900	N	6.43	-27.19	16.20	0.395	*Muscle*	<0.1	<0.05	<0.7
ØM-M-7	Brown trout	Mjøsa	F	8	71	4700	N	5.05	-27.65	15.83	0.337	*Muscle*	<0.1	<0.05	<0.7
ØM-M-8	Brown trout	Mjøsa	M	6	58	2500	N	1.30	-26.01	15.52	0.195	*Muscle*	<0.1	<0.05	<0.7
ØM-M-9	Brown trout	Mjøsa	F	11	80	6800	N	2.16	-26.98	14.69	0.727	*Liver*	<0.06	<0.02	<0.4
ØM-M-10	Brown trout	Mjøsa	M	7	66	3400	N	4.66	-27.80	15.29	0.388	*Liver*	<0.06	<0.02	<0.4
ØM-M-11	Brown trout	Mjøsa	M	7	66	3300	N	2.65	-27.53	14.93	0.265	*Liver*	<0.06	<0.02	<0.4
ØM-M-12	Brown trout	Mjøsa	F	7	66	3300	N	5.88	-28.39	15.30	0.381	*Liver*	<0.06	<0.02	<0.4
ØM-M-13	Brown trout	Mjøsa	F	6	72	2600	N	3.72	-28.92	15.63	0.457	*Liver*	<0.06	<0.02	<0.4
ØM-M-14	Brown trout	Mjøsa	F	8	77	3800	N	0.30	-26.32	15.69	1.495	*Liver*	<0.06	<0.02	<0.4
ØM-M-15	Brown trout	Mjøsa	F	7	64	3400	N		-27.47	15.32	0.523	*Liver*	<0.06	<0.02	<0.4
ØF-M-1	Brown trout	Femunden	F		41	727	N	1.32	-20.14	7.72	0.079	*Muscle*	<0.05	<0.05	<0.5
ØF-M-2	Brown trout	Femunden	M		38	539	N	1.30	-19.73	8.28	0.067	*Muscle*	<0.05	<0.05	<0.5
ØF-M-3	Brown trout	Femunden	F		42	851	N	0.83	-22.29	9.76	0.284	*Muscle*	<0.08	<0.03	<0.12
ØF-M-4	Brown trout	Femunden	M		41	789	N	2.22	-25.69	11.27	0.46	*Muscle*	<0.05	<0.05	<0.5
ØF-M-5	Brown trout	Femunden	F		37	534	N	0.37	-23.52	10.11	0.363	*Muscle*	<0.05	<0.05	<0.5
ØF-M-6	Brown trout	Femunden	F		44	748	N	0.84	-21.53	10.20	0.154	*Muscle*	<0.05	<0.05	<0.5
ØF-M-7	Brown trout	Femunden	F		47	1224	N	1.72	-23.11	9.99	0.231	*Muscle*	<0.05	<0.05	<0.5
ØF-M-8	Brown trout	Femunden	F		34	510	N	0.81	-25.00	10.25	0.307	*Muscle*	<0.05	<0.05	<0.5
ØF-M-9	Brown trout	Femunden	F		40	686	N	1.66	-24.35	11.35	0.509	*Muscle*	<0.05	<0.05	<0.5
ØF-M-10	Brown trout	Femunden	M		37	514	N	0.35	-22.34	9.64	0.171	*Muscle*	<0.05	<0.05	<0.5

ID	Matrix	Lake	UV-chem		PFAS										
			Sum-EHMC	OC		PFPA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUnDA	PFDoDA	PFTrDA	PFTeDA
				ng/g	*Tissue PFAS*	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
ZM-1	Zooplankton	Mjøsa	<0.5	<1.4	*Whole body*	<0.5	<0.5	<0.5	<0.5	<0.5	<0.4	<0.4	<0.4	<0.4	<0.4
ZM-2	Zooplankton	Mjøsa	<0.5	1.9	*Whole body*	<0.5	<0.5	<0.5	<0.5	<0.5	<0.4	<0.4	<0.4	<0.4	<0.4
ZM-3	Zooplankton	Mjøsa	<0.5	2.5	*Whole body*	<0.5	<0.5	<0.5	<0.5	<0.5	<0.4	<0.4	<0.4	<0.4	<0.4
MM-1	Mysis	Mjøsa	<0.12	<1.2	*Whole body*	<0.5	<0.5	<0.5	<0.5	<0.5	<0.4	<0.4	<0.4	<0.4	<0.4
MM-2	Mysis	Mjøsa	<0.12	<1.2	*Whole body*	<0.5	<0.5	<0.5	<0.5	<0.5	<0.4	<0.4	<0.4	<0.4	<0.4
MM-3	Mysis	Mjøsa	<0.12	1.2	*Whole body*	<0.5	<0.5	<0.5	<0.5	<0.5	<0.4	<0.4	<0.4	<0.4	<0.4
KM-M-1	E.smelt	Mjøsa	<0.12	<1.2	*Liver*	<0.5	<0.5	<0.5	<0.5	1.26	3.77	7.57	4.54	5.26	1.76
KM-M-2	E.smelt	Mjøsa	0.23	<1.2	*Liver*	<0.5	<0.5	<0.5	<0.5	1.83	7.72	18.25	10.38	16.42	3.90
KM-M-3	E.smelt	Mjøsa	1.17	<1.9	*Liver*	<0.5	<0.5	<0.5	<0.5	0.72	2.30	4.68	2.93	3.30	0.89
KM-M-4	E.smelt	Mjøsa	<0.12	<1.2	*Liver*	<0.5	<0.5	<0.5	<0.5	1.60	4.91	10.60	6.07	6.14	2.01
KM-M-5	E.smelt	Mjøsa	<0.12	<1.2	*Liver*	<0.5	<0.5	<0.5	<0.5	1.74	3.77	7.44	5.07	5.38	1.66
KM-M-6	E.smelt	Mjøsa	<0.12	<1.2	*Liver*	<0.5	<0.5	<0.5	<0.5	1.88	6.80	15.32	8.25	10.94	2.64
KM-M-7	E.smelt	Mjøsa	<0.128	<1.2	*Liver*	<0.5	<0.5	<0.5	<0.5	1.39	4.17	8.63	5.90	6.53	1.97
KM-M-8	E.smelt	Mjøsa	<0.12	<1.2	*Liver*	<0.5	<0.5	<0.5	<0.5	2.05	6.68	14.59	8.16	11.23	2.66
KM-M-9	E.smelt	Mjøsa	<0.12	<1.2	*Liver*	<0.5	<0.5	<0.5	<0.5	1.38	4.08	7.89	5.59	5.49	2.03
KM-M-10	E.smelt	Mjøsa	<0.12	<1.2	*Liver*	<0.5	<0.5	<0.5	<0.5	1.32	4.89	10.65	5.73	6.57	1.77
LM-M-1	Vendace	Mjøsa	<0.23	<0.8	*Liver*	<0.5	<0.5	<0.5	<0.5	0.65	1.32	2.83	2.07	2.12	0.97
LM-M-2	Vendace	Mjøsa	<0.23	<0.8	*Liver*	<0.5	<0.5	<0.5	<0.5	<0.5	1.10	2.23	1.90	1.37	0.72
LM-M-3	Vendace	Mjøsa	<0.23	<0.8	*Liver*	<0.5	<0.5	<0.5	<0.5	<0.5	1.09	2.62	2.03	1.88	0.97
LM-M-4	Vendace	Mjøsa	<0.23	<0.8	*Liver*	<0.5	<0.5	<0.5	<0.5	<0.5	1.17	2.74	2.00	1.73	0.89
LM-M-5	Vendace	Mjøsa	<0.23	<0.8	*Liver*	<0.5	<0.5	<0.5	<0.5	<0.5	1.42	2.89	2.31	1.67	0.87
ØM-M-1	Brown trout	Mjøsa	<0.75	<2	*Liver*	<0.5	<0.5	<0.5	<0.5	0.68	2.69	6.44	3.95	5.46	1.54
ØM-M-2	Brown trout	Mjøsa	<0.75	<2	*Liver*	<0.5	<0.5	<0.5	<0.5	<0.5	1.46	2.77	1.76	2.00	0.63
ØM-M-3	Brown trout	Mjøsa	<0.75	<2	*Liver*	<0.5	<0.5	<0.5	<0.5	<0.5	2.08	4.99	3.62	6.63	1.86
ØM-M-4	Brown trout	Mjøsa	<0.75	<2	*Liver*	<0.5	<0.5	<0.5	<0.5	0.54	1.99	4.38	2.98	4.59	1.30

ID	Matrix	Lake	UV-chem		PFAS										
			Sum-EHMC	OC		PFPA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUnDA	PFDoDA	PFTrDA	PFTeDA
				ng/g	*Tissue PFAS*	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
ØM-M-5	Brown trout	Mjøsa	<0.75	<2	*Liver*	<0.5	<0.5	<0.5	<0.5	0.57	2.49	4.98	1.39	3.99	0.99
ØM-M-6	Brown trout	Mjøsa	<0.75	<2	*Liver*	<0.5	<0.5	<0.5	<0.5	1.29	4.64	12.18	7.22	7.50	2.58
ØM-M-7	Brown trout	Mjøsa	<0.75	<2	*Liver*	<0.5	<0.5	<0.5	<0.5	<0.5	0.74	1.33	<0.4	1.03	<0.4
ØM-M-8	Brown trout	Mjøsa	<0.75	<2	*Liver*	<0.5	<0.5	<0.5	<0.5	0.59	2.60	7.75	5.15	8.97	2.40
ØM-M-9	Brown trout	Mjøsa	*<0.75*	*<1.2*	*Liver*	<0.5	<0.5	<0.5	<0.5	0.82	3.54	9.73	6.20	9.55	2.67
ØM-M-10	Brown trout	Mjøsa	*<0.75*	*<1.2*	*Liver*	<0.5	<0.5	<0.5	<0.5	0.90	4.11	11.12	6.21	8.61	2.64
ØM-M-11	Brown trout	Mjøsa	*<0.75*	*<1.2*	*Liver*	<0.5	<0.5	<0.5	<0.5	0.74	3.09	8.26	5.01	5.77	2.02
ØM-M-12	Brown trout	Mjøsa	*<0.75*	*<1.2*	*Liver*	<0.5	<0.5	<0.5	<0.5	0.59	3.53	7.97	4.69	6.10	1.73
ØM-M-13	Brown trout	Mjøsa	*<0.75*	*<1.2*	*Liver*	<0.5	<0.5	<0.5	<0.5	0.81	4.77	12.56	6.88	11.17	2.46
ØM-M-14	Brown trout	Mjøsa	*<0.75*	*<1.2*	*Liver*	<0.5	<0.5	<0.5	<0.5	0.53	2.88	7.73	5.84	11.17	2.69
ØM-M-15	Brown trout	Mjøsa	*<0.75*	*<1.2*	*Liver*	<0.5	<0.5	<0.5	<0.5	0.93	3.85	9.84	5.50	7.95	2.08
ØF-M-1	Brown trout	Femunden	<0.5	<1.4	*Liver*	<0.5	<0.5	<0.5	<0.5	0.66	1.15	4.50	2.17	7.00	0.98
ØF-M-2	Brown trout	Femunden	<0.5	<1.4	*Liver*	<0.5	<0.5	<0.5	<0.5	0.64	2.30	8.13	3.17	6.66	1.20
ØF-M-3	Brown trout	Femunden	<0.15	<1.9	*Liver*	<0.5	<0.5	<0.5	<0.5	0.55	1.53	7.42	4.18	15.94	2.29
ØF-M-4	Brown trout	Femunden	<0.5	<1.4	*Liver*	<0.5	<0.5	<0.5	<0.5	0.62	2.16	12.06	6.70	26.60	4.40
ØF-M-5	Brown trout	Femunden	<0.5	<1.4	*Liver*	<0.5	<0.5	<0.5	<0.5	<0.5	2.50	13.62	8.03	31.57	5.23
ØF-M-6	Brown trout	Femunden	<0.5	<1.4	*Liver*	<0.5	<0.5	<0.5	<0.5	2.67	3.08	8.71	2.75	5.93	1.14
ØF-M-7	Brown trout	Femunden	<0.5	<1.4	*Liver*	<0.5	<0.5	<0.5	<0.5	0.62	1.22	7.22	4.25	15.00	2.82
ØF-M-8	Brown trout	Femunden	<0.5	<1.4	*Liver*	<0.5	<0.5	<0.5	<0.5	0.70	2.34	12.84	7.37	26.44	3.90
ØF-M-9	Brown trout	Femunden	<0.5	<1.4	*Liver*	<0.5	<0.5	<0.5	<0.5	0.73	1.46	6.98	4.16	14.23	2.39
ØF-M-10	Brown trout	Femunden	<0.5	<1.4	*Liver*	<0.5	<0.5	<0.5	<0.5	<0.5	1.10	5.84	3.30	11.24	1.97

ID	Matrix	Lake	PFAS												
			PFPeDA	PFHxDA	PFBS	PFPS	PFHxS	PFHpS	PFOS	8Cl-PFOS	PFNS	PFDS	PFDoS	PFOSA	N-MeFOSA	N-EtFOSA
			ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
ZM-1	Zooplankton	Mjøsa	<0.4	<0.4	<0.2	<0.2	<0.2	<0.2	<0.1	<0.2	<0.2	<0.2	<0.2	<0.1	<0.3	<0.3
ZM-2	Zooplankton	Mjøsa	<0.4	<0.4	<0.2	<0.2	<0.2	<0.2	<0.1	<0.2	<0.2	<0.2	<0.2	<0.1	<0.3	<0.3
ZM-3	Zooplankton	Mjøsa	<0.4	<0.4	<0.2	<0.2	<0.2	<0.2	<0.1	<0.2	<0.2	<0.2	<0.2	<0.1	<0.3	<0.3
MM-1	Mysis	Mjøsa	<0.4	<0.4	<0.2	<0.2	<0.2	<0.2	0.12	<0.2	<0.2	<0.2	<0.2	<0.1	<0.3	<0.3
MM-2	Mysis	Mjøsa	<0.4	<0.4	<0.2	<0.2	<0.2	<0.2	0.13	<0.2	<0.2	<0.2	<0.2	<0.1	<0.3	<0.3
MM-3	Mysis	Mjøsa	<0.4	<0.4	<0.2	<0.2	<0.2	<0.2	0.11	<0.2	<0.2	<0.2	<0.2	<0.1	<0.3	<0.3
KM-M-1	E.smelt	Mjøsa	<0.4	<0.4	<0.2	<0.2	<0.2	<0.2	6.20	<0.2	<0.2	<0.2	<0.2	0.76	<0.3	<0.3
KM-M-2	E.smelt	Mjøsa	0.72	<0.4	<0.2	<0.2	<0.2	<0.2	13.20	<0.2	<0.2	<0.2	<0.2	1.13	<0.3	<0.3
KM-M-3	E.smelt	Mjøsa	<0.4	<0.4	<0.2	<0.2	<0.2	<0.2	4.50	<0.2	<0.2	<0.2	<0.2	0.55	<0.3	<0.3
KM-M-4	E.smelt	Mjøsa	<0.4	<0.4	<0.2	<0.2	<0.2	<0.2	7.80	<0.2	<0.2	<0.2	<0.2	0.82	<0.3	<0.3
KM-M-5	E.smelt	Mjøsa	<0.4	<0.4	<0.2	<0.2	<0.2	<0.2	6.20	<0.2	<0.2	<0.2	<0.2	0.71	<0.3	<0.3
KM-M-6	E.smelt	Mjøsa	0.51	<0.4	<0.2	<0.2	<0.2	<0.2	10.60	<0.2	<0.2	<0.2	<0.2	1.41	<0.3	<0.3
KM-M-7	E.smelt	Mjøsa	<0.4	<0.4	<0.2	<0.2	<0.2	<0.2	6.80	<0.2	<0.2	<0.2	<0.2	1.10	<0.3	<0.3
KM-M-8	E.smelt	Mjøsa	0.52	<0.4	<0.2	<0.2	<0.2	<0.2	10.50	<0.2	<0.2	<0.2	<0.2	1.17	<0.3	<0.3
KM-M-9	E.smelt	Mjøsa	<0.4	<0.4	<0.2	<0.2	<0.2	<0.2	5.80	<0.2	<0.2	<0.2	<0.2	1.13	<0.3	<0.3
KM-M-10	E.smelt	Mjøsa	<0.4	<0.4	<0.2	<0.2	<0.2	<0.2	7.60	<0.2	<0.2	<0.2	<0.2	1.15	<0.3	<0.3
LM-M-1	Vendace	Mjøsa	<0.4	<0.4	<0.2	<0.2	<0.2	<0.2	2.70	<0.2	<0.2	<0.2	<0.2	0.10	<0.3	<0.3
LM-M-2	Vendace	Mjøsa	<0.4	<0.4	<0.2	<0.2	<0.2	<0.2	2.30	<0.2	<0.2	<0.2	<0.2	0.11	<0.3	<0.3
LM-M-3	Vendace	Mjøsa	<0.4	<0.4	<0.2	<0.2	<0.2	<0.2	2.90	<0.2	<0.2	<0.2	<0.2	0.12	<0.3	<0.3
LM-M-4	Vendace	Mjøsa	<0.4	<0.4	<0.2	<0.2	<0.2	<0.2	2.50	<0.2	<0.2	<0.2	<0.2	<0.1	<0.3	<0.3
LM-M-5	Vendace	Mjøsa	<0.4	<0.4	<0.2	<0.2	<0.2	<0.2	2.80	<0.2	<0.2	<0.2	<0.2	0.11	<0.3	<0.3
ØM-M-1	Brown trout	Mjøsa	<0.4	<0.4	<0.2	<0.2	<0.2	<0.2	5.75	<0.2	<0.2	<0.2	<0.2	0.89	<0.3	<0.3
ØM-M-2	Brown trout	Mjøsa	<0.4	<0.4	<0.2	<0.2	<0.2	<0.2	3.25	<0.2	<0.2	<0.2	<0.2	0.71	<0.3	<0.3
ØM-M-3	Brown trout	Mjøsa	0.53	<0.4	<0.2	<0.2	<0.2	<0.2	4.96	<0.2	<0.2	<0.2	<0.2	0.74	<0.3	<0.3
ØM-M-4	Brown trout	Mjøsa	<0.4	<0.4	<0.2	<0.2	<0.2	<0.2	4.48	<0.2	<0.2	<0.2	<0.2	0.51	<0.3	<0.3
ØM-M-5	Brown trout	Mjøsa	<0.4	<0.4	<0.2	<0.2	<0.2	<0.2	5.38	<0.2	<0.2	<0.2	<0.2	0.54	<0.3	<0.3

ID	Matrix	Lake	PFAS												
			PFPeDA	PFHxDA	PFBS	PFPS	PFHxS	PFHpS	PFOS	8Cl-PFOS	PFNS	PFDS	PFDoS	PFOSA	N-MeFOSA	N-EtFOSA
			ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
ØM-M-6	Brown trout	Mjøsa	0.62	<0.4	<0.2	<0.2	<0.2	<0.2	9.88	<0.2	<0.2	<0.2	<0.2	1.19	<0.3	<0.3
ØM-M-7	Brown trout	Mjøsa	<0.4	<0.4	<0.2	<0.2	<0.2	<0.2	1.72	<0.2	<0.2	<0.2	<0.2	0.50	<0.3	<0.3
ØM-M-8	Brown trout	Mjøsa	0.60	<0.4	<0.2	<0.2	<0.2	<0.2	6.49	<0.2	<0.2	<0.2	<0.2	1.37	<0.3	<0.3
ØM-M-9	Brown trout	Mjøsa	0.74	<0.4	<0.2	<0.2	<0.2	<0.2	8.95	<0.2	<0.2	<0.2	<0.2	0.47	<0.3	<0.3
ØM-M-10	Brown trout	Mjøsa	0.71	<0.4	<0.2	<0.2	<0.2	<0.2	9.86	<0.2	<0.2	<0.2	<0.2	1.23	<0.3	<0.3
ØM-M-11	Brown trout	Mjøsa	0.45	<0.4	<0.2	<0.2	<0.2	<0.2	7.32	<0.2	<0.2	<0.2	<0.2	1.02	<0.3	<0.3
ØM-M-12	Brown trout	Mjøsa	0.46	<0.4	<0.2	<0.2	<0.2	<0.2	7.55	<0.2	<0.2	<0.2	<0.2	1.06	<0.3	<0.3
ØM-M-13	Brown trout	Mjøsa	0.63	<0.4	<0.2	<0.2	<0.2	<0.2	10.79	<0.2	<0.2	<0.2	<0.2	1.00	<0.3	<0.3
ØM-M-14	Brown trout	Mjøsa	0.83	<0.4	<0.2	<0.2	<0.2	<0.2	7.70	<0.2	<0.2	<0.2	<0.2	0.50	<0.3	<0.3
ØM-M-15	Brown trout	Mjøsa	0.52	<0.4	<0.2	<0.2	<0.2	<0.2	7.47	<0.2	<0.2	<0.2	<0.2	1.45	<0.3	<0.3
ØF-M-1	Brown trout	Femunden	0.43	<0.4	<0.2	<0.2	<0.2	<0.2	1.7	<0.2	<0.2	<0.2	<0.2	0.19	<0.3	<0.3
ØF-M-2	Brown trout	Femunden	<0.4	<0.4	<0.2	<0.2	<0.2	<0.2	2.9	<0.2	<0.2	<0.2	<0.2	0.19	<0.3	<0.3
ØF-M-3	Brown trout	Femunden	0.57	<0.4	<0.2	<0.2	<0.2	<0.2	2.4	<0.2	<0.2	<0.2	<0.2	0.42	<0.3	<0.3
ØF-M-4	Brown trout	Femunden	1.36	<0.4	<0.2	<0.2	<0.2	<0.2	3.3	<0.2	<0.2	<0.2	<0.2	0.58	<0.3	<0.3
ØF-M-5	Brown trout	Femunden	2.36	<0.4	<0.2	<0.2	<0.2	<0.2	4.3	<0.2	<0.2	<0.2	<0.2	0.61	<0.3	<0.3
ØF-M-6	Brown trout	Femunden	0.37	<0.4	<0.2	<0.2	<0.2	<0.2	4.3	<0.2	<0.2	<0.2	<0.2	0.64	<0.3	<0.3
ØF-M-7	Brown trout	Femunden	0.70	<0.4	<0.2	<0.2	<0.2	<0.2	2.6	<0.2	<0.2	<0.2	<0.2	0.21	<0.3	<0.3
ØF-M-8	Brown trout	Femunden	1.33	<0.4	<0.2	<0.2	<0.2	<0.2	3.3	<0.2	<0.2	<0.2	<0.2	0.59	<0.3	<0.3
ØF-M-9	Brown trout	Femunden	0.89	<0.4	<0.2	<0.2	<0.2	<0.2	2.3	<0.2	<0.2	<0.2	<0.2	0.58	<0.3	<0.3
ØF-M-10	Brown trout	Femunden	0.45	<0.4	<0.2	<0.2	<0.2	<0.2	1.9	<0.2	<0.2	<0.2	<0.2	0.23	<0.3	<0.3

ID	Matrix	Lake	PFAS												
			N-MeFOSE	N-EtFOSE	4:2 FTS	6:2 FTS	8:2 FTS	10:2 FTS	4:2 F53B	6:2 F53B	N-MeFOSAA	N-EtFOSAA	F53	7:3 FTCA	PFBSA
			ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
ZM-1	Zooplankton	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
ZM-2	Zooplankton	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
ZM-3	Zooplankton	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
MM-1	Mysis	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
MM-2	Mysis	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
MM-3	Mysis	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
KM-M-1	E.smelt	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.32
KM-M-2	E.smelt	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.45
KM-M-3	E.smelt	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
KM-M-4	E.smelt	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.33
KM-M-5	E.smelt	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
KM-M-6	E.smelt	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.52
KM-M-7	E.smelt	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.32
KM-M-8	E.smelt	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.41
KM-M-9	E.smelt	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.30
KM-M-10	E.smelt	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.42
LM-M-1	Vendace	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
LM-M-2	Vendace	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
LM-M-3	Vendace	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
LM-M-4	Vendace	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
LM-M-5	Vendace	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
ØM-M-1	Brown trout	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	5.63
ØM-M-2	Brown trout	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	2.87
ØM-M-3	Brown trout	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	1.92
ØM-M-4	Brown trout	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	2.04

ID	Matrix	Lake	PFAS												
			N-MeFOSE	N-EtFOSE	4:2 FTS	6:2 FTS	8:2 FTS	10:2 FTS	4:2 F53B	6:2 F53B	N-MeFOSAA	N-EtFOSAA	F53	7:3 FTCA	PFBSA
			ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
ØM-M-5	Brown trout	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	1.90
ØM-M-6	Brown trout	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	6.49
ØM-M-7	Brown trout	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	2.35
ØM-M-8	Brown trout	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	3.95
ØM-M-9	Brown trout	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	2.93
ØM-M-10	Brown trout	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	5.46
ØM-M-11	Brown trout	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	4.69
ØM-M-12	Brown trout	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	3.83
ØM-M-13	Brown trout	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	3.73
ØM-M-14	Brown trout	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	2.61
ØM-M-15	Brown trout	Mjøsa	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	6.55
ØF-M-1	Brown trout	Femunden	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.53
ØF-M-2	Brown trout	Femunden	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.40
ØF-M-3	Brown trout	Femunden	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	2.19
ØF-M-4	Brown trout	Femunden	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	4.17
ØF-M-5	Brown trout	Femunden	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	3.22
ØF-M-6	Brown trout	Femunden	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	4.54
ØF-M-7	Brown trout	Femunden	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	1.66
ØF-M-8	Brown trout	Femunden	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	2.19
ØF-M-9	Brown trout	Femunden	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	7.79
ØF-M-10	Brown trout	Femunden	<2	<2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	1.37

ID	Matrix	Lake	PFAS		cVMS			oPFR									
			N-MeFBSA	N-EtFBSA	D4	D5	D6	TEP	TCEP	TPrP	TCPP	TiBP	BdPhP	TPP	DBPhP	TnBP	TDCPP
			ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
ZM-1	Zooplankton	Mjøsa	<0.3	<0.3	<0.69	1.9	<1.08	<1	< 0.4	< 0.01	0.88	< 0.15	< 0.01	0.67	< 0.01	0.12	< 0.2
ZM-2	Zooplankton	Mjøsa	<0.3	<0.3	<0.69	1.5	<1.89	<1	< 0.4	< 0.01	0.51	< 0.15	< 0.01	0.50	< 0.01	0.11	< 0.2
ZM-3	Zooplankton	Mjøsa	<0.3	<0.3	<0.69	1.8	<1.08	<1	< 0.4	< 0.01	0.39	< 0.15	< 0.01	0.56	< 0.01	0.09	< 0.2
MM-1	Mysis	Mjøsa	<0.3	<0.3	<0.69	5.0	<1.89	<1	< 0.4	< 0.01	0.51	< 0.15	< 0.01	0.32	< 0.01	< 0.1	< 0.2
MM-2	Mysis	Mjøsa	<0.3	<0.3	<0.69	4.8	<1.89	<1	< 0.4	< 0.01	0.34	< 0.15	< 0.01	0.41	< 0.01	0.09	< 0.2
MM-3	Mysis	Mjøsa	<0.3	<0.3	<1.76	5.5	<1.89	<1	< 0.4	< 0.01	0.21	< 0.15	< 0.01	0.15	< 0.01	< 0.1	< 0.2
KM-M-1	E.smelt	Mjøsa	<0.3	<0.3	<0.93	31.4	4.1	<1	< 0.4	< 0.01	0.32	< 0.15	< 0.01	0.25	< 0.01	< 0.1	< 0.2
KM-M-2	E.smelt	Mjøsa	<0.3	<0.3	<0.93	25.6	<2.94	<1	< 0.4	< 0.01	0.42	< 0.15	< 0.01	0.23	< 0.01	< 0.1	< 0.2
KM-M-3	E.smelt	Mjøsa	<0.3	<0.3	<0.93	24.3	3.8	<1	< 0.4	< 0.01	0.32	< 0.15	< 0.01	0.12	< 0.01	< 0.1	< 0.2
KM-M-4	E.smelt	Mjøsa	<0.3	<0.3	<0.93	19.3	3.2	<1	< 0.4	< 0.01	0.40	< 0.15	< 0.01	0.10	< 0.01	< 0.1	0.31
KM-M-5	E.smelt	Mjøsa	<0.3	<0.3	<0.93	12.4	<2.94	<1	< 0.4	< 0.01	0.19	< 0.15	< 0.01	< 0.03	< 0.01	< 0.1	< 0.2
KM-M-6	E.smelt	Mjøsa	<0.3	<0.3	<0.93	39.9	4.8	<1	< 0.4	< 0.01	0.26	< 0.15	< 0.01	0.06	< 0.01	< 0.1	< 0.2
KM-M-7	E.smelt	Mjøsa	<0.3	<0.3	<0.93	74.3	6.2	<1	< 0.4	< 0.01	0.35	< 0.15	< 0.01	0.07	< 0.01	0.27	< 0.2
KM-M-8	E.smelt	Mjøsa	<0.3	<0.3	<0.93	34.3	4.8	<1	< 0.4	< 0.01	0.24	< 0.15	< 0.01	0.06	< 0.01	0.12	< 0.2
KM-M-9	E.smelt	Mjøsa	<0.3	<0.3	<0.93	16.5	<2.94	<1	< 0.4	< 0.01	0.20	< 0.15	< 0.01	< 0.03	< 0.01	< 0.1	< 0.2
KM-M-10	E.smelt	Mjøsa	<0.3	<0.3	<0.93	64.6	4.9	<1	< 0.4	< 0.01	0.39	< 0.15	< 0.01	0.06	< 0.01	< 0.1	< 0.2
LM-M-1	Vendace	Mjøsa	<0.3	<0.3	<2.16	22.9	6.2	<1	< 0.6	< 0.05	0.86	< 0.20	< 0.05	0.10	< 0.05	< 0.10	< 0.20
LM-M-2	Vendace	Mjøsa	<0.3	<0.3	<2.16	38.4	8.9	<1	< 0.6	< 0.05	0.54	< 0.20	< 0.05	0.33	< 0.05	< 0.10	< 0.20
LM-M-3	Vendace	Mjøsa	<0.3	<0.3	<2.16	17.7	6.3	<1	< 0.6	< 0.05	0.44	< 0.20	< 0.05	0.27	< 0.05	< 0.10	< 0.20
LM-M-4	Vendace	Mjøsa	<0.3	<0.3	<5.8	36.1	7.0	<1	< 0.6	< 0.05	0.32	< 0.20	< 0.05	0.15	< 0.05	< 0.10	< 0.20
LM-M-5	Vendace	Mjøsa	<0.3	<0.3	<2.16	17.0	6.2	<1	< 0.6	< 0.05	1.05	< 0.20	< 0.05	0.27	< 0.05	0.17	< 0.20
ØM-M-1	Brown trout	Mjøsa	<0.3	<0.3	0.8900	48.5	5.6	<0.3	< 0.4	< 0.01	< 0.05	< 0.15	< 0.01	0.05	< 0.01	< 0.1	< 0.2
ØM-M-2	Brown trout	Mjøsa	<0.3	<0.3	0.8500	31.6	4.6	<0.3	< 0.4	< 0.01	< 0.05	< 0.15	< 0.01	< 0.03	< 0.01	< 0.1	< 0.2
ØM-M-3	Brown trout	Mjøsa	<0.3	<0.3	<0.34	3.9	1.8	<0.3	< 0.4	< 0.01	0.24	< 0.15	< 0.01	0.08	< 0.01	< 0.1	< 0.2
ØM-M-4	Brown trout	Mjøsa	<0.3	<0.3	1.2000	44.7	6.7	<0.3	< 0.4	< 0.01	< 0.05	< 0.15	< 0.01	< 0.03	< 0.01	< 0.1	< 0.2

ID	Matrix	Lake	PFAS		cVMS			oPFR									
			N-MeFBSA	N-EtFBSA	D4	D5	D6	TEP	TCEP	TPrP	TCPP	TiBP	BdPhP	TPP	DBPhP	TnBP	TDCPP
			ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
ØM-M-5	Brown trout	Mjøsa	<0.3	<0.3	<0.74	56.3	7.1	<0.3	< 0.4	< 0.01	< 0.05	< 0.15	< 0.01	< 0.03	< 0.01	< 0.1	< 0.2
ØM-M-6	Brown trout	Mjøsa	<0.3	<0.3	<0.74	29.5	3.9	<0.3	< 0.4	< 0.01	< 0.05	< 0.15	< 0.01	< 0.03	< 0.01	< 0.1	< 0.2
ØM-M-7	Brown trout	Mjøsa	<0.3	<0.3	1.0300	49.9	5.6	<0.3	< 0.4	< 0.01	< 0.05	< 0.15	< 0.01	0.06	< 0.01	< 0.1	< 0.2
ØM-M-8	Brown trout	Mjøsa	<0.3	<0.3	<0.74	24.6	3.9	<0.3	< 0.4	< 0.01	< 0.05	< 0.15	< 0.01	< 0.03	< 0.01	< 0.1	< 0.2
ØM-M-9	Brown trout	Mjøsa	<0.3	<0.3	<0.74	18.7	4.2	<0.3	< 0.4	< 0.01	< 0.05	< 0.15	< 0.01	< 0.03	< 0.01	< 0.1	< 0.2
ØM-M-10	Brown trout	Mjøsa	<0.3	<0.3	1.0100	48.7	5.6	<0.3	< 0.4	< 0.01	< 0.05	< 0.15	< 0.01	< 0.03	< 0.01	< 0.1	< 0.2
ØM-M-11	Brown trout	Mjøsa	<0.3	<0.3	<0.74	34.0	4.7	<0.3	< 0.4	< 0.01	< 0.05	< 0.15	< 0.01	< 0.03	< 0.01	< 0.1	< 0.2
ØM-M-12	Brown trout	Mjøsa	<0.3	<0.3	1.5700	67.9	7.4	<0.3	< 0.4	< 0.01	< 0.05	< 0.15	< 0.01	< 0.03	< 0.01	< 0.1	< 0.2
ØM-M-13	Brown trout	Mjøsa	<0.3	<0.3	1.7500	98.8	7.6	<0.3	< 0.4	< 0.01	< 0.05	< 0.15	< 0.01	0.05	< 0.01	< 0.1	< 0.2
ØM-M-14	Brown trout	Mjøsa	<0.3	<0.3	<0.74	2.6	1.7	<0.3	< 0.4	< 0.01	< 0.05	< 0.15	< 0.01	< 0.03	< 0.01	< 0.1	< 0.2
ØM-M-15	Brown trout	Mjøsa	<0.3	<0.3	<0.34	10.3	3.1	<0.3	< 0.4	< 0.01	< 0.05	< 0.15	< 0.01	< 0.03	< 0.01	< 0.1	< 0.2
ØF-M-1	Brown trout	Femunden	<0.3	<0.3	<2.16	<1.95	5.1	<0.3	< 0.6	< 0.05	0.20	< 0.20	< 0.05	< 0.05	< 0.05	< 0.10	< 0.20
ØF-M-2	Brown trout	Femunden	<0.3	<0.3	<2.16	<1.95	5.0	<0.3	< 0.6	< 0.05	0.16	< 0.20	< 0.05	< 0.05	< 0.05	< 0.10	< 0.20
ØF-M-3	Brown trout	Femunden	<0.3	<0.3	<2.16	<1.95	5.4	<0.3	< 0.6	< 0.05	0.21	< 0.20	< 0.05	< 0.05	< 0.05	< 0.10	< 0.20
ØF-M-4	Brown trout	Femunden	<0.3	<0.3	<2.16	<1.95	5.3	<0.3	< 0.6	< 0.05	< 0.10	< 0.20	< 0.05	< 0.05	< 0.05	< 0.10	< 0.20
ØF-M-5	Brown trout	Femunden	<0.3	<0.3	<2.16	<1.95	5.4	<0.3	< 0.6	< 0.05	0.15	< 0.20	< 0.05	< 0.05	< 0.05	< 0.10	< 0.20
ØF-M-6	Brown trout	Femunden	<0.3	<0.3	<2.16	<1.95	5.8	<0.3	< 0.6	< 0.05	< 0.10	< 0.20	< 0.05	< 0.05	< 0.05	< 0.10	< 0.20
ØF-M-7	Brown trout	Femunden	<0.3	<0.3	<2.16	<1.95	5.1	<0.3	< 0.6	< 0.05	0.13	< 0.20	< 0.05	< 0.05	< 0.05	< 0.10	< 0.20
ØF-M-8	Brown trout	Femunden	<0.3	<0.3	<2.16	<1.95	<4.71	<0.3	< 0.6	< 0.05	< 0.10	< 0.20	< 0.05	< 0.05	< 0.05	< 0.10	< 0.20
ØF-M-9	Brown trout	Femunden	<0.3	<0.3	<2.16	<1.95	<4.71	<0.3	< 0.6	< 0.05	0.27	< 0.20	< 0.05	< 0.05	< 0.05	< 0.10	< 0.20
ØF-M-10	Brown trout	Femunden	<0.3	<0.3	<2.16	<1.95	5.6	<0.3	< 0.6	< 0.05	< 0.10	< 0.20	< 0.05	< 0.05	< 0.05	< 0.10	< 0.20

ID	Matrix	Lake	oPFR					Phenols							
			TBEP	TCP	EHDP	TXP	TEHP		4,4-bis-A	2,4-bis-A	bis-G	4,4-bis-S	2,4-bis-S	4,4-bis-F	2,4-bis-F
			ng/g	ng/g	ng/g	ng/g	ng/g	Tissue	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
ZM-1	Zooplankton	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	1.23	*Whole body*	<12	<1	<2	<5.5	<0.5	<2.6	<4
ZM-2	Zooplankton	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	0.97	*Whole body*	<12	<1	<2	<5.5	<0.5	<2.6	<4
ZM-3	Zooplankton	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	1.47	*Whole body*	<12	<1	<2	<5.5	<0.5	<2.6	<4
MM-1	Mysis	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	4.10	*Whole body*	<12	<1	<2	<5	<0.5	<2.5	<4
MM-2	Mysis	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	4.02	*Whole body*	<12	<1	<2	<5	<0.5	<2.5	<4
MM-3	Mysis	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	2.70	*Whole body*	<12	<1	<2	<5	<0.5	<2.5	<4
KM-M-1	E.smelt	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	< 0.2	*Muscle*	<11	<1	<2	<5	<0.5	<2.5	<3.5
KM-M-2	E.smelt	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	< 0.2	*Muscle*	45.2	<1	<2	<5	<0.5	<2.5	<3.5
KM-M-3	E.smelt	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	2.30	*Muscle*	<11	<1	<2	<5	<0.5	<2.5	<3.5
KM-M-4	E.smelt	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	2.59	*Muscle*	<11	<1	<2	<5	<0.5	<2.5	<3.5
KM-M-5	E.smelt	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	< 0.2	*Muscle*	<11	<1	<2	<5	<0.5	3.1	3.7
KM-M-6	E.smelt	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	< 0.2	*Muscle*	<11	<1	<2	<5	<0.5	<2.5	<3.5
KM-M-7	E.smelt	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	< 0.2	*Muscle*	<11	<1	<2	<5	<0.5	3.7	3.8
KM-M-8	E.smelt	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	< 0.2	*Muscle*	<11	<1	<2	<5	<0.5	5.9	7.1
KM-M-9	E.smelt	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	< 0.2	*Muscle*	<11	<1	<2	<5	<0.5	2.7	<3.5
KM-M-10	E.smelt	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	< 0.2	*Muscle*	<11	<1	<2	<5	<0.5	<2.5	<3.5
LM-M-1	Vendace	Mjøsa	< 0.05	< 0.10	0.17	< 0.10	< 0.10	*Muscle*	<7.5	<2	<3	<1	<1	<9	<9
LM-M-2	Vendace	Mjøsa	< 0.05	< 0.10	0.77	< 0.10	< 0.10	*Muscle*	<7.5	<2	<3	<1	<1	<9	<9
LM-M-3	Vendace	Mjøsa	< 0.05	< 0.10	0.16	< 0.10	< 0.10	*Muscle*	<7.5	<2	<3	<1	<1	32.5	29.3
LM-M-4	Vendace	Mjøsa	< 0.05	< 0.10	0.26	< 0.10	< 0.10	*Muscle*	<7.5	<2	<3	<1	<1	<9	<9
LM-M-5	Vendace	Mjøsa	0.11	4.41	0.19	< 0.10	< 0.10	*Muscle*	<7.5	<2	<3	<1	<1	<9	<9
ØM-M-1	Brown trout	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	< 0.2	*Bile*	9.6	<1.5	<2	<0.5	<0.5	<3	<11
ØM-M-2	Brown trout	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	< 0.2	*Bile*	11.3	<1.5	<2	<0.5	<0.5	<3	<11
ØM-M-3	Brown trout	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	< 0.2	*Bile*	<9.5	<1.5	<2	<0.5	<0.5	<3	26.9
ØM-M-4	Brown trout	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	< 0.2	*Bile*	<9.5	<1.5	<2	<0.5	<0.5	<3	<11

ID	Matrix	Lake	oPFR					Phenols							
			TBEP	TCP	EHDP	TXP	TEHP		4,4-bis-A	2,4-bis-A	bis-G	4,4-bis-S	2,4-bis-S	4,4-bis-F	2,4-bis-F
			ng/g	ng/g	ng/g	ng/g	ng/g	Tissue	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
ØM-M-5	Brown trout	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	< 0.2	*Bile*	<9.5	<1.5	<2	<0.5	<0.5	<3	<11
ØM-M-6	Brown trout	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	< 0.2	*Bile*	<9.5	<1.5	<2	<0.5	<0.5	<3	<11
ØM-M-7	Brown trout	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	< 0.2	*Bile*	16.3	<1.5	<2	<0.5	<0.5	<3	<11
ØM-M-8	Brown trout	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	< 0.2	*Bile*	<9.5	<1.5	<2	<0.5	<0.5	<3	<11
ØM-M-9	Brown trout	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	< 0.2	*Bile*	10.7	<1.5	<2	<0.5	<0.5	<3	<11
ØM-M-10	Brown trout	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	< 0.2	*Bile*	18.9	<1.5	<2	<0.5	<0.5	<3	<11.4
ØM-M-11	Brown trout	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	< 0.2	*Bile*	<9.5	<1.5	<2	<0.5	<0.5	<3	<11
ØM-M-12	Brown trout	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	< 0.2	*Bile*	<9.5	<1.5	<2	<0.5	<0.5	<3	<11
ØM-M-13	Brown trout	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	< 0.2	*Bile*	<9.5	<1.5	<2	<0.5	<0.5	<3	<11
ØM-M-14	Brown trout	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	< 0.2	*Bile*	<9.5	<1.5	<2	<0.5	<0.5	<3	<11
ØM-M-15	Brown trout	Mjøsa	< 0.1	< 0.05	< 0.1	< 0.05	< 0.2	*Bile*	<9.5	<1.5	<2	<0.5	<0.5	<3	18.2
ØF-M-1	Brown trout	Femunden	< 0.05	< 0.10	< 0.10	< 0.10	< 0.10	*Muscle*	<9.5	<1.5	<2	<1.5	<1	<3	<12
ØF-M-2	Brown trout	Femunden	< 0.05	< 0.10	< 0.10	< 0.10	< 0.10	*Muscle*	<9.5	<1.5	<2	<1.5	<1	<3	<12
ØF-M-3	Brown trout	Femunden	< 0.05	< 0.10	< 0.10	< 0.10	< 0.10	*Bile*	11.0	<1.5	<2	<1.5	<1	<3	13.0
ØF-M-4	Brown trout	Femunden	< 0.05	< 0.10	< 0.10	< 0.10	< 0.10	*Bile*	<9.5	<1.5	<2	<1.5	<1	<3	<12
ØF-M-5	Brown trout	Femunden	< 0.05	< 0.10	< 0.10	< 0.10	< 0.10	*Muscle*	<9.5	<1.5	<2	<1.5	<1	<3	<12
ØF-M-6	Brown trout	Femunden	< 0.05	< 0.10	< 0.10	< 0.10	< 0.10	*Bile*	<9.5	<1.5	<2	<1.5	<1	<3	<12
ØF-M-7	Brown trout	Femunden	< 0.05	< 0.10	< 0.10	< 0.10	< 0.10	*Bile*	<9.5	<1.5	<2	<1.5	<1	<3	<12
ØF-M-8	Brown trout	Femunden	< 0.05	< 0.10	< 0.10	< 0.10	< 0.10	*Bile*	<9.5	<1.5	<2	<1.5	<1	<3	<12
ØF-M-9	Brown trout	Femunden	0.3120	< 0.10	0.5242	< 0.10	< 0.10	*Bile*	<9.5	<1.5	<2	<1.5	<1	48.2	59.2
ØF-M-10	Brown trout	Femunden	< 0.05	< 0.10	< 0.10	< 0.10	< 0.10	*Muscle*	10.0	<1.5	<2	<1.5	<1	4.10	<12

ID	Matrix	Lake	Phenols							PBDEs					
			2,2-bis-F	bis-P	bis-Z	TBBPA	4-tert-octylphenol	4-octyl-phenol	4-nonylphenol	TBA	17	28	47	49	66
			ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
ZM-1	Zooplankton	Mjøsa	<0.5	<1.5	<3	<3	<6	<3.5	<5	<0.0034	<0.0033	<0.0040	<0.0221	<0.0024	<0.0015
ZM-2	Zooplankton	Mjøsa	<0.5	<1.5	<3	<3	<6	<3.5	<5	<0.0034	<0.0033	<0.0040	<0.0221	<0.0024	<0.0015
ZM-3	Zooplankton	Mjøsa	<0.5	<1.5	<3	<3	<6	<3.5	<5	0.0041	<0.0033	<0.0040	<0.0221	<0.0024	<0.0015
MM-1	Mysis	Mjøsa	<0.5	<1	<3	<3	<6	<3.5	<5	0.0040	<0.0033	<0.0040	0.1540	0.0106	0.0042
MM-2	Mysis	Mjøsa	<0.5	<1	<3	<3	<6	<3.5	<5	0.0036	<0.0033	<0.0040	0.1390	0.0091	0.0040
MM-3	Mysis	Mjøsa	<0.5	<1	<3	<3	<6	<3.5	<5	0.0042	<0.0033	<0.0040	0.1380	0.0087	0.0047
KM-M-1	E.smelt	Mjøsa	<0.5	<1	<3	<3	<5.5	<3	<5	<0.0111	<0.0033	0.0063	0.7310	0.0355	0.0214
KM-M-2	E.smelt	Mjøsa	<0.5	<1	<3	<3	<5.5	<3	<5	<0.0072	<0.0022	0.0099	1.1800	0.0460	0.0215
KM-M-3	E.smelt	Mjøsa	<0.5	<1	<3	<3	<5.5	<3	<5	<0.0071	<0.0027	0.0130	1.4800	0.0600	0.0241
KM-M-4	E.smelt	Mjøsa	<0.5	<1	<3	<3	<5.5	<3	<5	<0.0055	<0.0022	0.0096	1.7400	0.0664	0.0277
KM-M-5	E.smelt	Mjøsa	<0.5	<1	<3	<3	<5.5	<3	<5	0.0054	0.0029	0.0085	0.6340	0.0337	0.0141
KM-M-6	E.smelt	Mjøsa	<0.5	<1	<3	<3	<5.5	<3	<5	<0.0034	0.0073	0.0071	0.8190	0.0273	0.0124
KM-M-7	E.smelt	Mjøsa	<0.5	<1	<3	<3	<5.5	<3	<5	0.0045	<0.0013	0.0052	1.0700	0.0369	0.0119
KM-M-8	E.smelt	Mjøsa	<0.5	<1	<3	<3	<5.5	<3	<5	0.0041	<0.0022	0.0111	2.2300	0.0631	0.0249
KM-M-9	E.smelt	Mjøsa	<0.5	<1	<3	<3	<5.5	<3	<5	0.0047	<0.0022	0.0092	1.8100	0.0549	<0.0022
KM-M-10	E.smelt	Mjøsa	<0.5	<1	<3	<3	<5.5	<3	<5	0.0045	<0.0022	0.0120	1.9000	0.0546	<0.0013
LM-M-1	Vendace	Mjøsa	<1.5	<2	<3.5	<4.5	<5	<5	<7.5	0.0123	<0.0033	0.0079	1.1700	0.1020	0.0465
LM-M-2	Vendace	Mjøsa	<1.5	<2	<3.5	<4.5	<5	<5	<7.5	0.0130	<0.0033	0.0072	1.1700	0.0891	0.0420
LM-M-3	Vendace	Mjøsa	<1.5	<2	<3.5	<4.5	<5	<5	<7.5	0.0144	<0.0033	0.0075	1.6800	0.1190	0.0585
LM-M-4	Vendace	Mjøsa	<1.5	<2	<3.5	<4.5	<5	<5	<7.5	0.0205	<0.0033	0.0070	1.0200	0.0827	0.0367
LM-M-5	Vendace	Mjøsa	<1.5	<2	<3.5	<4.5	<5	<5	<7.5	0.0161	<0.0033	0.0079	1.1600	0.0851	0.0427
ØM-M-1	Brown trout	Mjøsa	<0.5	<2	<3	<3.5	<4.5	<3	<4	0.0091	0.0027	0.0192	4.6600	0.2420	0.0911
ØM-M-2	Brown trout	Mjøsa	1.06	<2	<3	<3.5	<4.5	<3	<4	0.0092	0.0024	0.0121	2.6700	0.1730	0.0374
ØM-M-3	Brown trout	Mjøsa	1.84	<2	<3	<3.5	<4.5	<3	<4	<0.0013	<0.0013	0.0043	4.1000	0.0883	0.0669
ØM-M-4	Brown trout	Mjøsa	<0.5	<2	<3	<3.5	<4.5	<3	<4	0.0063	0.0036	0.0186	6.7700	0.3270	0.1090

ID	Matrix	Lake	Phenols							PBDEs					
			2,2-bis-F	bis-P	bis-Z	TBBPA	4-tert-octylphenol	4-octyl-phenol	4-nonylphenol	TBA	17	28	47	49	66
			ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
ØM-M-5	Brown trout	Mjøsa	0.63	<2	<3	<3.5	<4.5	<3	<4	0.0054	0.0038	0.0192	5.0900	0.2420	0.0752
ØM-M-6	Brown trout	Mjøsa	<0.5	<2	<3	<3.5	<4.5	<3	<4	0.0221	0.0048	0.0190	4.5800	0.2940	0.0761
ØM-M-7	Brown trout	Mjøsa	<0.5	<2	<3	<3.5	5.1	<3	<4	0.0218	<0.0053	0.0251	6.2600	0.3460	0.1490
ØM-M-8	Brown trout	Mjøsa	<0.5	<2	<3	<3.5	<4.5	<3	<4	0.0055	<0.0013	0.0050	0.9320	0.0553	0.0195
ØM-M-9	Brown trout	Mjøsa	0.84	<2	<3	<3.5	<4.5	<3	<4	0.0067	0.0030	0.0175	3.7600	0.2140	0.1050
ØM-M-10	Brown trout	Mjøsa	<0.5	<2	<3	<3.5	<4.5	<3	<4	0.0161	0.0041	0.0239	4.9900	0.2890	0.1220
ØM-M-11	Brown trout	Mjøsa	<0.5	<2	<3	<3.5	<4.5	<3	<4	0.0075	0.0014	0.0061	1.2800	0.0565	0.0191
ØM-M-12	Brown trout	Mjøsa	<0.5	<2	<3	<3.5	<4.5	<3	<4	0.0348	0.0058	0.0252	5.7200	0.2410	0.1230
ØM-M-13	Brown trout	Mjøsa	<0.5	<2	<3	<3.5	<4.5	<3	<4	0.0124	0.0035	0.0158	3.4800	0.2960	0.0753
ØM-M-14	Brown trout	Mjøsa	<0.5	<2	<3	<3.5	<4.5	<3	<4	<0.0013	0.0089	0.0087	5.3300	0.1090	0.0813
ØM-M-15	Brown trout	Mjøsa	1.07	<2	<3	<3.5	<4.5	<3	<4	0.0041	0.0017	0.0098	2.8000	0.1580	0.0445
ØF-M-1	Brown trout	Femunden	<0.5	<2	<3	<4	<5	<3.5	<4.5	0.0475	<0.0066	0.0092	0.2510	0.0252	0.0130
ØF-M-2	Brown trout	Femunden	<0.5	<2	<3	<4	<5	<3.5	<4.5	0.0096	<0.0013	0.0021	0.0522	0.0051	0.0021
ØF-M-3	Brown trout	Femunden	<0.6	<2	<3	<4	<5	<3.5	<4.5	0.0066	<0.0013	0.0020	0.0691	0.0076	0.0046
ØF-M-4	Brown trout	Femunden	<0.5	<2	<3	<4	<5	<3.5	<4.5	0.0184	<0.0013	0.0035	0.2960	0.0374	0.0172
ØF-M-5	Brown trout	Femunden	<0.5	<2	<3	<4	<5	<3.5	<4.5	0.0071	<0.0013	0.0018	0.1300	0.0164	0.0070
ØF-M-6	Brown trout	Femunden	<0.5	<2	<3	<4	<5	<3.5	<4.5	0.0091	<0.0013	0.0017	0.1080	0.0124	0.0048
ØF-M-7	Brown trout	Femunden	<0.5	<2	<3	<4	<5	<3.5	<4.5	0.0125	<0.0013	<0.0016	0.0847	0.0096	0.0045
ØF-M-8	Brown trout	Femunden	<0.5	<2	<3	<4	<5	<3.5	<4.5	0.0159	<0.0013	0.0035	0.2040	0.0249	0.0095
ØF-M-9	Brown trout	Femunden	1.63	<2	<3	<4	<5	<3.5	<4.5	0.0119	<0.0013	0.0025	0.2480	0.0298	0.0126
ØF-M-10	Brown trout	Femunden	<0.5	<2	<3	<4	<5	<3.5	<4.5	0.0045	<0.0013	<0.0016	0.0547	0.0065	0.0031

ID	Matrix	Lake	PBDEs												
			71	77	85	99	100	119	126	138	153	154	156	183	184
			ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
ZM-1	Zooplankton	Mjøsa	<0.0012	<0.0006	<0.0008	<0.0071	<0.0034	<0.0016	<0.0005	<0.0044	<0.0038	<0.0026	<0.0071	<0.0021	<0.0010
ZM-2	Zooplankton	Mjøsa	<0.0012	<0.0006	<0.0009	0.0076	<0.0034	<0.0016	<0.0007	<0.0044	<0.0038	<0.0026	<0.00712	<0.0021	<0.0010
ZM-3	Zooplankton	Mjøsa	<0.0012	<0.0006	<0.0008	<0.0071	<0.0034	<0.0016	<0.0006	<0.0030	<0.0028	<0.0018	<0.0048	<0.0021	<0.0010
MM-1	Mysis	Mjøsa	<0.0012	<0.0006	<0.0012	0.0665	0.0277	<0.0016	<0.0009	<0.0044	<0.0038	0.0127	<0.0072	<0.0021	<0.0010
MM-2	Mysis	Mjøsa	<0.0012	<0.0006	<0.0013	0.0585	0.0239	<0.0016	<0.0009	<0.0036	<0.0031	0.0128	<0.0058	<0.0021	<0.0010
MM-3	Mysis	Mjøsa	<0.0012	<0.0006	<0.0018	0.0588	0.0220	<0.0016	<0.0012	<0.0031	0.0057	0.0108	<0.0050	<0.0021	<0.0010
KM-M-1	E.smelt	Mjøsa	<0.0041	<0.0028	<0.0100	0.0496	0.1570	<0.0091	<0.0071	<0.0044	<0.0367	0.0840	<0.0714	<0.0083	<0.0065
KM-M-2	E.smelt	Mjøsa	<0.0024	<0.0016	<0.0064	0.0676	0.2570	<0.0058	<0.0045	<0.0243	0.0392	0.1440	<0.0393	<0.0058	<0.0046
KM-M-3	E.smelt	Mjøsa	<0.0037	<0.0025	<0.0050	0.0574	0.3330	0.0085	<0.0035	<0.0203	0.0568	0.1640	<0.0328	<0.0065	<0.0051
KM-M-4	E.smelt	Mjøsa	<0.0036	<0.0025	<0.0047	0.0786	0.3730	<0.0043	<0.0034	<0.0159	0.0642	0.1920	<0.0257	<0.0044	<0.0035
KM-M-5	E.smelt	Mjøsa	<0.0019	<0.0012	<0.0022	0.0464	0.1590	<0.0020	<0.0016	<0.0062	0.0313	0.0754	<0.0097	<0.0047	<0.0038
KM-M-6	E.smelt	Mjøsa	<0.0030	<0.0020	<0.0036	0.1140	0.1860	<0.0034	<0.0025	<0.0107	0.0285	0.0861	<0.0158	<0.0059	<0.0047
KM-M-7	E.smelt	Mjøsa	<0.0005	<0.0003	<0.0038	0.0453	0.1840	<0.0036	<0.0027	<0.0007	0.0312	0.0906	<0.0012	<0.0008	<0.0004
KM-M-8	E.smelt	Mjøsa	<0.0030	<0.0019	<0.0033	0.0325	0.4380	<0.0031	<0.0023	<0.0030	0.0490	0.1680	<0.0046	<0.0021	<0.0017
KM-M-9	E.smelt	Mjøsa	<0.0023	<0.0015	<0.0037	0.0712	0.3520	<0.0035	<0.0026	<0.0034	0.0605	0.1570	<0.0053	<0.0017	<0.0013
KM-M-10	E.smelt	Mjøsa	<0.0014	<0.0009	<0.0051	0.0325	0.3760	<0.0047	<0.0035	<0.0029	0.0474	0.1400	<0.0045	<0.0017	<0.0013
LM-M-1	Vendace	Mjøsa	<0.0034	<0.0025	<0.0030	0.7300	0.3480	0.0125	<0.0021	<0.0033	0.0653	0.1170	<0.0056	0.0148	<0.0012
LM-M-2	Vendace	Mjøsa	<0.0016	<0.0011	<0.0028	0.6630	0.3610	0.0117	<0.0020	<0.0063	0.0620	0.1380	<0.0105	<0.0026	<0.0020
LM-M-3	Vendace	Mjøsa	<0.0021	<0.0015	<0.0033	1.1000	0.5270	0.0219	<0.0023	<0.0034	0.0919	0.1970	<0.0056	<0.0021	<0.0017
LM-M-4	Vendace	Mjøsa	<0.0013	<0.0009	<0.0033	0.6080	0.2690	<0.0029	<0.0023	<0.0048	0.0568	0.0981	<0.0081	<0.0027	<0.0021
LM-M-5	Vendace	Mjøsa	<0.0025	<0.0018	<0.0042	0.6980	0.3050	<0.0037	<0.0029	<0.0038	0.0569	0.1040	<0.0064	<0.0021	<0.0013
ØM-M-1	Brown trout	Mjøsa	<0.0012	0.0031	<0.0019	1.2800	1.3100	0.0314	<0.0014	<0.0011	0.2190	0.4560	<0.0019	<0.0018	0.0046
ØM-M-2	Brown trout	Mjøsa	<0.0006	0.0013	<0.0036	0.7260	0.6240	<0.0033	<0.0026	<0.0009	0.1140	0.2900	<0.0016	<0.0009	<0.0007
ØM-M-3	Brown trout	Mjøsa	<0.0010	<0.0008	<0.0036	1.0100	1.9600	0.0293	<0.0026	<0.0070	0.3000	0.7000	<0.0125	<0.0017	0.0044
ØM-M-4	Brown trout	Mjøsa	<0.0008	<0.0006	<0.0039	2.6900	2.5900	0.0388	0.0159	<0.0026	0.4770	1.0000	<0.0046	<0.0018	0.0111

ID	Matrix	Lake	PBDEs												
			71	77	85	99	100	119	126	138	153	154	156	183	184
			ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
ØM-M-5	Brown trout	Mjøsa	<0.0010	<0.0008	<0.0063	1.4400	1.3700	0.0895	<0.0046	<0.0027	0.2640	0.5900	<0.0049	<0.0020	0.0069
ØM-M-6	Brown trout	Mjøsa	<0.0016	0.0045	<0.0038	1.6100	1.3600	0.0274	<0.0028	<0.0019	0.1960	0.4980	<0.0033	0.0056	0.0061
ØM-M-7	Brown trout	Mjøsa	<0.0071	<0.0055	<0.0174	2.1600	2.2100	<0.0141	<0.0133	<0.0245	0.2850	0.7040	<0.0440	<0.0118	<0.0092
ØM-M-8	Brown trout	Mjøsa	<0.0014	<0.0011	<0.0028	0.2090	0.2540	<0.0023	<0.0022	<0.0245	0.0521	0.1250	<0.0044	0.0030	0.0036
ØM-M-9	Brown trout	Mjøsa	<0.0012	<0.0009	<0.0022	1.4300	1.0600	<0.0018	<0.0016	<0.0017	0.2160	0.4260	<0.0031	0.0037	0.0055
ØM-M-10	Brown trout	Mjøsa	<0.0017	<0.0013	<0.0046	1.5000	1.3800	0.0326	<0.0035	<0.0027	0.2440	0.5360	<0.0048	0.0046	0.0070
ØM-M-11	Brown trout	Mjøsa	<0.0007	<0.0006	<0.0017	0.1830	0.2760	0.0076	<0.0012	<0.00178	0.0460	0.1100	<0.0031	<0.0013	0.0011
ØM-M-12	Brown trout	Mjøsa	<0.0073	<0.0057	<0.0059	0.8380	1.6600	0.0449	<0.0045	<0.0077	0.2090	0.5110	<0.0138	<0.0049	<0.0039
ØM-M-13	Brown trout	Mjøsa	<0.0006	0.0025	<0.0034	1.4700	0.9350	<0.0031	<0.0025	<0.0011	0.1960	0.4370	<0.0019	<0.0008	0.0063
ØM-M-14	Brown trout	Mjøsa	0.0988	0.0508	0.0111	1.0800	2.1500	0.0299	0.0081	<0.0010	0.2950	0.6870	<0.0016	<0.0008	<0.0007
ØM-M-15	Brown trout	Mjøsa	<0.0009	0.0016	<0.0037	0.7720	0.7480	0.0176	<0.0027	<0.0024	0.1350	0.3150	<0.0040	<0.0010	0.0046
ØF-M-1	Brown trout	Femunden	<0.0025	<0.0012	<0.0060	0.1480	0.0955	<0.0053	<0.0043	<0.0065	<0.0056	0.0782	<0.01080	<0.0052	<0.0041
ØF-M-2	Brown trout	Femunden	<0.0005	<0.0002	<0.0019	0.0211	0.0158	<0.0017	<0.0014	<0.0008	0.0051	0.0135	<0.0013	<0.0008	0.0006
ØF-M-3	Brown trout	Femunden	<0.0005	<0.0002	<0.0010	0.0401	0.0282	<0.0009	<0.0007	<0.0014	0.0099	0.0290	<0.0023	<0.0012	0.0019
ØF-M-4	Brown trout	Femunden	<0.0005	<0.0005	<0.0019	0.2150	0.1780	0.0192	<0.0014	<0.0018	0.0483	0.1610	<0.0028	<0.0010	0.0067
ØF-M-5	Brown trout	Femunden	<0.0005	<0.0002	<0.0014	0.0889	0.0681	0.0099	<0.0010	<0.0007	0.0195	0.0652	<0.0011	0.0017	0.0028
ØF-M-6	Brown trout	Femunden	<0.0005	<0.0002	<0.0014	0.0787	0.0621	0.0049	<0.0010	<0.0007	0.0185	0.0553	<0.0012	0.0022	0.0025
ØF-M-7	Brown trout	Femunden	<0.0005	<0.0002	<0.0014	0.0540	0.0351	0.0048	<0.0007	<0.0008	0.0094	0.0313	<0.0013	<0.0008	0.0015
ØF-M-8	Brown trout	Femunden	<0.0005	<0.0002	<0.0012	0.1370	0.0906	0.0087	<0.0008	<0.0007	0.0239	0.0842	<0.0011	0.0034	0.0041
ØF-M-9	Brown trout	Femunden	<0.0005	<0.0002	<0.0022	0.1950	0.1610	0.0221	<0.0016	<0.0008	0.0393	0.1410	<0.0012	0.0035	0.0055
ØF-M-10	Brown trout	Femunden	<0.0005	<0.0002	<0.0006	0.0348	0.0288	<0.0006	<0.0004	<0.0007	0.0066	0.0258	<0.0011	<0.0008	0.0010

ID	Matrix	Lake	PBDEs							nBFRs					
			191	196	197	202	206	207	209	ATE (TBP-AE)	a-TBECH	b-TBECH	g/d-TBECH	BATE	PBT
			ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
ZM-1	Zooplankton	Mjøsa	<0.0021	<0.0042	<0.0034	<0.0051	<0.0088	<0.0066	<0.0780	<0.0088	<0.0389	<0.0272	<0.0175	<0.0066	<0.0105
ZM-2	Zooplankton	Mjøsa	<0.0021	<0.0034	<0.0027	<0.0042	<0.0088	<0.0066	<0.0780	<0.0088	<0.0313	<0.0219	<0.0140	<0.0055	<0.0105
ZM-3	Zooplankton	Mjøsa	<0.0017	<0.0035	<0.0029	<0.0043	<0.0102	<0.0088	0.4250	<0.0088	<0.0247	<0.0172	<0.0111	<0.0055	<0.0105
MM-1	Mysis	Mjøsa	<0.0020	<0.0041	<0.0033	<0.0049	<0.0092	<0.0079	<0.0780	<0.0088	<0.0100	<0.0082	<0.0046	<0.0055	<0.0105
MM-2	Mysis	Mjøsa	<0.0019	<0.0035	<0.0029	<0.0043	<0.0088	<0.0066	<0.0780	<0.0088	<0.0100	<0.0082	<0.0046	<0.0055	<0.0105
MM-3	Mysis	Mjøsa	<0.0017	<0.0034	<0.0027	<0.0042	<0.0102	<0.0087	<0.0780	<0.0088	<0.0100	<0.0082	<0.0046	<0.0055	<0.0105
KM-M-1	E.smelt	Mjøsa	<0.0143	<0.0253	<0.0208	<0.0306	<0.0926	<0.0079	<0.700	0.0409	0.0470	0.0397	0.0146	0.0207	0.0169
KM-M-2	E.smelt	Mjøsa	<0.0101	<0.0175	<0.0144	<0.0212	<0.0663	<0.0565	<0.2420	0.0083	<0.0097	<0.0069	<0.0033	0.0046	<0.0070
KM-M-3	E.smelt	Mjøsa	<0.0111	<0.0228	<0.0187	<0.0276	<0.0823	<0.0701	<0.3520	0.0067	<0.0091	0.0107	<0.0031	<0.0037	<0.0070
KM-M-4	E.smelt	Mjøsa	<0.0077	<0.0114	<0.0093	<0.0138	<0.0568	<0.0484	<0.3100	<0.0059	<0.0099	<0.0071	<0.0033	<0.0037	<0.0070
KM-M-5	E.smelt	Mjøsa	<0.0076	<0.0164	<0.0129	<0.0199	0.1260	0.1240	0.6050	0.0167	0.0180	0.0232	0.0185	0.0220	0.0251
KM-M-6	E.smelt	Mjøsa	<0.0091	<0.0110	<0.0090	<0.0141	<0.0381	<0.0339	<0.0988	<0.0059	<0.0066	<0.0055	<0.0031	<0.0037	<0.0070
KM-M-7	E.smelt	Mjøsa	<0.0007	<0.0014	<0.0011	0.0019	<0.0035	<0.0026	<0.0312	<0.0059	<0.0103	<0.0103	<0.0063	<0.0037	<0.0070
KM-M-8	E.smelt	Mjøsa	<0.0034	<0.0047	<0.0039	<0.0062	<0.0058	<0.0044	0.0624	<0.0059	<0.0066	<0.0055	<0.0031	<0.0037	<0.0070
KM-M-9	E.smelt	Mjøsa	<0.0026	<0.0069	<0.0057	<0.0090	<0.0061	<0.0055	0.0946	<0.0059	<0.0066	<0.0055	<0.0031	0.0042	<0.0070
KM-M-10	E.smelt	Mjøsa	<0.0026	<0.0050	<0.0041	<0.0065	<0.0058	<0.0044	0.0705	<0.0059	<0.0066	<0.0055	<0.0031	0.0038	<0.0070
LM-M-1	Vendace	Mjøsa	<0.0028	<0.0034	0.0095	<0.0042	<0.0088	<0.0066	<0.0780	0.0088	0.0331	0.0325	0.0374	0.0263	0.0317
LM-M-2	Vendace	Mjøsa	<0.0045	<0.0034	<0.0027	<0.0042	<0.0088	<0.0067	<0.0780	<0.0088	<0.0192	0.0213	0.0317	0.0240	0.0313
LM-M-3	Vendace	Mjøsa	<0.0038	<0.0034	<0.0027	<0.0042	<0.0088	<0.0066	<0.0780	0.0427	0.0397	0.0420	0.0469	0.0484	0.0517
LM-M-4	Vendace	Mjøsa	<0.0047	<0.0034	<0.0027	<0.0042	<0.0088	<0.0066	<0.0780	0.0209	0.0265	0.0251	0.0224	0.0280	0.0320
LM-M-5	Vendace	Mjøsa	<0.0030	<0.0042	<0.0033	<0.0047	<0.0088	<0.0066	<0.0780	0.0116	0.0212	0.0180	0.0240	0.0201	0.0243
ØM-M-1	Brown trout	Mjøsa	<0.0033	<0.0017	<0.0013	<0.0018	<0.0035	<0.0026	<0.0312	<0.0035	<0.0095	<0.0067	<0.0032	0.0031	<0.0042
ØM-M-2	Brown trout	Mjøsa	<0.0016	<0.0014	<0.0011	<0.0017	<0.0035	<0.0026	<0.0312	<0.0035	<0.0080	<0.0057	<0.0027	<0.0022	<0.0042
ØM-M-3	Brown trout	Mjøsa	<0.0031	<0.0024	<0.0018	<0.0024	<0.0039	<0.0034	<0.0312	<0.0035	<0.0094	<0.0067	<0.0032	<0.0022	<0.0042
ØM-M-4	Brown trout	Mjøsa	<0.0034	<0.0029	<0.0021	<0.0029	<0.0037	<0.0033	<0.0312	<0.0035	<0.0105	<0.0075	<0.0035	<0.0022	<0.0042

ID	Matrix	Lake	PBDEs							nBFRs					
			191	196	197	202	206	207	209	ATE (TBP-AE)	a-TBECH	b-TBECH	g/d-TBECH	BATE	PBT
			ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
ØM-M-5	Brown trout	Mjøsa	<0.0037	<0.0024	<0.0018	0.0114	<0.0035	<0.0026	<0.0312	<0.0035	<0.0110	<0.0079	<0.0037	<0.0022	<0.0042
ØM-M-6	Brown trout	Mjøsa	<0.0037	<0.0025	<0.0018	<0.0025	<0.0035	<0.0026	<0.0312	<0.0035	<0.0058	<0.0041	<0.0019	<0.0022	<0.0042
ØM-M-7	Brown trout	Mjøsa	<0.0201	<0.0266	<0.0208	<0.0295	<0.0297	<0.0252	0.0824	<0.0035	<0.0098	<0.0070	<0.0033	<0.0022	<0.0042
ØM-M-8	Brown trout	Mjøsa	<0.0020	<0.0022	<0.0018	0.0080	<0.0036	<0.0030	<0.0312	0.0161	0.0138	0.0133	0.0098	0.0113	0.0083
ØM-M-9	Brown trout	Mjøsa	<0.0019	<0.0015	<0.0012	0.0051	<0.0035	<0.0026	<0.0312	0.0071	0.0081	0.0098	0.0062	0.0059	0.0071
ØM-M-10	Brown trout	Mjøsa	<0.0020	<0.0021	0.0024	0.0084	<0.0035	<0.0029	0.0320	<0.0035	<0.0079	0.0069	0.0041	0.0033	<0.0042
ØM-M-11	Brown trout	Mjøsa	<0.0024	<0.0016	<0.0012	<0.0017	<0.0035	<0.0026	0.0350	<0.0035	<0.0048	<0.0034	<0.0018	0.0023	0.0044
ØM-M-12	Brown trout	Mjøsa	<0.0086	<0.0074	<0.0058	<0.0083	<0.0066	<0.0056	<0.0312	0.0117	0.0164	0.0143	0.0100	0.0099	0.0103
ØM-M-13	Brown trout	Mjøsa	<0.0015	<0.0022	<0.0017	<0.0023	<0.0035	<0.0026	<0.0312	0.0074	0.0090	0.0088	0.0065	0.0069	0.0074
ØM-M-14	Brown trout	Mjøsa	<0.0015	<0.0018	<0.0013	<0.0019	<0.0035	<0.0026	<0.0312	0.0042	<0.0058	0.0044	0.0037	0.0046	0.0053
ØM-M-15	Brown trout	Mjøsa	<0.0018	<0.0019	<0.0014	<0.0019	<0.0035	<0.0026	<0.0312	<0.0035	<0.0040	0.0051	0.0037	0.0046	<0.0042
ØF-M-1	Brown trout	Femunden	<0.0093	<0.0099	<0.0076	<0.0108	<0.0175	0.0137	<0.1560	<0.0035	<0.0042	<0.0033	<0.0024	<0.0022	<0.0042
ØF-M-2	Brown trout	Femunden	<0.0007	<0.0014	<0.0011	<0.0017	<0.0035	<0.0026	<0.0312	<0.0035	<0.0096	<0.0096	<0.0059	<0.0022	<0.0042
ØF-M-3	Brown trout	Femunden	<0.0021	<0.0017	<0.0013	<0.0019	<0.0035	<0.0026	<0.0312	<0.0035	<0.0138	<0.0138	<0.0085	<0.0045	<0.0042
ØF-M-4	Brown trout	Femunden	<0.0018	<0.0022	<0.0017	<0.0025	<0.0035	<0.0026	<0.0312	<0.0035	<0.0159	<0.0159	<0.0098	<0.0036	<0.0042
ØF-M-5	Brown trout	Femunden	<0.0007	<0.0014	<0.0011	<0.0017	<0.0035	<0.0026	<0.0312	<0.0035	<0.0061	<0.0061	<0.0037	<0.0022	<0.0042
ØF-M-6	Brown trout	Femunden	<0.0009	<0.0014	0.0012	<0.0017	<0.0035	<0.0026	<0.0312	<0.0035	<0.0065	<0.0065	<0.0040	<0.0022	<0.0042
ØF-M-7	Brown trout	Femunden	<0.0007	<0.0014	<0.0011	<0.0017	<0.0035	<0.0026	<0.0312	<0.0035	<0.0065	<0.0065	<0.0039	<0.0022	<0.0042
ØF-M-8	Brown trout	Femunden	<0.0009	<0.0014	<0.0011	<0.0017	<0.0035	<0.0026	<0.0312	<0.0035	<0.0040	<0.0033	<0.0018	<0.0022	<0.0042
ØF-M-9	Brown trout	Femunden	<0.0010	<0.0014	0.0017	0.0021	<0.0035	<0.0026	<0.0312	<0.0035	<0.0051	<0.0051	<0.0031	<0.0022	<0.0042
ØF-M-10	Brown trout	Femunden	<0.0007	<0.0014	<0.0011	<0.0017	0.0063	<0.0026	0.0324	<0.0035	<0.0054	<0.0054	<0.0033	<0.0022	<0.0042

ID	Matrix	Lake	nBFRs									Dechloranes	
			PBEB	PBBZ	HBB	DPTE	EHTBB	BTBPE	TBPH (BEH /TBP)	DBDPE	Dibromo-aldrin	Dechlorane 602	Dechlorane 603
			ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
ZM-1	Zooplankton	Mjøsa	<0.0066	<0.0859	<0.0352	<0.0031	<0.0067	<0.0219	<0.0271	<4.47	<0.0344	<0.0031	<0.0034
ZM-2	Zooplankton	Mjøsa	<0.0066	<0.0859	0.0399	<0.0031	<0.0098	<0.0219	<0.0271	<4.47	<0.0344	<0.0031	<0.0034
ZM-3	Zooplankton	Mjøsa	<0.0066	<0.0859	<0.0352	<0.0031	<0.0065	<0.0219	<0.0271	<4.47	<0.0344	<0.0031	<0.0034
MM-1	Mysis	Mjøsa	<0.0066	<0.0859	<0.0352	<0.0031	<0.0152	<0.0219	<0.0271	<4.47	<0.0344	<0.0031	<0.0034
MM-2	Mysis	Mjøsa	<0.0066	<0.0859	<0.0352	<0.0031	<0.0116	<0.0219	<0.0271	<4.47	<0.0344	<0.0031	<0.0034
MM-3	Mysis	Mjøsa	<0.0066	<0.0859	<0.0352	<0.0031	<0.0104	<0.0219	<0.0271	<4.47	<0.0344	<0.0031	<0.0034
KM-M-1	E.smelt	Mjøsa	0.0160	<0.0572	0.0269	0.0146	0.1130	0.0205	<0.0180	<2.98	<0.0229	0.0029	<0.0022
KM-M-2	E.smelt	Mjøsa	<0.0044	<0.0572	<0.0235	<0.0035	0.0567	<0.0146	<0.0180	<2.98	<0.0229	0.0051	<0.0022
KM-M-3	E.smelt	Mjøsa	<0.0044	<0.0572	0.0309	0.0059	<0.0206	<0.0146	<0.0180	<2.98	<0.0229	0.0057	<0.0022
KM-M-4	E.smelt	Mjøsa	<0.0044	<0.0572	<0.0235	0.0035	<0.0178	<0.0146	<0.0180	<2.98	<0.0229	0.0066	<0.0022
KM-M-5	E.smelt	Mjøsa	0.0212	<0.0572	0.0424	0.0150	0.0528	0.0284	0.0781	9.0	<0.0368	<0.0089	<0.0110
KM-M-6	E.smelt	Mjøsa	<0.0044	<0.0572	<0.0235	<0.0021	<0.0863	<0.0146	<0.0180	<2.98	<0.0229	0.0041	<0.0029
KM-M-7	E.smelt	Mjøsa	<0.0044	<0.0572	0.0244	<0.0021	<0.0149	<0.0146	<0.0180	<2.98	<0.0229	0.0076	<0.0058
KM-M-8	E.smelt	Mjøsa	<0.0044	<0.0572	<0.0235	<0.0021	<0.0518	<0.0146	<0.0180	<2.98	<0.0229	0.0059	<0.0022
KM-M-9	E.smelt	Mjøsa	<0.0044	<0.0572	<0.0235	<0.0021	<0.0703	<0.0146	<0.0180	<2.98	<0.0229	0.0056	<0.0026
KM-M-10	E.smelt	Mjøsa	<0.0044	<0.0572	<0.0235	<0.0021	<0.0240	<0.0146	<0.0180	<2.98	<0.0229	0.0046	<0.0023
LM-M-1	Vendace	Mjøsa	0.0278	<0.0859	0.0689	0.0336	0.0386	<0.0219	<0.0271	<4.47	<0.0344	0.0105	<0.0053
LM-M-2	Vendace	Mjøsa	0.0266	<0.0859	0.0717	0.0276	0.0263	0.0224	<0.0271	<4.47	<0.0344	0.0083	<0.0054
LM-M-3	Vendace	Mjøsa	0.0471	<0.0859	0.0824	0.0387	0.0505	0.0358	<0.0271	<4.47	<0.0344	0.0117	<0.0048
LM-M-4	Vendace	Mjøsa	0.0282	<0.0859	0.0650	0.0282	0.0336	0.0295	<0.0271	<4.47	<0.0344	0.0083	<0.0049
LM-M-5	Vendace	Mjøsa	0.0227	<0.0859	0.0607	0.0256	0.0284	0.0229	<0.0271	<4.47	<0.0344	0.0095	<0.0056
ØM-M-1	Brown trout	Mjøsa	<0.0026	<0.0343	0.0185	0.0021	<0.0047	<0.0088	<0.0108	<1.79	<0.0137	0.0163	<0.0013
ØM-M-2	Brown trout	Mjøsa	<0.0026	<0.0343	0.0196	<0.0012	<0.0108	<0.0088	<0.0108	<1.79	<0.0137	0.0135	<0.0013
ØM-M-3	Brown trout	Mjøsa	<0.0026	<0.0343	0.0146	<0.0014	<0.0084	<0.0088	<0.0108	<1.79	<0.0137	0.0200	<0.0013
ØM-M-4	Brown trout	Mjøsa	<0.0026	<0.0343	0.0170	<0.0012	<0.0340	<0.0088	<0.0108	<1.79	<0.0137	0.0443	<0.0013

ID	Matrix	Lake	nBFRs									Dechloranes	
			PBEB	PBBZ	HBB	DPTE	EHTBB	BTBPE	TBPH (BEH /TBP)	DBDPE	Dibromo-aldrin	Dechlorane 602	Dechlorane 603
			ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
ØM-M-5	Brown trout	Mjøsa	<0.0026	<0.0343	0.0170	<0.0012	<0.0252	<0.0088	<0.0108	<1.79	<0.0137	0.0312	<0.0013
ØM-M-6	Brown trout	Mjøsa	<0.0026	<0.0343	0.0167	<0.0012	<0.0106	<0.0088	<0.0108	<1.79	<0.0137	0.0231	<0.0013
ØM-M-7	Brown trout	Mjøsa	<0.0026	<0.0343	0.0238	<0.0012	<0.0099	<0.0088	<0.0108	8.0	<0.0137	0.0259	<0.0015
ØM-M-8	Brown trout	Mjøsa	0.0072	<0.0343	0.0293	0.0073	<0.0178	<0.0088	<0.0108	<1.79	<0.0137	0.0059	<0.0013
ØM-M-9	Brown trout	Mjøsa	0.0046	<0.0343	0.0167	0.0044	<0.0103	<0.0088	<0.0108	<1.79	<0.0137	0.0152	<0.0013
ØM-M-10	Brown trout	Mjøsa	<0.0026	<0.0343	0.0147	0.0025	<0.0177	<0.0088	<0.0108	<1.79	<0.0137	0.0203	<0.0013
ØM-M-11	Brown trout	Mjøsa	<0.0026	<0.0343	0.0195	0.0025	<0.0143	<0.0088	<0.0108	<1.79	<0.0137	0.0067	<0.0013
ØM-M-12	Brown trout	Mjøsa	0.0088	<0.0343	0.0259	0.0095	<0.0121	0.0107	<0.0108	<1.79	<0.0137	0.0164	<0.0013
ØM-M-13	Brown trout	Mjøsa	0.0055	<0.0343	0.0239	0.0062	<0.0132	0.0090	<0.0108	<1.79	<0.0137	0.0194	<0.0013
ØM-M-14	Brown trout	Mjøsa	0.0035	<0.0343	0.0204	0.0040	0.0060	<0.0088	<0.0108	<1.79	<0.0137	0.0104	<0.0013
ØM-M-15	Brown trout	Mjøsa	0.0038	<0.0343	<0.0141	0.0036	<0.0190	<0.0088	<0.0108	<1.79	<0.0137	0.0133	<0.0013
ØF-M-1	Brown trout	Femunden	<0.0026	<0.0343	<0.0141	<0.0012	<0.0055	<0.0088	<0.0108	2.5	<0.0916	<0.0186	<0.0253
ØF-M-2	Brown trout	Femunden	<0.0026	<0.0343	<0.0141	<0.0014	<0.0058	<0.0088	<0.0108	<1.79	<0.0137	0.0022	<0.0026
ØF-M-3	Brown trout	Femunden	<0.0026	<0.0343	<0.0141	<0.0022	<0.0116	<0.0088	<0.0154	<1.79	<0.0172	0.0048	<0.0051
ØF-M-4	Brown trout	Femunden	<0.0026	<0.0343	0.0158	<0.0018	<0.0093	<0.0088	<0.0151	<1.79	<0.0188	0.0199	<0.0057
ØF-M-5	Brown trout	Femunden	<0.0026	<0.0343	<0.0141	<0.0012	<0.0079	<0.0088	<0.0108	<1.79	<0.0137	0.0073	<0.0023
ØF-M-6	Brown trout	Femunden	<0.0026	<0.0343	0.0197	<0.0013	<0.0058	<0.0088	<0.0108	<1.79	<0.0137	0.0094	<0.0026
ØF-M-7	Brown trout	Femunden	<0.0026	<0.0343	<0.0141	<0.0012	<0.0047	<0.0088	<0.0108	<1.79	<0.0137	0.0042	<0.0029
ØF-M-8	Brown trout	Femunden	<0.0026	<0.0343	<0.0141	<0.0012	<0.0041	<0.0088	<0.0108	<1.79	<0.0137	0.0109	<0.0033
ØF-M-9	Brown trout	Femunden	<0.0026	<0.0343	<0.0141	<0.0012	<0.0059	<0.0088	<0.0108	<1.79	<0.0137	0.0182	<0.0028
ØF-M-10	Brown trout	Femunden	<0.0026	<0.0343	<0.0141	<0.0012	<0.0041	<0.0088	<0.0108	3.1	<0.0137	0.0042	<0.0021

ID	Matrix	Lake	Dechloranes					
			Dechlorane 604	Dechlorane 601	Dechlorane plus syn	Dechlorane plus anti	1,3-DPMA	1,5-DPMA
			ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
ZM-1	Zooplankton	Mjøsa	<0.0939	<0.0151	<0.0410	<0.0541	<0.0312	<0.0643
ZM-2	Zooplankton	Mjøsa	<0.0939	<0.0151	<0.0410	<0.0541	<0.0312	<0.0643
ZM-3	Zooplankton	Mjøsa	<0.0939	<0.0151	<0.0410	<0.0541	<0.0312	<0.0643
MM-1	Mysis	Mjøsa	<0.0939	<0.0151	<0.0410	0.0859	<0.0312	<0.0643
MM-2	Mysis	Mjøsa	<0.0939	<0.0151	<0.0410	<0.0541	<0.0312	<0.0643
MM-3	Mysis	Mjøsa	<0.0939	<0.0151	<0.0410	<0.0541	<0.0312	<0.0643
KM-M-1	E.smelt	Mjøsa	<0.0626	<0.0100	<0.0274	<0.0360	<0.0208	<0.0429
KM-M-2	E.smelt	Mjøsa	<0.0626	<0.0100	<0.0274	<0.0360	<0.0208	<0.0429
KM-M-3	E.smelt	Mjøsa	<0.0626	<0.0100	<0.0274	<0.0360	<0.0208	<0.0429
KM-M-4	E.smelt	Mjøsa	<0.0626	<0.0100	<0.0274	<0.0360	<0.0208	<0.0429
KM-M-5	E.smelt	Mjøsa	<0.1680	<0.0531	0.0498	0.0784	<0.0208	<0.0835
KM-M-6	E.smelt	Mjøsa	<0.0626	<0.0136	<0.0274	<0.0360	<0.0208	<0.0429
KM-M-7	E.smelt	Mjøsa	<0.1020	<0.0303	<0.0274	<0.0360	<0.0208	<0.0429
KM-M-8	E.smelt	Mjøsa	<0.0626	<0.0103	<0.0274	<0.0360	<0.0208	<0.0429
KM-M-9	E.smelt	Mjøsa	<0.0626	<0.0125	<0.0274	<0.0360	<0.0208	<0.0429
KM-M-10	E.smelt	Mjøsa	<0.0626	<0.0115	<0.0274	<0.0360	<0.0208	<0.0429
LM-M-1	Vendace	Mjøsa	<0.1090	<0.0282	<0.0410	<0.0541	<0.0312	<0.0643
LM-M-2	Vendace	Mjøsa	<0.1050	<0.0291	<0.0410	<0.0541	<0.0312	<0.0643
LM-M-3	Vendace	Mjøsa	<0.1000	<0.0258	<0.0410	<0.0541	<0.0312	<0.0643
LM-M-4	Vendace	Mjøsa	<0.0970	<0.0263	<0.0410	<0.0541	<0.0312	<0.0643
LM-M-5	Vendace	Mjøsa	<0.1100	<0.0300	<0.0410	<0.0541	<0.0312	<0.0643
ØM-M-1	Brown trout	Mjøsa	<0.0375	<0.0060	<0.0164	<0.0216	<0.0125	<0.0257
ØM-M-2	Brown trout	Mjøsa	<0.0375	<0.0060	<0.0164	<0.0216	<0.0125	<0.0257
ØM-M-3	Brown trout	Mjøsa	<0.0375	<0.0060	<0.0164	<0.0216	<0.0125	<0.0257
ØM-M-4	Brown trout	Mjøsa	<0.0375	<0.0060	<0.0164	<0.0216	<0.0125	<0.0257

ID	Matrix	Lake	Dechloranes					
			Dechlorane 604	Dechlorane 601	Dechlorane plus syn	Dechlorane plus anti	1,3-DPMA	1,5-DPMA
			ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
ØM-M-5	Brown trout	Mjøsa	<0.0375	<0.0060	<0.0164	<0.0216	<0.0125	<0.0257
ØM-M-6	Brown trout	Mjøsa	<0.0375	<0.0060	<0.0164	0.0354	<0.0125	<0.0257
ØM-M-7	Brown trout	Mjøsa	<0.0375	<0.0076	<0.0164	<0.0216	<0.0125	<0.0257
ØM-M-8	Brown trout	Mjøsa	<0.0375	<0.0060	<0.0164	<0.0216	<0.0125	<0.0257
ØM-M-9	Brown trout	Mjøsa	<0.0375	<0.0060	<0.0164	<0.0216	<0.0125	<0.0257
ØM-M-10	Brown trout	Mjøsa	<0.0375	<0.0060	0.0266	0.0381	<0.0125	<0.0257
ØM-M-11	Brown trout	Mjøsa	<0.0375	<0.0060	<0.0164	<0.0216	<0.0125	<0.0257
ØM-M-12	Brown trout	Mjøsa	<0.0375	<0.0060	<0.0164	<0.0216	<0.0125	<0.0257
ØM-M-13	Brown trout	Mjøsa	<0.0375	<0.0060	<0.0164	<0.0216	<0.0125	<0.0257
ØM-M-14	Brown trout	Mjøsa	<0.0375	<0.0060	<0.0164	<0.0216	<0.0125	<0.0257
ØM-M-15	Brown trout	Mjøsa	<0.0375	<0.0060	<0.0164	<0.0216	<0.0125	<0.0257
ØF-M-1	Brown trout	Femunden	<0.4960	<0.1320	<0.0453	<0.0661	<0.1000	<0.2
ØF-M-2	Brown trout	Femunden	<0.0450	<0.0138	<0.0164	<0.0216	<0.0125	<0.0257
ØF-M-3	Brown trout	Femunden	<0.0934	<0.0266	<0.0164	<0.0216	<0.0187	<0.0376
ØF-M-4	Brown trout	Femunden	<0.1020	<0.0295	<0.0164	<0.0216	<0.0204	<0.041
ØF-M-5	Brown trout	Femunden	<0.0457	<0.0120	<0.0164	<0.0216	<0.0125	<0.0257
ØF-M-6	Brown trout	Femunden	<0.0447	<0.0134	<0.0164	<0.0216	<0.0125	<0.0257
ØF-M-7	Brown trout	Femunden	<0.0506	<0.0153	<0.0164	<0.0216	<0.0125	<0.0257
ØF-M-8	Brown trout	Femunden	<0.0550	<0.0171	<0.0164	<0.0216	<0.0125	<0.0257
ØF-M-9	Brown trout	Femunden	<0.0503	<0.0147	<0.0164	<0.0216	<0.0125	<0.0257
ØF-M-10	Brown trout	Femunden	<0.0375	<0.0109	<0.0164	<0.0216	<0.0125	<0.0257

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Norwegian Institute for Water Research

Gaustadalléen 21 • NO-0349 Oslo, Norway
Telephone: +47 22 18 51 00
www.niva.no • post@niva.no